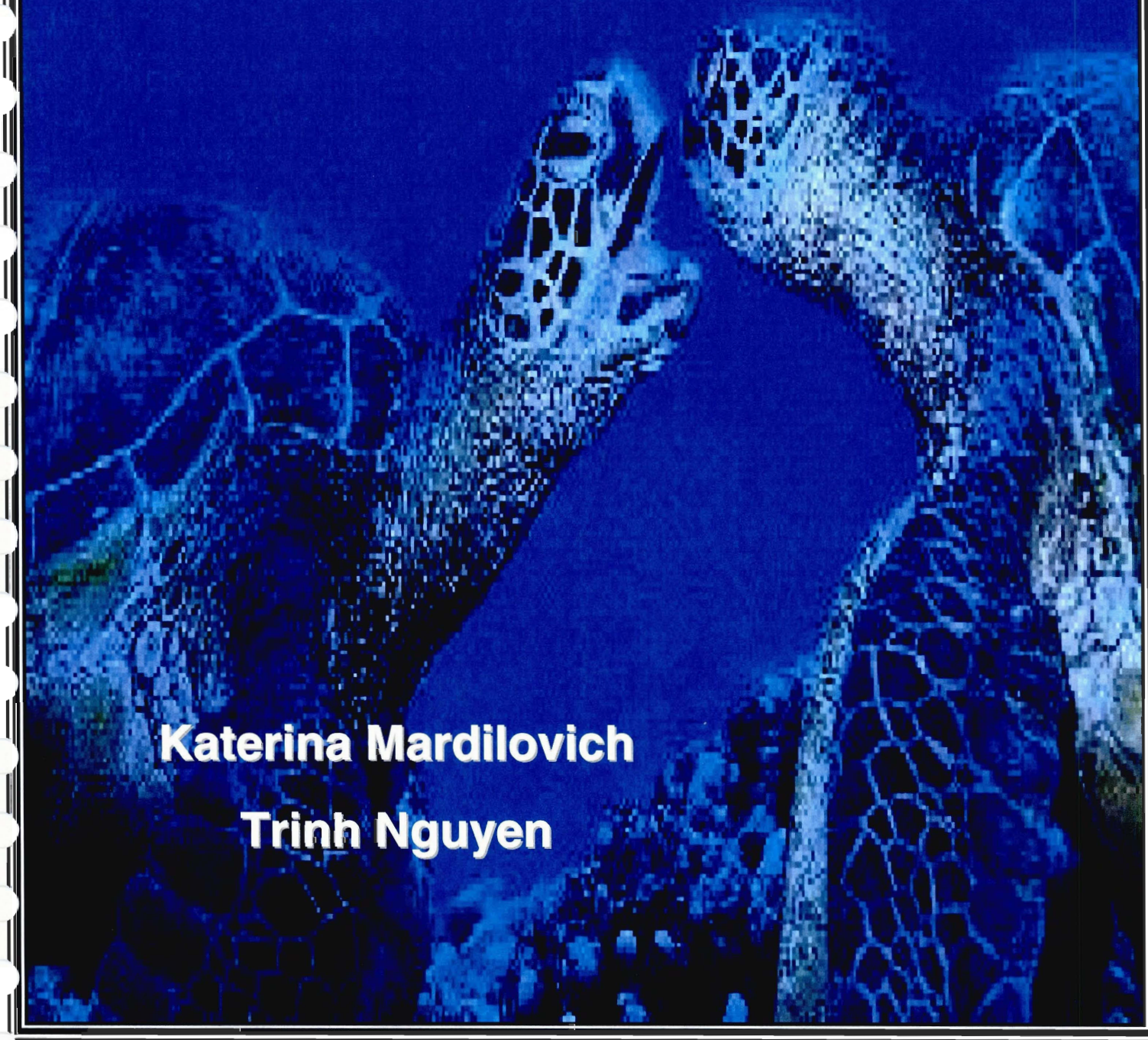
Improving Sea Turtle Conservation in Costa Rica through Environmental Education



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Report Submitted to:

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By

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In Cooperation With
M. A. Solano Martínez, Coordinator of the Wetlands Program
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THE IMPROVEMENT OF SEA TURTLE CONSERVATION IN COSTA RICA THOUGH ENVIRONMENTAL EDUCAION

July 2, 2003

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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 constructed as a working document by the reader.

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July 2, 2003

Sr. Marco A. Solano Martínez
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Dear Sr. Solano,

Enclosed is our report entitled The Improvement of Sea Turtle Conservation Through Environmental Education. It was written at the SINAC office during the period March 12 through July 2, 2003. Preliminary work was completed in Worcester, Massachusetts, prior to our arrival in Costa Rica. Copies of this report are simultaneously being submitted to Professors Vernon-Gerstenfeld and Manzari for evaluation. Upon faculty review, the original copy of this report will be catalogued in the Gordon Library at Worcester Polytechnic Institute. We appreciate the time that you and Maria Teresa Koberg have devoted to us.

Sincerely,

Katerina Mardilovich

Trinh Nguyen

AUTHORSHIP

The work produced to complete this project was completed equally in the group. All ideas were collaborated between the two of us through brainstorming and discussion. In the write up for the project, each member in our group had an equal say in the format, structure, and language.

The research for this project consisted of literature searches and interviews. Both members were present for all interviews. Literature searches were always conducted by both members. During the interviews, Trinh Nguyen was the main communicator, while Katerina Mardilovich took notes.

Editing was also completed equally between the two of us. Documents were often passed between the two of us multiple times or we would sit together and make corrections.

ACKNOWLEDGMENTS

We would like to thank our sponsor, MINAE, and our liaisons working with the organization. We are extremely grateful for this opportunity to help Costa Rica and the sea turtles that inhabit the country. Without Marco Solano and his assistant, María Teresa Koberg, we would not have known where to begin our project. Thank you for pointing us in the right direction. We would also like to especially thank Sra. Koberg for the translation of the educational booklet and the Executive Summary into Spanish.

