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Dear Señor Solano and Señora Dick:

What follows is our report entitled *Collection and Communication of Conservation Data Concerning Hawksbill Sea Turtles (Eretmochelys Imbricata)*. It was written for the Inter-American Convention for the Protection the Conservation of Sea Turtles between May 11th and July 4th 2007. Preliminary research was completed on the Worcester Polytechnic Institute campus in Worcester, Massachusetts in the United States. Our professors, Professor Lorraine Higgins and Professor Tahar El-Korchi, will simultaneously receive a copy of this report for evaluation. Upon faculty review, the original report will be electronically catalogued in the Gordon Library of the Worcester Polytechnic Institute. We would like to thank you and Ms. Belinda Dick for the time you have dedicated to us.

Sincerely,

Alisha Begin

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Report Submitted to:

Professor Tahar El-Korchi
Professor Lorraine Higgins

San José, Costa Rica, Project Center

By

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In Cooperation With

Marco Solano, Secretariat Pro-Tempore, Inter-American Convention for the Protection
and Conservation of Sea Turtles

COLLECTION AND COMMUNICATION OF CONSERVATION DATA
CONCERNING HAWKSBILL SEA TURTLES *Eretmochelys Imbricata*

July 4th, 2007

This project report is submitted in partial fulfillment of the degree requirements of Worcester Polytechnic Institute. The views and opinions expressed herein are those of the authors and do not necessarily reflect the positions or opinions of the Inter-American Convention for the Protection and Conservation of Sea Turtles or Worcester Polytechnic Institute.

This report is the product of an education program and is intended to serve as partial documentation for the evaluation of academic achievement. The report should not be construed as a working document by the reader.

Abstract

The recent decline of the hawksbill sea turtle (*Eretmochelys imbricata*) and the uncertain state of all sea turtles worldwide has prompted many conservation efforts. This project for the Inter-American Convention for the Protection and Conservation of Sea Turtles(IAC) resolved several issues facing conservation work. Analysis of their current techniques for gathering information on sea turtle nesting trends led to a redesign of surveys and annual report materials used to collect this data. Specific research on the hawksbill turtle allowed for the creation of a more complete database, a new mapping system, and a brochure, all of which will be used to communicate information on the recent decline of the species. These tools will help the IAC provide the information policy makers need to make effective decisions about conservation research and laws.

Authorship Page

The entirety of this project was planned and reviewed by all group members. Writing was done in sections individually, with each member revising and rewriting in all sections of the report. All members were present for interviews. Each member was primarily responsible for designing one deliverable of the project, though each member contributed to all the products. A. Begin was the primary designer of the brochure, B. Buck was the primary designer of the annual report document, and J. Politz was the primary designer of the mapping system.

Table of Contents

Abstract.....	iii
Authorship Page.....	iv
Table of Contents.....	v
Table of Figures.....	vii
Table of Tables.....	ix
Executive Summary.....	1
Resumen Ejecutivo.....	4
1 Introduction.....	1
2 Background.....	3
2.1 Sea Turtles: Threats and Consequences.....	3
2.1.1 The Effect of Sea Turtles on the Ecosystem.....	4
2.1.2 Sea Turtles' Effects on Society.....	5
2.1.3 Threats and Dangers to Sea Turtles.....	6
2.1.4 Threats and Migration.....	10
2.2 The IAC and Reports on Sea Turtle Life.....	11
2.2.1 The IAC.....	11
2.2.2 The IAC Annual Reports.....	12
2.2.3 The Role of the Technical Assistant to the Secretariat.....	13
2.3 Communicating and Displaying Information.....	13
2.3.1 Message Source.....	13
2.3.2 Mapping Systems.....	14
2.3.3 The IAC Leatherback Brochure.....	23
2.4 Summary and Objectives.....	24
3 Methods.....	26
3.1 Annual Report Analysis.....	26
3.1.1 Analyzing the Annual Reports.....	26
3.1.2 Content Analysis of Threats.....	28
3.2 Acquiring Information about Hawksbills.....	30
3.2.1 Correspondence with IAC Secretariat.....	30
3.2.2 Interview with Didiher Chacón.....	31
3.2.3 Conservation Work at Gandoca Beach.....	31
3.2.4 Surveys.....	32
3.3 Mapping System Design.....	35
3.4 Design of the Brochure.....	36
3.5 New Annual Report Format Design.....	37
3.6 Methods Summary.....	37
4 Results.....	38
4.1 Analysis of the Annual Reports.....	38
4.2 Missing Information Acquired.....	41
4.3 Changes to the IAC Annual Report Format.....	43
4.4 Summarizing the Information Graphically.....	48
4.4.1 Mapping System of Database Content.....	48
4.4.2 Country Specific Version.....	49
4.4.3 Glyph Design and Testing.....	50
4.4.4 Key.....	52

4.4.5 Displaying Threats	52
4.4.6 Cover Sheet	53
4.4.7 Regional Map	54
4.5 Brochure Design	54
4.6 Summary of Results	58
5 Conclusions and Recommendations	60
5.1 Collecting Conservation Information	60
5.1.1 Missing Information Acquired	60
5.1.2 The New Format for Annual Reports	61
5.1.3 Changing the Information Requested	61
5.1.4 Using Database Software	62
5.2 Communicating Conservation Information	62
5.2.1 Mapping System for the Hawksbill Sea Turtle	63
5.2.2 Improvements to the Mapping System	64
5.2.3 Brochure Concerning the Hawksbill Sea Turtle	64
5.2.4 Improving the Brochure and Map in the Future	65
5.3 Final Statement	66
Works Cited	67
Glossary	70
Appendix A Biological Information	73
Hawksbill Sea Turtle	73
Loggerhead Sea Turtle	74
Green Sea Turtle	75
Olive Ridley Sea Turtle	77
Kemp's Ridley Sea Turtle	78
Flatback Sea Turtle	79
Leatherback Sea Turtle	80
Appendix B Annual Reports Format	82
Annual Report Instructions	82
Annual Report Forms	87
Appendix C Volunteer Work at Gandoca	92
Appendix D Survey Prototypes	100
English Microsoft Word Prototype	100
Spanish Microsoft Word Prototype	101
English Microsoft Excel Prototype	102
Spanish Microsoft Excel Prototype	102
Instructions	103
English Instructions	103
Spanish Instructions	104
Appendix E Glyph Testing	106
Appendix F Hawksbill Brochure	110
Appendix G Country Maps	112
Appendix H Cover Sheet for Map	118
Appendix I Map Database	119

Table of Figures

Figure 1: Hawksbill jewelry (WWF, 2007, section on Trade)	7
Figure 2: Carapace used for artwork (WWF, 2007, section on Trade).....	7
Figure 3: Green sea turtle with fibropapillomatosis (Ursula Keuper-Bennett and Peter Bennett, Cited in World Conservation Union, n.d., image 4).....	8
Figure 4: Commercial trawler disposing a leatherback (Karumbe Photos, 2002, Cited in Proyecto Tinglado Isla de Culebra, n.d. first image)	9
Figure 5: Hawksbill sea turtle (J Chevalier, in IAC Secretariat, 2007, section on hawksbill).....	10
Figure 6: IAC leatherback nesting sites map (Dick, 2007).....	14
Figure 7: IAC Flash map main screen (Dick, 2007).....	15
Figure 8: IAC Flash map Costa Rica screen (Dick, 2007)	16
Figure 9: Map in Flash of leatherbacks in Costa Rica (Dick, 2007).....	17
Figure 10: Pop-up box in Flash (Dick, 2007)	17
Figure 11: WWF map, overview (WWF, 2004, section on maps)	18
Figure 12: SWOT map overview (State of the World's Sea Turtles, 2005, loggerhead and leatherback nesting sites)	19
Figure 13: SWOT Caribbean map (State of the World's Turtles, 2005, loggerhead and leatherback nesting sites)	20
Figure 14: UNEP IOSEA map overview (UNEP, 2007, Marine Turtle interactive mapping system)	21
Figure 15: UNEP IOSEA Philippines map (UNEP, 2007, Marine Turtle Interactive Mapping System).....	22
Figure 16: UNEP IOSEA Map legend.....	22
Figure 17: Leatherback brochure (Dick, 2007).....	24
Figure 18: Section 1.2 of annual reports.....	26
Figure 19: Section 2 of IAC report	27
Figure 20: Sections 3 of IAC report.....	28
Figure 21: Radio buttons in Excel	33
Figure 22: Drop down boxes in Excel	34
Figure 23: Old format of annual report.....	44
Figure 24: Icon leading to documents.....	44
Figure 25: Drop down box for hatchlings.....	45
Figure 26: Error message on restricted responses.....	46
Figure 27: Help boxes	46
Figure 28: Comments field	47
Figure 29: Additional sheets	47
Figure 30: Example map of Costa Rica	49
Figure 31: Examples of the glyphs	51
Figure 32: Categorical threats and icons, from cover sheet.....	53
Figure 33: Regional map.....	54
Figure 34: The hawksbill brochure	55
Figure 35: Hawksbill and coral reef connection	56
Figure 36: Graph of the decline of hawksbill in Mexico	57
Figure 37: Principle threats to hawksbill from brochure	57

Figure 38: Hawksbill sea turtle (J. Chevalier, in IAC Secretariat, 2007)	73
Figure 39: Loggerhead sea turtle (Projeto TAMAR, in IAC Secretariat, 2007).....	74
Figure 40: Green turtle (S Castaneda, in IAC Secretariat, 2007)	75
Figure 41: Green turtle hatchlings (CCC, in IAC Secretariat, 2007).....	76
Figure 42: Olive Ridley sea turtle (CCC, in IAC Secretariat, 2007)	77
Figure 43: Arribada of Olive Ridley sea turtle (M. Jensen, in IAC Secretariat, 2007)	78
Figure 44: Kemp's Ridley sea turtle (E. Seney, in IAC Secretariat, 2007).....	78
Figure 45: Leatherback turtle (Matthew Godfrey, in IAC Secretariat, 2007)	80
Figure 46: Leatherback hatchlings (CCC, in IAC Secretariat, 2007)	81
Figure 47: Outside the hatchery showing the baskets over the nests.....	96
Figure 48: The hatchlings in a cooler waiting to be released	97
Figure 49: Ben retrieving the eggs from a nest that already hatched.....	97
Figure 50: Leatherback hatchling being released	98
Figure 51: The project team releasing leatherback hatchlings.....	99
Figure 52: English version of Word Survey	100
Figure 53: Spanish version of Word Survey	101
Figure 54: English version of excel survey.....	102
Figure 55: Spanish version of excel survey	102
Figure 56: Glyphs for Pre-Testing	106
Figure 57: Slide 1 of pre-testing	107
Figure 58: Slide 2 of pre-testing	107
Figure 59: Slide 3 of pre-testing	108
Figure 60: Slide 4 of pre-testing	109
Figure 61: First page of hawksbill brochure	110
Figure 62: Second page of hawksbill brochure.....	111
Figure 63: USA and Puerto Rico	112
Figure 64: Netherlands Antilles	112
Figure 65: Belize.....	113
Figure 66: Brazil	114
Figure 67: Costa Rica.....	115
Figure 68: Ecuador.....	115
Figure 69: Guatemala.....	116
Figure 70: Honduras	116
Figure 71: Mexico.....	117
Figure 72: Venezuela	117
Figure 73: Cover Sheet for mapping system.....	118

Table of Tables

Table 1: Sea turtle biological information	4
Table 2: Keywords used to categorize threats	29
Table 3: Percentages of nesting and location information received in annual reports	39
Table 4: Threats in each country from annual reports analysis	40
Table 5: Sample of database-Costa Rica	42
Table 6: Sample of database accompanying map	50
Table 7: Results from pre-testing glyphs	51

Executive Summary

Every species of sea turtle which exists on our planet today is classified as an endangered species. Within the last several years the hawksbill sea turtle, *Eretmochelys imbricata*, has faced a crisis. For example, the number of nesting sites in the Yucatan peninsula in Mexico alone has decreased drastically since 2000. If left unchecked, this problem will eventually end with the extinction of the species and lead to major changes to the coastal ecosystem inhabited by the sea turtles. This project, through the Inter-American Convention for the Protection and the Conservation of Sea Turtles (IAC) responds to the issue by improving the data gathering and distribution of information on sea turtle nesting sites collected across the Americas. The IAC is an international conservation organization focused on sea turtles. Because of the international scope of the convention, they are positioned to conduct this type of research.

There were two major goals of this project aimed to help the IAC with their research. First, a new method was needed to collect data about all sea turtles from the member countries of the IAC. The focus of the data collection portion focused on redesigning the format of the annual reports used by the IAC to gather information from each of the member countries every year. The second goal focused on communicating conservation information about the hawksbill sea turtle. This was done through the design of a mapping system and accompanying brochure to concisely display this information. A summary of the available information was important for providing understandable, non-technical information to policy makers. Improving the data collection in the future and communicating the available information are key steps in the IAC's efforts in conservation of sea turtles.

A number of methods were used to arrive at the final products created in this project. The first concern was to analyze the available information and data collection methods of the IAC. To do this, the project team:

- Tabulated data included in the annual reports and recorded it in a spreadsheet
- Identified areas where data was missing or incorrect in the reports
- Created surveys to send to member countries to gather missing information
- Performed research in IAC records to gather missing information
- Designed a new format for the report to facilitate complete and specific responses
- Interviewed experts for feedback on the components in the redesigned format.

The information collected provided the basis for a mapping system and brochure to communicate with policy makers. To create these products, the project team:

- Researched best practices for existing mapping systems and brochures
- Used the style of an existing IAC brochure to maintain consistency
- Designed and user tested graphical components for the map
- Interviewed experts for feedback on the components and contents of each product.

Through these methods, three products were created: a redesigned format for the annual reports, a mapping system displaying nesting sites of the hawksbill sea turtle, and an accompanying brochure with detailed conservation information.

The new annual report format is easy to use and will help the IAC retrieve more complete responses in the future. The new annual report was consolidated from two documents to a single document, allowing for logical flow, ease of use, and effective data gathering. As suggested by user testing, devices called “restricted responses” were utilized to prevent the user from entering unexpected types of responses into the form. Restricted responses can limit the type of data entered to a discreetly defined list, or a specific data type (for example, a number between 0 and 180 for the number of degrees in latitude and longitude). In addition the instructions were redesigned to employ redundancy. A general set of instructions precedes instructions specific to each section. In addition, pop up help boxes were used to remind the user of key instructions. Based on our research with experts in the field, these changes to the annual report form will increase the usability of the document.

The final product for the mapping system consisted of several regional maps and a country by country map designed in Macromedia Flash. Flash was chosen because it easily allows interactive features to be integrated into the maps. The maps themselves display more than just the locations of the nesting sites. Through pre-testing and interviews with experts, a set of glyphs for the maps were designed to show the nesting location, the number of nests per year, and whether that number was increasing, decreasing, or constant. To accompany the map, a brochure was designed, based on a successful prototype and input from experts. The brochure outlines the crisis in decreasing number of hawksbill nesting sites facing the species. It was recommended to the project team that a handout be made to accompany the electronic mapping system to attract people who may not respond well to electronic media.

The mapping system was designed to be user friendly for both the users and developers. The map and database were designed facilitate easy updates, and to be easy to make interactive. The information contained on the map allows users to easily interpret the nesting sites. The end result is a tool which can help governments make informed decisions about conservation efforts. For example, by plotting all of this information on the map, it will help policy makers decide which beaches need the most amount of aid for conservation efforts.

This report concludes with several recommendations to the IAC for future consideration and implementation. In particular, our research suggests that the IAC

- Move the forms designed in this project into a database program such as Microsoft Access. This program allows for more efficient data organization than Microsoft Excel.
- Modify the content of the information requested in the annual reports. In particular, one expert interviewed cited specific areas in the “Threats” section of the reports that were ambiguous, and could be improved by altering the types of responses.
- Design a standardized database to store all information relating to sea turtles. This would provide organization for new data acquired every year.

- Create similar mapping systems and brochures for all species of sea turtle. Since the current formats have been found to be effective, creating a series for all species would provide concise information for all sea turtles
- Implement interactive features to the mapping system. This would make the maps easier and more engaging to use.
- Display additional information, such as foraging and migrating, in the mapping systems. This information is available, but was not included in the maps created in this project.

With these recommendations, the IAC can improve upon the final products created in this project to strengthen data collection and communication for sea turtle conservation in the Americas.

Resumen Ejecutivo

Cada especie de tortuga marina que existe en nuestro planeta hoy en día está en peligro de extinción. Durante los últimos años la tortuga marina carey, *Eretmochelys imbricata*, ha estado en crisis porque el número de sitios de anidación en la península Yucatán en México ha disminuido drásticamente desde el año 2000. Si no es corregido, eventualmente el problema acabará con la extinción de la especie, que causará más cambios al ecosistema costero habitado por las tortugas. Este proyecto, por la Convención Interamericana para la Protección y Conservación de las Tortugas Marinas, CIT (IAC por sus siglas en inglés), responde al asunto por mejorando el proceso de recolectar, mostrar, y distribuir información sobre sitios de anidación de tortugas marinas por todas partes de las Américas. La CIT es una organización internacional de conservación enfocada a las tortugas marinas. A causa del alcance internacional de la convención, la CIT está preparado para conducir este tipo de investigación.

Hay dos metas principales del proyecto diseñado para ayudar la CIT con sus investigaciones. Primero, fue creado un método nuevo para recolectar y organizar información sobre las tortugas marinas. Parte de la fuente es recoger la información que es un rediseño del formato de los informes anuales usados por la CIT para recoger información de cada de los países asistentes cada año. La segunda meta se enfoca en la comunicación de información sobre la tortuga carey. Éste fue complementado por un diseño que consiste en un sistema de mapas acompañado por un folleto que muestra concisamente la información. Un resumen de la información disponible es importante para proporcionar información sencilla y comprensible a los gobiénales. Mejorar el proceso de recolectar la información en el futuro y comunicar la información disponible son pasos claves en los esfuerzos de conservación de la CIT.

Se usaron unos métodos para completar los productos finales creados para este proyecto. Lo primero fue para analizar la información disponible y los métodos de recolección de información de la CIT. Para hacer éste, el equipo del proyecto:

- Tabuló la información incluida en los informes anuales y se grabó en una base de datos
- Identificó partes donde mucha información fue desconocida anteriormente o encontrado en los error en pasados informes anuales
- Creó otros informes para enviar a países asistentes de la CIT para recolectar la información desconocida
- Investigó los archivos de la CIT para recolectar la información desconocido
- Diseño un formato nuevo del los informes anuales para facilitar respuestas específicas y completas
- Entrevistó a expertos para recomendaciones en el formato nuevo.

La información recolectada proporcionó la base para un sistema de mapas y un folleto para comunicar a los gobiénales. Para hacer de éstos productos, el equipo de proyecto:

- Investigó las mejoras practicas para sistemas de mapas y folletos ya existentes
- Usó el estilo de un folleto ya existente de la CIT para mantener consistencia
- Diseño y probó con usuarios los elementos gráficos del mapa
- Entrevistó a expertos para recomendaciones en cada producto.

Por estos métodos, tres productos finales fueron creados: un formato rediseñado para los informes anuales, un sistema de mapas para mostrar sitios de anidación de la tortuga carey, y un folleto para acompañarlo con información detallada.

El nuevo formato de los informes anuales es fácil de usar y ayudará a la CIT para recobrar respuestas más completas en el futuro. El formato nuevo fue diseñado para ser un solo documento, en contraste a los anteriores dos documentos por separados, para permitir uso lógico y fácil, y el recolectar efectivamente la información. Las pruebas con usuarios sugirió el uso de elementos que se llaman “respuestas restringidas” para limitar la cantidad de respuestas inesperadas en el formato. Respuestas restringidas pueden limitar el tipo de información lleno en una forma a una lista definida discretamente o un tipo de información específica (por ejemplo, un número entre 0 y 180 para el número de grados de latitud y longitud). Además, las instrucciones fueron rediseñados para usar redundancia. Las instrucciones generales de las formas explica como usar el documento, e instrucciones específicos para cada sección explica precisamente como llenarla bien. En adición, fueron usados cuadros de ayuda para recordar al usuario la manera correcta de llenar la forma. La investigación con expertos sugiere que estas adiciones aumentan la utilidad del documento.

El producto final para el sistema de mapas consistió en unos mapas de regiones y un mapa para cada país diseñado en Macromedia Flash. Flash fue escogido porque con él, es fácil hacer interactivo los mapas en flash. Los mapas propios muestran más información que solamente los lugares de los sitios de anidación. Por investigación y entrevistas con expertos, los símbolos de los mapas fueron diseñados para mostrar la ubicación, la cantidad de nidos cada año, y si este número está aumentando, disminuyendo, o es constante. Para acompañar el mapa, un folleto fue diseñado, modelado por un folleto exitoso ya existente y la información de expertos. El folleto explica la crisis de la tortuga carey. Es una recomendación que este folleto acompañe el mapa para atraer a gente que quizás no responda bien a medios electrónicos.

El sistema de mapas fue diseñado para ser fácil a los usuarios y a la CIT. El mapa y base de datos fueron diseñados para facilitar la actualización de la información y el proceso de hacerlo interactivo. También, la información contendida en el mapa permitirá fácilmente a los usuarios interpretar la información sobre los sitios de anidación. Éste resultado en una herramienta que puede ayudar a gobiernos para tomar decisiones informados sobre los esfuerzos de conservación. Por ejemplo, éste ayudaría a los gobiernos a decidir cuales sitios necesitan dinero para esfuerzos de conservación.

El reporte concluye unas recomendaciones directas a la CIT para consideración e implementación en el futuro. Específicamente, las investigaciones sugieren que la CIT debe:

- Usar las formas diseñadas en este proyecto a un programa diseñado para bases de datos, como Microsoft Access. Este programa permite organización de información más eficiente que Excel.
- Modificar el contenido de la información solicitado en los informes anuales. Particularmente, D. Chacón le recomendó al equipo del proyecto que la sección de amenazas es ambiguo, y debe ser cambiado.
- Diseñar una base de datos estandarizada para grabar toda la información relevante a las tortugas marinas. Ésta proporcionaría organización para la información adquirida cada año.

- Crear sistemas de mapas y folletos semejantes para cada una de las seis especies de tortugas marinas que viven en las Américas. Porque el formato es efectivo, una serie para cada especie proporcionaría información concisa para todas las tortugas marinas.
- Implementar elementos interactivos al sistema de mapas. Esto haría más fácil usar los mapas.
- Implementar información adicional, como áreas de forraje y rutas migratorias, en los sistemas de mapas. Esta información está disponible, pero no fue incluido en los mapas de este proyecto.

Con estas recomendaciones, la CIT puede mejorar los productos finales creados por este proyecto para fortalecer el proceso de recolectar y comunicar información sobre las tortugas marinas en las Américas.

1 Introduction

The planet on which we live is very fragile. According to the Committee on Recently Extinct Organisms, CREO, there are thousands of endangered species in the world today, with more becoming extinct every year (2007). An accelerated decline of species has been linked to growing human influence. These types of human influence range from over-consumption to exploitation and destruction of natural resources and habitats (Dick, 2007). Over 150 species are reported to have gone extinct or are suspected to have gone extinct (CREO Database, 2007, Excel spreadsheet). Sea turtles are on the verge of becoming new additions to this list.

There are seven species of sea turtles, all of which are considered endangered (Caribbean Conservation Corporation [CCC], 2007a, section on information on sea turtles). Four of these species nest in Costa Rica (Spotila and Paladino, 2004, p.194-209). The hawksbill sea turtle, *Eretmochelys imbricata*, has a number of nesting sites on Costa Rican shores and is currently critically endangered (Information on Sea Turtles, 2007, hawksbill section). Many threats to hawksbill sea turtles are known; for example, the fishing industry, beach development, pollution, and excessive tourism. There are many efforts to reduce the effects of these threats, both locally in Costa Rica and internationally. Government programs, such as the Fundación de Parques Nacionales, FPN, in Costa Rica have tried to implement conservation programs. On a larger scale, conferences such as the Inter-American Convention for the Protection and Conservation of Sea Turtles, the IAC, provide a global platform for encouraging sea turtle conservation. In spite of all of these efforts, hawksbill populations continue to decline.

Conservation efforts concerning sea turtles, hawksbills in particular, face several challenges. Coordinating a conservation effort across a number of countries is important but difficult. Each country in which sea turtles nest, forage and migrate needs to collaborate in conservation efforts. All need to provide ample support from the governments and the ability to report accurate information on these activities in the annual reports.

Hawksbill sea turtles range over a large area of the ocean, making it difficult to make contact other than during nesting times. To facilitate the research on sea turtles, each year the member countries of the IAC are required to provide a report on the status of sea turtles in their territory. There are a number of gaps in the information provided to the IAC, and it is impossible to come up with any plan to save the species without knowing about its habits and behavior on a global scale (IAC Secretariat, 2004, p. 11). Effective conservation policy on a global scale is difficult without both international cooperation and accurate information, both which could be provided by the IAC.

Working for the IAC through its Secretariat in Costa Rica, our project addressed several goals:

1. to perform a detailed analysis of the information given to the IAC by its member parties in order to identify gaps in the information;
2. to acquire the missing information and improve future information-gathering processes; and
3. to summarize and communicate the information in a visual and easily readable format so that it might be used to educate IAC members about the decline of the hawksbill sea turtle.

In order to better advise government officials in the Americas, the convention facilitates international conservation efforts throughout the continents. One of their preliminary successes is the creation of a graphical database devoted to leatherback sea turtles in the Americas. While a large amount of observational data is collected every year about sea turtles, there are still gaps in what the countries have reported, and no such database exists for the hawksbill. Our goal was to determine exactly which data was missing from the annual reports and find the data itself. Knowing where and why sea turtles are nesting is invaluable for programs concerning sea turtle conservation, if it is reliably collected on a large scale. The components of this project represent ways to improve the content, collection, and display of information integral to the continued survival of this threatened species.

2 Background

Sea turtles are an important feature of the ecosystems they live in. All seven species are endangered, and four of these endangered species nest in Costa Rica. In this chapter we explain the importance of these endangered species, discuss the various threats to their survival, and investigate ways to help them survive. There are a number of threats to their survival, from beach development to pollution to the fishing industry. Sea turtles are difficult animals to protect, as they often range over a wide area of the globe. In this section we also discuss the need for collaboration among nations due to the range of sea turtle populations.

2.1 Sea Turtles: Threats and Consequences

In this section we discuss the importance of sea turtles, as well as some of the threats to sea turtles. Detailed biological information on each sea turtle can be found in Appendix A. Each of the seven species of sea turtles worldwide is endangered. Each has its own unique characteristics and habitat. Table 1 summarizes important information about the different species, including their habitat and their endangered status. According to the international definition, endangered means the specie is facing a high risk of extinction in the wild. Critically Endangered means the specie is facing an extremely high risk of extinction in the wild in the near future. Those with an asterisk next to the name nest in Costa Rica.

Table 1: Sea turtle biological information

Name (common)	Name (Latin)	Estimated Global Population	Habitat	Endangered Status (“Information on Sea Turtles,” 2007)
Leatherback*	<i>Dermochelys corriacea</i>	33,000	Global: Any non-arctic	Endangered
Green*	<i>Chelonia mydas</i>	88,520	Global: Temperate to Tropical	Endangered
Hawksbill*	<i>Eretmochelys imbricata</i>	22,900	Global: Tropical to Subtropical	Critically Endangered
Olive Ridley*	<i>Lepidochelys olivacea</i>	800,000	Global: Tropical to Subtropical	Critically Endangered
Kemps Ridley	<i>Lepidochelys kempii</i>	2,500	Local: Gulf of Mexico, North America	Endangered
Flatback	<i>Natator depressus</i>	20,285	Local: Australia and Papa New Guinea	Critically Endangered
Loggerhead	<i>Caretta caretta</i>	44,560	Global: Temperate to Tropical	Critically Endangered

The focus of this project is to improve data gathering and communication strategies for information concerning the hawksbill species. The hawksbill is currently critically endangered, and facing a period of crisis in North America (Dick, 2007). In the following section we explain how they are important parts of the ecosystems they inhabit, and their existence is in jeopardy.

2.1.1 The Effect of Sea Turtles on the Ecosystem

Sea turtles are described as an indicator species. The health of an indicator species is a good measure of the health of the ecosystems in which it inhabits (Spotila & Paladino, 2004, p.194-209). An indicator species is often deeply rooted in its environment, meaning that it depends on many factors of its environment, and many other factors of its environment depend on it. Because of this, it serves a very important function within the environment. In this section we explain how sea turtles directly affect two major ecosystems, and why their extinction would be a major problem in ocean ecosystems.