We would also like to acknowledge Professor Vernon-Gerstenfeld and Professor Manzari for their guidance and patience. Without them, this project would not have been possible.

To Jorge Gamboa for answering our questions, arranging interviews, and helping us find the right contacts, we thank you. To Alvaro Soto and everyone in the office for the coffee, tea, and cookies, and friendly atmosphere, we thank you so much!

Last but not least, we would like to thank everyone that participated in the Costa Rica project center for keeping us sane and making the trip fun.

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EXECUTIVE SUMMARY

Sea turtle conservation became an issue during the 1970s when all eight species were listed as threatened or endangered. Since then, scientists, researchers, and volunteers have been working actively to prevent the extinction of marine turtles. Many have turned their efforts to sea turtle conservation in Costa Rica where six of the eight species nest and feed.

To protect wildlife in Costa Rica, the Ministerio del Ambiente y Energía (MINAE) was created in 1982 by the government. Its main purpose is to manage the natural resources of Costa Rica. The chief subdivision of MINAE, Sistema Nacional de Áreas de Conservación (SINAC), is specifically responsible for species conservation. To conserve important nesting beaches, MINAE has created several marine national parks and refugees to fulfill their responsibility. The creation of the National Parks allowed researchers from different countries to work in collaboration with SINAC – MINAE.

Different foundations and organizations from around the world conduct research and protect sea turtles on nesting beaches in Costa Rica. Since it is important to raise public interest and awareness, many of the organizations have developed volunteer programs. In the programs, volunteers are able to help park guides, patrol beaches at night, and assist researchers in collecting data on nesting sea turtles, nests, and hatchlings. Volunteers are taught about the about appropriate behaviors on nesting beaches and techniques necessary to help researchers. Volunteers also read scientific articles and other materials about sea turtles that cover information on the research they are going to work with. The programs are important educational tools that are also effective in promoting environmental concepts and information to possible tourists.

Some projects, such as Earthwatch Leatherback project in Las Baulas National Park, also have site-visiting programs for Costa Rican school students (Earthwatch Expedition, 2003). However, there are only few such programs. Most of the research projects in Costa Rica have no educational programs for school students. MINAE-SINAC has a wide volunteer program but does not have projects that involve children of school age (Jorge Gamboa, technical assistant at Programa National de Humadales, MINAE, personal communication, June 23, 2003).

Marco Solano, coordinator of the Wetlands Program in the Ministerio del Ambiente y Energía (MINAE) and *pro tempore* secretary of the Inter American Convention, requested help from a two person team of students from Worcester Polytechnic Institute to create a booklet about sea turtles that can be used to educate students and program volunteers. Included in the booklet is an introduction to sea turtles, descriptions of each species, the threats that they currently face, and other useful information. The booklet also promotes awareness of conservation concepts, which is most important to sea turtles. We also had to create an annotated bibliography that will illustrate how we created the educational booklet. The bibliography can be used by our sponsor, researchers, and students for future reference.

The booklet was originally intended for fifth grade students. Unfortunately, teachers and educators from the public school system went on strike, and as a result the schools closed. Students attending public schools are important because they are generally not as advanced in their curriculum as the students that attend private schools. Before the changes were made to our project, we had already studied the cognitive level of the fifth graders through interviews and a survey.

The information obtained from the interviews with teachers from Escuela Anglo-Americana supported the common ideas about children's cognitive level described in the literature. Bransford, Brown, & Cocking (2000) stated that children have the same intellectual capacity as adults. It is more difficult for kids to learn because their memory capacity is smaller. Therefore, any information presented to children of chosen age group has to be compact and meaningful. To make it easier for children to learn new material, the information must be expressed in short sentences.

We also visited the Museo de Los Niños in San José and interviewed Sra. Fabiola Rodríguez, the executive director. According to Sra. Rodríguez, children from age six to twelve can understand and accept even the most complicated information, but only if it is presented in a simple way. Using the national curriculum of Costa Rica, the museum bases each of the exhibits around the material that students are required to learn. Determined by the Ministerio de Educación, the national curriculum is not required for private schools. Since the Escuela Anglo-Americana is a private school, it uses its own curriculum, which is determined by a board of directors and teachers. Although the school follows its own curriculum, it does follow the national curriculum in science.

To determine how much information students already knew about ecology and sea turtles, we conducted a survey of the fifth grade of Escuela Anglo-Americana. The results showed that students were familiar with such term as "extinction" but only few could explain what "ecosystem" meant. As a result, we included a wide explanation of ecosystem in the booklet as well as the role of sea turtles in marine and world ecosystems.

Some of the students specified that they learned general information about turtles from places such as Tortuguero. The results of the survey showed that these students did the best on the test. Since many people learn better with hands-on activities or through interaction, it is best if the students took a field trip to turtle nesting sites to see close up how to behave around sea turtles. The information learned on the field trip will last much longer than information read in an educational guide.

After the plans for our project changed, it was important for us to update the language used. Our target audience became volunteers and secondary students that visit the conservation areas. We slightly adjusted the language level for more advanced minds. The booklet is no longer solely for fifth graders, but for students of all ages and volunteers that visit the nesting sites.

The educational booklet targets children from twelve to sixteen years old and older. It is important to conservation efforts of sea turtles in Costa Rica because children tend to share all new learned information with their families and friends. Therefore, it will educate not only children but also their friends and relatives. Functioning as an educational guide, the booklet should be used with younger students that attend primary school while the students of secondary school age can utilize it as reading material. If used in this manner, many students can receive the same information that will be useful towards environmental education and sea turtle conservation.

When located at nesting sites, the book can educate both students and volunteers. It is easy for students in seventh grade and higher to understand the contents because it uses language and writing styles that are easy for that age group. It also includes a

glossary with explanations of some scientific terms if users have difficultly remembering specific words.

The second goal of the project was to create an annotated bibliography of the sources used for the project that would also accompany the booklet. The bibliography is a reference source that creation of the educational booklet. Researchers can use the information in the bibliography to create an educational program. If used by students and researchers alike, further programs can be created to be used in the classrooms or at the conservation areas. It can also guide teachers and older students in their further learning and more in depth information about sea turtles

Among our recommendations for MINAE is the establishment of an educational program for school students at national parks. It should include visits to the nesting beach, turtle watching as well as on-site lecturing. Park guides or volunteers can help to educate visitors as part of the sea turtle conservation movement. The booklet we produced will help volunteers to determine the information that should be presented to children. Since park guides are trained and already know all information about sea turtles, they can use the bibliography we produced to update their knowledge. It is important for the guides and volunteers to use the most effective pedagogical methods when lecturing. For this particular program, it is best to keep the lectures short and simple.

Our second recommendation is the creation of a summer educational center for children at the conservation areas. The centers should be structured similarly to a day care or day camp. Tourists with children do not often visit nesting sites because there are

no facilities for children. Not only will the establishment educate the children, it will attract more tourists to the areas.

It would be useful for MINAE to build a website devoted solely to sea turtles. This page should contain general information about sea turtles, habitat, biology, and behavior patterns. All nesting sites for specific species should also be listed in this page along with the organizations conducting research at the particular sites. It is important to constantly update the website for tourists and visitors looking for up to date information about the facilities and events. Including the information about the volunteer programs will advertise and attract students and possible sponsors to the nesting sites in Costa Rica.

RESUMEN EJECUTIVO

La conservación de las tortugas marinas se convirtió en un problema significativo durante la década de los 1970s, cuando las ocho especies fueron consideradas amenazadas o en peligro. Desde entonces los científicos, los investigadores y los voluntarios han estado trabajando activamente para prevenir la extinción de las tortugas marinas. Muchos han dirigido sus esfuerzos a la conservación de las tortugas marinas en Costa Rica donde seis de las ocho especies desovan y se desarrollan.

El Ministerio del Ambiente y Energía (MINAE), fue creado por el gobierno en 1982 para proteger la vida silvestre. Su propósito fundamental consistió en el manejo de los recursos naturales de Costa Rica. La principal subdivisión del MINAE, el Sistema Nacional de Áreas de Conservación (SINAC), es responsable específicamente por la conservación de las especies. Con el fin de proteger importantes sitios para el desove de las tortugas marinas, MINAE ha creado varios parques nacionales y refugios de vida silvestre marinos. La creación de esas áreas protegidas permite a los investigadores de diferentes países trabajar en colaboración con el SINAC-MINAE.

Mundialmente, varias fundaciones y organizaciones realizan investigaciones para proteger a las tortugas marinas en sus playas de desove en Costa Rica. Ya que es tan importante crear conciencia en el gran público, muchas organizaciones desarrollan programas de voluntariado. Los voluntarios se entrenan en el comportamiento adecuado en las playas de desove y las técnicas requeridas para ayudar a los investigadores. Ellos también leen artículos científicos y otros materiales sobre tortugas marinas con información sobre programas de investigación con los cuales estarían vinculados. Estos

programas son instrumentos significativos de educación ambiental por su eficacia para promover conceptos ambientales e información para los posibles visitantes.

Algunos proyectos, tales como el de Baulas de Earthwatch en el parque nacional marino del mismo nombre, organizan visitas de estudiantes costarricenses a las playas de sus proyectos (Earthwatch Expedition, 2003). Las empresas Ecology Project International y EcoTeach, también llevan estudiantes costarricenses y norteamericanos a las reservas privadas de tortugas baula *(D. coriacea),* en Pacuare. Sin embargo, la mayoría de los programas de investigación en Costa Rica no manejan proyectos educativos para estudiantes de escuelas y colegios. El MINAE-SINAC administra un programa muy importante de voluntariado pero aún no ha participado con jóvenes de edad escolar (comentario personal de Jorge Gamboa, Asistente Técnico del Programa Nacional de Humedales del MINAE, junio 23 del 2003).

Marco Solano, Secretario *Pro tempore* de la Convención Interamericana para la Protección y Conservación de las Tortugas Marinas y hasta hace poco coordinador del Programa de Humedales del Ministerio del Ambiente y Energía (MINAE), solicitó la colaboración de dos estudiantes del Worcester Polytechnic Institute, para producir un librito sobre tortugas marinas que fuese útil en la educación de estudiantes y en los programas de voluntariado. Incluidos en el libro se encuentran una introducción sobre las tortugas marinas, la descripción de cada especie, las amenazas contemporáneas que enfrentan e información adicional útil. El libro también promueve el conocimiento de los conceptos conservacionistas, algo de la mayor importancia para las tortugas marinas. Tuvimos que crear, asimismo, una bibliografía anotada ilustrando como llegamos a

producir el librito educativo. La bibliografía puede ser útil como referencia en el futuro para nuestro patrocinador, los investigadores y también los estudiantes.

Originalmente, los estudiantes de quinto grado constituyeron la meta del librito. Desafortunadamente, maestros y educadores del sistema de educación pública se declararon en huelga y como resultado de la misma las escuelas públicas cerraron sus puertas. Estos alumnos de las escuelas públicas son importantes porque en términos generales no están tan avanzados en su currículo como los estudiantes de los centros educativos privados. Anterior a estos cambios en nuestro proyecto, nosotras ya habíamos analizado el nivel de conocimiento de los alumnos de quinto grado por medio de entrevistas y una encuesta.

La información obtenida de las entrevistas con profesores de la Escuela Anglo-Americana, apoyó nuestra concepción sobre el nivel de conocimiento de los niños descrito en la literatura. Bransford, Brown y Cocking (2000), afirman que los niños tienen la misma capacidad intelectual que los adultos. Pero es más difícil para los niños aprender porque su capacidad para memorizar es menor. Por lo tanto, toda información dirigida a niños en este estadio, debe ser compacta y repleta de significado. Para que los niños aprendan material nuevo, la información debe expresarse en frases cortas.