The ocean is the primary ecosystem that sea turtles affect. Within the oceanic ecosystem, sea turtles play a very important role. For example, sea grass would suffer from the extinction of turtles. Sea grass is where fish, shellfish, and crustaceans breed and

develop. Without it, many of these species would be put in danger as well, eventually affecting human harvest of these species leading to problems with marine economy (Major ecological effects, n.d. ¶ 2). Sea turtles are one of the few species in the ocean that consume sea grass. Like the grass on our lawns, it needs to be trimmed regularly or it becomes unhealthy. According to J. Spotila and F. Paladino, there has been a decline in the populations of sea grass and many people are blaming this on the dwindling number of sea turtles. The sea turtles effect on this specific marine ecosystem is very important for the rest of the species higher up on the food chain, including humans (2004, p.194-209).

Very similar to the marine ecosystem, the beach and dune systems are directly affected by nesting turtles. The increase in beach erosion has been related to the decrease in turtle populations (Major ecological effects, n.d., ¶ 3). This is because sand does not hold nutrients, making it very difficult for plants to grow in the dunes. Sea turtles make a big difference in this case. Every nesting season the beaches thrive because the sea turtles leave behind many sources of nutrients such as the unhatched eggs, trapped hatchlings and discarded shells. With these nutrients, plants on the dunes can then start growing which greatly improves the health of the beach. The strong vegetation helps protect beaches from erosion, which is one of the threats to sea turtle survival in the first place. The dunes are also the natural habitat for many beach animals (Major ecological effects, n.d., ¶ 3). Both of these systems, the marine and beach, would suffer greatly if the sea turtle populations continue to decline, underscoring the relevance of protection and conservation. “If you lose one the rest will eventually follow” (Major ecological effects, n.d., ¶ 4) aptly applies to this situation, as any threat to turtles can be a threat to a large portion of the species.

2.1.2 Sea Turtles’ Effects on Society

In recent years, a number of community-based conservation efforts have been put into effect. These programs are designed to benefit both the sea turtles populations and the communities near the nesting sites. The conservation programs provide jobs for the citizens of the community, which often provide more income to the communities than the consumptive use of the sea turtles on the beaches. For example, at the conservation program of Gandoca in Costa Rica, it is estimated that the ex-poachers make three times as

much money due to increased business from volunteers in conservation programs as they could selling turtle products. The complete loss of sea turtles could significantly damage the economies of these communities. This information was gathered from personal communication with the director of the project team at the Gandoca project center, which is discussed in chapter 3.

2.1.3 Threats and Dangers to Sea Turtles

This section discusses many of the threats that sea turtles face. These range from environmental problems such as pollution of the environment to human consumption and exploitation of the turtles (Hawksbill-*Eretmochelys imbricata*, n.d., current threats section). Although there are conservation efforts in place, the threats that humans pose have placed sea turtles high on the endangered species list.

According to the United Nations Environment Program, or UNEP, one of the greatest threats to hawksbill turtles in particular is their consumption by humans. The eggs are eaten in many places, and mature turtles are also consumed as a delicacy (Hawksbill-*Eretmochelys imbricata*, n.d., “Current Threats” section). Products made from hawksbill shell are widely considered luxury items and are valuable in international markets. The trade in tortoiseshell for decoration and jewelry, which continues in spite of international law against it, is one of the main reasons for the decline of hawksbills (Hawksbill-*Eretmochelys imbricata*, n.d., “Reasons for Decline” section).



Figure 1: Hawksbill jewelry (WWF, 2007, section on Trade)



Figure 2: Carapace used for artwork (WWF, 2007, section on Trade)

Environmental pollution causes problems as well. Fibropapillomatosis, a disease associated primarily with green turtles, but documented in all species, is a cancerous condition associated with poor water management, hazardous runoff, and other sources of human pollution (Aguirre & Lutz, 2004, p. 275-283). These types of pollution are primarily a result of development of beach property, poor watershed management, and lack of pollution control. There is not much known about this disease, but many scientists say that it is an indicator of the increased pollution in the oceans (Aguirre & Lutz, 2004, p. 275-283).



Figure 3: Green sea turtle with fibropapillomatosis (Ursula Keuper-Bennett and Peter Bennett, Cited in World Conservation Union, n.d., image 4)

Beach development, however, is an important issue for reasons other than pollution (CCC, 2007b, section on beach activities). Beach development brings more people towards nesting sites, thus more pollution and more light, all of which is detrimental to turtle nesting. Poor watershed management as mentioned above, compounded by an increased human presence near beaches, leads to polluted waters and debris along beaches, creating unfavorable conditions for the mothers and the hatchlings traveling towards the water. The extraction of sand from beaches and destruction of natural vegetation can make the beach unsuitable for turtle nesting. In addition, development on the beaches brings more people to critical nesting areas, which in itself can be harmful (CCC, 2007b, section on coastal armoring). The lighting from structures themselves can be harmful, as any bright source of light can disorient nesting mothers and hatchlings alike. Hatchlings born at night tend toward the brightest horizon, and developed areas often provide a bright horizon that leads

to roads and civilization rather than the ocean (CCC, 2007b, section on artificial lighting). This type of modification to the beach is a large source of decreased sea turtle populations.

The issue of beach development is compounded with efforts to increase tourism. More development on the beaches means more tourism is possible, and more tourism means more money. However, tourism and motor vehicles on beaches are killing turtles and changing the habitats, impeding their ability to nest. Domestic pets on beaches have been known to dig up nests and eat the eggs, while the mere presence of people on beaches may be enough to scare a nesting turtle to return to the water before laying any eggs (CCC, 2007b, section on beach activities). The human threats to sea turtle life from pollution and beach development are very damaging.

Another major human cause of mortality to sea turtles is incidental capture in the fishing industry. While the turtle is not the target species, the gear used is non-discriminatory. Accidental capture has been widely documented as threats to sea turtle life. There have been marginally successful efforts to reduce this trend (De Azevedo, Barata, Gallo, Kotas, & dos Santos, 2006, initial page) but incidental capture of sea turtles is still a problem. Efforts to reduce incidental catch have faced controversial resistance. Fishermen fear that modification of equipment will decrease the overall catch of the target species and that the gear will add an increased overhead. In addition, damaging fishing practices can take place over wide areas of sea turtle habitats, the ramifications of which we discuss below.



Figure 4: Commercial trawler disposing a leatherback (Karumbe Photos, 2002, Cited in Proyecto Tinglado Isla de Culebra, n.d. first image)

2.1.4 Threats and Migration

In this section we discuss the issue of the range and migration of sea turtles, and how it compounds the difficulty of protecting them. All sea turtles, hawksbills in particular, have a wide range of nesting sites that they may move between from year to year. Due to their tendency to travel long distances, most turtles are only observed when they come ashore to nest, which means that only the female population is usually observed (CCC, 2007b, section on migration). It is also difficult to track what happens to newborn turtles when they enter the water for the first time, and how they reach maturity. In short, it is known that sea turtles are a migratory species, and do spend much of their time, ninety percent according to the CCC (2007b, section on migration), away from shore. However, little is known about the time they spend in the open ocean not nesting, including their development, mating habits, and foraging habits (CCC, 2007b, section on migration).



Figure 5: Hawksbill sea turtle (J Chevalier, in IAC Secretariat, 2007, section on hawksbill)

These obstacles to the understanding of the species lead to a number of problems in developing successful conservation strategies. Hawksbill sea turtles have some of the widest variety of nests of any turtle population, so observing their sparse numbers in the wild is especially difficult (Hawksbill-*Eretmochelys imbricata*, n.d., section on current population). This also means that efforts to protect them need to take into account precisely which threats are relevant on each nesting beach. These beaches can be clustered or spread across many countries, with different threats relevant in different areas. In the next section

we discuss how the IAC was created to foster international cooperation in sea turtle conservation.

2.2 The IAC and Reports on Sea Turtle Life

In this section we discuss the Inter-American Convention for the Protection and Conservation, or the IAC, and its goals and efforts in researching and protecting marine turtles. In particular, we examine the database that has been created from annual reports of the member nations of the IAC.

2.2.1 The IAC

The IAC was first convened in 2002 with the goal of promoting “the protection, conservation and recovery of sea turtle populations and the habitats on which they depend, based on the best available scientific evidence, taking into account the environmental, socio-economic and cultural characteristics of the Parties” (IAC Secretariat 2004, p 11). The text of the convention acknowledges the need for multinational cooperation, and states the importance of coordination among nations for effective policies concerning sea turtle conservation (IAC Secretariat, 2004, p. 11).

There are twelve nations party to the Convention at the time of this writing: USA, Mexico, Guatemala, Belize, Honduras, Costa Rica, Netherlands Antilles, Venezuela, Ecuador, Peru, Uruguay, and Brazil. According to the IAC Secretariat (2004, p 12-13), as parties to the convention these nations are expected to:

- Protect sea turtles and their habitats
- Prohibit exploitive trade of sea turtles
- Reduce incidental capture of sea turtles
- Assist international efforts in research and conservation

To encourage international collaboration in research, the IAC instituted a policy of submission of annual reports from member nations in 2005. Each party to the convention

is required to submit information on sea turtles in its country each year. These reports are of particular interest to this study, as they provide the basis for the information included in the IAC's sea turtle database which was used for this research project.

2.2.2 The IAC Annual Reports

In the annual reports, a variety of information is requested about sea turtles from each member nation. Each nation is required to submit a document that responds to a number of specific questions about sea turtle activity within its territory. A complete outline of the report is included in Appendix B. Specific information from the reports is used to create a database on sea turtle life. Information in the database includes general biological information about the sea turtles, as well as information specific to individual nesting sites. The general information includes which species in the region are identified, whether they are reproducing, migrating, or foraging; and the location of important sites for conservation. The information provided by individual sites contains: the location (latitude / longitude) of the site, species observed, general status of the sea turtles, number of nests at the site, and if the area is considered protected or is privately owned (IAC Secretariat 2006).

Although the annual reports as conceived were intended as a valuable tool for research, especially on turtles as wide ranging as the hawksbill, many nations did not provide the complete requested data . The IAC Annual Reports from the year 2006 had several gaps in the content provided by a number of countries, which include:

- Number of nests at each site
- Threats relevant to each site
- Latitude and longitude of each site

The missing information in the annual reports is discussed in more detail in both the methods and results chapter. It is relevant to note here that according to Belinda Dick, an expert working for the IAC, there were several nations which did not provide enough data necessary to be usable in the database. The IAC would ideally provide a way for the

nations of the Americas to collaborate on sea turtle conservation. A database on sea turtle life could be made more complete, however, with greater participation from the parties to the convention.

2.2.3 The Role of the Technical Assistant to the Secretariat

As the Technical Assistant to the Pro-Tempore Secretariat of the IAC, Belinda Dick is in a unique position to speak to the convention. At each scheduled conference of the parties, she has the opportunity to present the results of efforts individual countries have been making, suggest courses of action to better protect sea turtles, and propose changes to the way the convention functions. This is also the only opportunity to speak to all the parties to the convention at one time. As such, B. Dick's role in the IAC provides a platform for an influential message to be conveyed. Any changes to the structure of the annual report or reports on the information contained within them will be communicated by B. Dick at such a meeting.

2.3 Communicating and Displaying Information

To foster greater participation from those nations which have inaccurate and incomplete information, B. Dick suggested an easy to understand, recognizable, and attractive method of displaying this information. From experience, she recommended several practices that could be effective in communicating this information to the parties of the IAC. In this section we present the methods proposed by B. Dick, and investigate how other organizations have tried the same methods.

2.3.1 Message Source

The source of the message given in communication is crucial, according to C. Atkin (1981). A receiver is more likely to be responsive to a message from a source that is trusted and understood. From experience, B. Dick recommended that for communication with the parties to the convention in this situation, the most credible source is information provided by the parties themselves. She states that many government officials at IAC

meetings are less responsive to information provided by non-government organizations, or NGOs. Using information provided only by the nations at the convention is more likely to be effective in communicating the state of the hawksbill sea turtle.

2.3.2 Mapping Systems

Previously, a map of the nesting sites of the leatherback turtle was created for use both publicly and within the IAC for informing the parties, according to B. Dick. The map is shown in Figure 6

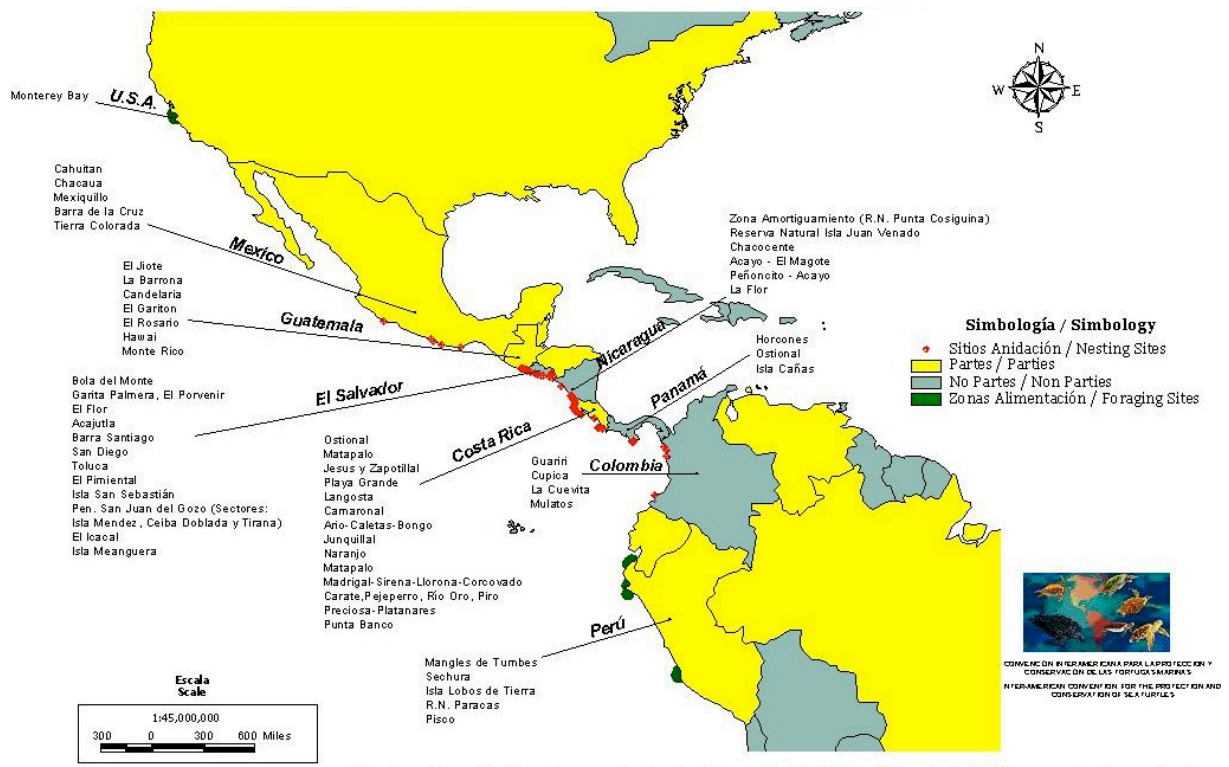


Figure 6: IAC leatherback nesting sites map (Dick, 2007)

According to B. Dick, there are several strengths and weaknesses of this map.

Strengths:

- Shows where there are a number of nesting sites to indicate important regions
- Shows which countries have submitted information and which ones have not
- Summarizes a lot of information into one image

Weaknesses:

- The size of each nesting site is not displayed
- Some officials are skeptical of information in non-party countries
- Information about individual sites' named are difficult to label

The IAC has produced another map, which contains information on all six species of turtles which nest in the nation's party to the convention in the America's. It contains interactive content to show more detailed information. This interface uses the Macromedia Flash player for animation and interactivity. A sample of the map is shown in Figure 7.



Figure 7: IAC Flash map main screen (Dick, 2007)

This map shows which countries are party to the convention, similar to the static image map shown in Figure 7. The individual country names, shown on the left, are clickable and provide a closer view of the individual countries. As an example, if you click on Costa Rica, the resulting display is shown in Figure 8.



Figure 8: IAC Flash map Costa Rica screen (Dick, 2007)

Figure 8 shows all the reported nesting sites, with the Latin name for each species at the bottom. Clicking on the name of the species shows only the beaches related to that species, and makes the individual points interactive. When these points are clicked on, a pop-up box shows more detailed information about that beach. The leatherback beaches are shown in Figure 9, and a sample of a pop-up box is shown in Figure 10.



Figure 9: Map in Flash of leatherbacks in Costa Rica (Dick, 2007)

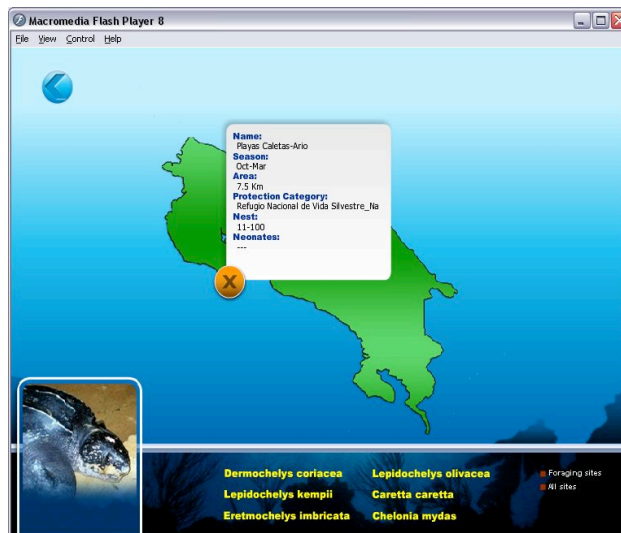


Figure 10: Pop-up box in Flash (Dick, 2007)

Several other organizations have created mapping systems in the past for various species of turtle, which are more sophisticated and have designs which are capable of displaying more information.

A screenshot of a map created by information compiled by the World Wildlife Fund, or WWF, is shown in Figure 11.



Figure 11: WWF map, overview (WWF, 2004, section on maps)

Figure 11 is a map of solely hawksbill nesting sites in the Caribbean. As an NGO, the WWF gets information from many different sources, including private researchers. As a result, many of the sites shown on maps made by NGO's are not the ones reported annually to the IAC. The format for displaying the nesting sites is similar to that of the leatherback map from the IAC – a graphic display of red dots that represent nesting sites. However, there are a number of other options included in the map aside from nesting sites, shown as “Sitios de Anidación” above, including:

- Ocean currents
- Surface temperature of the water
- Salinity of the water
- Barometric pressure
- Political boundaries
- Coral reefs

- Sea grass
- Number of nests
- Predicted migration routes

Each of these views provides a different perspective of how conditions may relate to hawksbills in the region. Any and all of them can be selected at once, and are displayed layered on top of one another on the map. There is also the option to look closer at specific areas of the map by using the zoom tool, and the map can be dragged around with the mouse to look at different areas when zoomed in.

The State of the World's Sea Turtles organization, or SWOT, has also produced a map, which contains information on leatherback and loggerhead species worldwide. A screenshot of this map is shown in Figure 12.

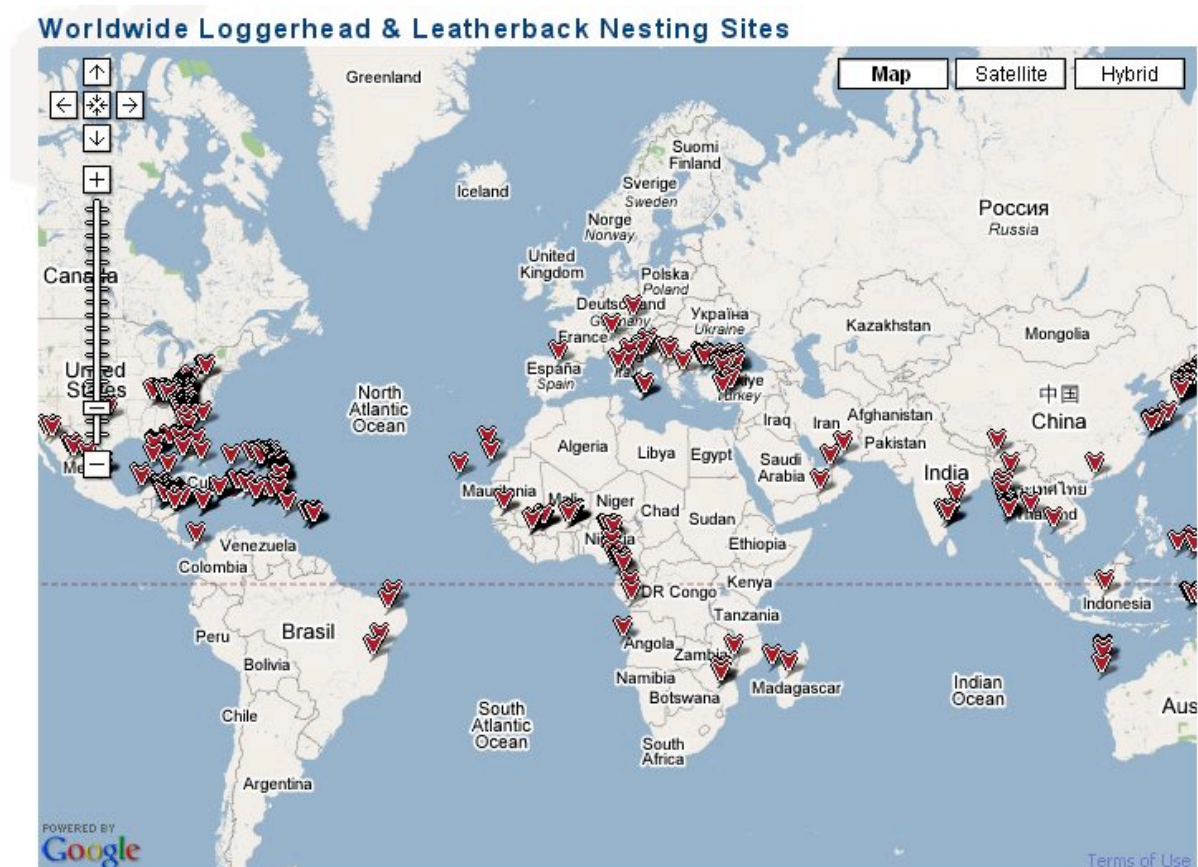


Figure 12: SWOT map overview (State of the World's Sea Turtles, 2005, loggerhead and leatherback nesting sites)

This map contains information concerning turtles in all areas of the world. It has some useful functionality which allows the user to zoom in on different areas using the slide-bar tool on the side. Each red arrow is also interactive – clicking on it provides information about the type of turtle nesting there, and where the information about the turtle comes from. There is an option to show a satellite image instead of a flat map image, which can depict terrain on beaches. There is no graphical indication of whether the site represents a leatherback nesting site, a loggerhead nesting site, or both, however. Figure 13 shows an example of a closer view and the type information contained in each point.

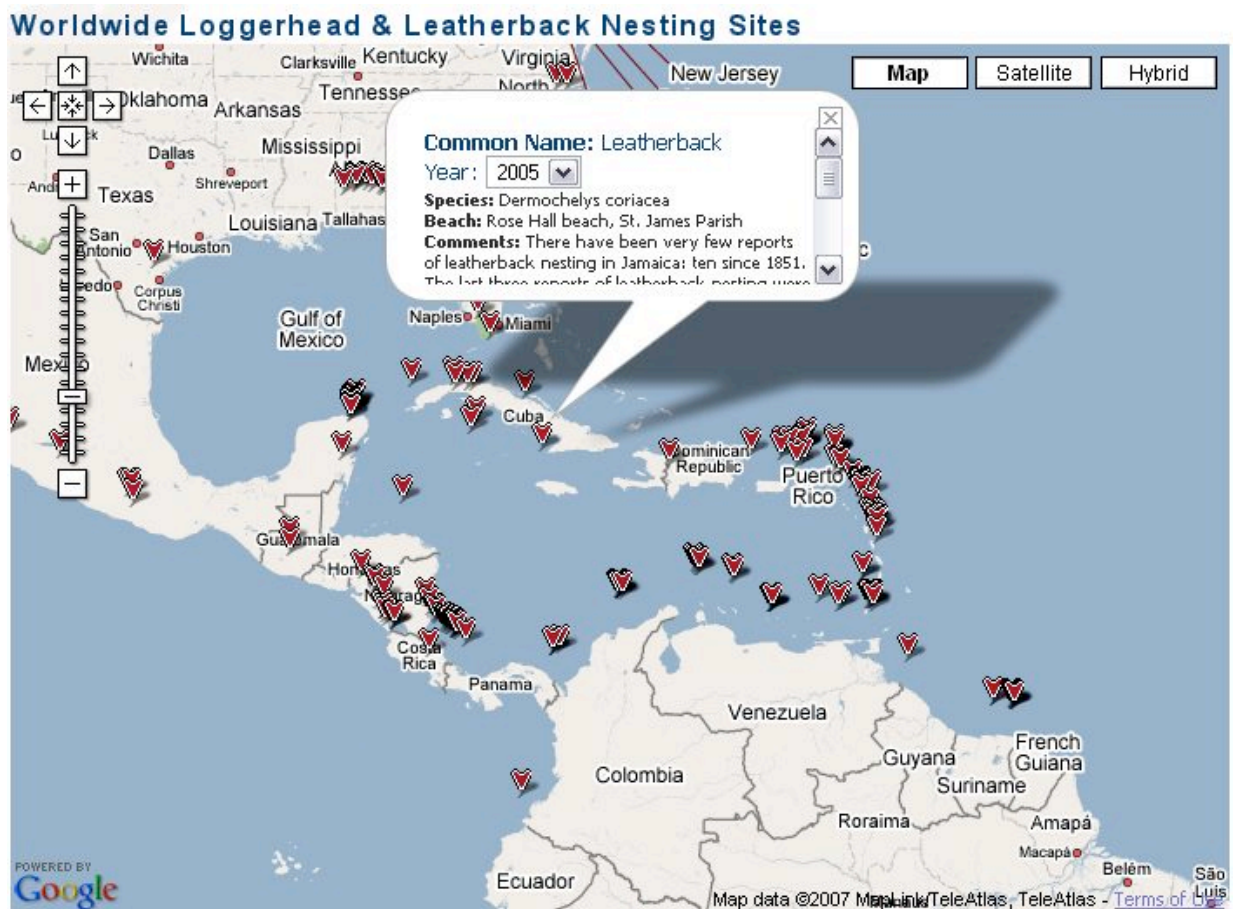


Figure 13: SWOT Caribbean map (State of the World's Turtles, 2005, loggerhead and leatherback nesting sites)

A closer view shows some more detailed aspects of the map. Some of the points do not appear to line up with coasts, for instance. The detailed information screen shows which species nests at the given site, allows for information to be shown based on year, and provides comments and other data about turtles at the beach. These boxes are the only way

the map provides to see this information, as before a point is clicked there is no information shown aside from the location of each site.

The Indian Ocean – South-East Asian Marine Turtle Memorandum of Understanding, or IOSEA, produces a map in a different format. It contains information on all species of turtle, but is limited to the Indian and Pacific Ocean around Asia. The widest view of the map is shown in Figure 14.

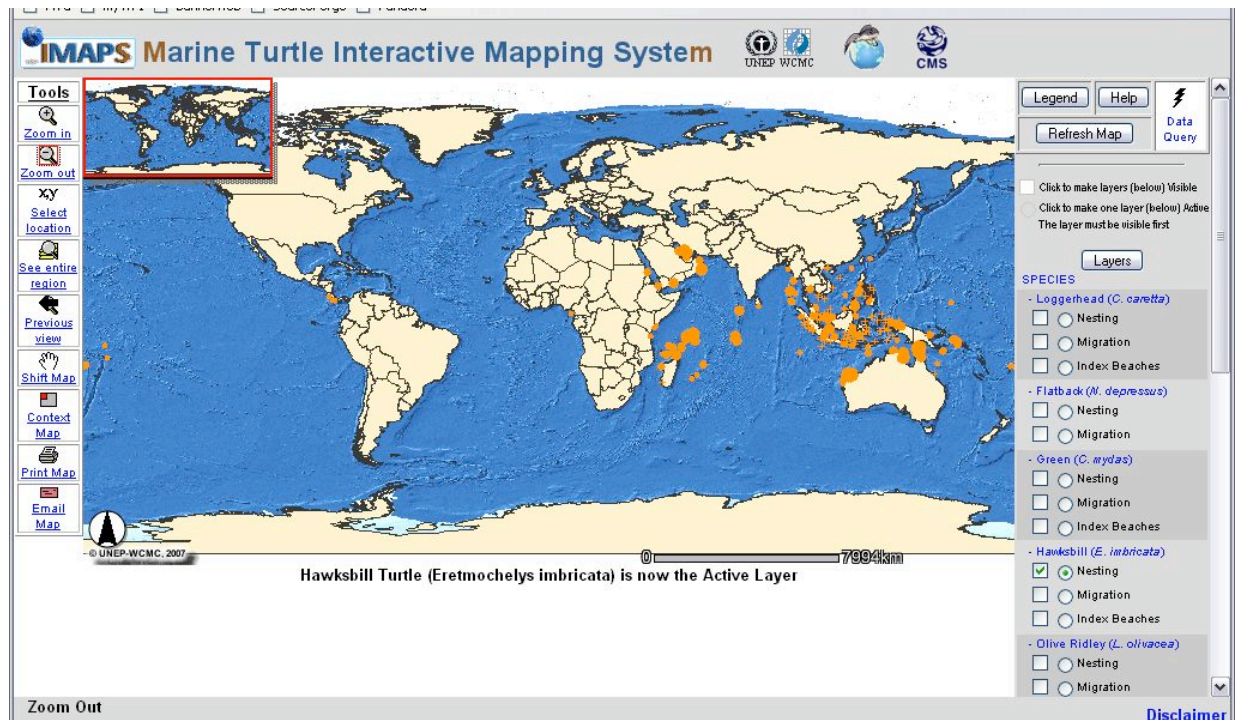


Figure 14: UNEP IOSEA map overview (UNEP, 2007, Marine Turtle interactive mapping system)

To use this map, the user checks the boxes of the species of turtle of interest, and clicks “Refresh Map” to display the changes they made. The dots appear as different sizes or shapes to display specific information. As in other examples, a zoom tool allows the user to see specific areas of interest. The user can also click on the “Legend” button to see what the different sizes and type of symbol mean. A closer view, still of hawksbill nesting sites, is shown in Figure 15.