También visitamos el Museo de los Niños en San José y entrevistamos a la señora Fabiola Rodríguez, su directora ejecutiva. De acuerdo a la señora Rodríguez, los niños de seis a doce años pueden comprender y aceptar hasta la información más compleja, pero solamente si se les presenta de una manea simple. Utilizando el currículo de Costa Rica, cada una de las exhibiciones del Museo es creada utilizando el material que se requiere aprendan los niños. El Ministerio de Educación Pública elabora el currículo que

deben usar los centros educativos del sistema de educación pública, pero los privados no están obligados a seguirlo. Ya que la Escuela Anglo- Americana es un centro educativo privado, usa su propio currículo el cual es aprobado por un cuerpo colegiado de directores y profesores. Aunque la Anglo-Americana cumple su propio currículo, sí se adhiere al currículo nacional de ciencias.

Para conocer el grado de información que los estudiantes manejan sobre ecología y las tortugas marinas, realizamos una encuesta con los estudiantes de quinto grado la Escuela Anglo-Americana. Los resultados demostraron que los estudiantes conocían el término "extinción", pero muy pocos podían expresar el significado de "ecosistema". Como consecuencia de lo anterior, incluimos una amplia explicación en el librito sobre ecosistemas, lo mismo que sobre el rol de las tortugas en los ecosistemas marinos y mundiales.

Algunos estudiantes señalaron que habían aprendido información general sobre las tortugas en sitios tales como Tortuguero. Los resultados de la encuesta demostraron que estos estudiantes alcanzaron las mejores notas en las pruebas. Ya que las personas aprenden mejor con actividades "sobre la marcha" o interactivas, es preferible para los estudiantes visitar los sitios de desove para conocer personalmente el comportamiento de las tortugas marinas. Los conocimientos aprendidos en un paseo a una playa de desove tendrán más vigencia que lo aprendido en un librito educativo.

Cuando cambiaron los planes de nuestro proyecto, tuvimos que reinventar el lenguaje utilizado. Ahora nuestra población meta era los voluntarios y los estudiantes de segunda enseñanza que visitaban las áreas de conservación. Editamos entonces para un nivel de lenguaje apto para mentes un poco más avanzadas. En la actualidad el librito no

es tan solo para estudiantes de quinto grado sino para estudiantes de todas las edades y voluntarios que visitan los sitios de desove.

El librito educativo está concebido para jóvenes desde los doce a los dieciséis años o más. Es importante para complementar los esfuerzos de conservación de las tortugas marinas en Costa Rica, porque los jóvenes tienden a compartir los nuevos conocimientos con sus familiares y amigos. Por lo tanto, será útil para educar a los jóvenes pero también a sus familiares y amistades. Como guía educativa, el libro está dirigido a estudiantes más jóvenes de enseñanza primaria mientras que los estudiantes de enseñanza secundaria lo pueden utilizar directamente como material de lectura. Si se usa de esta manera, muchos estudiantes recibirán información que les será útil lo mismo para la educación ambiental que para la conservación de las tortugas marinas.

Ya ubicado en los sitios de desove, el librito puede servir a ambos, los estudiantes y los voluntarios. Es fácil para estudiantes de sétimo año y aún mayores comprender su contenido, porque utiliza un lenguaje y un estilo de escritura apto para ese estadio. También incluye un glosario con las explicaciones de los términos científicos si es que los lectores experimentan dificultad en recordar términos específicos.

El objetivo siguiente del proyecto para acompañar el librito, fue crear una bibliografía anotada de todas las fuentes consultadas. La bibliografía consiste en una fuente de referencias del librito educativo. Los investigadores pueden usar su información para crear programas de educación ambiental. Si es utilizada por ambos, los estudiantes y los investigadores, pueden derivarse programas adicionales sobre las áreas de conservación para implementarse en las aulas o las áreas de conservación. Asimismo,

puede convertirse en guía de profesores y estudiantes más avanzados para informarse más ampliamente sobre las tortugas marinas.

Nuestras recomendaciones para el MINAE incluyen el establecimiento de programas educativos para escolares en los parques nacionales. También debe incluir visitas a las playas de desove, observar a las tortugas y participar en charlas allí mismo en esos sitios. Los guardaparques y los voluntarios pueden contribuir a la educación de los visitantes como parte del movimiento para conservar a las tortugas marinas. El librito que hemos producido puede ayudar a los voluntarios a decidir sobre la información que deben presentarle a los niños. Ya que los guardaparques están entrenados y de hecho conocen la información sobre tortugas marinas, pueden utilizar la bibliografía para mantenerse al día en sus conocimientos. Es importante para los guías y los voluntarios hacer uso de los métodos pedagógicos de la manera más efectiva. Para este programa en particular, lo mejor es mantener las charlas cortas y sencillas.

Nuestra segunda recomendación es la creación de centros de veraneo para la educación de niños en las áreas de conservación. Estos centros deben estar estructurados como una guardería para un día de campo. A menudo los turistas no visitan los sitios de desove porque no hay facilidades disponibles para los niños. Estos desarrollos dirigidos a los niños los educarían y a la vez atraerán más turistas a las áreas.

Sería importante que el MINAE desarrolle un sitio web dedicado únicamente a las tortugas marinas. Este sitio debe ofrecer la información general sobre las tortugas marinas, sus hábitat, biología y patrones de comportamiento. Todos los sitios de desove de las diferentes especies deben incluirse en este sitio, lo mismo que las organizaciones que realizan investigaciones. Es muy importante actualizar el sitio web para los turistas y

los visitantes que necesiten información sobre las facilidades y los eventos programados. La información sobre los programas de voluntariado debe incluirse para informar y atraer más estudiantes y posibles patrocinadores para los sitios de dosove costarricenses.

Chapter 1. INTRODUCTION

Numerous species of sea turtles once populated the world's oceans. The earliest known sea turtle fossils are approximately 110 million years old. Over the past one hundred years, there has been a dramatic increase in demand for turtle eggs, meat, skin, and shells. As a result, sea turtle numbers have significantly dropped and are now on the endangered species list (Sea Turtle Survival League, 2002). Poachers and fishermen are not the only ones to blame for the near disappearance of sea turtles. Others that are responsible for destroying turtle nesting and feeding grounds are tourists and the general public. An increasing problem for marine turtles is pollution. Caused by a number of ways, pollution can be found in the oceans and on beaches (Sea Turtle Survival League, 2002). If action is not taken against the problems that sea turtles are facing, these creatures could very well become extinct.

Once marine turtles were listed as endangered species, many countries have taken steps towards conservation of sea turtles. One of the countries that are deeply concerned about marine turtle conservation is Costa Rica (D. Chacón, Marine and Wetlands Program Coordinator, ANAI, personal communication, May 23, 2003). It has several of the most important sea turtle nesting sites in the world. There are many groups studying and researching sea turtles in Costa Rica two of the organizations are El Ministerio del Ambiente y Energía (MINAE) and Sistema Nacional de Áreas de Conservación (SINAC). SINAC is the general division of MINAE and is responsible for species preservation and conservation in Costa Rica. Currently, SINAC – MINAE is sponsoring

research dealing with conserving sea turtles and increasing the number of females nesting along Costa Rica's beaches.

Sea turtles have significant importance to Costa Rica and the world for many reasons. Attracting tourists and researchers alike, sea turtles play a large role in the Costa Rican economy and culture. In 2001, commerce and tourism made up forty percent of Costa Rica's gross domestic product (GDP) (Bureau of Public Affairs, 2002). Biologically, sea turtles are important because they are a part of the marine and beach ecosystems. Affecting other living organisms in the same ecosystems, sea turtles play an important role that keeps the system balanced. The extinction of sea turtles will not only wipe out one species, but also have its effect on other species that are members of the same ecosystems.

There are several reasons for sea turtle deaths in Costa Rica. As a part of the Inter-American Convention for Sea Turtle Conservation, the organizations are taking legislative moves to help marine turtles. Moving to pass laws that will stop fishermen from using tools and equipment that are dangerous to sea turtles, MINAE represents Costa Rica in the Inter-American Convention for Conservation of Sea Turtles.

Sr. Marco Solano is currently the Coordinator of the Wetlands Program at MINAE. Additionally, he is the *pro tempore* Secretary of the Inter American Convention. Sr. Solano requested help from the students of Worcester Polytechnic Institute to collect information concerning the sea turtles and compose an educational booklet for volunteer programs at nesting sites based on the findings from the research. The purpose of the booklet is to stimulate an interest in marine turtles and promote knowledge of sea turtle conservation. This booklet will be used to introduce sea turtle

information and conservation concepts to school students and volunteers in the environment. The task also requires the creation of an annotated bibliography that includes all books, articles, and scientific journals that contain information related to sea turtles and were used to create the booklet. The bibliography will be used by the sponsoring organization, MINAE, and potentially any researchers that need to find a quick reference to information about marine turtles.

To complete the project, our group had to gain an understanding about the cognitive level of our target audience. For this reason interviews were conducted with school teachers to determine the level at which their students work. Not only is it important that Costa Rican students understand the information, but our team also wanted the most important information students and volunteers must know about marine turtles to be included in the booklet. To find the information, we conducted another set of interviews with professionals who have led or taken part in research on turtle conservation.

Chapter 2. **BACKGROUND AND LITERATURE REVIEW**

The problem of the rapid decline of sea turtle population throughout the world created a movement towards their conservation. All sea turtle species were listed as endangered in the 1970s (U.S. Fish and Wildlife Service, 2002). Since then, many researchers and organizations have combined their efforts to preserve sea turtles. Studies have been conducted all over the world to understand more about their behavior, migration, and biology. With all this knowledge, conservational organizations have been able to develop methods and regulations that meant to conserve sea turtles and their habitats. One of this methods include public education that razes the awareness among people and present to them important information about sea turtles and their conservation.

Sea Turtles

Turtles are air-breathing reptiles that inhabit tropical and subtropical seas throughout the world (Caribbean Conservation Corporation (CCC), 2002a). Sea turtles are almost completely marine animals, spending ninety percent of their lifetime in water (Sea Turtle Survival League, 2002). Only during the mating season do sea turtles swim close to the shore. Afterwards, male turtles return to the ocean while females remain on the beach to lay eggs. Sea turtles are able to migrate hundreds and thousands of miles between their nesting beaches and feeding places and back. Females lay their eggs at the exact same beach where they were born each nesting season, which is called the natal beach (CCC, 2002a). Although it is unknown how turtles are able to navigate under water with accurate precision, it is known that they can sense gravity but this fact does not fully explain their navigational skills.

Some species lay the eggs by excavating a hole on the beach to make a nest and throwing sand over it to mask it from predators. A sea turtle, depending on the specie, lays about a hundred eggs in each nest. Eggs are laid several times during the nesting season, but females nest every one to three years (CCC, 2002a).

Many factors effect hatchling development. The eggs are incubated for more than two months. The temperature of the sand during the incubation period is extremely important. Eggs incubated in cooler sand tend to produce more males, while eggs in hot sand results in more females (CCC, 2002a). When baby turtles hatch from the eggs, they make a common effort to dig themselves out from the nest. As soon as they reach the top of the nest, they rush towards the ocean. They spot it as the brightest light source on the beach. Therefore, any artificial light near the beach can disorient hatchlings and direct them to the opposite direction from the ocean. In this case, they become victims of birds and crabs or die from dehydration. As soon as hatchlings reach the water, sharks or any other large fish can eat them. Only 2.5 per thousand green turtle hatchlings will live to adulthood (Hirth & Schaffer, 1974). The survival of loggerhead turtle (*Caretta caretta)* hatchlings was estimated to be less than one per thousand (Frazer, 1986).

Ocean currents carry hatchlings to their feeding places where food is abundant and there are few enemies. Young turtles are able to stay there for several months or even years until they reach adulthood. Sea turtles regularly eat seaweed, small fish, mollusks, jellyfish, and sea grass. Although marine turtles do not have teeth, they have very powerful jaws that help them to crush and grind their food (CCC, 2002a).