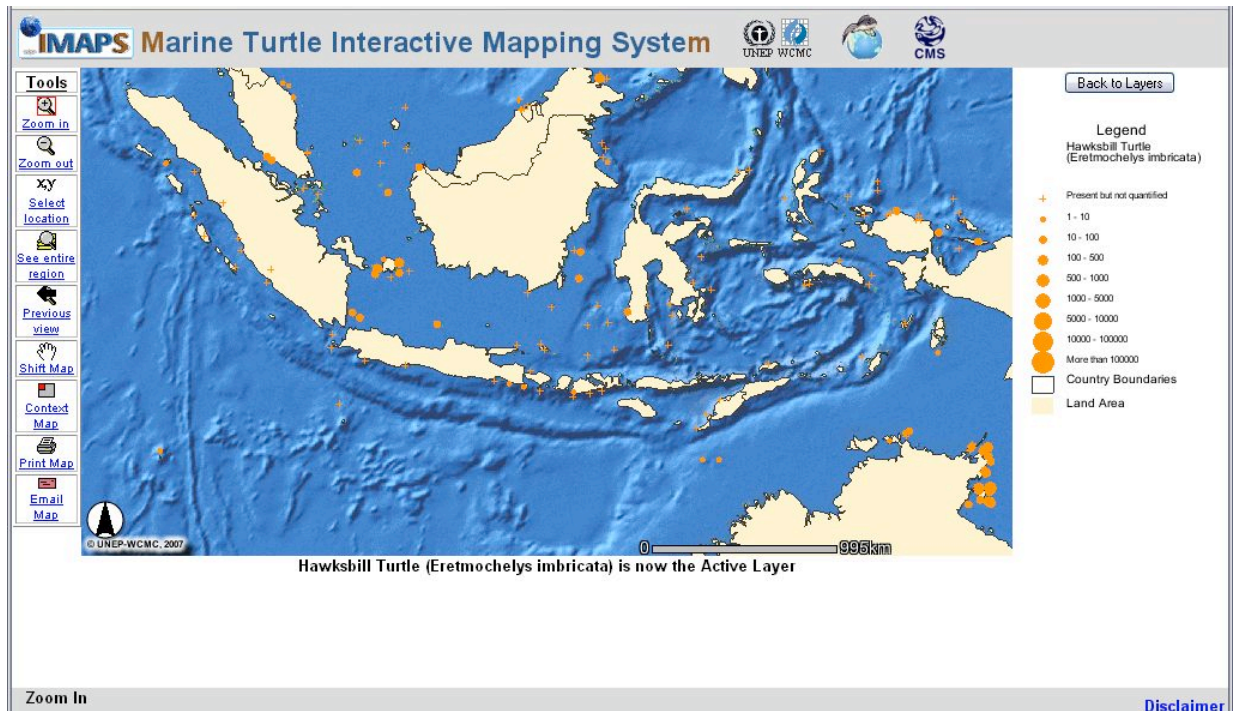


Figure 15: UNEP IOSEA Philippines map (UNEP, 2007, Marine Turtle Interactive Mapping System)

In this map, it is apparent what each of the sized dots mean, information that is not shown graphically in the other mapping styles. There is also the cross shape to show that there is evidence of a nesting site, but no quantity information available. The legend is shown in detail in Figure 16.

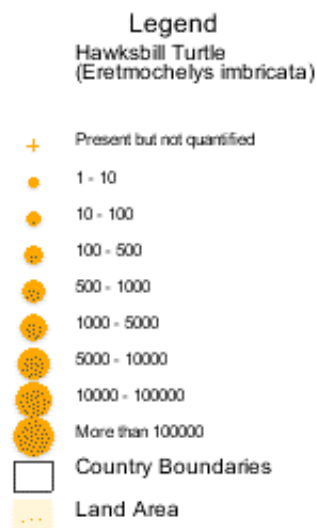


Figure 16: UNEP IOSEA Map legend

This way of depicting the quantity of nests makes it visible on the map itself. There is no requirement that the user click on individual points for information. There is no way to show the names of the beaches, however.

Each of these mapping strategies provides different functionality and methods for viewing information. Points or icons are displayed as unchanging or interactive, and can hold more information than just location. Other type's information can be displayed along with the information about nesting sites, primarily indications of ocean conditions or protected areas. An analysis of which types of mapping strategies would most effectively communicate information about hawksbills is discussed further in the methods chapter. However, some of the common strategies used are:

- On/off buttons for displays of information
- Points that display more detailed information when clicked
- Different sizes or shapes of points to convey information about nesting sites
- Zoom features to view specific areas in detail
- Individual nation views for detailed information
- Displays of non-nesting information, such as migratory routes or ocean conditions

2.3.3 The IAC Leatherback Brochure

The information contained in mapping systems is not the only data that can be influentially conveyed concerning hawksbill turtles. According to B. Dick, brochures are a popular item with governments for quickly communicating key information about turtles. Important information to include can be the most relevant threats, recent conservation strategies, recent trends in sea turtle populations, and reasons why turtles are important. For leatherback turtles, the IAC released a brochure that highlighted most of the key issues involving leatherbacks. The layout of the brochure is shown in Figure 17.

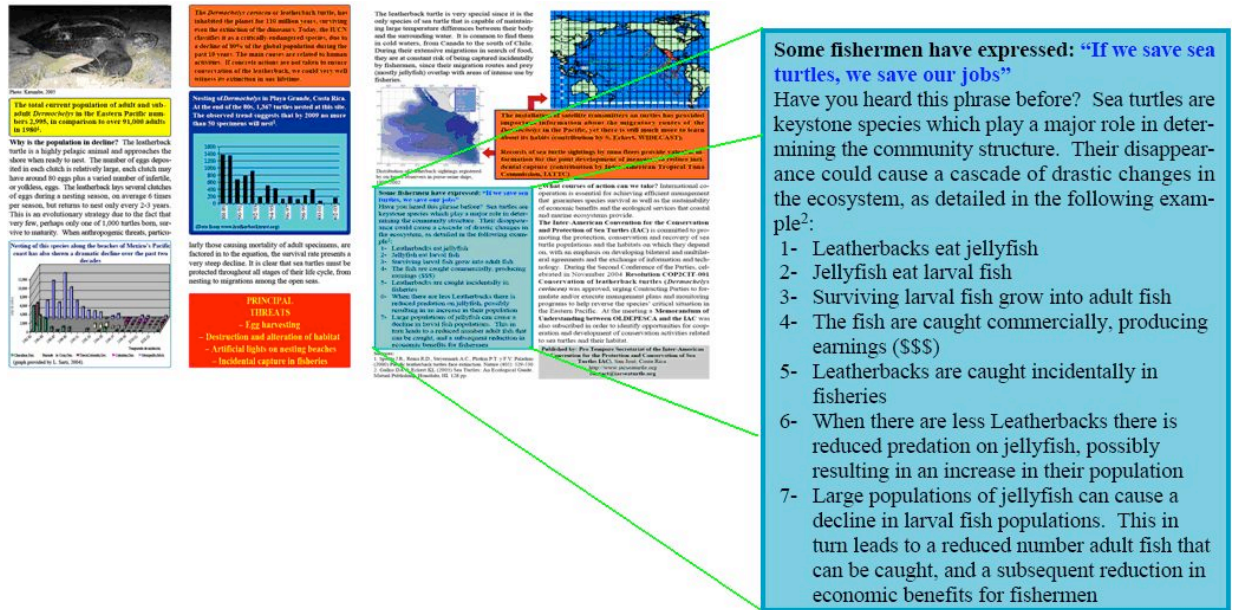


Figure 17: Leatherback brochure (Dick, 2007)

Cited as particularly influential by B. Dick is the box that describes the impact on fishing that decreased leatherback populations could have. A detailed view is shown in Figure 17. The reason given for the increased influence was that this description provided a specific, understandable, and immediate example of the importance of leatherback turtles. Overall, the brochure uses color and graphics to show a variety of information about the leatherback species. There are maps which show the results of recent conservation efforts, graphs which show recent trends in populations, and boxes that describe relevant threats and conservation practices.

Also of note is that the majority of the information in the brochure is based on information provided by the parties to the convention. Having the parties themselves as the source, according to B. Dick, was important for the positive impact of the brochure. She has emphasized the success of this brochure largely for this reason, and expects that a similar brochure concerning the hawksbill species could be equally effective.

2.4 Summary and Objectives

There are a number of problems facing hawksbill sea turtles in Costa Rica. The IAC provides a valuable resource for the future of sea turtle conservation in the countries of

North and South America. Through an analysis of the annual reports, specific gaps in information about hawksbills were identified. Filling in these gaps could provide a valuable resource to countries' conservation efforts. Effectively communicating this information to the parties of the convention will encourage greater participation and increase general awareness of the problems facing hawksbill turtles. A design for both a mapping system and brochure may prove to be valuable tools for this communication. With as much of the missing information as possible found and consolidated into an effectively communicable format, a large step will be taken in the understanding and future protection of hawksbill sea turtles by the IAC.

These goals were accomplished in a number of ways. The gaps in the information provided in the annual reports were filled through research to find exact locations of beaches, contact with turtle experts including B. Dick and Didiher Chacón an expert working for the ANAI-WIDECASST turtle conservation group, and further contact with the governments which submitted the reports. The communication of this information through a mapping system and brochure was accomplished by testing designs and prototypes of the two documents. Finally, the format of the annual report was improved to encourage better participation in the years to come. In the next chapter we discuss these methods in further detail

3 Methods

The goal of our project was to aid the IAC with sea turtle conservation practices, specifically in redesigning their information gathering tools, developing a more complete database, and creating a visual representation of hawksbill sea turtle nesting sites as well as informational brochure on the species. In order to create a more comprehensive database, our team needed to 1) Identify missing information in member countries' annual reports, 2) design ways to acquire the missing information, 3) Develop methods to improve the format of the annual reports, 4) Design an effective system for mapping the data, and 5) Create a brochure for policy makers using information that relates to the IAC. In what follows, we specify our procedures for identifying and collecting the missing data, and deciding on the designs for a format for the annual report, mapping system, and brochure.

3.1 Annual Report Analysis

3.1.1 Analyzing the Annual Reports

The database compiled by the IAC is drawn mainly from member countries' annual reports. Belinda Dick provided the annual reports from the IAC's records. The information most pertinent to our research, specifically mapping the nests, was in Section 1.2 of the reports. The template for this section is shown in Figure 18.

	Name of Site	Species (s)	Season	Geographic Location (Lat/Long)	Area (km or hectares, if applicable)	Protection Category	Observati
Nesting Site							
Foraging Site							
Migratory Routes							

Figure 18: Section 1.2 of annual reports

For our study, we were primarily interested in three columns of this section: the name of the site, the species nesting there, and the geographic location. The name of the site refers to a specific location where the listed type of behavior was seen (nesting, foraging, or migrating). Nesting locations are always the names of beaches, while migrating and foraging could be beaches or bodies of water. We looked for locations that indicated hawksbill or *Eretmochelys imbricata*. Of particular importance to our project was the geographic location of the site for use in mapping.

We used information from Sections 2 and 3 as well. Both of these sections focus on the threats to the turtles. Section 2, shown in Figure 19, asks for information about the use sea turtles products are used in both consumptive and non-consumptive ways.

	Types of use	Specie	Products	Ocean Basin	Origin*		Estimated annual quantity	Information source	Actions
					L	I			
Consumptive Use									
Non-consumptive									

* L = legal, I = illegal

Figure 19: Section 2 of IAC report

As one of the greatest threats to the hawksbill sea turtle, illegal use was one area that was of particular concern. The category labeled *types of use* was the primary source of information about these types of consumption.

Section 3, shown in Figure 20, asks for more general information about threats to the sea turtle, including incidental/intentional capture and the effects of habitat change.

3. Main threats

3.1 Habitat and other threats

Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

3.2 Capture (Intentional/incidental)

Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

Figure 20: Sections 3 of IAC report

We gathered data from the eleven annual reports submitted by the member countries. Uruguay, having joined the convention during the term of the project, had no annual report from 2006. The information in these three sections was tabulated using Microsoft Excel. In this process, we noted where information was missing or submitted in a different form than the instructions called for. In addition the sites were given serial numbers to reference and organize the database for later use. The reports were accompanied by specific instructions on the format of responses; we noted deviations from the requested format.

3.1.2 Content Analysis of Threats

In the annual reports, countries were provided with a place to report specific threats. The standardized form for the responses was not followed; so many different descriptions of varying phenomena were indicated in the reports. To organize this information, we performed a content analysis of the responses. The goal was to organize all of the threats described into discrete categories. For categories, we used those reported by the Marine Turtle Specialist Group of the World Conservation Union (2005):

1. Fisheries Impact
2. Direct Take
3. Global Warming
4. Pollution and Pathogens
5. Coastal Development

There were a number of keywords used to divide the data, and some threats were determined to not fall into these categories. A list of the keys used to identify each category is displayed in Table 2.

Table 2: Keywords used to categorize threats

	Global	Pollution and	Coastal
Direct Take	Fisheries	Warming	Pathogens
Capture	Capture	Erosion	Contamination
Capture	Fisheries	Habitat	Debris
Commercial	Fishermen	Hurricanes	Hydrocarbon
Consumption	Gillnet	Natural	Obstacles
Craft	Incidental	Reefs	Oil
Eggs	Long line		Plastic
Harvesting	Net		Pollution
Hunting	Seine		Spills
Intentional	Shrimp		Waste
Meat	Trawling		Vehicle
Ornament			
Poaching			
Sale			
Skins			
Traffic			

Some of these keys warrant further explanation.

- *Capture* – This key was found relating to both Direct Take and Fisheries Impact. Interpreted as related to Direct Take when accompanied by the phrases “on beaches” and “intentional.” Interpreted as Fisheries Impact when accompanied by “at sea” and “incidental.”
- *Hydrocarbon* – Contaminant from byproducts of oil spills

- *Seine* – A type of fishing net

This coding was important for several reasons. First, it was a useful starting point for deriving a restricted list of responses that users may be able to select for responses in the annual reports. In addition, it allowed threats that fell outside of these main categories to be noted, as these could potentially be important issues that wouldn't otherwise be addressed. For these reasons, the content analysis was performed to provide a more structured view of what threats existed as reported in the annual reports.

The data that was available in the reports, including threat information, was compiled into a Microsoft Excel spreadsheet with the goal of making the gaps in the information for each country easily visible. For many nations, a considerable portion of the information was not provided. At this point, one goal of the project was clearly defined: The database that we had contained a number of gaps, and we needed to fill them. This was accomplished in a number of ways, including surveys, archival research, interviews, and information provided by B. Dick.

3.2 Acquiring Information about Hawksbills

A significant portion of our research involved acquiring the information that was not included in the annual reports. We also looked for information not requested in the annual reports to create a more robust database. In this section, we describe the methods that we used to find this data.

3.2.1 Correspondence with IAC Secretariat

One source for this information came from personal contact with B. Dick. B. Dick has many years of experience in working with marine turtles, and her experience and records provided a key resource in our research. We asked her for information she had concerning hawksbill turtles on the following subjects:

1. Specific nesting sites
2. Estimates for numbers of nests at each site
3. Location of the sites in longitude and latitude
4. Threats to the turtles at each site
5. Patterns in the recent population of nesting turtles

We were able to research this information in archival records that B. Dick provided us, as well. These sources included records of her contact with experts in other countries, follow up surveys to the annual reports which she had administered, and a database that included number of clutches and locations of beaches in the mapping program ArcView. When possible, we used this information to fill some of the needed info in the database.

3.2.2 Interview with Didiher Chacón

We gathered additional information about the sea turtle nesting habits in personal communications with Didiher Chacón, an expert in the field. D. Chacón is an experienced expert in working with sea turtle conservation, and is a member of the Wider Caribbean Sea Turtle Conservation League (WIDECAST) we asked D. Chacón questions about three specific nesting beaches in Costa Rica. For the beaches of Cahuita, Puerto Viejo, and Gandoca, we asked for

1. An estimate of the number of nests at the site
2. Whether this number was increasing or decreasing

We also asked questions regarding several design considerations for the format of the annual reports and the mapping system discussed later in this chapter.

3.2.3 Conservation Work at Gandoca Beach

Through direct observation at a volunteer conservation program our project team was able to understand where the data from the annual reports was coming from and how it was retrieved. The project team spent two days working at Gandoca beach on the Caribbean coast of Costa Rica. Communication with the project directors at the Gandoca project center also provided us with information about the benefits of community efforts, which were described in Chapter 2. In Appendix C there is a more detailed description of what types of work volunteers do at the program.

3.2.4 Surveys

The majority of missing information in the database was only available through direct communication with the individual countries. In order to acquire this additional information, we designed a survey to be distributed to the governments that submitted annual reports. If the country had submitted an incomplete report, this gave them the opportunity to provide new information. In addition, already existing information could be verified with this survey.

The survey was designed to be very simple for two important reasons. First, we wanted to encourage the completion of the survey by making it brief, and would only require information that the contact would likely have close at hand. Second, we wanted to ensure that there would be no confusion about what information we were asking them to provide.

For each beach the country submitted in their annual report, we asked for four specific pieces of information:

1. Latitude and longitude
2. Approximate number of clutches each nesting season
3. An indication of whether the number of clutches is increasing or decreasing
4. Specific threats to the turtles

To prevent any confusion, we set the survey up to restrict the responses to categories which we have previously defined. The latitude and longitude must be given in decimal degrees from north and west. The number of clutches ranges from “0-10” to “5000+”, and the user may select only one option using a drop down box. The same design is used for the pattern on the beaches: decreasing, increasing, or staying the same. Both the number of clutches and the pattern fields have the options “Unknown” and “Unavailable”, which account for countries where the information hasn’t been researched and for countries where research records do not hold the requested information, respectively. It was a design concern in the survey that these terms were ambiguous. However, since they were used in the annual reports given by the IAC, the format was kept for consistency between the documents. The final part of the survey provides discrete yes or no responses for specific threats, and has a field for “Other” threats to be entered in a text box.

We created two prototypes of the survey which can be seen in Appendix D and tested each for ease of use. The first, designed in Microsoft Word, was intended to be aesthetically appealing and user friendly. The second, designed in Microsoft Excel, was intended to allow more efficient data entry and to show more information at once. Both versions used radio buttons, shown in Excel in Figure 21.

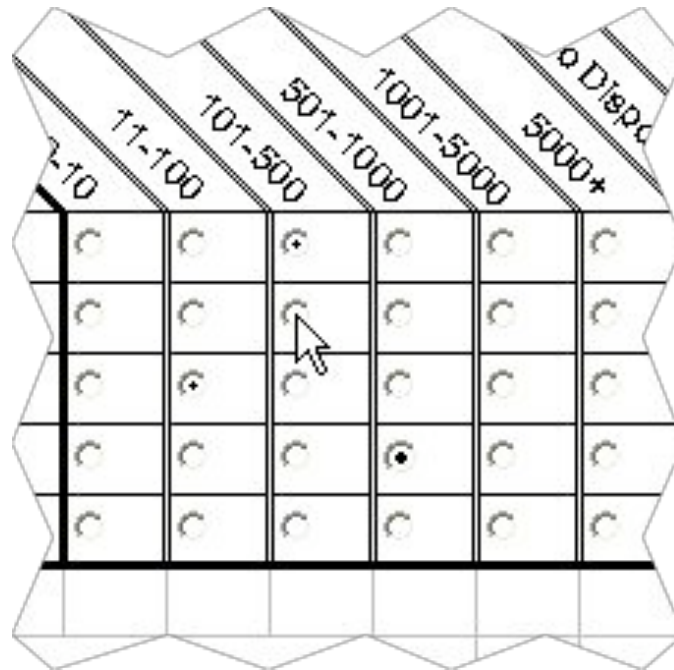


Figure 21: Radio buttons in Excel

B. Dick and L. Higgins proofread the survey to ensure proper grammar and congruency with the questions asked in the annual reports. After, we tested the survey on several employees from the FPN who have experience dealing with government organizations. The pre-testing showed that both files were too large to load on many computers in a reasonable amount of time. The pre-testing also showed that the Excel version was easier to use, so the components in the document were modified to lower the file size. Specifically, we employed drop down boxes as opposed to check boxes or radio buttons. A sample of the spreadsheet using a drop down box is shown in Figure 22.

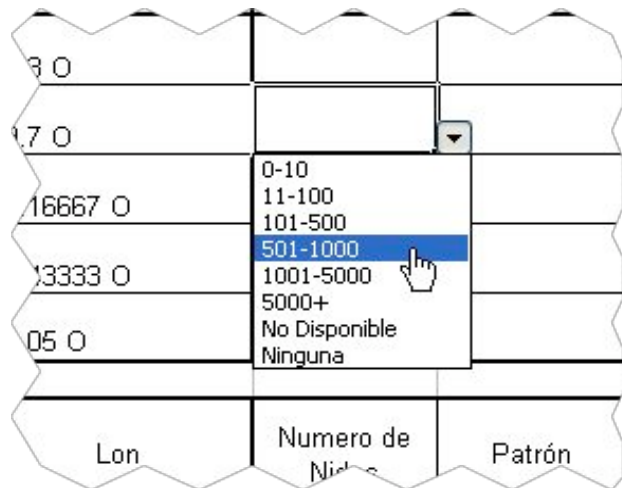


Figure 22: Drop down boxes in Excel

The surveys were distributed to eight of the twelve countries party to the IAC by email. On recommendation from B. Dick, we did not submit the survey to the governments of Honduras, Guatemala, or Peru, since responses were not expected. Uruguay was not a member of the IAC at the time, so a survey was not sent to Uruguay. Peru is a member of the IAC but the hawksbill species does not nest on their beaches. Honduras has trouble retrieving nesting information, and the locations of beaches are controversial due to legal issues over the ownership of many islands. B. Dick had visited this country before our arrival to Costa Rica and had explained that she had obtained as much information as was available. Based on B. Dick's experience, a response was not expected from Guatemala, which also only has two nesting beaches for hawksbill turtles, so was not considered a priority.

After the surveys are returned, the information will be incorporated into the database. The format for the database will remain constant to allow B. Dick to continue to use it if survey responses arrive after our time with the project is completed. The database format can be changed by B. Dick if she decides to add additional information which is also discussed in the recommendations chapter.

The information from the database was used to develop a mapping system of hawksbill nesting sites. As surveys and the 2007 annual reports are returned to the IAC the database and mapping system will be updated accordingly.

3.3 Mapping System Design

We used a number of strategies for determining how to best display information about hawksbill nesting graphically in a map. This section discusses the research behind our mapping system and the testing we did to improve it.

The IAC's map of all marine turtle nesting sites provided a model for our mapping system, as similar functionality and visuals were ideal for our project. We examined the methods that were used for plotting the data and for displaying information within the program.

To augment and improve the style of the IAC map we began with, we examined key features of the successful mapping models described in the background chapter, investigating their approaches to the following:

- Types of data displayed, including
 - Size of nests
 - Threats to turtles
 - Species information
 - Ocean conditions
 - Patterns or trends at individual sites.
- Style of glyphs used, including
 - Size of glyphs
 - Use of color
 - Use of shape.
- View options, including
 - Ability to zoom or pan
 - Option to see countries one at a time
 - Filter of displays that allowed features to be shown or hidden.

From this information, and the IAC's map model, we created a prototype design for the mapping system.

We used the information we already had from the annual reports to fill in the mapping system. The beaches for which we had latitude and longitude information were plotted in the appropriate geographical locations to use for a sample map.

To determine the style of glyphs to use for the map, we designed prototypes and pre-tested them. Twelve WPI students and one WPI professor provided feedback in a brief survey that focused on aesthetics and readability of the glyphs.

For the user testing, we generated images of coastlines containing different versions of the prototype glyphs. These images can be seen in Appendix E. In the first test, users were asked questions about what they thought different colors of glyphs represented. This was to determine which colors of glyphs we should use to represent patterns in sea turtle populations. Their responses were recorded. In the second test, three coastlines containing different styles of glyphs were displayed side by side. We asked the subject which set of glyphs they preferred visually, and which displayed the information most accurately. Their responses were recorded. The final test showed two coastlines side by side containing two styles of prototype glyphs representing threats to turtles. We asked the subject which was more understandable and why. Their responses were recorded.

From this pre-testing, we used those glyph designs most preferred and understood by our users to create a new set of prototype maps. For more feedback, we discussed the prototypes with D. Chacón asking him

Which of the versions we presented he recommended and why

- Methods for representing threats graphically
- Methods for representing more detailed information about turtles graphically, such as data on foraging and migrating

The feedback from this interview provided us with a number of improvements in the final design of the map.

3.4 Design of the Brochure

We decided to create two formats to use as visual aids to represent the information in the database. The mapping system was the first, and we proceeded with the design of an accompanying informative brochure showing information on the decline of the hawksbill sea turtle. This would be a product that would be provided along with the map. In talking to B. Dick we then decided to use a prior brochure that she had created as a prototype, which can be seen in Appendix F. In the future, B. Dick intends to make similar brochures

for all of the species, so keeping the design format was important to maintain consistency. Also along with the design B. Dick also mentioned the importance of retrieving as much information for the brochure as we could from the IAC sources. As mentioned in Chapter 2, this brochure will be influential because the source of the information is an organization recognized as credible by each member nation.

3.5 New Annual Report Format Design

In addition to the mapping system, another deliverable was a new format for the annual reports. From the analysis of the annual reports, we considered several improvements to the format. We generated a prototype of these improvements, and presented them to D. Chacón in an interview and asked specific questions about their usability. D. Chacón is a member of the scientific committee of the IAC, and has experience in designing and completing reports of this type. In particular, we asked about the ease of use of a number of components in the prototype, and inquired about strategies that could be used in making the report more efficient. Further contact with B. Dick provided feedback that led us to the final design of the report format.

3.6 Methods Summary

We have used a number of methods in discovering strategies to gather and represent data concerning hawksbill sea turtles. Through an analysis of the annual reports by the parties to the IAC, we found gaps in information, and identified ways in which the reports could be improved. Best practices from previous mapping systems provided a means to display this information graphically. Interviews and direct contact with experts on sea turtles provided content for an informative brochure and recommendations for gathering and displaying information. The results of our research and discussions of the final products are the concern of the next chapter.

4 Results

This project has primarily resulted in the creation of a number of deliverables for the IAC. We analyzed the annual reports to determine which information was missing and used various methods to fill in that information. This analytical data was used to make improvements to the format of the annual reports and to produce a better format to be distributed by the IAC each year. The information gathered was used to populate the database. A visual mapping system was created to display this information. The images from the mapping system were used in an informational brochure for raising awareness of decline of the hawksbill sea turtle and their importance to a healthy ecosystem. This set of results will help the IAC advance their research and promote awareness for sea turtle conservation.

4.1 Analysis of the Annual Reports

In our analysis of the annual reports, we found a number of gaps in the information provided. This section summarizes what kind of information was missing and from which countries.

There were two sets of information missing from the reports that we analyzed. They included the number of sea turtle nests and the coordinates of the location of each beach in each country. To find the gaps it was only a matter of looking at the data to determine if a country had reported the information or not. Table 3 summarizes the quantity of information contributed by each country and the average for all countries for each category.