After reaching their mature age, sea turtles return to land for nesting. It can take from fifteen to fifty years for a sea turtle to return, depending on the species to reach the mature reproductive age (CCC, 2002a). It is also theorized that some species can live

over one hundred years. The leatherback (*Dermochelys coriacea)* is the largest recorded marine turtle to exist. According the data of Caribbean Conservation Corporation (2003), adult individuals can reach 1.2 to 2.4 meters in length and up to 650 kilograms in weight. The smallest species is the olive ridley turtle (*Lepidochelys olivacea).* These are only approximately 60 to 70 centimeters in length and weigh from 35 to 50 kilograms.

Species Description

There are seven species of sea turtles that populate the marine environment in the Americas, which are: green *(Chelonia mydas)*, leatherback *(Dermochelys coriacea)*, loggerhead *(Caretta caretta),* black *(Mydas agassizi)*, Kemp's ridley *(Lepidochelys kempii)*, and olive ridley (*Lepidochelys olivacea).*

Green turtles *(Chelonia mydas)* are shown in Figure 1. They are named not after their green shell but for the green color of their body fat (CCC, 2002b). The Eastern Pacific population of the green turtle is also called the black sea turtle *(Mydas agassizi)*; shown in Figure 2, which received its name due to dark, almost black shell. Green turtles average more than 90 centimeters in carapace length, and average about 150 kilograms in weight. Green sea turtles' diet changes significantly during its life. Young sea turtles feed on worms, crustaceans, aquatic insects, grasses and algae. Adult species feed on sea grass and algae, which makes it the only sea turtle that is strictly herbivorous as an adult. Green turtles nest at every two, three, or more years. They lay an average of three to five egg clutches, with about twelve days intervals. There is an average of 115 eggs per clutch and they incubate for approximately sixty days (CCC, 2002b).

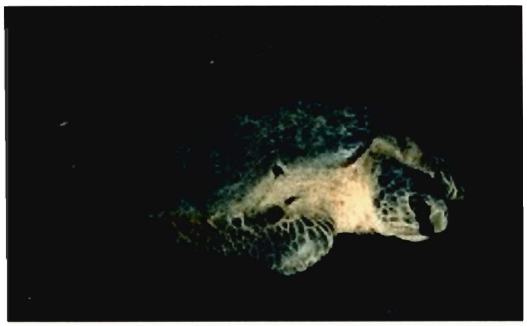


Figure 1. Green Sea Turtle (*Chelonia mydas)*
Source: CCC (1996)

Figure 2. Black Pacific Sea Turtle (*Chelonia agassizi)*
Source: CCC (1996)

The loggerhead sea turtle *(Caretta caretta)* is the most often seen of the seven species (Figure 3).

Figure 3. Loggerhead Sea Turtle *(Caretta caretta)*
Source: CCC (1996)

Adult loggerheads weigh up to 175 kilograms and have a reddish-brown carapace (upper shell) and a brown to yellow plastron (lower shell). Fully grown, they average from 82 to 105 centimeters in length. Loggerheads have powerful jaws and feed on shellfish, horseshoe crabs, clams, mussels, and other invertebrates (CCC, 1996). Loggerheads lay eggs at intervals of two, three, or more years. They lay four to seven nests per season every fourteen days. The average number of eggs in each clutch ranges from 100 to 126, and the eggs incubate for sixty days (CCC, 1996).

The leatherback *(Dermochelys coriacea)* is the largest sea turtle in the world, shown in Figure 4.

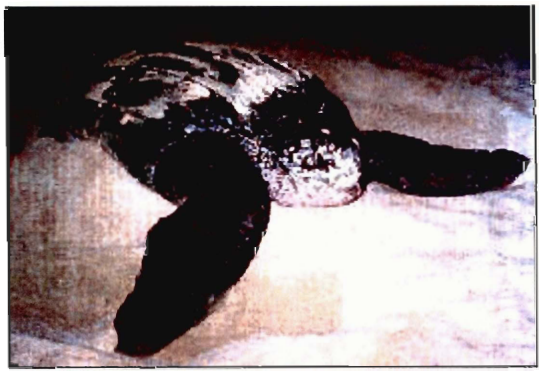


Figure 4. Leatherback Sea Turtle *(Dermochelys coriacea)*
Source: CCC (1996)

Mature leatherbacks typically reach about 1.3 to 1.75 meters in length and weighs from 325 to 650 kilograms (CCC, 2002b). It was named for its shell, which is composed of a layer of thin, tough, and rubbery skin that is strengthened by thousands of tiny bone plates (CCC, 1996).

Their main part of their diet is jellyfish. Because leatherbacks are very large and active animals and jellyfish consists mostly of water, young leatherbacks eat twice their weight in jellyfish each day to grow normal and healthy (CCC, 1996).

Leatherbacks nest every two to three years, laying six to nine clutches in a season, which leaves about ten days between each nesting. Each leatherback clutch contains approximately eighty large fertilized eggs and thirty smaller unfertilized eggs. The eggs incubate for approximately sixty-five days (CCC, 1996).

Hawksbill *(Eretmochelys imbriacata)* turtles are named after their heads, which resembles a bird, specifically, the hawk, as shown in Figure 5. The hawksbill is one of the smallest sea turtles. They average between seventy six to ninety one centimeters in length and forty to sixty kilograms in weight. The unique shaped beak allows the hawksbill to reach food from small crevices found in coral reefs. They eat sponges, anemones, squid, and shrimp.

Hawksbill turtles nest at intervals of two, three, or more years. An average of two to four egg clutches are laid approximately fifteen days apart during nesting season. An average of 160 eggs per clutch is laid and they incubate for approximately sixty days. Although they nest on beaches throughout the Caribbean, they are no longer found anywhere in large numbers.

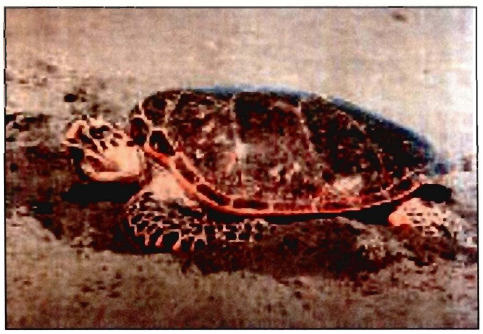


Figure 5. Hawksbill Sea Turtle *(Eretmochelys imbriacata)*
Source: CCC (1996)

Kemp's ridleys *(Lepidochelys kempii)* are the smallest of all species. Adults measure sixty-two to seventy centimeters in carapace length and weigh between thirty-five

to forty-five kilograms. The carapace of adults is olive green and the plastron is yellow. They have powerful jaws that help them to crush and grind crabs, calms, mussels, and shrimp.

Unlike other sea turtles, Kemp's ridleys nest annually. They lay about two clutches during each season, which are approximately twenty-five days apart. Each nest contains approximately 105 eggs, which incubate for 55 days. Kemp's ridleys also nest in mass synchronized nestings called *arribadas*, which is Spanish for "arrival."

Figure 6. Kemp's Ridley Sea Turtle *(Lepidochelys kempii)*
Source: CCC (1996)

The olive ridley (*Lepidochelys olivacea)* is also a small marine turtle, usually less than 50 kilograms. The overall color of this turtle is olive green, which can be seen in Figure 7 (CCC, 2002b). It feeds on crustaceans, mollusks, and tunicates. An average clutch size is over 110 eggs that incubate for fifty-two to fifty-eight days. The olive ridley inhabits tropical and subtropical coastal bays and estuaries (CCC, 2002b).

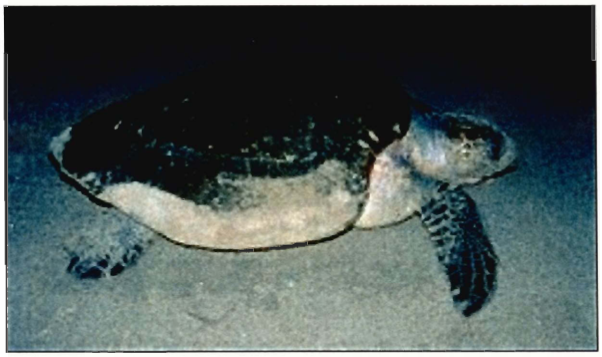


Figure 7. Olive Ridley Sea Turtle (*Lepidochelys olivacea)*
Source: CCC (1996)

Reasons for High Numbers of Sea Turtle Mortality

For the past two centuries, sea turtles have become a major target for fishermen and poachers because of their valuable eggs and precious shells (U.S. Fish & Wildlife Service, 2002). Historically, sea turtle eggs and meat were not only important nutritionally, but also culturally to the coastal communities (Chacón, 2002). The trade of sea turtle products began in the eighteenth century. Uncontrolled hunting and development of technologies led to a significant decrease in the sea turtle population.

Frazer (1992) stated that in last three decades sea turtles have faced new causes for their mortality and do not have sufficient time to adapt to their new hindrance. Adult sea turtles have been caught in gill nets and long lines as well as shrimp trawlers (Hillestad et al., 1982). Spotila (2000) reports a significant decrease in the leatherback population in the Eastern Pacific. His mathematical model based on the assessment of leatherback population predicts an unsustainable adult mortality that is a result of human fishing activity. Mayor, et al (2002) also supports these ideas about sea turtles. They indicate that the high rate of leatherback mortality in the Pacific Ocean is mainly caused by capture in commercial fisheries where marine turtles are often, but accidentally, caught in the large fishing nets and drown.

Another cause responsible for the decline in sea turtle population is the indiscriminate harvesting of turtle eggs (Paladino, 2000). Not only are adult sea turtles hunted for their meat, their nests are raided by poachers that sell eggs for approximately 250 colones, depending on the species of the eggs and the location of the market (R. Silman, personal communication May 26, 2003). If it is taken into account that there is only one nesting season for turtles every few years, rather than annually, and most of their progeny dies before reaching the mature age of reproduction, the harvesting of eggs is devastating to the turtle population.

Nesting females and hatchlings are disoriented by artificial lighting such as street lights or lights on houses or hotels on developed beaches (Koeppel & Witherington, 2000). The light from these sources often scare the female back into the water and cause her to false crawl. As tourism and development increases, light pollution on the beach also increases and females nest less often.

Hatchlings find their way to the ocean from the light that reflects off the ocean from the moon or stars. Any artificial lighting can direct them away from the water where they are more susceptible to become victims of predators, die from dehydration, or are run over by cars (CCC, 2002a). To increase the sea turtle population, it is important that no light pollution occurs around beach areas during nesting season.

In 2002, the National Marine Fisheries Service (NMSF) developed the list of dozens of other reasons that are causing turtle deaths and a decline in their population. Erosion of nesting beaches can result in loss of nesting habitat. Development of beachfronts results in a dry nesting beach by preventing females from reaching their nesting sites. Any kind of beach use at nighttime can disturb nesting turtles, especially loud noises or active movement. Another factor leading to their decline is any sort of

beach or ocean pollution with oil, heavy metals, pesticides, or garbage. Many turtles are found dead because they consume garbage in the water, which they mistake for food. Leatherbacks commonly eat balloon pieces, plastic bags, and other plastic garbage, mistaking it for jellyfish. Many turtle deaths are caused by their accidental collision with boats and harvesting of their eggs (CCC, 2002a).

Endangered Species

Except where indicated, all the information regarding the status of sea turtles was taken from the U.S. Fish and Wildlife Service (2002).

The hawksbill turtle has been hunted almost to extinction for the pattern in its beautiful shell. The hawksbill sea turtle was listed as endangered in its entire range in 1970. According to Balline and Groombridge (1996), the worldwide exploitation of hawksbill for its shell, meat, and eggs, led to an eighty percent decrease in its population during the 1990's. For this reason, hawksbill sea turtles were listed as "critically endangered" in the International Union for the Conservation of Nature (IUCN) red list of threatened animals in 1996.