Table 3: Percentages of nesting and location information received in annual reports

Country	Clutch Quantity Information	Beach Location
Belize	0%	0%
Brazil	100%	100%
Costa Rica	13%	38%
Ecuador	0%	40%
Guatemala	0%	50%
Honduras	0%	0%
Mexico	64%	73%
Netherlands Antilles	0%	100%
United States	83%	0%
Venezuela	0%	95%
Total for All Reports	20%	52%

The percentage value for each country represents how much information was retrieved from the annual reports. The total value is the amount of information submitted in the annual reports by all countries. Table 3 shows that only twenty percent of all nesting site information and fifty-two percent of all beach locations were provided by the member countries. From this analysis, nesting information was only reported for one in five beaches in the reports. Latitude and longitude information was reported for just over half of the nesting sites. Brazil was the only country to provide complete information; Costa Rica, Ecuador, Guatemala, Mexico, Netherland Antilles, United States, and Venezuela provided near-complete information; and Belize and Honduras did not provide any information for either the locations of the beaches or the number of clutches. The United States reported in the comments field what states or regions the nests were in, such as Florida or Puerto Rico, but they did not provide latitude and longitude coordinate information. From this analysis of the reports, it was clear that a significant amount of information was lacking from the annual reports. In addition, some information was not entered in the format requested in the document.

In the annual reports, there was no systematic method by which threats to sea turtles in each country were reported. There were specific instructions for how to submit this information, but they were not always followed. In most cases, threats were described through text in a comments box that was provided in the reports. From the content analysis

described in section 3.1.2, we created a chart of which countries had reported threats in each category. A summary of this information is shown in Table 4.

Table 4: Threats in each country from annual reports analysis

	Direct Take	Fisheries Impact	Global Warming	Pollution and Pathogens	Coastal Development
Belize	Reported	Reported	Reported	Reported	Reported
Costa Rica	Reported	Reported	Reported	Reported	Reported
Ecuador	Reported	Reported	Not Reported	Reported	Reported
Honduras	Reported	Reported	Reported	Not Reported	
Netherlands Antilles	Reported	Not Reported		Not Reported	
Guatemala	Reported	Reported	Reported	Reported	Reported
Mexico	Reported	Reported	Reported	Not Reported	
Peru	Reported	Reported	Reported	Reported	Reported
USA	Reported	Reported	Not Reported		Reported
Venezuela	Reported	Reported	Reported	Reported	Reported
Brazil	Reported	Reported	Not Reported	Reported	Reported

	Reported
	Not Reported

Table 4 shows the countries that reported threats in each of the five major categories. Direct take was the most widely reported threat, which is consistent with our background research and affirms the assumption that the greatest danger to hawksbills is their consumptive use. Fisheries impact was a problem in almost all areas, as well. The least reported threat was global warming. This could be because the effects of global warming are largely environmental and may be the most difficult to detect.

In addition, several countries reported threats that did not fit into any of these five categories. These included:

- *Legislative and enforcement issues* – Reported by several countries, this is not a direct threat, but is a consideration that may increase the effects of other threats.
- *Predation by animals* – Several instances of feral or domestic animals attacking the eggs and or hatchlings were reported.

- *Destruction of habitat* – Closely related to both development and tourism, but also includes sand extraction from beaches, which is different than development of the beaches.

It is important to note the minority of threats that fall outside the major categories as they still have effects and could grow in importance in the future. Organizing the threats into these categories allowed for a clearer display of which threats applied to each country, especially in the creation of the mapping system.

4.2 Missing Information Acquired

In order to have as much information as possible to use in the mapping system and database, we needed to find the number of clutches, beach locations and threats from more than just the 2006 annual reports. We found data on hawksbills from a number of sources; direct contact with B. Dick, the ArcView database she provided, communication with Didiher Chacón and the IAC Flash map database. Through these sources we acquired more data than was initially available from the 2006 annual reports. In particular:

- The ArcView database contained latitude and longitude coordinates for nineteen beaches.
- B. Dick's personal records and contact provided nesting information for eight beaches.
- The 2007 annual reports for Brazil (the only country submitted at the time of this writing) provided nesting information for five beaches.
- The IAC Flash map database provided location information for eight beaches in Honduras.
- D. Chacón provided nesting and pattern information for four beaches in Costa Rica.

This information, in addition to the initial data acquired from the annual reports, was used in the creation of the mapping system. At the time of this writing, none of the countries had responded to the surveys mentioned in chapter 3. It is expected that some

responses will be received in the future. For this reason, we designed the database with features to make it easy to add data to, and easy to catalog the origin of any data we receive. A few specific features of the database accomplished this goal. The database was created in Excel, and the cells in the table were color-coded based on the origin of the information contained within. A sample of the database is shown in Table 5

Table 5: Sample of database-Costa Rica

Serial #	Name of Beach	Latitude	Longitude	Number of Clutches	Pattern
CR1	Tortuguero	10.5975 N to 10.31778 N	83.52778 W to 83.36083 W	11-100	Decrease
CR2	Gandoca	9.60164 N	82.60834 W	11-100	Decrease
CR3	Cahuita	9.73221 N	82.81706 W	11-100	Decrease
CR4	Isla Uvita			0-10	
CR5	Playa Negra de Puerto Vieja	9.6600000 N	82.754000 W	11-100	Decrease
CR6	Playas Caletas- Ario			0-10	
CR7	Punto Banco			0-10	
CR8	Punto Pargos			0-10	

Legend (Source)
ArcView Database
2007 Annual Reports
Belinda Dick
Didiher Chacon
Annual Reports
Not available


The beaches are all serialized with a short code so they can be referenced easily even if reported in different languages or with different spellings. The convention used for coding was a short country code followed by a sequential numbering of the beaches in the order they were listed on the annual reports. When information arrives from the surveys, it can simply be added to the appropriate location in the table found by the serial number. The same can be done for information from the 2007 annual reports, which would not have arrived before the completion of the project. With the annual reports, it will be necessary to match up the beaches with a characteristic other than the serial number, since these serial numbers only exist in the database created for this project. However, the name and location of the beach should be sufficient to add it to the database with the correct serial number. With this structure in place, further information can be easily included in the database.

This structure provided an organization of all the data available for the creation of a mapping system.

4.3 Changes to the IAC Annual Report Format

Throughout this research it became apparent that the complexity of the initial annual report format distributed by the IAC was an obstacle to data collection. As a way to reduce the amount of researching that had to be done after the reports were turned in, we designed an improved annual reports format to be distributed to each of the countries. This format was designed to be simple to use, and to reduce the amount of errors that a user could potentially make. With this new format, it will be easier for the member countries to fill out the report, and easier for the IAC to disseminate the information.

The information requested in the annual reports and much of the specific wording for the categories of the information could not be changed. According to B. Dick, this information is decided upon at the convention, it would take years of work to make minor changes due to the fact that the organization needs to vote on any changes before the report would be approved. Upon recommendation of B. Dick, the redesign of the format was kept to changes in the interface for inputting data, without altering the types of information. She stressed the importance of improving the format of the annual reports before making changes in the content of the annual report. One of the most noticeable changes to the design of the report format was the way that the tables were arranged within the file. Most all of the information entered in the reports needed to be entered in tables. In order to keep the format a single document, B. Dick had designed embedded spreadsheets within the document. Figure 23 is an example from the previous annual reports format. A complete sample of the annual reports format may be found in Appendix B.



Inter-American Convention for the
Protection and Conservation of Sea Turtles
[Insert Country]
2006 Annual Report

	Types of use	Specie	Products	Ocean Basin	Origin*		Estimated annual quantity	Information source	Actions
					L	I			
Consumptive Use									
Non-consumptive									

* L = legal, I = illegal

3. Main threats
3.1 Habitat and other threats

Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

3.2 Capture (Intentional/incidental)


Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

Figure 23: Old format of annual report

This method of embedding the spreadsheets into the document made it difficult for the users to easily add information, and made it difficult for their information to be displayed properly. Also, there was a separate document with the instructions, which made it necessary to cross reference two documents to fill out the information. The redesigned file solved both of these problems by making the format more useable. The final document has all of the instructions in each of their respective sections, directly before the areas designed for data entry. Any information that needs to be entered into a table has a link with an icon shaped like a turtle (see Figure 24).

1. Biological Information

1.1. Species present
Fill in the respective blanks depending on (the Convention) for different phases: R = reproduction; F = foraging



1.2. Important sites for sea turtle conservation

a. For each phase, indicate the names of places and their seasons. Confirmed presence of sea turtles at each site and its season. Confirmed presence of sea turtles at each site and its season.

Figure 24: Icon leading to documents

When the user double clicks on the link, a spreadsheet will pop up in a separate window to allow the user to enter information. For some sections, the user can also add written information to respond to open ended questions. D. Chacón recommended these types of organizational devices and told us that they had been successful in the past (2007). These changes make the format much more organized, as less information is displayed on the screen at one time.

Within the tables themselves, several features for responding are added or altered. Each of the tables was redesigned with simplicity, ease of use, and aesthetics in mind. The tables' visual layouts were kept similar in order to help users who were already familiar with the previous design. Techniques were employed that we had investigated during the pre-testing of the survey we designed. Many of the options are available as restricted responses using drop down boxes which will let the user enter only a defined list of items or a specific range as shown in Figure 25.

Protection Category	Observations		
	Clutches	Hatchlings	Other
n/a	11-100	10001-50000	many turtles were seen
n/a	0-10	Unknown	Often there are turtles on
		Unknown	
		Unavailable	
		0-1000	
		1001-10000	
		10001-50000	
		50001-100000	
		100001-500000	
		500001-1000000	

Figure 25: Drop down box for hatchlings

All of the possible responses are defined in the instructions, but the drop down boxes adds a component of redundancy to the format. Error messages will give instructions should the user enter an incorrect value, as seen in Figure 26.

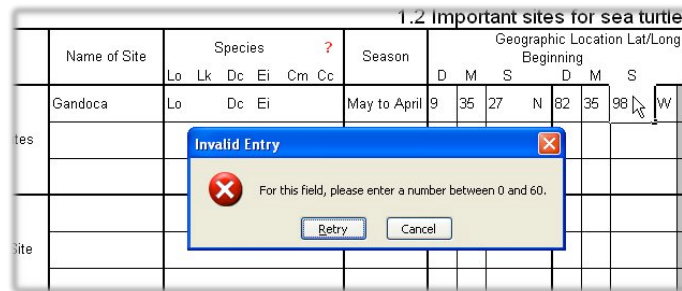


Figure 26: Error message on restricted responses

This simplifies the process for the user by not making them reference the instructions page to be reminded of what the possible responses are. In addition, this simplifies the analysis process for the IAC by reducing the number of unexpected responses. Drop down menus, however, were only one of the improvements to the tables themselves.

B. Dick recommended, and D. Chacón confirmed, that having pop up help boxes will help users fill out the reports (2007). The final product has many pop up menus which provide the user with help on a specific category as seen in Figure 27.

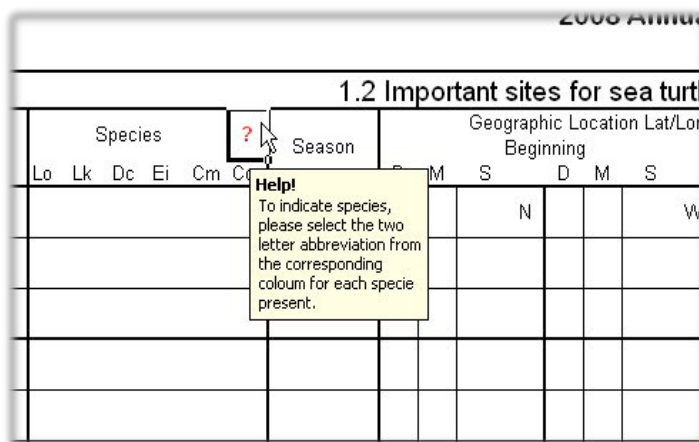


Figure 27: Help boxes

Much of the information in the pop up boxes repeats the instructions, adding redundancy to the format. These help boxes make it easier for the user to fill out the report.

There were some minor, non-conflicting, changes to the actual information requested in the annual reports. On many of the pages where the user has to answer using restricted responses, we added ‘comments’ field to allow the user to communicate any

additional information necessary to explain their entries. An example of the comments field is shown in Figure 28.

Actions	Comments
Segun la nencion	Las amenazas son frecuentemente
Segun la nencion	No comun
Segun la nencion	sin efecto, pero con las

Figure 28: Comments field

In several of the sheets, we added a separate blank worksheet to allow for input of graphs, tables, and large quantities of data as seen in Figure 29.

migratory routes	Pacuare	Lo	Dc	Ei	August
	Gandoca	Lo	Dc	Ei	Feb to August

1.2 Important Sites / Additional Information

Figure 29: Additional sheets

B. Dick had informed us that oftentimes the countries may have information to report, but it would be obscured by the format of the report, or would be too difficult to insert into the document (2007). This will allow the user to easily add graphics, graphs, or data without disrupting the format of the report. Also, we added a separate annex to the format to ask for information on the countries' actions regarding several specific resolutions of the convention. B. Dick had told us that Mexico had responded to each of the resolutions separately in their last report, and she felt that allowing this type of response would be a useful addition. All of these changes will help increase the quality of information received from the countries each year.

Finally, the format was designed to be easy to distribute without worrying about errors. D. Chacón had recommended a file size of no more than five megabytes to accommodate for low speed dial up connections in many areas of Latin America. The combined annual report format and instructions of the older annual reports was 1.3 megabytes. The final size, with all of our additions was 1.6 megabytes, well within the acceptable size limits. In addition, all of the worksheets are password protected against

changes to the format. This has a twofold purpose. It not only reduces the chance that a user will accidentally modify the format, but it prevents users from intentionally changing the format. These small but important details make the final product an easy to use and implement document.

The final product is a usable document. It allows for efficient input of information, is well organized, and employs redundancy within the instructions to reduce confusion on the user side. Based on our research, the new format is a definite improvement over the one used previously. An electronic copy of the full document accompanies this report in the file named “ANNUAL_REPORT_FORMAT_2008.doc”. This document provides a tool for the IAC to improve the quality of their data collection and simplify the dissemination process of the annual reports.

4.4 Summarizing the Information Graphically

4.4.1 Mapping System of Database Content

To display the information we had compiled from the annual reports and other sources, we created a display of the data in a mapping system. Two versions of the display were created, with different purposes in mind. One provided a more detailed view of each country, and the other provided a view of the Caribbean as a whole. The same graphical style was used in both versions, and both were designed using a combination of Macromedia Flash and ArcView.

4.4.2 Country Specific Version

This version of the map was created first. We started with images for eleven of the twelve member countries of the IAC (Uruguay again was excluded), using maps that had been used in the mapping system previously created by the IAC. Figure 30 shows the map for Costa Rica.

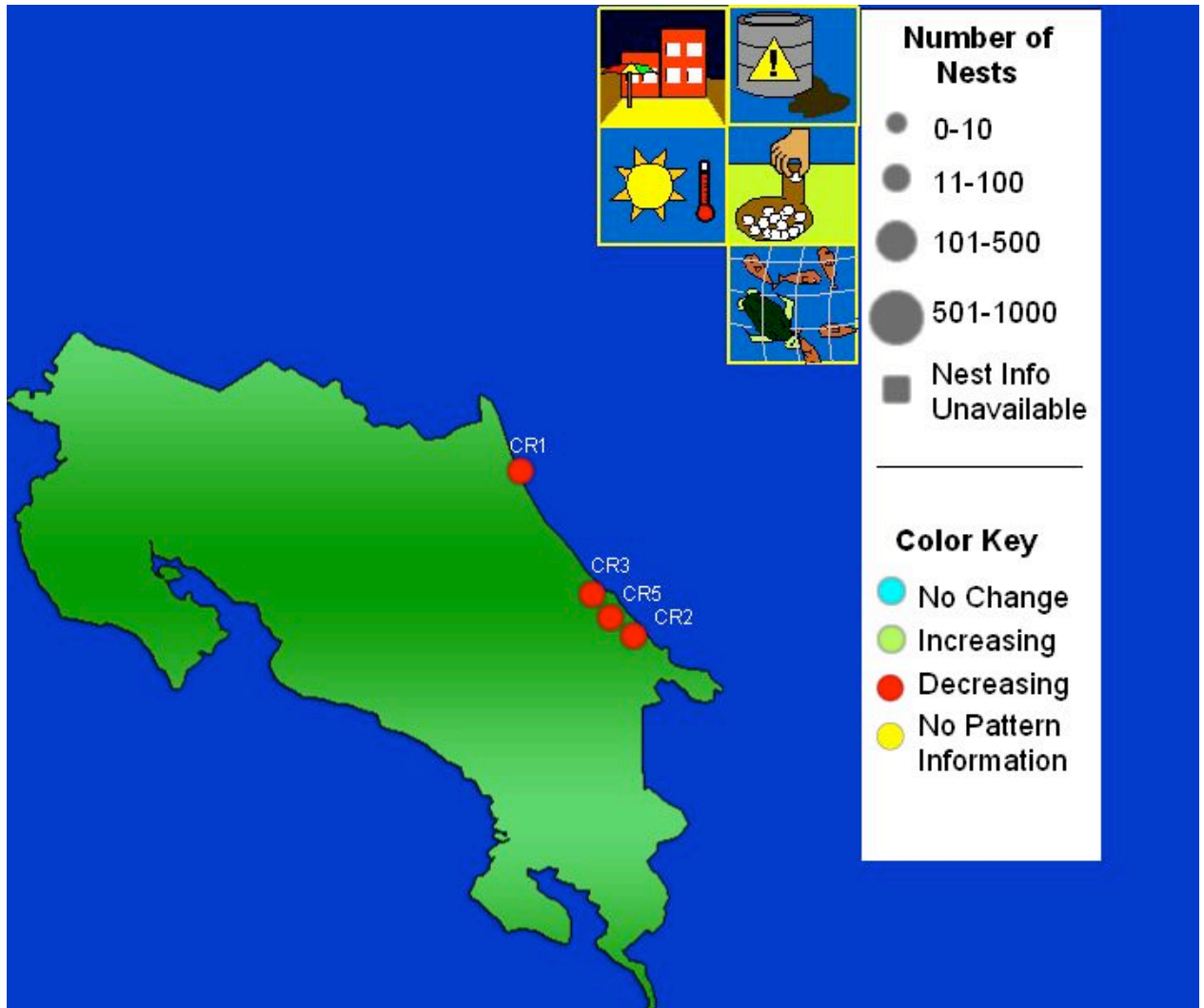


Figure 30: Example map of Costa Rica

The information shown in this map is contained in each country's map.

Specifically, this includes

1. Locations of nesting beaches shown as colored glyphs
2. Key that details information about the meaning of glyphs
3. Serial numbers corresponding to individual beaches
4. Icons which display the main categories of threats reported by the country

Further information about each beach is provided in an accompanying spreadsheet. The serial numbers at each beach are used to reference specific information about the beach in the table. Part of the table for Mexico is shown in Table 6.

Table 6: Sample of database accompanying map

<u>Mexico</u>	Name	Latitude	Longitude	Nests
M1	El Cuyo, Yuc.	21.48333 N to 21.54583 N	87.49167 W to 87.8 W	101-500
M2	Isla Aguada, Cam.	18.95 N to 18.78333 N	91.3 W to 91.46667 W	101-500
M3	Punta Xen, Cam.	19.5 N to 19.225 N	90.75 W to 90.84333 W	101-500
M4	Las Coloradas, Yuc.	21.61111 N to 21.54167 N	88.16667 W to 87.79167 W	101-500
M5	Chenkan, Cam.	19.225 N to 19.07 N	90.84333 W to 91.21806 W	101-500
M6	Tecolutla, Ver.	20.49083 N to 20.57528 N	97.01444 W to 97.10861 W	0-10

When the beaches were plotted on the map, a number of them had already been plotted in the ArcView database provided by B. Dick. These points were placed on the map by visual examination. The amount of error caused by plotting in this way was deemed insignificant due to the size of the dots relative to the accuracy of the location information. According to D. Chacón, it was more important that the map be readable and clear, which involved having the points be so large that they did not convey precisely accurate location information (2007). For beaches which were not in the ArcView database, but had locations, the program Google Earth was used. Google Earth is a mapping utility that allows the user to input longitude and latitude coordinates, and displays the location on a graphical globe. Once again, exact geographical accuracy was not as important as readability and clarity, so placing the beaches visually provided a map that was sufficiently precise to display the information we needed to communicate.

4.4.3 Glyph Design and Testing

Different styles of glyphs were tested, and the set found in the final map was determined to best communicate the size and pattern information. As the key in Figure 30 shows, each of four colors corresponds to a pattern that is increasing, decreasing, remaining constant, or is unknown. The size of the glyph shows how large the nesting site is, and two different shaped glyphs show if the size information is unknown or unavailable, as defined in the annual reports.

The choice of these specific glyphs was based partially on the results of pre-testing. One important question asked the users which colors the users thought were the most representative of the different pattern information. We showed the colored glyphs on a map to 12 students, and asked them to choose which color best represented each of the four categories of pattern. The results of this test are shown in Table 7.

Table 7: Results from pre-testing glyphs

<u>Increasing</u>	<u>Decreasing</u>	<u>Constant</u>	<u>Unknown</u>
Green: 83.3%	Red: 91.7%	Yellow: 66.6%	Gray: 91.7%
Yellow: 8.3%	Yellow: 8.3%	Blue: 25.0%	Yellow: 8.3%
Blue: 8.3%		Red: 8.3%	

With the information on which colors were chosen the most in each category, there were some strong suggestions. Green, red, and gray were the most clearly represented, with the vast majority of the respondents choosing these colors for the respective meanings shown in Table 7. Yellow was also strongly favored as the color to represent a “constant.”

In the second test, the use of symbols was evaluated. Most users responded that they thought the glyphs which used both symbols and color to show the pattern information were more informative. The two styles of glyph are shown in Figure 31.



Figure 31: Examples of the glyphs

Correspondence with D. Chacón provided more feedback on possibilities for glyph designs. He indicated that the symbols on the glyphs were often extraneous. If the colors were clearly understandable and there existed a simple key, the symbols were unnecessary. In addition, symbols tended to be difficult to read when a number of beaches were close to one another. This was not an issue that pre-testing subjects acknowledged because the example maps used did not have close clusters of beaches. For this reason we chose colored glyphs containing no symbols to use on the final map.

When prototypes of the map were created, some changes were made to the color selections. While users reported gray as an indicative color choice for an unknown or unavailable pattern, we anticipated that a number of beaches would have the pattern

information unavailable. For this reason, we wanted a color that had more contrast with similar glyphs around it. Yellow was chosen as the color to represent “unknown” information, as it had good contrast with its darker outline, and was the only other color reported to represent unknown in pre-testing. Blue was then chosen as the color to represent a constant pattern, as it was both visible and a second choice in testing.

4.4.4 Key

These final glyphs were used in the design of the map and used to create the key that can be seen in Figure 30 at the beginning of this section. Gray was used to show the different sizes of glyphs, as it was not a color that represented pattern information. The different shapes used for information about size information that was unavailable or unknown are also displayed along with the color information.

4.4.5 Displaying Threats

Over the course of designing and developing a prototype of the mapping system, a number of techniques were considered for displaying threats to specific beaches or specific nations. D. Chacón suggested using icons, or regionalizing threats based on larger areas in which they took place. In the maps we were designing, it wasn't feasible to fit the threats specific to each beach on the image. So instead, the categories of threats that were reported in each country were simply displayed as text on each map. The five categories, with the icons used to represent them, are shown in Figure

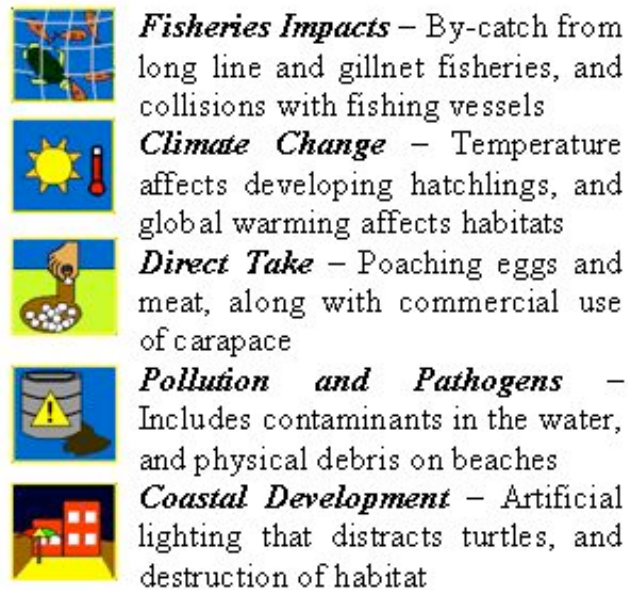


Figure 32: Categorical threats and icons, from cover sheet

Several icons were developed to represent these threats. The icons are included in the database next to the key, and are explained in the cover sheet. Each icon was designed to clearly communicate the threat in a simple, clear manner. Any additional threats not included in these five categories are described in the accompanying database.

4.4.6 Cover Sheet

To explain some of the features of the mapping system when shown in a presentation, a cover sheet was created with descriptions of the components of the images. The cover sheet in its entirety can be found in Appendix H. The main points included in the cover sheet were:

- A key that described the threat icons
- An explanation of the nesting information and pattern information keys
- A reminder that the number of nests at a beach is often significantly greater than the number of nesting females, since females nest more than once a season

This cover sheet, used in conjunction with the mapping system and accompanying database, is intended to provide the IAC with tools to present information about nesting hawksbills concisely and effectively.

4.4.7 Regional Map

In addition to the individual country views, we created a map that showed the entire Caribbean region, broken up into three areas as shown in Figure 33.

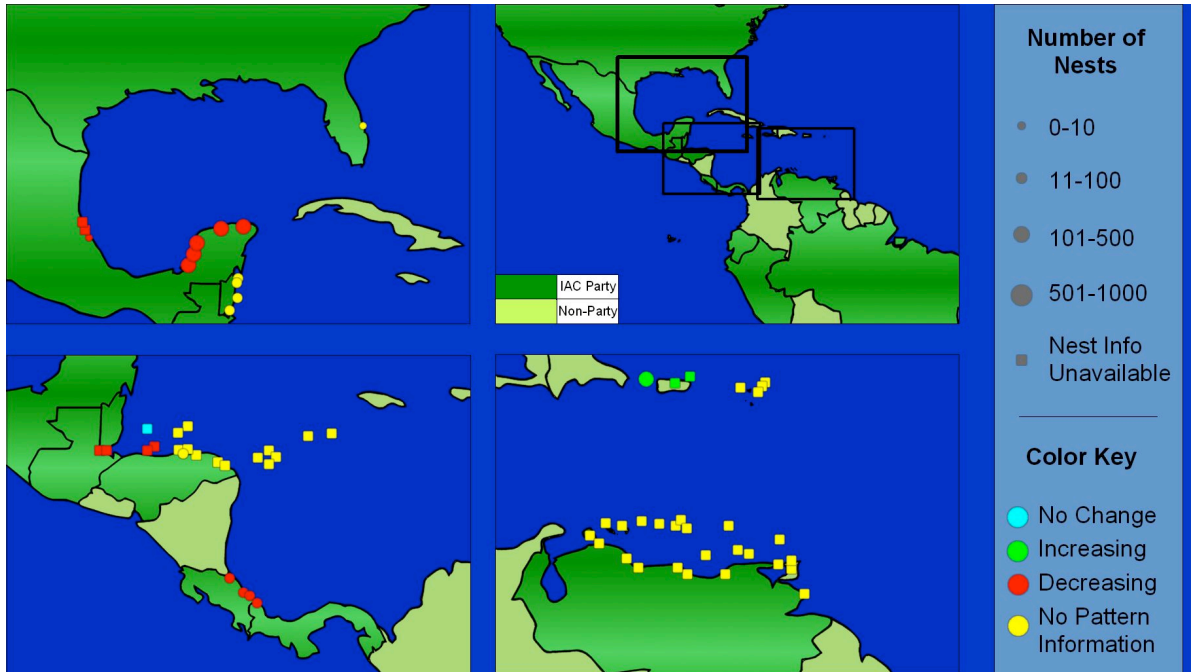


Figure 33: Regional map

This map uses the same glyphs as the country specific maps, and uses the same sources for its information. The distinction is made between members and non-members of the IAC, and information is only shown for member countries. The reason this separate map was created was to have a more compact image that could be used in the brochure described in the next section. In contrast, the country specific images will be used to recommend an interactive presentation of the data.

4.5 Brochure Design

To accompany the map and the database, we created a paper brochure. Modeled after a similar brochure for the leatherback turtle, this brochure focuses on the decline of the hawksbill turtle and its importance to the environment. The brochure includes

information on the history of the species, principal threats, and major causes of the recent decline. Much of the information in the brochure came from background research and personal communication with B. Dick. The layout of the brochure is shown in Figure 34, with labels highlighting key features. For the entire brochure, refer to Appendix F.

1 Hawksbill and Coral Reefs:

- 1. Hawksbill turtles are important to the health of the coral reef by having a specific grazing population. If their population were to diminish, they would compete with other species for space and sunlight, leading to a loss of diversity.
- 2. A loss of biodiversity will weaken and eventually destroy the reef. The loss of these grazing species will lead to a loss of structural complexity and diversity.
- 3. Without grazing and the hundreds of species that depend on them, the reef will be degraded.

2 Date of Hawksbill decline in the Western Hemisphere, from the 1970s decade since 2000.

3 Map of the Caribbean and Western Atlantic showing the distribution of Hawksbill turtles.

4 Principal Threats:

- Over-exploitation of shells
- Global Warming
- Destruction and alteration of habitats: loss of coral reefs

5 Map of the Caribbean and Western Atlantic showing the distribution of Hawksbill turtles.

At the fourteenth meeting of the conference of the parties of the Convention on International Trade of Endangered Species (CITES), a Resolution was adopted. CITES called on governments with the IAC to make funds for such a meeting possible in the meeting on the protection of the IAC.

What sources of action can you take? International cooperation is essential in tracking and managing species survival. Collaboration on hawksbill conservation also allows the sustainability of economic benefits of coastal and marine ecosystems provide. The Inter American Convention for the Conservation and Protection of Sea Turtles (IAC) is committed to promoting the protection, conservation and recovery of sea turtle populations and the habitats on which they depend with an emphasis on developing bilateral and multilateral agreements and the exchange of information and technology. Due to the critical state of the hawksbill, the Third Conference of the Parties, held in Mexico in 2006, approved Resolution CITES COP14 Res. 6.1, Conservation of the Hawksbill Turtle (*Eretmochelys imbricata*), urging contracting parties to monitor and control trade of hawksbill and to prohibit, among other actions, poaching, and stop illegal trade. Another goal of the resolution is to protect important hawksbill nesting and foraging sites. The resolution calls for joint research efforts on the cause of the recent decline in hawksbill populations in an attempt to stop this negative trend. It also calls for an global trade embargo for hawksbill products.

Figure 34: The hawksbill brochure

Figure 34 highlights the five major graphical items in the brochure.

1. Hawksbills’ effects on coral reefs:

Hawksbills and Coral Reefs:

1. Coral reefs, one of the Earth's most diverse living ecosystems, are often called the rainforest of the sea. They provide homes and a nursery for numerous marine species, and the livelihoods of millions of people around the globe depend on their health. They also provide coastal communities with protection from storms, wave damage and erosion. There is also evidence that they may hold undiscovered biomedical resources.
2. Hawksbills play an important role in the health of the coral reefs by feeding on specific sponge populations. If these populations are left unchecked, they can out compete other species for space and nutrients, resulting in a loss of diversity.
3. A loss of diversity can kill coral reefs and other species that live there. The less diverse systems aren't as resilient to both natural and anthropogenic threats such as climate change, sedimentation and run-off.
4. Without thriving reefs the livelihood of fisherman that depend on them as well as the safety of coastal towns would be at great risk.

Figure 35: Hawksbill and coral reef connection

Figure 35 shows a detailed view of the description of hawksbills' effects on coral reefs. This component was designed primarily due to the reported effectiveness of a similar section of the IAC leatherback brochure that described how the presence of the leatherback is important to the fishing industry. Identifying the significant effects that the decline of the species could have is intended to underscore the importance of the conservation message.

- Graph of hawksbill populations on the Yucatán Peninsula in Mexico as seen below in figure 36.

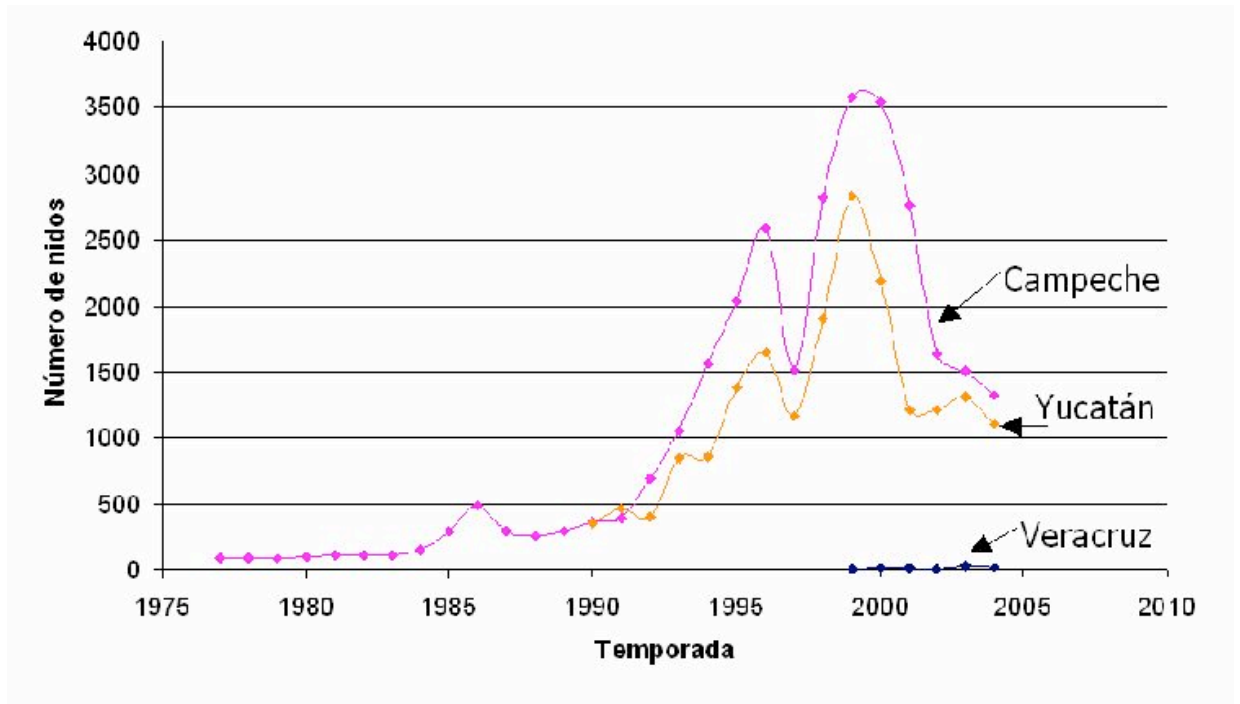


Figure 36: Graph of the decline of hawksbill in Mexico

This graph was included in the brochure to show the recent and significant drop in hawksbill populations in Mexico. The recent decline shown in the picture shows data that supports the recent crisis facing the hawksbill.

- These are images of hawksbill jewelry given for reference. The text of the brochure describes products made from hawksbill carapace, and the images shown in the brochure show the kinds of products described.
-



Figure 37: Principle threats to hawksbill from brochure

This box displays the major threats to hawksbill sea turtles. This information was determined to be important enough that it be highlighted and conveyed in a clear, succinct form.

5. The regional map of hawksbill nesting sites in the Caribbean is included in the report to illustrate the kinds of materials that are available concerning hawksbills. The text also contains a hyperlink to a website that readers could use to access the complete slideshow mapping system on the IAC website.

The text of the brochure provides detailed descriptions of a number of key issues concerning hawksbill sea turtles, including:

- Possible ways to protect hawksbills
- Statistics on the decline of the species worldwide
- The Inter-American Convention for the Conservation for the Protection and Conservation of Sea Turtles
- An upcoming meeting on hawksbills hosted by the Convention on International Trade in Endangered Species (CITES)

According to B. Dick, there is a better response to online resources presented at conferences and meetings if the members are also provided with a physical document as a reference. This brochure should be effective in providing a tangible document to relay key facts and information about hawksbill turtles at conferences and meetings which the IAC hosts and presents.

4.6 Summary of Results

These final deliverables which we have created for the IAC provide them with a new way to collect, distribute, and represent information. We created two types of visual aids, a map and a brochure, to appeal to different audiences. B. Dick and Sr. Chacon stressed the importance of providing information in more than one medium. This helps to ensure that information is received by a broad audience which includes government

officials working with the IAC. The new annual report format will increase the ability of countries to provide quality responses to the IAC. Restricted responses and error checking will improve the accuracy as well as the ease of use of the format. The creation of the database led us to these deliverables and provided the basis for a number of the conclusions and recommendations which we discuss in the following chapter.

5 Conclusions and Recommendations

This project addressed several specific issues concerning sea turtle conservation and the IAC. Analyzing the annual reports revealed where information was missing, and where data collection could be improved. A new form used to gather information will help keep these types of publications up to date, and facilitate the ease of creating of future publications. We researched information necessary to compile the mapping system and make the accompanying brochure. Together, these two mediums are an effective tool for communicating information about hawksbill sea turtles. These final products represent current improvements to the IAC, and our recommendations offer suggestions for the future.

5.1 Collecting Conservation Information

One of the challenges facing the IAC was acquiring accurate and complete information from the parties of the Convention. There were a number of gaps in the 2005 and 2006 annual reports and it became apparent that a new solution was needed. This project addressed this problem in two ways. First, we conducted research to find information about hawksbill nesting at specific beaches in the countries party to the IAC in order to fill in current gaps in information. To address the problem of acquiring data in the future, we investigated ways to modify the format of the annual reports filled out by the nations of the IAC. While our research supports that the changed format is one method for reaching this goal, it is only the first step in a system for collecting conservation data on sea turtles on a large scale.

5.1.1 Missing Information Acquired

We collected conservation information on hawksbill sea turtles from a number of sources, with the goal of filling in gaps in the annual reports. We acquired specific

information about hawksbill nesting at particular beaches or in particular regions. The data we acquired was primarily important for the mapping system we created to show hawksbill nesting information in particular areas. However, it did not provide all information needed to complete the annual reports. For acquiring this data on a large scale, it was necessary to investigate the tools the IAC used to collect data from its parties.

5.1.2 The New Format for Annual Reports

The IAC primarily used the annual reports to gather information from the parties. The analysis of the reports suggested that a significant portion of missing or ambiguous responses was due to the format of the report. For this reason, we made several modifications, each of which serves a specific purpose in increasing the accuracy and completeness of responses. User testing of the elements used, including drop-down menus and restricted responses, supports the usability of these components. Merging the instructions with the forms for filling information made the file smaller and the directions more effective, according to input from D. Chacón. Redundancy in the instructions helped provide similar functionality and reduce the quantity of mistakes made in filling out the form. These modifications serve to make the document used for the annual reports a more effective tool for collecting information.

Communication with D. Chacón and B. Dick supports that the modified format has a number of features that make it more concise, understandable, and easy to use. Based on our research, we have concluded the redesigned document should improve data collection if used in future annual reports.

5.1.3 Changing the Information Requested

Although problems were resolved by changing the format, this did not resolve all of the problems associated with data collection. The fields in the report that request information about threats to sea turtles and the impact of these threats contained some of the most consistently ambiguous responses. This is because instructions for reporting

threats discretely are not followed, and there isn't a standard for reporting the impact of each threat. With the current form of responses, a significant amount of analysis is needed to categorize the threats reported into distinct categories. In addition, it is difficult to rank the threats in order of importance. We recommend that the IAC consider methods for quantifying these responses and utilizing some type of restricted responses. For example, sand mining on beaches can damage the habitat of the sea turtles, but reporting the volume of sand mined does not necessarily reflect its effect on the animals themselves. Instead, the report could require that the country provide an estimate of the proportion of habitat damaged or number of nests affected by the activity. This will allow for easier analysis of the data reported, and a more descriptive account of which threats are critically important in each of the countries.

5.1.4 Using Database Software

Changes to the format of the report and the information requested will improve the accuracy and completeness of the responses. However, there also exist several software options for organizing the types of data in the reports. Microsoft Word and Microsoft Excel were used in this project because they are widely available and had been used in the past by the IAC. However, a database program such as Microsoft Access would provide the enhanced functionality with a much more structured interface for merging, changing, and updating information as it becomes available. We recommend that the IAC consider providing this software to the parties, and investigate methods for implementing a similar format for the annual reports in Microsoft Access or a similar program.

5.2 Communicating Conservation Information

Another important goal of the IAC is to communicate conservation information in a way that is concise and understandable. Not all of the information gathered by the IAC is used for policy decisions about conservation strategies. Providing all the available

information to government officials can lessen its effectiveness, as they often do not have the resources or experience to interpret large amounts of scientific information. Instead, to inform policy decisions, it is more effective to provide concise information in certain areas. The creation of a mapping system and a brochure for hawksbill sea turtles was intended to summarize and display data about hawksbill sea turtles briefly but effectively.

5.2.1 Mapping System for the Hawksbill Sea Turtle

The mapping system created to display nesting sites, nesting quantity estimates, and threat information about hawksbill turtles is a useful tool for communicating conservation information. Through the research of similar prior mapping efforts, best practices were determined for the design. In particular, the presentation of the maps draws from the style used by the IAC, which is discussed in Chapter 2. With these best practices as a model, we developed structures for use in the mapping system that were deemed descriptive and effective through user testing. The primary components of the maps were descriptive glyphs for displaying nesting information, and a series of icons which displayed the threats to sea turtles. Contact with experts in the field, including D. Chacón and B. Dick, supports the utility of the glyphs and icons used.

The mapping system is particularly effective for several reasons. First, it summarizes all of the information graphically, providing a visual representation of the data. Secondly, graphical information can be understood by audiences that speak different languages, eliminating a significant amount of translation. Finally, the information in the map can be easily updated along with the database by simply adding points to the image, instantly providing a new graphical view of the information. For these reasons, we recommend the use of the mapping system created in this project for use in IAC presentations that communicate sea turtle conservation information.

5.2.2 Improvements to the Mapping System

Although we have determined the current design of the mapping system is usable and effective, there are two specific improvements that could be made. First, interactive features would make a useful addition to the map. The program created in Flash by the IAC to map all the sea turtle species had several interactive features that could be applied in the hawksbill map created for this project (please see section 2.3.2). The current mapping system requires the distribution of a document along with the mapping system. This document contains a database which contains all of the information represented on the map. With an interactive map, this information could be shown simply by clicking on the appropriate beach location. The program wouldn't require any other resources, like an external database, to function properly. Second, other information could be included in the map as well, to give a more complete picture of all the information available concerning hawksbill turtles. For example, some information about the foraging and migrating habits of sea turtles is included in the annual reports, but was not displayed on the map. We recommend that the IAC investigates possibilities for a more detailed system that could include both this information and interactive features. This would make a stand-alone map system that would concisely communicate all the relevant information concerning hawksbill sea turtles.

5.2.3 Brochure Concerning the Hawksbill Sea Turtle

The brochure created in this project is another tool for communicating conservation information. Designed to accompany the map, the brochure was intended to provide the information through multiple media to help connect with different audiences. The brochure also contains a more direct message than the map, as it details a number of facts specific to the hawksbill crisis. It also includes a section that links the decline in hawksbill populations to societal issues, a description of the main threats to hawksbills, an indication

of initiatives to protect the turtles, and a graph that depicts the recent decline of the species. The design of the brochure draws from the style of the brochure published by the IAC concerning leatherbacks. This choice was made to maintain consistency across IAC documents. In addition, due to the effectiveness of the leatherback brochure in the past as reported by B. Dick, we concluded that a brochure of this type for hawksbills would be similarly successful. Past experience with these two types of mediums suggests that the combination of a text document containing persuasive information and a graphical mapping system providing a concise view of data is an effective way to communicate conservation data concerning sea turtles.

5.2.4 Improving the Brochure and Map in the Future

The past success of the IAC leatherback brochure suggests that the brochure's design and content will be effective. Its effectiveness will be based on the data being up to date and relevant in the present context of sea turtle conservation. For this reason we recommend that the IAC continues to create updated brochures in this style that contain the newest conservation information available. For example, this year the Convention on International Trade in Endangered Species (CITES) drafted a resolution to collaborate with the IAC to raise funds to carry out a meeting on the hawksbill crisis, and this information would provide a valuable addition to the brochure.

In addition, both the mapping system and the brochure only apply to the hawksbill species. These types of communication have been successful concerning leatherbacks in the past, and more detail can be shown by focusing on one species at a time. For these reasons, we recommend that the IAC continue to produce similar materials for each species of sea turtle. The information in each element of the series can be continually updated with information provided in the annual reports to create a system of displaying the data that is always up to date.

5.3 Final Statement

This project has provided a strong starting point for communicating conservation information, specifically concerning the hawksbill sea turtle. Based on our preliminary testing, the deliverables produced by this project will be effective, but more work can be done to improve their success in the future. This involves a constant process, as the information to be communicated needs to be complete and up to date. This goal can be accomplished by improving the data collection process used by the IAC in the future. Our research suggests that the redesigned format is an improvement over previous methods for gathering data. In the next few years, the IAC may be able to improve on this design further. Together, these techniques for collecting and displaying data provide a resource that the IAC can use to communicate an effective conservation message. It is essential that the general populace and policy makers have access to up-to-date information which stresses the importance that sea turtles play on the ecosystem and economy. Sea turtles worldwide remain close to extinction, but using new tools to collect and communicate relevant information is the first step in conserving these irreplaceable species.

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Glossary

ArcView: ArcView is a mapping program. It is an industry standard for creating maps.

Beach erosion: Beach erosion refers to changes in the shape or profile of the beach caused by natural displacement of sand. Climate changes have been linked to increased beach erosion

CCC: Caribbean Conservation Corporation

CITES: Convention on International Trade in Endangered Species

Clutch: A clutch describes a nest where a turtle not only dug the hole, but also laid eggs in the nest.

Consumptive Use: Consumptive use is any use of the turtle which kills the turtle, eggs, or hatchlings. Examples may be egg poaching, harvesting turtles for meat, and decorative use of the carapace.

CREO: Committee on Recently Extinct Organisms

Drop-down box: A drop-down box is a small menu which allows the user to select a response from a discreetly defined list. They were used in our project for the survey sent out to the member countries, and for the improved annual reports format.

Ecosystem: An ecosystem is generally defined as a community of organisms living in a particular environment and the physical elements in that environment with which they interact (The Environmental Literacy Council, 2007).

Flash or Macromedia Flash: Flash is an animation program produced by Macromedia. It is a powerful program for designing and publishing multimedia presentations or animations. We used it as a powerful drawing tool for designing our maps

Foraging: Foraging refers to the feeding phase of sea turtles.

Gillnet: A gillnet is a type of fishing net which uses many fine threads in the net which catch on the fishes gills and thus entrap them. Sea turtles are known to become entangled in these nets.

Glyph: The word 'glyph' refers to the symbols or points used on a map. In our mapping system, we tested which glyphs were the most effective.

Hatchlings: Hatchlings are sea turtles which have recently hatched from their eggs and escaped from the nest.

Inter-American Convention for the Protection and Conservation of Sea Turtles or “The IAC” or “El CIT”: This is our sponsor. The IAC is a multinational organization designed to facilitate the communication between governments on the subject of sea turtle conservation. We worked with the secretariat pro-tempore, Marco Solano, and his technical assistant, Belinda Dick.

Indicator Species: An indicator species is a species which is generally very important to the health of the ecosystem in which it lives, and the health of the ecosystem is very important to the species. Because of this, people use the health of an “indicator species” as a measurement of the health of the ecosystem in which it lives.

IOSEA: Indian Ocean- South East Asian Marine Turtle Memorandum

Long Line Fishing: Long line fishing is a type of fishing which has been documented to be harmful to sea turtles. Short fishing lines are prepared with many baited hooks and then attached to a central (long) line. Many of these short lines are set, and then the entire line is left for a certain amount of time to “soak” before the line is reeled in and the target species are recovered. The central, long, line may be longer than 1km.

Macromedia Flash: see “Flash”

Non-Artic: Non-Artic refers to areas between the 66.5 North latitude and the 66.5 South latitude.

Non-Consumptive Use: Non-Consumptive Use refers to use of sea turtles which does not kill the turtles, eggs, or hatchlings. Examples may be turtle friendly tourism, or volunteer programs.

Non-Government Organization or NGO: An NGO is an organization, in our report, which deals with conservation but is not necessarily an official entity of the government of the hosting country.

Sub Tropical: Sub tropical refers to areas immediately North or South of the 23.5 North latitude and the 23.5 South latitude respectively.

SWOT: State of the World’s Sea Turtles Organization

Temperate: Temperate refers to the areas between the 23.5 and 66.5 latitudes.

Tropical: Tropical refers to the areas between the 23.5 North latitude and the 23.5 South latitude.

Trawling: Trawling is a type of fishing which is harmful to sea turtles. Generally, a trawling vessel with lower a net into the water and then “trawl” or pull the net through the water, catching everything which crosses the threshold of the net.

UNEP: United Nations Environment Program

WIDECAST: Wider Caribbean Sea Turtle Conservation League

WWF: World Wildlife Fund

Appendix A Biological Information

This section covers biological aspects of all the sea turtles, along with the areas in which they can be found. All of this information has been taken from the Caribbean Conservation Corporation (2007).

Hawksbill Sea Turtle



Figure 38: Hawksbill sea turtle (J. Chevalier, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation website has a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Hawksbill sea turtle. The Hawksbill Sea Turtle was named as such because it has a narrow head and a hawk-like beak. Its scientific name is *Eretmochelys imbricata*. As one of the smaller turtles its features are very simple. There are two pairs of prefrontal scales below the eyes and four lateral scales with a shell that has an elliptical shape, and two claws on the flippers. The color is orange, brown, or yellow and the hatchlings are mostly brown with pale blotches in the scales. The adults grow from two-and-a-half to three feet in carapace length and weigh from 100 to 150 lbs. The shape of the beak makes it so the turtle can get food from crevices in coral reefs, where they mostly eat sponges, anemones, squid and shrimp. They nest every two, three, or more years and two to four times per season with an average of 160 eggs per nest that incubate for sixty days. They live in tropical and

subtropical waters of the Atlantic, Pacific and Indian Oceans (CCC, 2007a, section on the Hawksbill).

Loggerhead Sea Turtle



Figure 39: Loggerhead sea turtle (Projeto TAMAR, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation's website includes a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Loggerhead sea turtle. The loggerhead has a large head and very heavy and strong jaws. Its scientific name is *Caretta caretta*. The carapace is heart shaped and has five lateral scales. The front flippers are short and thick with two claws. The rear flippers can have two or three claws on them. The carapace is a reddish-dark brown that has a yellowish-brown plastron. Hatchlings have a dark brown shell and their flippers are pale brown. Loggerheads can be from two-and-a-half to three-and-a-half feet in carapace and most of the adults weigh up to 250 lbs. They are also mostly carnivorous and eat shellfish such as horseshoe crabs, clams, mussels, and other invertebrates. The turtles feed mostly on the shelves of the Atlantic, Pacific, and Indian Oceans. Every two, three, and or more years these turtles nest and when they do they lay four to seven nests, twelve to fourteen days apart and holding 100 to 126 eggs per nest, which then incubate for sixty days. The areas of the globe that these animals can be found are in all temperate and tropical waters (CCC, 2007a, section on the Loggerhead sea turtle).

Green Sea Turtle



Figure 40: Green turtle (S Castaneda, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation's website includes a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Green sea turtle. Their scientific name is *Chelonia mydas*. The head is quite small and their jaw is serrated. The carapace varies in a few ways; it can be pale or vary dark grey or even plain to very yellow, brown, and green with stripes. They shell has only four lateral scales and the body is almost oval and is flatter. One visible claw can be seen on each flipper. The plastron can vary from white, dirty white, or yellowish. The hatchlings are dark brown or almost black and have a white underneath with white flippers. There are a few differences with the Pacific green turtles. First they have a strong elevated of vaulted body. The color of the carapace is dark grey or black and in the Pacific the plastron it is dark grey-bluish-green and the hatchlings are dark-brown or black with a narrow white boarder and they are white underneath.



Figure 41: Green turtle hatchlings (CCC, in IAC Secretariat, 2007)

Adult shells reach three-and-a-half to four feet in length. These are the largest of the Cheloniidae family,; one of the largest ever found was five feet and 871 lbs. They weigh from 300 to 400 lbs. Throughout the green turtle's lifespan their diet changes a few times. When they are less than eight to ten inches the hatchlings eat worms, young crustaceans, aquatic insects, grasses, and algae. After they reach 8 to 10 inches they mostly eat sea grass and algae. Finally after their jaw is serrated they are strictly herbivores and they are the only turtle to do this as an adult. Green Sea Turtles mostly stay near the coastlines and around islands; they enjoy bays where there are sea grass beds and a rarely seen in open ocean. Every two, three, or more years these turtles nest and when they do they nest three to five times per season. Around 115 eggs are in each nest and then they incubate for sixty days. They can be found in all the temperate and tropical waters around the globe (CCC, 2007a, section on Green sea turtle).

Olive Ridley Sea Turtle



Figure 42: Olive Ridley sea turtle (CCC, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation gives a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Olive Ridley sea turtle. The Olive Ridley is named for the olive green colored shell that it has. Its scientific name is *Lepidochelys olivacea*. The head is small there are large scales present has six or more lateral scales and is nearly circular and smooth, the body is much deeper than the Kemp's Ridley. Both the front and rear flippers have one or two claws visible and sometimes there is an extra claw on the front flippers. Juveniles are charcoal and grey in color, while the adults are a dark grey green, and the hatchlings are black when wet and have greenish sides. The adults range from two to two-and-a-half feet in carapace length and weigh 77-110 lbs. Powerful jaws allow them to be omnivores and eat crustaceans, shrimp, crabs, mollusks, tunicates and fish. Generally they can be found in coastal bays and estuaries. They can dive deep to fifty feet to feed on the bottom dwelling crustaceans. They nest every year in arribadas during a mass synchronization of the turtles. They nest around two times. Laying over 105 eggs per nest that then incubate for fifty-five days.



Figure 43: Arribada of Olive Ridley sea turtle (M. Jensen, in IAC Secretariat, 2007)

They inhabit tropical and subtropical waters of the Pacific, Atlantic, and Indian Oceans (CCC, 2007a, section on Olive Ridley).

Kemp's Ridley Sea Turtle



Figure 44: Kemp's Ridley sea turtle (E. Seney, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation gives a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Kemp's Ridley sea turtle. The Kemp's Ridley is named after Richard Kemp, who helped discover and study the turtle. The scientific name is *Lepidochelys kempii*. The head is moderately

sized but is triangular shaped. The carapace has five lateral scaled and is very rounded the front flippers have one claw and the rear flipper can have one or two claws. Adults have a carapace that is dark green with a white or yellowish plastron, while the hatchlings are jet black. They grow to around two feet in length and weigh from seventy-seven to one-hundred lbs. Their powerful jaws help them crush and grind their food. The diet consists of crabs, mussels, and shrimp and also likes to eat fish, sea urchins, squid, and jellyfish. Shallow waters with sandy and muddy bottoms are where they enjoy being. The Kemp's Ridley nest every one-and-a-half years in arribadas. Nesting two to three times per season and laying around 110 eggs per nest that then incubate for fifty-five days. The adults are limited to the Gulf of Mexico. Juveniles range between tropical and temperate coastal areas of the Northwest Atlantic and the East coast of the United States (CCC, 2007a, section on the Kemp's Ridley).

Flatback Sea Turtle

The Caribbean Conservation Corporation gives a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the Flatback sea turtle. The Flatback sea turtle's scientific name is *Natator depressus*. The head has a single pair of prefrontal scales and has four lateral scales. The carapace is oval or round and is very flat; also the edge is folded and covered by thin waxy scales. There is only one claw on the flippers. Hatchlings form a unique pattern of dark-grey and the center of each scale is olive colored. They measure up to three-and-a-quarter feet in carapace length and weight an average of 198 lbs. They eat sea cucumbers, jellyfish, mollusks, prawns, bryozoans, other invertebrates and seaweed. They mostly stay inshore in bays or coastal reefs and grassy shallows. The turtle nests four times per season with fifty eggs per nest. Then the eggs incubate for fifty-five days, and hatch larger than most other species. This turtle is found only in the waters of Australia and Papua New Guinea in the Pacific (CCC, 2007a, section on the Flatback).

Leatherback Sea Turtle



Figure 45: Leatherback turtle (Matthew Godfrey, in IAC Secretariat, 2007)

The Caribbean Conservation Corporation gives a section called Information on Sea Turtles and The Threats to Their Survival (2007); this is the information on the leatherback sea turtle. The leatherback Sea Turtle is named because of the unique shell that is very tough rubbery skin, which is strengthened by thousands of tiny bone plates that make it look ‘leathery’. The scientific name is *Dermochelys corriacea*. The head has a deeply notched upper jaw with two cusps and is the only turtle not to have a hard shell. With seven distinct ridges running the length of the turtle it is much larger and elongated. The hatchlings are the only ones that have scales and none of the flippers have claws. Hatchlings have white blotches on their carapace. Adults range from four to six feet in length and weighing 500 to 1545 lbs. The largest ever recorded was ten feet from tip of beak to tip of tail and weighed 2,019 lbs. Their diet is exclusively jellyfish because the delicate scissor-like jaws would be damaged if they ate anything else. Primarily found in open ocean ranging as high north as Alaska and as south as the tip of Africa. They feed in areas right offshore at around forty degrees Fahrenheit and is the only reptile known to remain active at such low temperature. Nesting happens every two to three years but can happen every year. They nest from six to nine times per season with ten days between each and lay 120 eggs. Of those there are around eighty eggs that are fertilized and thirty smaller eggs that are unfertilized, and incubate for sixty-five days.



Figure 46: Leatherback hatchlings (CCC, in IAC Secretariat, 2007)

Unlike other species the Leatherback can change the beaches that it nest on but usually stay in the same region. Of all the sea turtles this is the most widely distributed around the globe, and can swim for thousands of miles over open oceans (CCC, 2007a, section on leatherback sea turtle).

Appendix B Annual Reports Format

Annual Report Instructions



Inter-American Convention for the
Protection and Conservation of Sea Turtles
San Jose, Costa Rica

Instructions for completing the Third Annual Report form 2007

Following the provisions laid down in annex IV of the Convention text, each Contracting Party shall hand in an Annual Report. This format will be reviewed and adapted to the needs that arise to be used in the future writing of the annual reports; therefore, we request that your comments on ways to improve this form are attached as an annex in order to improve it year after year. To complete this Report, it is important that the Focal Points make the necessary consultations to the various stakeholders involved in sea turtle issues. We remind you that the date to hand in this information is April 30th of 2007.

General Information:

Do not modify the original tables of the Report.

Please include a glossary of acronyms used for official institutions, NGOs, etc.

Use the following codes to list the different species: Cc = *Caretta caretta*; Cm = *Chelonia mydas*; Dc = *Dermochelys coriacea*; Ei = *Eretmochelys imbricata*; Lk = *Lepidochelys kempii*; Lo = *Lepidochelys olivacea*.

For information on nesting, fill in the form using the latest nesting season. For other information, fill in the form according to the information of the latest calendar year.

Please complete all tables. Indicate if information exists, but it is not available or unknown (NA) or if no information exists (None).

Fill in the blanks using the best information available.

Add more lines if necessary.

1. Biological Information

1.1. Species present

Fill in the respective blanks depending on the oceanographic basin (according to the provisions in Art. III of the Convention) for each species, using the following codes for the different phases: R = reproduction; F = foraging; M = migration; D= phase unknown.

1.2. Important sites for the conservation of sea turtles

a. For each phase, indicate the names of priority sites mentioning the species present in each site and its season. Confirmed migratory routes should be integrated as a separate

table where relevant data can be added, for example, beginning and ending point (LAT/LON), tag/recovery. If migratory route maps already exist as well as their course in LAT/LON, please add them as an annex so that this information may be included in the GIS of the IAC.

- b. Geographic location: Specify latitude and longitude in degrees, minutes and seconds
 - provide one or two points for nesting places (if available). For migratory routes, please describe them briefly in the observations column.
- c. Extension:
 - Nesting sites, provide the total length in Kilometers of the beach used by the turtles.
 - Foraging sites (or feeding areas) provide the extension in Hectares (if available).
 - Migratory Routes: not applicable
- d. Category of protection: Indicate if the area is declared as some type of protected area, the name of the Management Category, briefly describe in terms of use or protection offered
- e. Observations: Include an estimate of the number of clutches (the number of eggs produced (laid) by a turtle at one time) and hatchlings per year. The ranges for clutches are: unknown, unavailable, 0-10, 11-100, 101-500, 501-1000, 1001-5000, 5001-10000, 10001-100000, 100001-500000, >500000. The ranges for hatchlings are: unknown, not available, 0-1000, 1001-10000, 10001-50000, 50001-100000, 100001-500000, 500001-1000000, 1000001-10000000, 1000001-50000000, >50000000. On a separate sheet, provide a brief description/justification on why each site that was mentioned is considered important (sites with greater abundance, endemism, genetic, others). Include historical information (graphic and/or tables) showing the population status of each species present in the site. If available, provide information on the species for a wider region than the specific nesting place.

2. Information on the derived use of sea turtles

- a. The types of use (non consumptive/consumptive) may be, among others: Domestic (for subsistence), cultural, commercial, medicinal, tourism, scientific.
- b. Products or parts used: eggs, skin, carapace, meat, oil, craftsmanship, etc.
- c. Ocean Basin: Pacific, Atlantic or Caribbean
- d. Origin: make reference to the law that forbids/allows it from chapter 4 (Juridical framework) of this form.
- e. Estimated annual quantity:
 - Legal: refer to chapter 5 (Exceptions) of this form
 - Illegal: total amount of eggs or clutches, total animals (per sex, per stage)
- f. Actions: refer to chapter 6 (Actions for conservation) of this form

3. Threats

Add impacts not listed here. Add sheets with additional observations whenever necessary.

3.1. Habitat and other threats:

- a. Using the following list, select the main threats and list the species affected, considering reproduction and foraging sites and migratory routes.
 - Accumulation of sand or presence of contention structures (please indicate)
 - Sand mining
 - Beach Erosion
 - Construction and infrastructure on the beach
 - Inadequate management of tourism

- Other human activities
 - Beach driving
 - Noise pollution (explain)
 - Artificial light
 - Depredation of eggs and hatchlings by domestic or feral animals
 - Agricultural, industrial waste and residual/sewage waters
 - Oil pollution
 - Obstacles on the beach (logs, plastic, etc.)
 - Impact on other associated habitats (reefs, mangroves, etc.)
 - Waste in the ocean (ropes, fishing gear, bags, etc.)
 - Diseases
 - Natural phenomena (indicate types)
 - Other (indicate)
- b. Size of impact: use the same as in the section above: total number of eggs, total animals (per sex, per stage)
- c. Geographic region(s) affected: make the most accurate reference, if possible use lat/long of the affected area.
- d. Make reference to the full quote in Chapter 9 (Source of information) of this form
- e. Actions: briefly explain the threat and mention the actions that are under way to prevent the threat or minimize its effect; if relevant, refer to chapter 6 (Actions for conservation) of this form.

3.2. Intentional / incidental capture:

- a. Using the following list, pick the main threats and list the affected species
- Capture of sea turtles in the ocean
 - Capture of sea turtles on the beach
 - Egg collection
 - Purse sein fisheries
 - Gill net fisheries
 - Longline artisanal fisheries
 - Longline commercial fisheries
 - Bottom Trawling
 - Pelagic Trawling
 - Fishing nets
- b. Size of impact: whenever possible provide Capture values per Unit of Effort (CPUE) making reference to the unit of effort (number of boats, lances, man hours, etc), or the total amount of animals or eggs captured/collected.
- c. Geographic region(s) affected: make reference as accurate as possible, if possible use lat/long of the affected area.
- d. Refer to the full quote in Chapter 9 (Source of information) of this form.
- e. Actions: briefly describe the threat and mention the actions that are under way to prevent the threat or minimize its effect; if relevant, refer to chapter 6 (Actions for conservation) of this form.

4. Juridical framework

- 4.1. List international instruments related to sea turtles and their habitat signed or ratified by your country.

4.2. List the national legislation in force related to the protection, conservation and use of sea turtles and the habitats on which they depend. Provide a brief description including the sanctions faced when violated.

4.3. Provide a brief explanation of the instrument in process.

4.4. Based on the national juridical framework, list any public or private institutions with responsibilities and actions in the conservation and protection of sea turtles and their habitat. Briefly describe the responsibilities of each of them.

5. Exceptions

Attach the management plan including limits on the levels of intentional capture and include information regarding such program based on article IV, item 3(a,b,d) of the text of the Convention. According to the provisions in Annex 4, the reports of the exceptions shall include follow up and mitigation measures, specifically relevant information on the number of turtles, nests and eggs affected and on the habitat areas affected by the implementation of this action.

6. Conservation efforts

6.1 Make a brief general description of the national plan for the protection and conservation of sea turtles and of their habitat.

6.2 List the most relevant public or private projects/activities for the conservation of sea turtles in your country; please include general objective or objectives, and the results obtained and the duration of each. Including projects/activities like the enhancement and development of new fisheries to reduce incidental capture and mortality of sea turtles, scientific research, environmental education actions, creation of databases, national plan, management plan, community participation or other kind of planning for the conservation and protection of sea turtles. Add more sheets if necessary.

7. International Cooperation. Describe the programs or projects involving cooperation of other states or international bodies, among others, within the area of the Convention.

8. National Directory: List the contacts (persons and/or institutions, public or private) related to the objectives of this Convention (specialists in fisheries, economy, statistic or others). Include at least name, specialty, telephone number, fax and e-mail address.

9. Sources of information: Include all the references used to fill in this form. In Annex I you will find examples as to how the citations should be referenced.

10. Annexes: Include the data gathering forms (methodology) and any piece of information considered relevant (maps, figures, field work protocols, additional publications, reports, etc.). Attach a glossary of acronyms used. Include information on the continuation of Resolution COP2CIT-001 and Resolution COP3CIT-001.

ANNEX 1

Text adapted from: How to Prepare Manuscripts of the Journal of Tropical Biology (<http://rbt.ots.ac.cr/prepare.pdf>)

References are ordered alphabetically and strictly follow this format, including details such as spacing, commas, underlining, capitals, etc. (Note: examples are from real references, modified for brevity):

Article (Author. Year. Title. Journal volume: pages.)

Bückle R., L.F., F. Díaz H. & S. Espina. 1996. Thermoregulatory behavior and culture of *Procambarus clarkii* (Decapoda: Cambaridae). *Rev. Biol. Trop.* 44: 123-126.

2. Book, report or proceedings (Author. Year. Title. Organization or publisher, City, State or Province. pages).

Vásquez-Yeomans, L. & A. González. 1991. Ichthyoplankton of two bays in Mexico. 15 th. Larval Fish Conference, Los Angeles, California. 15 p.

3. Chapter in multiauthored book (Author. Year. Chapter title, pages of chapter. In Editor (ed.) Book title. Publisher, City, State or Province.)

Donnelly, T.W. 1992. Geological setting and tectonic history of Mesoamerica, p. 1-24. In D. Quinteno & A. Aiello (eds.). *Insects of Panama and Mesoamerica*. Oxford University, Oxford.

4. Thesis (Author. Year. Thesis type, University, City).

Hedström, I. 1991. The guava fruit fly, *Anastrepha striata* University, Uppsala, Sweden. 43 p.

NOTE: mention country when city is not widely known, shorten printer's name (e.g. write Wiley instead of Wiley and Sons Publications, Inc., do not write "Press", "Verlag" and equivalent words). When the author is an institution, cite the author as Anonymous. Do not state edition number.

Annual Report Forms

Second Annual Report Form

Directory

Country	
Agency or institution responsible for preparing this report	
Name of the person in charge of this form	
Address	
P.O. Box	
Telephone(s)	
Fax	
E-mail	
Website	

Others who participated in the preparation of this form

Name	Affiliation	Contribution/ Topic	Telephone	E-mail

Focal Point

Institution:	
Name:	
Signature:	
Date:	

1. Biological Information

Species present

Species	Pacific Ocean	Atlantic Ocean	Caribbean Sea
	Phase(s)	Phase(s)	Phase(s)
<i>Lepidochelys olivacea</i>			
<i>Lepidochelys kempii</i>			
<i>Dermochelys coriacea</i>			
<i>Eretmochelys imbricata</i>			
<i>Chelonia mydas</i>			
<i>Caretta caretta</i>			

Phases: R = Reproduction; F = Foraging; M = Migration; D = Phase Unknown

Important sites for sea turtle conservation

	Name of Site	Species (s)	Season	Geographic Location (Lat/Long)	Area (km or hectares, if applicable)	Protection Category	Observations
Nesting Site							
Foraging Site							
Migratory Routes							

* include a brief and concise summary of relevant information regarding the population status on a separate page (for further information see the instructions)

2. Information regarding the use derived from sea turtles

	Types of use	Specie	Products	Ocean Basin	Origin*		Estimated annual quantity	Information source
					L	I		
Consumptive Use								
Non-consumptive								

* L = legal, I = illegal

3. Main threats

3.1 Habitat and other threats

Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

3.2 Capture (Intentional/incidental)

Threats	Specie(s) Affected	Size of Impact	Geographic Region(s) Affected	Information Source	Actions

4. Legal Framework

4.1. International instruments

Treaty, Convention, Agreements, Memorandum of Understanding	Year signed and/or ratification

4.2. National legislation

Type and name of legal instrument (No.)	Description (Range of application)	Sanction(s) Imposed

4.3. Indicate any legal instruments that are currently in the process of being approved.

4.4. Public and private institutions involved in sea turtle conservation

Institution/ Entity	Responsibilities

5. Exceptions

Programs involving extractive use (include Management Plan)

6. Conservation Efforts

6.1 General description of the sea turtle protection and conservation program

6.2 Relevant Projects and Activities

Project/Activities	General objective	Results obtained	Duration	
			From	Un

7. International Cooperation

8. National Directory

Name	Institutional affiliation	Line of work / Specialty	Telephone	Fax	E-mail	V

9. Sources of Information

10. Annexes

Appendix C Volunteer Work at Gandoca

After arriving at the conservation program run by ANAI at Gandoca beach, a volunteer is shown to where he or she will be lodging. There are two options:

1. To stay with a host family and pay thirty-five dollars as an inscription fee then fifteen dollars a day for meals and board.
2. To stay at the base camp called the “Station” and only pay the fifteen dollars a day for meals and board.

After this is decided, the volunteer goes through a basic training course on duties and rules. This training is necessary for all the volunteers and without this training the volunteer can not go on any patrols. As well as this basic training there is also a hatchery training that goes over all the processes for working in the hatchery:

The Work:

The aim of the volunteer program is to assist the project staff in:

1. Patrolling the beach in order to protect the nesting turtles and their nests from predators and poachers.
2. Relocating eggs that are threatened by beach erosion or poachers to safe locations.
3. Collecting all research information on the nesting behavior of the turtles (nest location, size of clutch, length and width of turtle, etc.).
4. Monitoring nests that have been relocated to the protected beach hatcheries

Working Hours:

Night Patrol:

The beach is eight-and-a-half miles long and split into three sectors (A, B, & C) with patrols in each sector. Patrol shifts are four hours long and are from 8pm-12 midnight and 12 midnight- 4am

Hatchery Duty:

There are two hatcheries at this beach and they need to be guarded twenty-four hours a day. The shifts are all six hours long: 6am-12 noon, 12 noon-6pm, 6pm-12 midnight, and 12 midnight- 6 am.

Patrol Leaders

An experienced team member will lead each patrol. The leader will be responsible for the work methods used for each turtle encounter, the patrol team and collection of research information. Always walk behind the team leader and never approach a turtle before the leader or without their instructions.

When going on patrol there are a few things that need to be known:

- Wear dark clothing that covers entire body
- Do not put on any insect repellent four hours before duty
- Bring lots of water
- Only use red light

The use of light while on duty:

This is a general rule for all the region of Central America: only use a red light when patrolling the beaches. But you can use white light when:

- There is a case of emergency, you need to send signals to the other patrols
- You are working on PIT's scanner
- You are looking for illegal poachers in the area

The Rules:

- Never take a picture of the turtles using a flash or other artificial light
- Never walk or stand in front of a turtle
- Never shine a flashlight in a turtle's face
- Never allow strangers to join the patrol and don't give any information about the work, just pass the basic information
- Never drink before you go on duty and never arrive for patrol drunk
- No use of illegal drugs will be tolerated
- Always arrive fifteen minutes earlier to patrol
- If you encounter poachers, report it to ANAI staff, never deal with them by yourself
- If you encounter a sea turtle in the daytime photo's are allowed, however respect the turtle at all times
- Always handle egg bags as gently as possible
- Never use repellent while working with the turtles or their eggs

- Dispose of food from hatchery. Otherwise this will attract ants
- If possible, do not walk on the high part of the beach as this may damage natural or relocated nests

There are some basic things that need to be known before going on patrol. The sections below describe what needs to be done when a turtle is located, relocation of the nests, and what to do at the hatchery. When the turtle is located the patrol leader looks at the location to figure out if this nest is safe; if it is not then the process below begins.

Collecting egg, from a natural nest and relocating them to an artificial nest is done as follows:

- Measure the depth and width of the nest
This is done by taking a stick from the woods and putting it into the hole then Taking it out to measure
- Wait until the female finishes constructing the nest and covers the hole with one of her flippers. Carefully place the plastic bag in the hole.
- After the infertile eggs begin to fall and the female moves her back flipper to begin covering the eggs with sand. This is the moment to remove the bag.

While all of this is going on the patrol leader instructs volunteers on how to measure the turtle and also look for any scars or imperfections in the turtle's carapace and flippers. The Patrol leader also takes this time to locate the tags on the turtle and or the PIT's, which are a microchip in all the right shoulders of the turtles, if the turtle does not have one at this time the patrol leader gives the turtle one.

After the bag is retrieved this is the point where it would be taken to the hatchery to be relocated. Over time the hatchery becomes full and then the nest that are retrieved need to be relocated somewhere on the beach that is safe. Below are some standards for relocation.

The Relocation and camouflaging of nest:

- Make sure there is no driftwood around
- They are not close to permanent or intermittent streams or rivers

- There are no plant roots in the sand nearby that could interfere with the nest
- There are no paths or trails nearby
- There are no houses nearby

If they can be relocated to the hatchery the night patrol hands off the bag at the closest hatchery. Then they start a process for relocating the eggs. A few things to be aware of are:

- Keep the bag closed until ready to relocate
- Never let the eggs touch dry sand
- Fill out all information in proper data books

A location is chosen within the grid that is created for the hatchery. Each nest is to be placed every other so that the nest all have space and volunteers can walk around without disturbing the nests. The hawksbill and green eggs need to be relocated to the back region of the hatchery for temperature reasons and the leatherback can be placed in the front of the hatchery. Then the hole is dug and the eggs then begin to be placed in the hole that is shaped according to what species. A leatherback nest is around seventy-five cm deep and is shaped like a 'boot', the green nests are fifty cm deep and the hawksbill is forty cm deep and both holes are "pear" shaped. While placing the eggs in the nest the number of eggs is recorded with both the fertile and infertile eggs recorded separately. Once all the eggs are in bury with wet sand first then cover the nest with a basket that has mosquito netting around it and make sure it is secure. Below is a picture of the hatchery.



Figure 47: Outside the hatchery showing the baskets over the nests

Another task that is asked of the hatchery workers is to regularly check the temperatures of the nests. The temperature of the sand determines what gender the hatchling is. The goal is an equal number of each gender. Later in the season hatchlings will begin to emerge. The volunteers are constantly checking the baskets to see if there are any hatchlings. When there are hatchlings this is when they record the size and weight of the species as well as the nest it came from. If it is during the day the hatchlings are put into a cooler with wet sand, this is so they can be released at dusk to help minimize predation and it is safer.



Figure 48: The hatchlings in a cooler waiting to be released

After a few days of hatchlings coming out of a nest volunteers then need to dig out the nest and retrieve the eggs to record data. During this process the volunteer is looking for hatchlings that are still alive and to take out all remains in the nest including dead hatchlings, shells, and unhatched eggs. This information is all recorded then compared to the data when the nest was relocated to see the actual results.



Figure 49: Ben retrieving the eggs from a nest that already hatched

All of this information is then collected and put into a master database. This data then tells the leaders of the program:

- Which and how many turtles are nesting that season.
- What locations of the beach were most popular
- How many nests had been laid that season and by what turtle
- How many hatchlings there were
- How many eggs were lost
- Estimate of how many female and male hatchlings

All of this data is very useful and in some conservation programs these types of data are given to the government and end up in annual reports like the one that the IAC distributes every year. This type of work is the base for any type of conservation of a species. The data they send off is what helps get governments to cooperate in the overall goal of saving the sea turtle species.



Figure 50: Leatherback hatchling being released



Figure 51: The project team releasing leatherback hatchlings

Appendix D Survey Prototypes

This section has pictures of the prototype surveys made. These surveys were pre-tested, and eventually we selected the survey made with Microsoft Excel. In this appendix both the Spanish and English versions are given. Please see section 3.2.3 in the methods chapter for a more detailed description.

English Microsoft Word Prototype

The IAC is creating a database for Hawksbill (*Eretmochelys imbricata*) nesting sites. This survey asks you to complete or fill in the following information: the geographical location of each nesting site, the average number of clutches per year, your assessment of whether this number is increasing, decreasing, or staying the same, and threats specific to each site. We have filled in all information found in your country's annual report. Please verify this information and fill in any missing information.

Instructions: First, please verify the name of the nesting site and the latitude and longitude in decimal degrees (e.g., 9.6425N 84.1154W). Then, please verify or select the average number of clutches at each beach per year. If you do not know this information, please select unknown. If the information is unavailable, please select unavailable. Next, indicate if the number of nests is increasing, decreasing, or is staying the same. Again, if you do not know this information select unknown, or if it is unavailable select unavailable. Finally indicate specific threats to each individual beach. Check as many as apply. The categories are:

Intentional Capture such as poaching and hunting; **Incidental Capture** such as the impact of fisheries and accidental by-catch; **Coastal Development** such as construction on beaches; **Climatic Change** such as the effects of erosion; **Pollution and illnesses** such as ingestion of plastics. Also, please indicate any **Other** specific threats.

When you have completed the form, please save the file and e-mail it to sea-turtles@wpi.edu. **Remember, this form is for Hawksbill, *Eretmochelys imbricata*, information only!!** Thank you very much for your participation!

Nesting Site	Geographic Location (Lat/Long)	Number of Clutches						Pattern				Threats								
		0-10	11-100	101-500	501-1000	1001-5000	5000+	Unavailable	Unknown	Decrease	Stays the same	Increase	Unavailable	Unknown	Intentional Capture	Incidental Capture	Coastal Development	Climatic Change	Pollution and Illnesses	Other (Please Indicate)
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 52: English version of Word Survey

Spanish Microsoft Word Prototype

La CIT esta trabajando en una base de datos sobre los sitios de anidación de la tortuga Carey (*Eretmochelys imbricata*) y le pedimos su ayuda en complementar y/o llenar la siguiente información: la ubicación geográfica de cada sitio de anidación, un estimado del número de nidos por año, e información sobre su patrón, si el número de nidos esta aumentando, disminuyendo, igual o no se sabe. También, le pedimos que nos informe sobre las amenazas específicas para cada sitio. La información proporcionada proviene de los informes anuales de la CIT. Por favor, verifique esta información y complementar la información no proporcionada.

Instrucciones: Primero, verifique el nombre de la playa, y la ubicación en LAT/LON (ej. 9.6425Norte 84.1154Oeste). Después, verifique o marca el número estimado de nidos por año. Si la información existe, pero no está disponible, o no se conoce, marca "No Disponible". Si no existe la información, marca "Ninguna". Indicar si el número estimado de nidos está aumentando, disminuyendo, o si sea igual cada año. Igual como antes, si la información existe, pero no está disponible, o no se conoce, marca "No Disponible", pero si no se cuenta la información, marca "No se sabe". Finalmente, haga clic en las cajas que corresponden a las amenazas específicas de cada playa. Marque todas que aplican. Las categorías son:

Captura intencional como el saqueo de los nidos y la captura dirigida; **Captura incidental** como el impacto de pesquerías; **Desarrollo costero** como construcción en las playas; **Cambio climático** como los efectos de la erosión; **Polución y enfermedades** como ingerir plásticos. Favor indicar cualquier **Otra** amenaza específica.

Cuando termina de llenar el formulario, favor guárdelo y envíalo por correo electrónico a sea-turtles@wpi.edu. **¡Recuerde que este formulario es solamente para información de la tortuga Carey, *Eretmochelys imbricata*!** Muchas gracias por su participación!

Sitios:	Ubicación Geográfica (Lat/Long)	Número de nidos						Pattern				Amenazas								
		0-10	11-100	101-500	501-1000	1001-5000	5000+	No Disponible	No se Sabe	Disminuyendo	Aumentando	Igual	No Disponible	No se Sabe	Captura intencional	Captura incidental	Desarrollo costero	Cambio Climático	Polución y enfermedades	Otras (indíquelas)
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Figure 53: Spanish version of Word Survey

English Microsoft Excel Prototype

The IAC is creating a database for Hawksbill (*Eretmochelys imbricata*) nesting sites. This survey asks you to complete or fill in the following information: the geographical location of each nesting site, the average number of clutches per year, your assessment of whether this number is increasing, decreasing, or staying the same, and threats specific to each site. We have filled in all information found in your country's annual report. Please verify this information and fill in any missing information.

Instructions: First, please verify the name of the nesting site and the latitude and longitude in decimal degrees (e.g., 9.6425N 84.1154W). Then, please verify or select the average number of clutches at each beach per year. If this information does not exist, please select unknown. If the information is unavailable, please select unavailable.

Next, indicate if the number of nests is increasing, decreasing, or is staying the same. Again, if you do not know this information select unknown, or if it is unavailable select unavailable.

Finally indicate specific threats to each individual beach. Check as many as apply. The categories are:

- **Intentional Capture** such as poaching and hunting
- **Incidental Capture** such as the impact of fisheries and accidental by-catch
- **Costal Development** such as construction on beaches
- **Climatic Change** such as the effects of erosion
- **Pollution and illnesses** such as ingestion of plastics
- Also, please indicate any **Other** specific threats

When you have completed the form, please save the file and e-mail it to sea-turtles@wpi.edu. **Remember, this form is for Hawksbill, *Eretmochelys imbricata*, information only!**

Thank you very much for your participation!

General Info			Number of Nests					Pattern					Threats					Other (Please Indicate)					
Nesting Site	Lat (Decimal Degree)	Long (Decimal Degree)	0-10	11-100	101-500	501-1000	1001-5000	5000*	Unknown	Unavailable	Increasing	Decreasing	Equal	Unknown	Unavailable	Intentional Capture	Incidental Capture	Development	Costal	Change	Climatic	Pollution and illnesses	Other (Please Indicate)
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure 54: English version of excel survey

Spanish Microsoft Excel Prototype

La CIT está trabajando en una base de datos sobre los sitios de anidación de la tortuga carey (*Eretmochelys imbricata*), le pedimos su ayuda para complementar la siguiente información: la ubicación geográfica de cada sitio de anidación, un estimado del número de nidos por año e información sobre su patrón, si el número de nidos ha aumentando, disminuido, si se mantiene igual o si no se sabe. También, le pedimos que nos informe sobre las amenazas específicas para cada sitio. Los datos proporcionados provienen de los informes anuales de la CIT. Por favor, verifique esta información y complétela.

Instrucciones: Primero, verifique el nombre de la playa, y la ubicación en LAT/LON (ej. 9.6425Norte 84.1154Oeste). Después, verifique o marque el número estimado de nidos por año. Si la información existe pero no está disponible, o no se conoce, marque "No Disponible". Si no existe la información, marque "Ninguna".

Segundo, indique si el número estimado de nidos ha aumentando, disminuido, o si se mantiene igual cada año. De la misma forma que en el caso anterior, si la información existe pero no está disponible, o no se conoce, marca "No Disponible", pero si no se cuenta la información, marca "No se sabe".

Finalmente, haga clic en las cajas que corresponden a las amenazas específicas de cada playa. Marque todas las que aplican. Las categorías son:

- **Captura intencional** como el saqueo de los nidos y la captura dirigida.
- **Captura incidental** como el impacto de pesquerías.
- **Desarrollo costero** como construcción en las playas.
- **Cambio climático** como los efectos de la erosión.
- **Polución y enfermedades** como ingerir plásticos.
- Favor indicar cualquier **Otra** amenaza específica.

Cuando termine de llenar el formulario, favor guárdelo y envíelo por correo electrónico a sea-turtles@wpi.edu Recuerde que este formulario es solamente para información de la tortuga carey (*Eretmochelys imbricata*)

¡Muchas gracias por su participación!

Información General			Numero de Nidos					Patrón					Amenazas					Other (Indique)				
Sitio de Anidación	Lat	Lon	0-10	11-100	101-500	501-1000	1001-5000	5000*	No Disponible	Aumentando	Disminuyendo	Igual	No Disponible	Ninguna	Intencional	Captura incidental	Captura Costero	Desarrollo	Climático	enfermedades	Polución y	Other (Indique)
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	

Figure 55: Spanish version of excel survey

Instructions

The following is the copy of the final instructions translated into English. The original Spanish version is also included

English Instructions

The IAC is creating a database for Hawksbill (*Eretmochelys imbricata*) nesting sites. This survey asks you to complete or fill in the following information: the geographical location of each nesting site, the average number of clutches per year, your assessment of whether this number is increasing, decreasing, or staying the same, and threats specific to each site. We have filled in all information found in your country's annual report. Please verify this information and fill in any missing information.

Instructions: First, please verify the name of the nesting site and the latitude and longitude in decimal degrees (e.g., 9.6425N 84.1154W). Then, please verify or select the average number of clutches at each beach per year. If this information does not exist, please select unknown. If the information is unavailable, please select unavailable.

Next, indicate if the number of nests is increasing, decreasing, or is staying the same. Again, if you do not know this information select unknown, or if it is unavailable select unavailable.

Finally indicate specific threats to each individual beach. Check as many as apply. The categories are:

- **Intentional Capture** such as poaching and hunting

- **Incidental Capture** such as the impact of fisheries and accidental by-catch
- **Coastal Development** such as construction on beaches
- **Climatic Change** such as the effects of erosion
- **Pollution and illnesses** such as ingestion of plastics
- Also, please indicate any **Other** specific threats

When you have completed the form, please save the file and e-mail it to sea-turtles@wpi.edu. **Remember, this form is for Hawksbill, *Eretmochelys imbricata*, information only!!**

Thank you very much for your participation!

Spanish Instructions

The following is the original Spanish version of the directions. This was translated to the English above.

La CIT está trabajando en una base de datos sobre los sitios de anidación de la tortuga Carey (*Eretmochelys imbricata*), le pedimos su ayuda para complementar la siguiente información: la ubicación geográfica de cada sitio de anidación, un estimado del número de nidos por año e información sobre su patrón, si el número de nidos ha aumentando, disminuido, si se mantiene igual o si no se sabe. También, le pedimos que nos informe sobre las amenazas específicas para cada sitio. Los datos proporcionados provienen de los informes anuales de la CIT. Por favor, verifique esta información y complétela.

Instrucciones: Primero, verifique el nombre de la playa, y la ubicación en LAT/LON (ej. 9.6425Norte 84.1154Oeste). Después, verifique o marque

el número estimado de nidos por año. Si la información existe pero no está disponible, o no se conoce, marque “*No Disponible*”. Si no existe la información, marque “*Ninguna*”.

Segundo, indique si el número estimado de nidos ha aumentando, disminuido, o si se mantiene igual cada año. De la misma forma que en el caso anterior, si la información existe pero no está disponible, o no se conoce, marca “*No Disponible*”, pero si no se cuenta la información, marca “*Ninguna*”.

Finalmente, haga clic en las cajas que corresponden a las amenazas específicas de cada playa. Marque todas las que aplican. Las categorías son:

- **Captura intencional** como el saqueo de los nidos y la captura dirigida.
- **Captura incidental** como el impacto de pesquerías.
- **Desarrollo costero** como construcción en las playas.
- **Cambio climático** como los efectos de la erosión.
- **Polución y enfermedades** como ingerir plásticos.
- Favor indicar cualquier **Otra** amenaza específica.

Cuando termine de llenar el formulario, favor guárdelo y envíelo por correo electrónico a sea-turtles@wpi.edu Recuerde que este formulario es solamente para información de la tortuga carey (*Eretmochelys imbricata*)

¡Muchas gracias por su participación!

Appendix E Glyph Testing

This appendix shows information about the pre-testing done for the glyphs used in the database. Figure 55-58 below shows all of the glyphs made for pre-testing. There are four different sets with 5 different colors each. In the end we selected the red, green, blue and yellow from the upper right of figure 54 for the database.

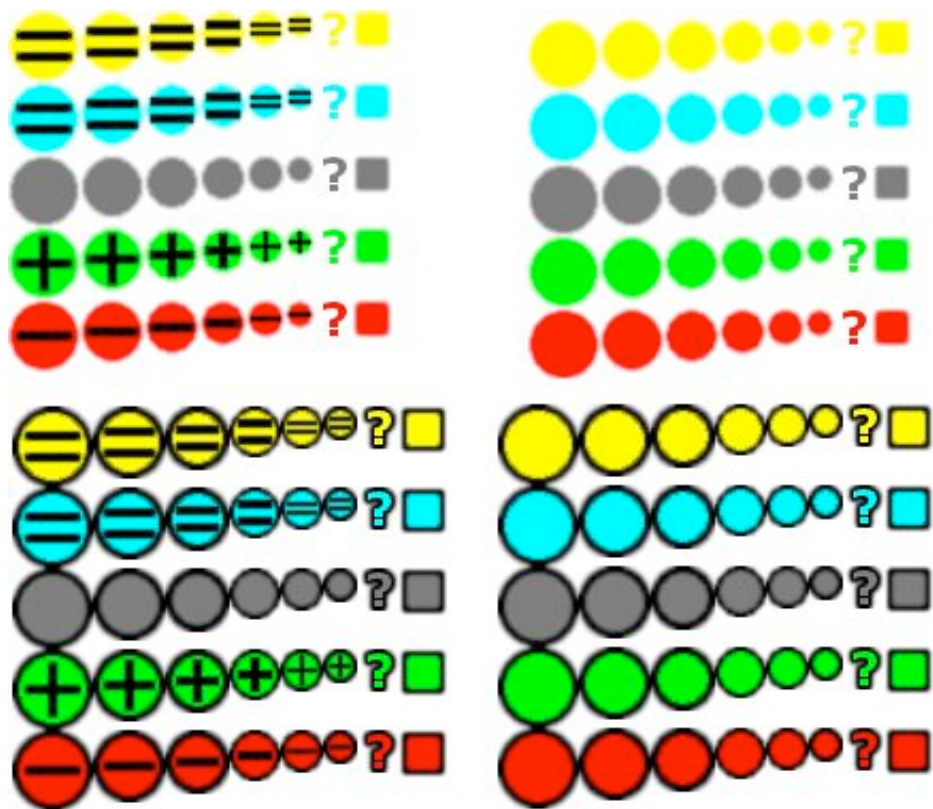


Figure 56: Glyphs for Pre-Testing

Below are the graphics used for the pre-testing procedure, along with the text and questions read to the subject.



Figure 57: Slide 1 of pre-testing

Thank you for helping us with our project. In the following slides you will see various images and hear descriptions of them. The goal of this test is to see which images are most naturally recognized. Please answer to the best of your ability. Feel free to ask for clarification.

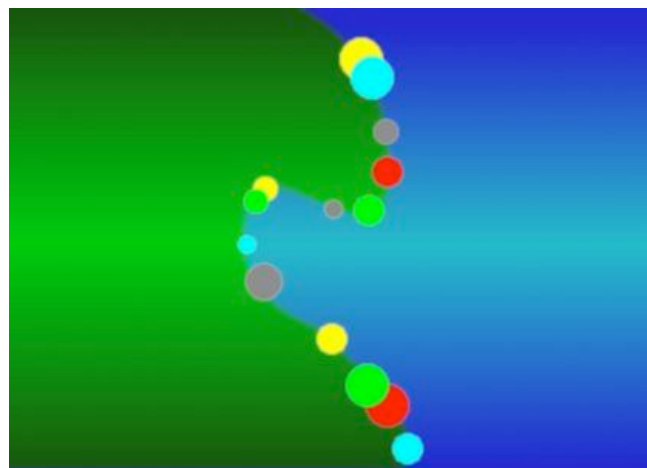


Figure 58: Slide 2 of pre-testing

This image shows a coast line with several dots on it. The dots represent nesting beaches for hawksbill sea turtles. The size of the dot

represents the number of nests in that beach. The colors represent if the number of nests is increasing, decreasing, staying the same, or is unknown. For each of the following questions, you may choose only one color. You will be asked which colors represent increasing, decreasing, staying the same, and unknown. Remember, this is to test which colors make the most sense to you. Which color represents increasing? Which color represents decreasing? Which color represents staying the same? Which color represents unknown?

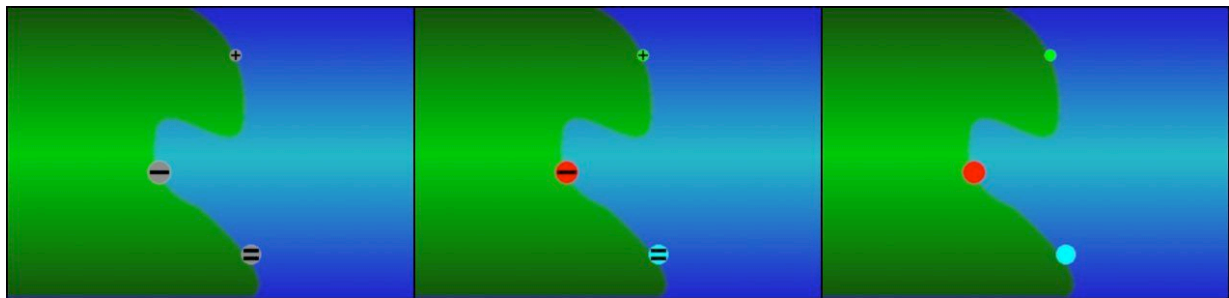


Figure 59: Slide 3 of pre-testing

This image shows 3 of the same coast lines with the same nesting beaches. On the left coast line, we use a plus sign to designate that the number of nests is increasing, a minus sign to indicate that the number of nests is decreasing, and an equals sign to indicate that the number of nests is staying the same. On the right side we use green to represent that the number of nests is increasing, red to represent that the number of nests is decreasing, and cyan to represent that the number of nests is staying the same. In the center we use a combination of the symbols and the colors. Please note that for this example there is no symbol or color to represent "unknown". Which of these methods do you feel is the most effective? What makes it that way? What is good or bad about the various methods?

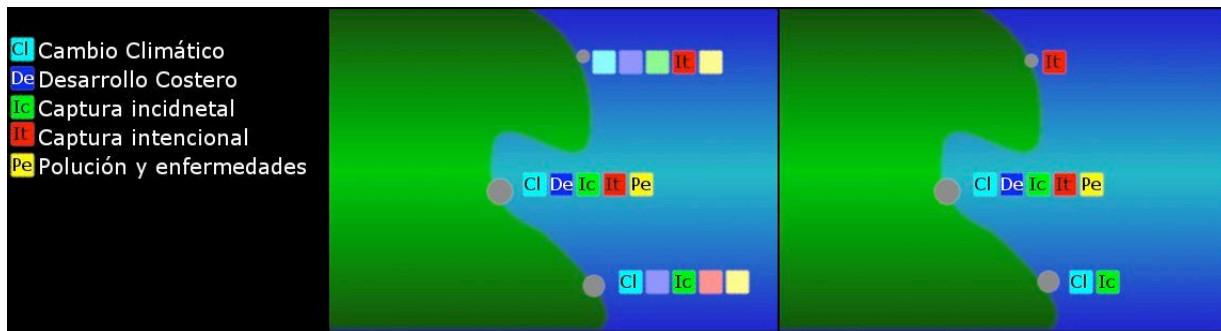


Figure 60: Slide 4 of pre-testing

This image shows 2 of the same nesting beaches. For this example there are several blocks next to each beach. Each of the blocks represents a different threat to sea turtles on that particular beach. The key to the threats is also shown on the far left. On the left coast, the blocks are always 5 blocks long, with the threats which are not present being slightly dimmer. On the right, only the threats which are present are shown. Which do you think is more readable? Why? What can we do to improve this?

The second phase of our pre-testing consisted of creating a prototype map shown below.

Appendix F Hawksbill Brochure



Inter-American Convention for the Conservation and Protection of Sea Turtles

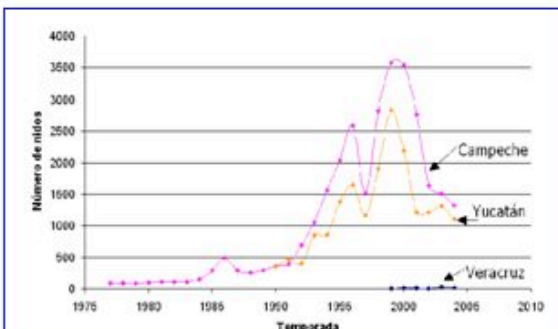
Hawksbill Decline in the Caribbean and Western Atlantic



Photo: ANAI

The International Union for Conservation of Nature and Natural Resources (IUCN) classifies the hawksbill as a critically-endangered species. Recent studies show a drastic decline in numbers of nests in the most important nesting beaches of the Mexican states of Veracruz, Campeche and Yucatán. The main causes are related to human activities. Without a significant change in this pattern, the extinction of the hawksbill could occur within our lifetimes.

Why is the population in decline? The habitat of the hawksbill turtle is the most tropical of all the sea turtle species. It lives mostly near the shore and around coral reefs, as well as in rocky areas, estuaries and lagoons. This species has a peculiar shaped beak that is used to get food out of crevices in the reefs, and their diet consists mainly of sponges.



Data on hawksbill decline in the Yucatan Peninsula. Note the sharp decline since 2000

Hawksbills come ashore to nest two to four times a season, but only nest every two, three or more years.

The number of eggs deposited in each clutch is relatively large — up to 160. However, on average, only one in every thousand hatchlings reaches maturity. Along with natural predation, additional threats lower

this survival rate further.



Photo: ANAI

Despite the fact that international hawksbill trade is prohibited through the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the main threat to the hawksbill turtle continues to be the illegal capture of juvenile and adult turtles for their beautiful carapace (shell), which is made into jewelry and other products commonly known as “tortoiseshell”. These include rings, bracelets, and hair pieces (see photos). Better enforcement and more serious penalties for trafficking hawksbill products could change this situation. Consumers can also make a difference. Imitation or faux hawksbill jewelry is available, usually molded from plastic. Jewelry made from coconut has also become a popular replacement.

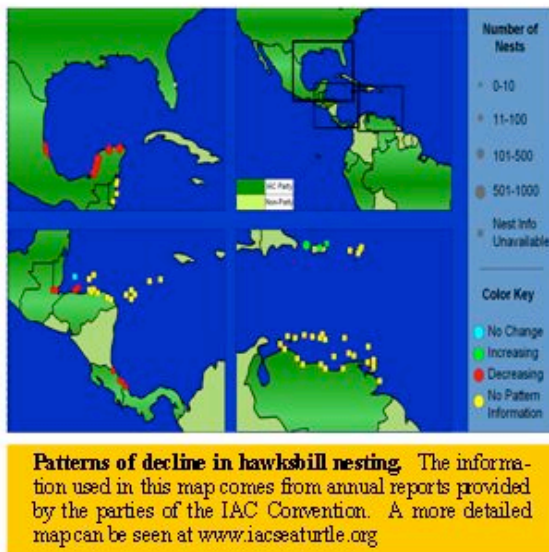


Photo: ANAI

Principal Threats

- Ornamental use of shell
- Global Warming
- Destruction and alteration of habitat; loss of coral reefs

Figure 61: First page of hawksbill brochure



What courses of action can we take? International cooperation is essential in tracking and managing species survival. Collaboration on hawksbill conservation is also important in addressing the sustainability of the economic benefits of coastal and marine ecosystems.

The Inter-American Convention for the Conservation and Protection of Sea Turtle (IAC) is committed to promoting the protection, conservation and recovery of sea turtle populations and the habitats on which they depend, with an emphasis on developing bilateral and multilateral agreements and the exchange of information and technology. Due to the critical state of the hawksbill, the Third Conference of the Parties, held in Mexico in 2006, approved **Resolution CIT-COP3-2006-R-1, Conservation of the Hawksbill Turtle (*Eretmochelys imbricata*)**, urging contracting parties to monitor use and illegal trade of hawksbills and their products, enforce existing legislation, and stop illegal trade. Another goal of the resolution is to protect important hawksbill nesting and foraging sites. The resolution calls for joint research efforts on the cause of the recent decline in hawksbill populations in an attempt to stop this negative trend. It also calls for a regional technical meeting to address the recommendations.

At the fourteenth meeting of the conference of the parties of the Convention on International Trade of Endangered Species (CITES), a Resolution was drafted. CITES offered to collaborate with the IAC to raise funds for the regional meeting. Updates concerning this meeting will be posted on the IAC website.

Hawksbills and Coral Reefs:

1. Coral reefs, one of the Earth's most diverse living ecosystems, are often called the rainforest of the sea. They provide homes and a nursery for numerous marine species, and the livelihoods of millions of people around the globe depend on their health. They also provide coastal communities with protection from storms, wave damage and erosion. There is also evidence that they may hold undiscovered biomedical resources.
2. Hawksbills play an important role in the health of the coral reefs by feeding on specific sponge populations. If these populations are left unchecked, they can out compete other species for space and nutrients, resulting in a loss of diversity.
3. A loss of diversity can kill coral reefs and other species that live there. Less diverse systems aren't as resilient to both natural and anthropogenic threats such as climate change, sedimentation and run-off.
4. Without thriving reefs the livelihood of fisherman that depend on them as well as the safety of coastal towns would be at great risk.

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 Edited by: Belinda Dick

Published by: Pro Tempore Secretariat of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), San José, Costa Rica.
<http://www.iacseaturtle.org>
 contact@iacseaturtle.org

Figure 62: Second page of hawksbill brochure

Appendix G Country Maps

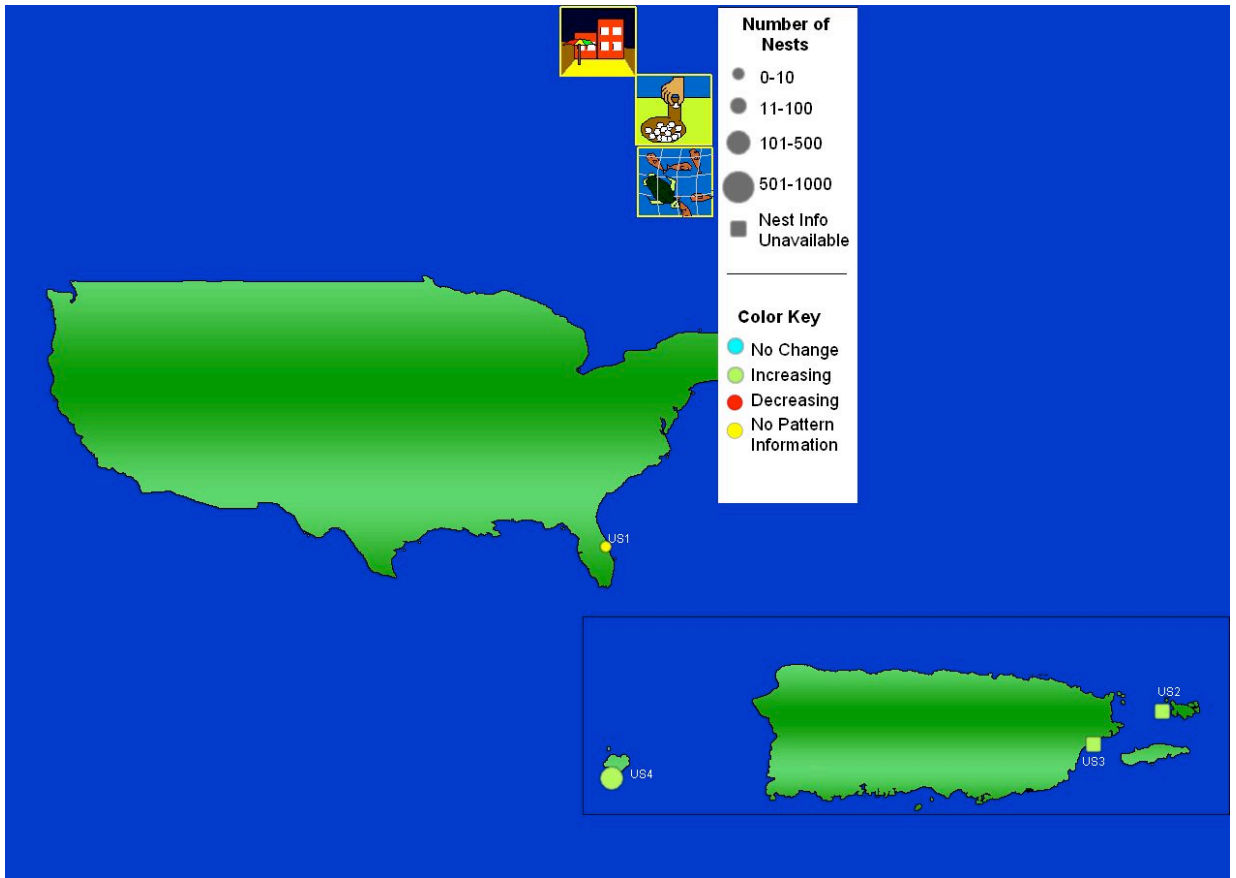


Figure 63: USA and Puerto Rico

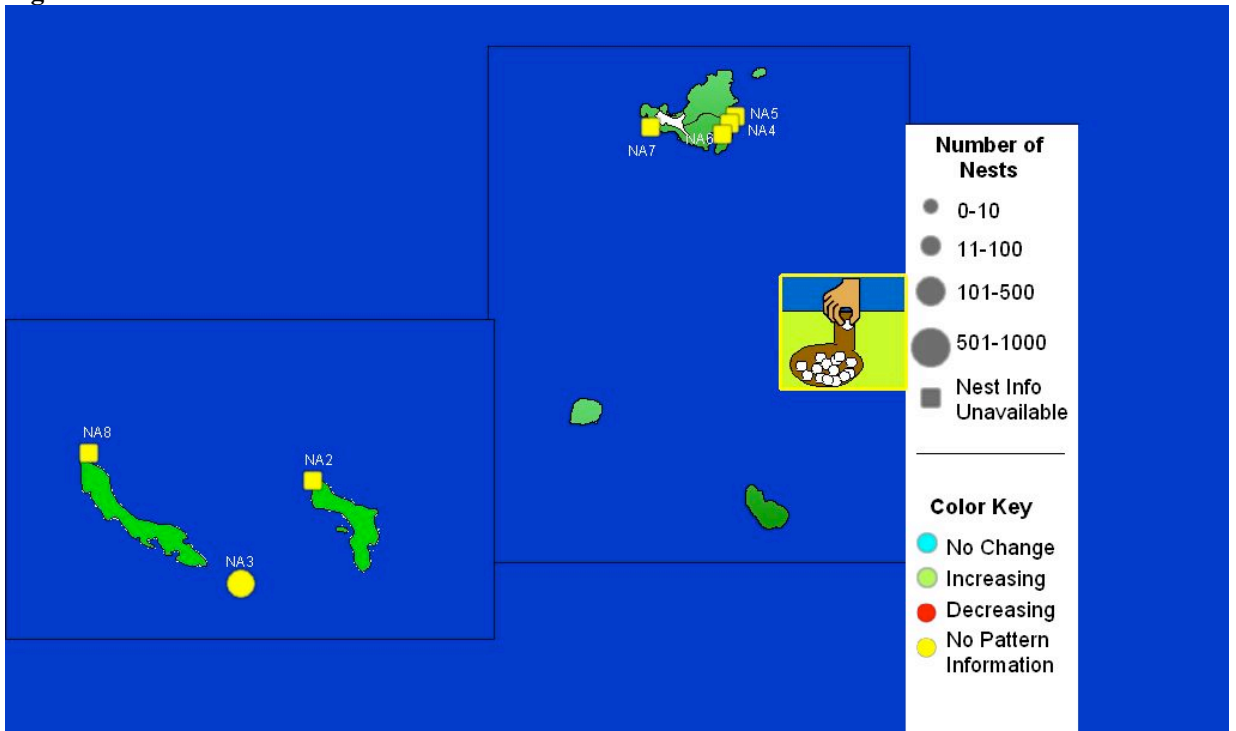


Figure 64: Netherlands Antilles

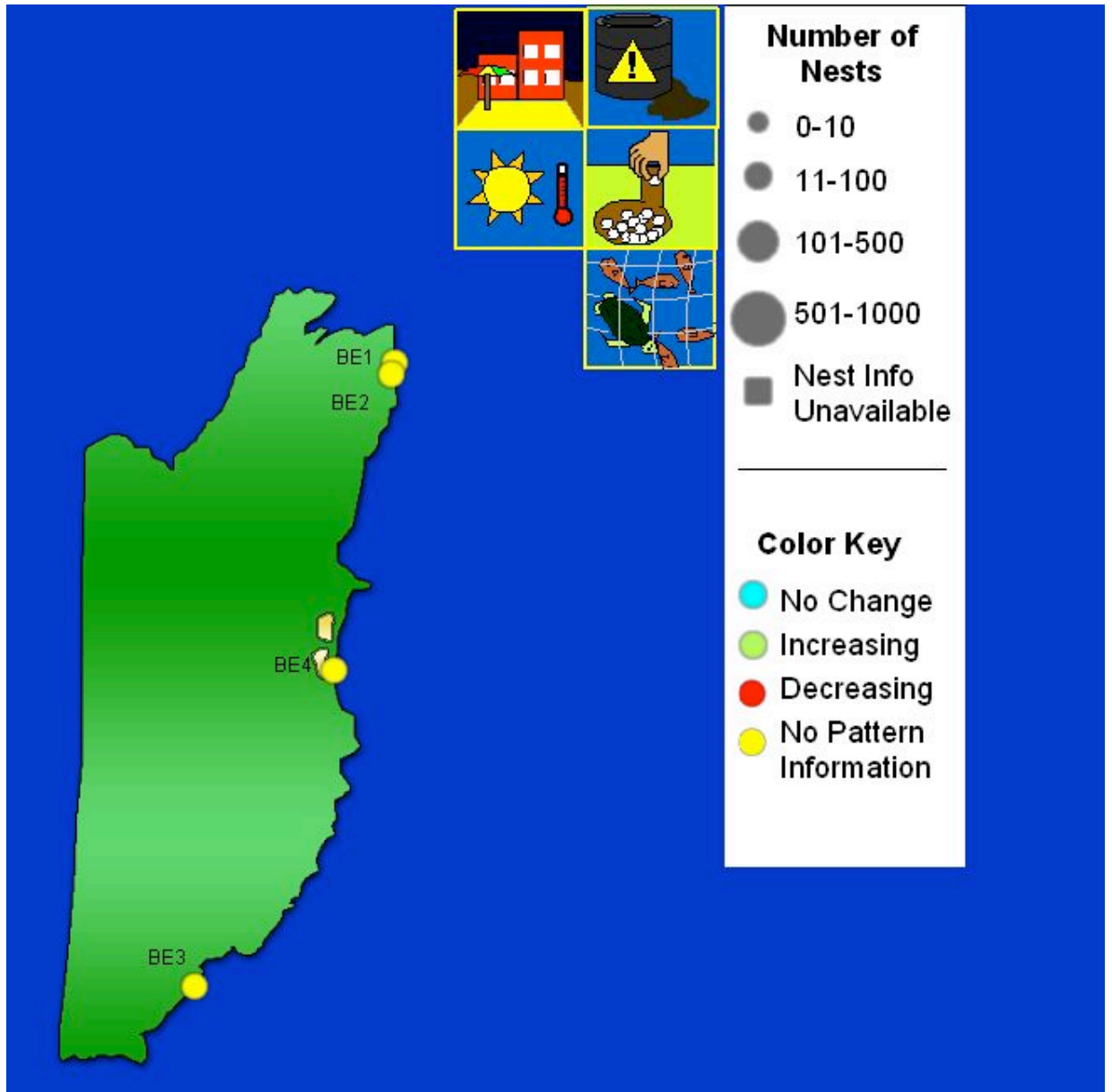


Figure 65: Belize

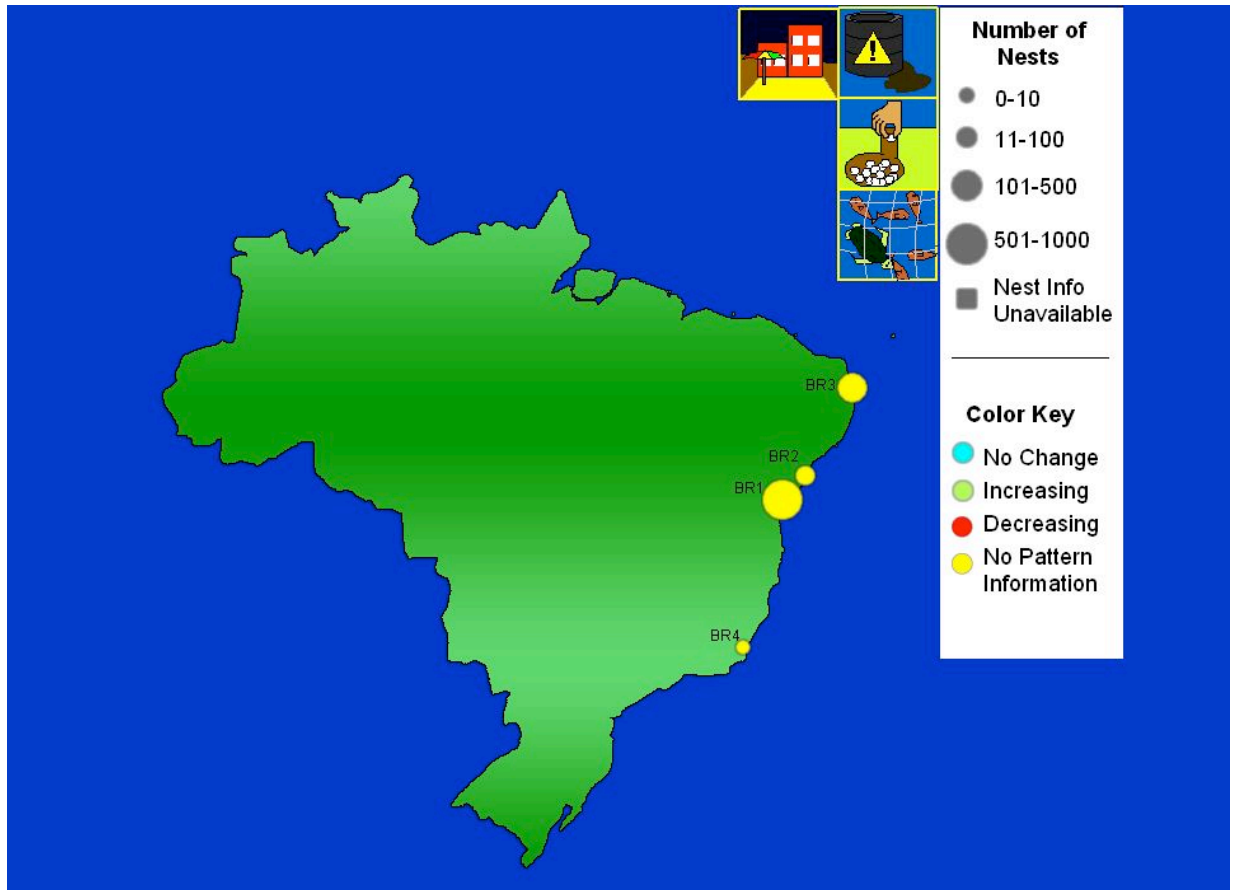


Figure 66: Brazil

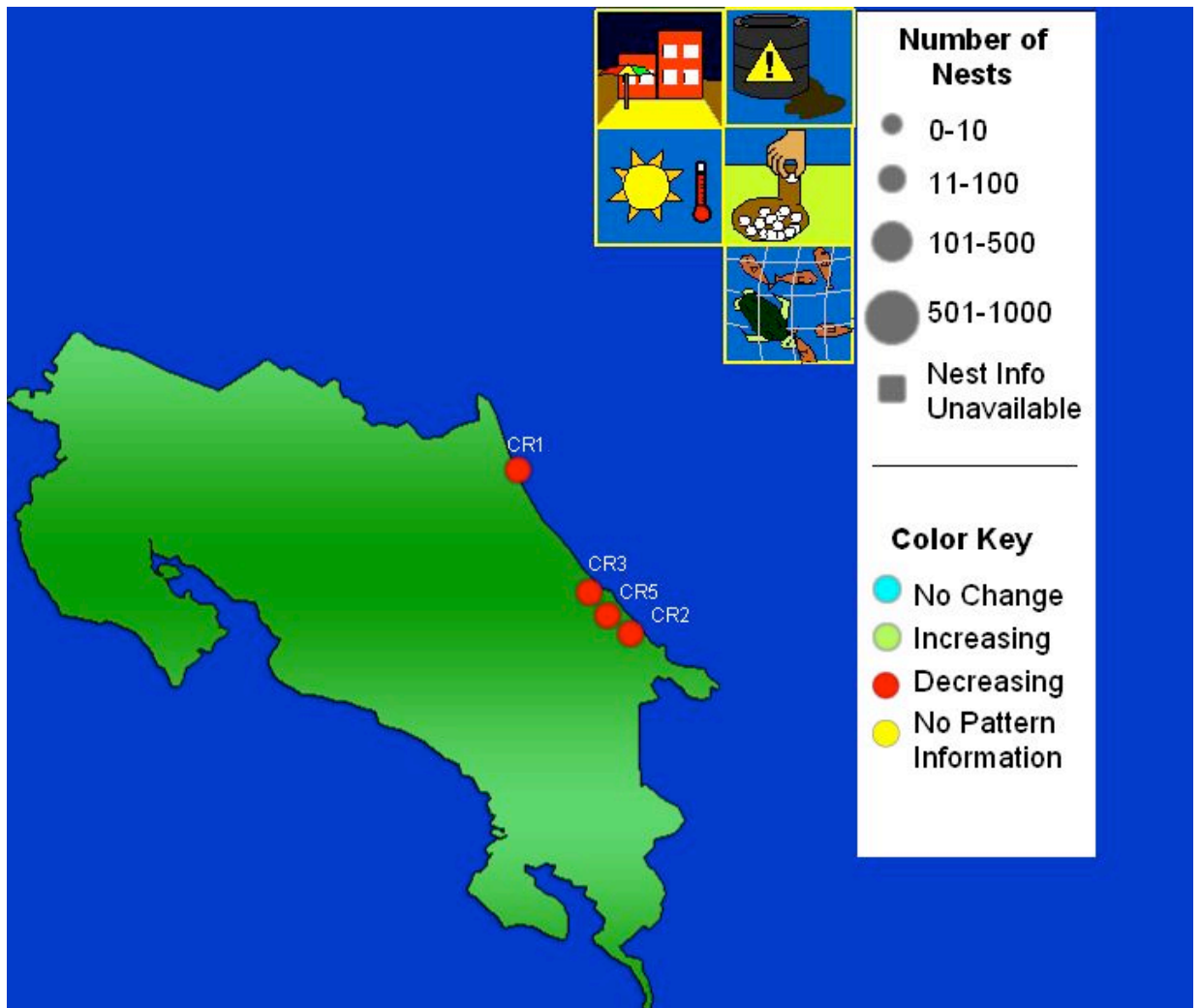


Figure 67: Costa Rica



Figure 68: Ecuador

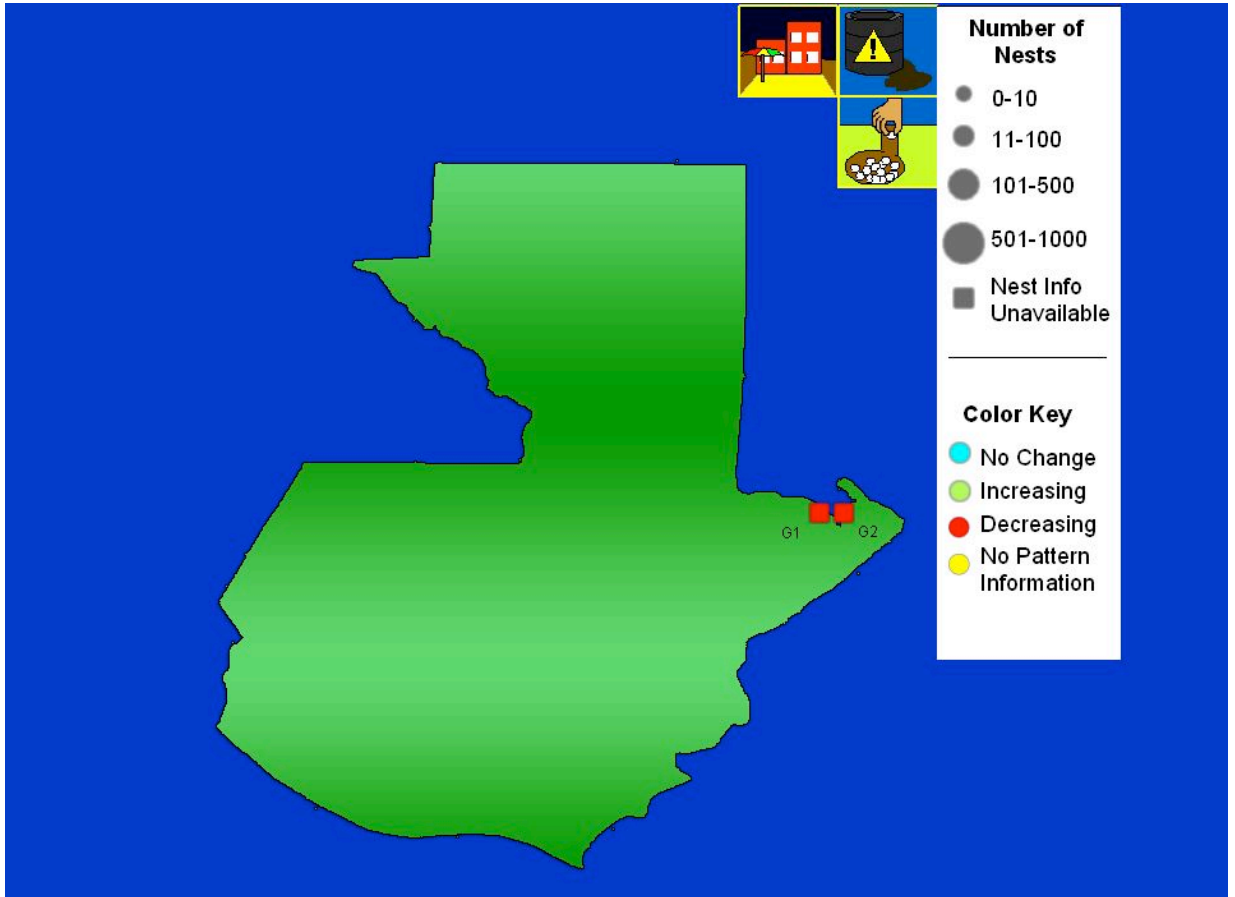


Figure 69: Guatemala

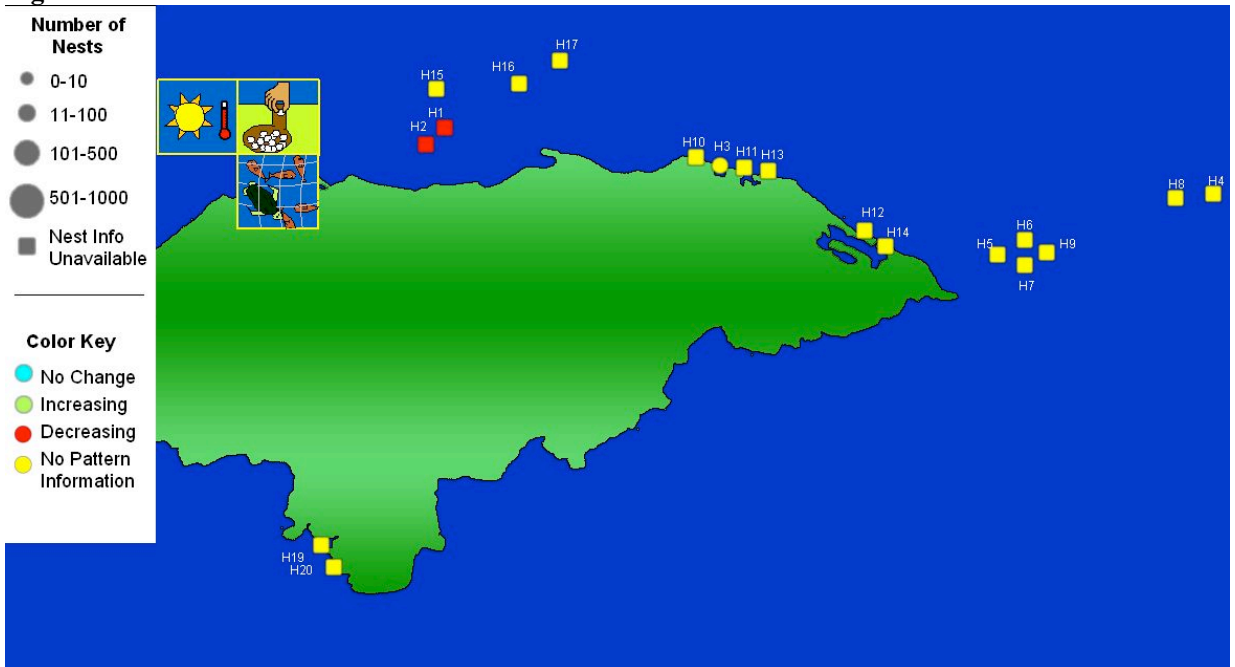


Figure 70: Honduras

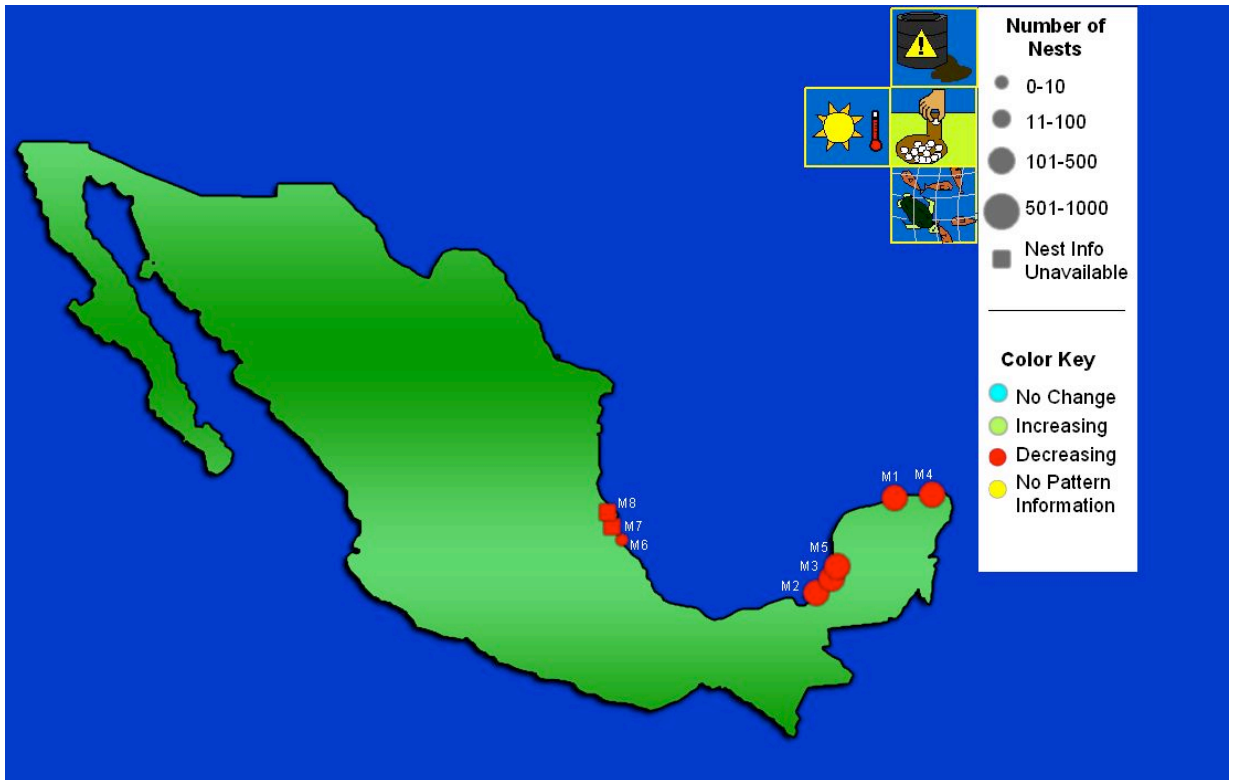


Figure 71: Mexico

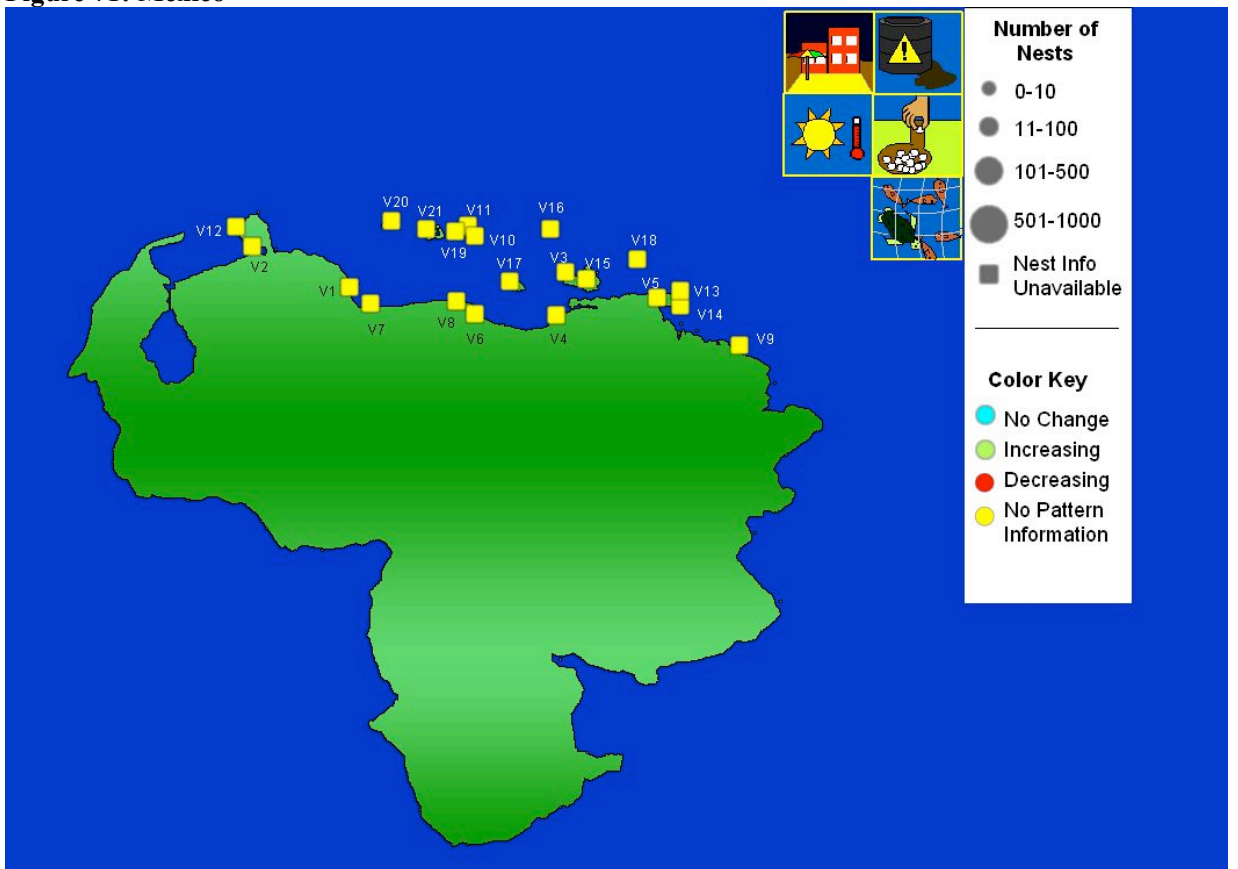
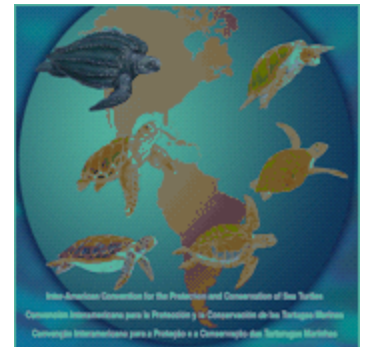


Figure 72: Venezuela

Appendix H Cover Sheet for Map

Hawksbill Nesting Sites In the Parties of the IAC – 2007

This map was created with information the Inter-American Convention for the Protection and Conservation of Sea Turtles collected from the annual reports of the parties, along with information that was researched independently and verified via a survey to the parties.



Threats:

The threats listed on each map under “Reported Threats Categories” come from a list of the greatest threats to sea turtles created by the Marine Turtles Specialist Group of the World Conservation Union (2007). These are:



Fisheries Impacts – By-catch from long line and gillnet fisheries, and collisions with fishing vessels



Climate Change – Temperature affects developing hatchlings, and global warming affects habitats



Direct Take – Poaching eggs and meat, along with commercial use of carapace



Pollution and Pathogens – Includes contaminants in the water, and physical debris on beaches



Coastal Development – Artificial lighting that distracts turtles, and destruction of habitat

The threats described in the annual reports from each country were divided into these categories. For some countries, all 5 were represented, and others reported threats outside the scope of these. Refer to each country’s map for detailed information.

Key:

Number of nests - The size of each dot represents the estimated number of hawksbill nests per year. The number of nests is not the same as the number of nesting females at a beach. Females nest more than once in a season, so the actual number of female turtles is less than the number of nests displayed on the map.



Unknown Nesting Information - The square represents that the nesting information is unavailable. This could mean that the research was not submitted, or that no research has taken place at the specified beach for the information.



Pattern Information - The color of the dot represents a pattern that has occurred in the population at certain beaches over several years, as reported by individual countries.



Yellow dots represent pattern information that was not available when these maps were created.

Serial Numbers:

Each beach on the map has a serial number which consists of an abbreviation of the country followed by a number. This number references the appropriate beach in the spreadsheet that accompanies the map. This spreadsheet contains the name of the beach and more specific information that is not shown in the map image.

Figure 73: Cover Sheet for mapping system

Appendix I Map Database

Country/Serial #	Site	Latitude	Longitude	Nests	Pattern	Additional
Belize						
BE1	Bacalar Chico Marine Reserve	18.170000 N	87.900000 W	11-100		1 Depr:
BE2	Rocky Point Beach	18.150000 N	87.900000 W	11-100		
BE3	Robles Beach	16.190000 N	88.560000 W	11-100		
BE4	Sapodilla Cayes Marine Reserve	17.210000 N	88.110000 W	11-100		
BE4	Gales Point Manatee Bar					
Costa Rica						
CR1	Tortuguero-Parismina- Pacuare	10.5975 N to 10.31778 N	83.52778 W to 83.36083 W	11-100	Decrease	
CR2	Gandoca	9.60164 N	82.60834 W	11-100	Decrease	
CR3	Cahuita	9.73221 N	82.81706 W	11-100	Decrease	
CR4	Isla Uvita			0-10		
CR5	Playa Negra de Puerto Vieja	9.6600000 N	82.754000 W	11-100	Decrease	
CR6	Playas Caletas- Ario			0-10		
CR7	Punto Banco			0-10		
CR8	Punto Pargos (Playas Avellanes-Lagartillo)			0-10		
Ecuador						
E1	La Playita de Salango	1.562306 S	80.833926 W			
E2	Los Frailes	1.491246 S	80.790916 W			
E3	Playa Cerro Viejo					
E4	Las Playitas de los Frailes					
E5	Machallia					

Honduras

H1	Cayos cochinos-Playa 3					Decrease
H2	Cayos Cochinos- Playa 2					Decrease
H3	Plaplaya				11-100	
H4	Cayos Vivorillos	15.841667 N	80.337500 W			
H5	Cayo Bobel	15.081111 N	82.676111 W			
H6	Cayo Sabana	15.14 N	82.589167 W			
H7	Cayo Port Royal or Tortuga	15.020833 N	82.589167 W			
H8	Cayos Bogas	15.841667 N	80.566667 W			
H9	Cayo Sur	15.082222 N	82.443889 W			
H10	Tocamacho	15.978611 N	84.999167 W			
H11	Ibans					
H12	Barra Catarasca					
H13	Cocobila					
H14	Cauquira					
H15	Utila					Equal
H16	Roatan					
H17	Guanaja	16.4525 N	85.878611 W			
H18	Cayos Cochinos					
H19	Las Gaviotas					
H20	Boca Rio Veijo					
H21	Cedona y Punta Condega					

Netherlands

Antilles

Country/Serial #	Site	Latitude	Longitude	Nests	Pattern	Additional
NA1	Klein Bonaire	12.15 N	68.3 W			1. Lack of
NA2	Bonaire	12 N to 12.31667 N	68.2 W to 68.41667 W			2. Sand m
NA3	Klein Curacao	11.99167 N	68.64167 W	101-500		
NA4	Gibbs Bay (St. Maarten)	18.01667 N to 18.03333 N	63 W to 63.13333 W			
NA5	Dawn Beach (St. Maarten)	18.01667 N to 18.03333 N	63 W to 63.13333 W			
NA6	Guana Bay (St. Maarten)	18.01667 N to 18.03333 N	63 W to 63.13333 W			
NA7	Mullet Bay (St. Martten)	18.01667 N to 18.03333 N	63 W to 63.13333 W			
NA8	Shete Boka, Curacao	12.36667 N	69.11667 W			

Guatemala

Country/Serial #	Site	Latitude	Longitude	Nests	Pattern	Additional
G1	Jaloba	15.95 N	88.616700 W			Decrease
G2	Vivero, Guatemala	15.855806 N	88.446330 W			Decrease

Mexico

M1	El Cuyo, Yuc.	21.48333 N to 21.54583 N	87.49167 W to 87.8 W	101-500	
M2	Isla Aguada, Cam.	18.95 N to 18.78333 N	91.3 W to 91.46667 W	101-500	
M3	Punta Xen, Cam.	19.5 N to 19.225 N	90.75 W to 90.84333 W	101-500	
M4	Las Coloradas, Yuc.	21.61111 N to 21.54167 N	88.16667 W to 87.79167 W	101-500	
M5	Chenkan, Cam.	19.225 N to 19.07 N	90.84333 W to 91.21806 W	101-500	
M6	Tecoluita, Ver.	20.49083 N to 20.57528 N	97.01444 W to 97.10861 W	0-10	
M7	Papantla, Ver.	20.57194 N to 20.62139 N	97.10056 W to 97.15056 W		
M8	Cazones, Ver.	20.68667 N to 20.68778 N	97.18333 W to 97.15056 W		
M9	Platanitos, Nay.				
M10	Holbox, Q.Roo.			501-1000	
M11	Celestun, Yuc			101-500	

United States

US1	Florida	35.666666 N	80.036700 W	0-10		1. Vessel s
US2	Culebra Island, Puerto Rico	18.305000 N	65.301400W	11-100	Increase	2. Degrade habitat
US3	Humacao, Puerto Rico	18.151700 N	65.827800 W		Increase	
US4	Mona Island, Puerto Rico	18.083333 N	67.883333 W	501-1000	Increase	
US5	Buck Island Reef, U.S. Virgin Islands	17.783333 N	64.516666 W	11-100		
US6	Sandy Point, U.S. Virgin Islands	17.693900 N	64.880800 W	0-10		

Venezuela

								1. Predatio	2. Ineffectiv
V1	P.N. Morocoy	10.88333 N	68.3 W						
V2	P.N. Medanos d Coro	11.58333 N	69.7 W						
V3	P.N. Restinga Lagoon	11 N	64.16667 W						
V4	P.N. Mochima	10.35 N	64.43333 W						
V5	P.N. Paria Peninsula	10.7 N	62.05 W						
V6	P.N. Tacarigua Lagoon	10.26667 N	65.83333 W						
V7	P.N. Henri Pittier	10.55 N	67.4 W						
V8	P.N. Delta Del Orinoco	9.7833333 N	61.51667 W						
V9	Delta Del Orinoco Biosphere Reserve	9.6833333 N	61.41667 W						
V10	P.N. Archip. De Los Roques	11.83333 N	66.73333 W						
V11	P.N. Archipelago de	11.8333333 N	66.716666 W						
V12	Peninsula de Parag	11.8333333 N	66.716666 W						
V13	Vertiente Norte de	10.716666 N	61.9833333 W						
V14	Vertiente Sur de l	10.6333333 N	62.000000 W						
V15	Edo Nueva Esparta	10.9333333 N	64.0333333 W						
V16	La Blanquilla	11.87 N	64.620000 W						
V17	La Tortuga	10.95 N	65.340000 W						
V18	La Testigo	11.3333333 N to 11.400000 N	63.000333 W to 63.001333 W						
V19	La Orchila	11.800000 N	66.9833333 W						
V20	Archipelago Las A	11.966666 N	67.650000 W						
V21	Archipelago Las A	11.9333333 N	67.400000 W						

Brazil

BR1	Bahia	12.977778 S to 11.45806 S	38.42139 W to 37.34861 W	501-1000	
BR2	Sergipe	10.51389 S	36.38889 W	11-100	
BR3	Rio Grande do Norte Pipa	6.280278 S to 6.595556 S	36.0233 W to 35.2075 W	500	
BR4	Rio de Janeiro	21.30222 S to 22.09556 S	40.96556 W to 41.13472 W	0-10	
BR6	Espirito Santo	18.4 S to 20.8 S	39.7 W to 40.63333 W	0-10	