The loggerhead was designated as threatened in 1978 in its entire range, which is all along the Atlantic coast of the U.S. and Central America. While all other species found near the U.S. coastline are listed as endangered, the loggerhead is classified as threatened. This means loggerheads are more numerous than the other species, but they are still in danger of extinction.

Green turtles have been killed mainly for their meat. They were designated as endangered in the breeding colony populations in Florida along the Gulf of Mexico in 1978. Also on this date, the green turtle was designated as threatened wherever found except where listed as endangered.

Leatherbacks are also endangered, but a few still nest on the east coast of Florida each year. They were designated as endangered in the 1970s. The main cause of leatherback deaths is usage of long gillnets and long-lines by commercial fisheries. The sea turtle population in Costa Rica has been decreasing during the last three decades. Paladino (2000) reports rapid decline in the Eastern Pacific leatherback population from 1,350 female nesting per season to between 130 and 140 individual turtles per season, from 1989 to 2000.

Kemp's and olive ridley turtles are the most endangered of all the species. They were designated as endangered in their entire range in 1970. In 1978, the olive ridley sea turtle was designated as threatened wherever found except where listed as endangered and as endangered in the breeding colony populations on the Pacific coast of Mexico.

Importance of Sea Turtles

Ecologically

Sea turtles have a significant value as ecological resources. They are unique components of complex ecological systems that consist of communities of organisms, also called an ecosystem (Sea Turtle Survival League (STSL), 2002).

Wilson (1999) proposed that ecologists consider two extreme possible ecosystems that exist on earth. The first is that all living organisms live together on earth and the death or creation of one species has no effect on another. The second extreme is that earth is essentially one large organism and if a species dies out, everything on earth will be affected. Ecologists generally consider that ecosystems work somewhere in between the two extremes. Assuming that ecosystems are somewhat of an organized community, ecologists believe the existence of one particular species in a particular habitat occurs by

chance. A species' existence relies heavily on chance or the existence of another species (Wilson, 1999). If one particular species becomes extinct, then its survival depends on its necessity in the ecosystem, where it was located in the food chain, how the ecosystem benefited from it, and a number of other factors. If sea turtles become extinct, there will be an effect on other creatures.

Sea turtles disperse and migrate over thousands of kilometers and take thirty to fifty years to mature. Knowing this, scientists use marine turtles as indicators of the health of coastal and marine ecosystems on both local and global scales. Green turtles specifically are among of the very few animals that eat sea grass. They act as grazing animals that cut the vegetation short and help maintain the health of the sea grass beds. Over the past decades, there has been a decline in sea grass beds, which may be linked to the decline of sea turtle numbers (STSL, 2002). Sea grass beds are important because they provide breeding and developmental grounds for many species of fish, shellfish, and crustaceans. Without sea grass beds many marine species that humans harvest will be lost (STSL, 2002). If sea turtles become extinct, there would be a serious decline in sea grass beds and a decline in all species dependant upon the grass beds for survival.

Sea turtles are also important to the plants along the beaches and biodiversity. When females come out of the ocean, they bring nutrients from the ocean onto the land. These nutrients include proteins, lipids, and nitrogen. Nutrients are also left from the eggshells. Absorbing the nutrients, plants and trees are able to grow healthy root systems along the beach, which helps to prevent erosion (W. Quiros, technical assistant, ANAI, personal communication May 23, 2003).

Economically

Ecotourism is new to countries that have large biodiversity and have beautiful landscapes. Ecotourism is a tourist development that gears towards the development of natural, historical, cultural, and social structures that works with the physical environment, land use and cultural characteristics to ensure sustainability in the sense of preservation for future generations (UNEP, 1994). Natural landscapes, wildlife, and plants are attracting tourists from all over the world. Different from nature tourism and adventure tourism, ecotourism is linked to resource protection and benefits natural areas instead of being another mechanism for extracting utility from them (UNEP, 1994). The major challenge for ecotourism is how it will benefit the local communities.

Ecotourism is the way to raise public awareness and foster people's interest in a subject, which is important for obtaining funds for preservation programs. In addition, it is a valuable educational tool. Many organizations use programs that give people hands on experience by showing species of animals and plants in their natural environment. Causing less harm to the wildlife and increasing the income of National Parks and wildlife refuges, ecotourism is helpful to both countries' economy and environment (UNEP, 1994).

Conservation in the U.S.

There are seven kinds of endangered sea turtles in waters near the U.S.; green, leatherback, hawksbill, black, Kemp's ridley, olive ridley, and loggerhead. All of the seven species in the U.S. are protected under the Endangered Species Act 1973 (U.S. Fish & Wildlife Service, 2002).

To prevent complete disappearance of the sea turtles, researchers, organizations, and scientists took action in sea turtle conservation. One of the most important ways The

National Marine Fisheries Service (NMFS) acts to protect sea turtles is by requiring trawl fisherman to use Turtle Excluder Devices (TED) while fishing. The first turtle excluder devise law was passed in 1989 (Paladino, 2000). NMFS (2002) describes the TED device as a grid of bars that has an opening on it. The grid is fitted on the neck of the shrimp trawl. With the grid in place, small animals like shrimp easily slide through the bars, while larger animals, such as turtles and sharks, cannot.

Beginning on November 21, 1989, efforts by the United States government to protect sea turtles were formally extended beyond its national borders. According to the Public Law, on that date, federal legislation was implemented, which prohibited the importation of shrimp harvested by countries that do not have sea turtle conservation measures in their shrimp fishery comparable to those of the U.S. (Mitchell, 2001).

The CCC (2002a) continued to report that many dead turtles were still found along the Atlantic and Pacific coasts in the U.S. and Central America. It appeared that the TEDs that were used were too small for adult turtles to escape. Therefore the decision was made in February 2003 to use bigger TEDs on shrimp trawlers. Appelson and Godfrey (2003) report that new TEDs will be required in U.S. waters south of the North Carolina/Virginia border and in the Gulf of Mexico. They also stated that increasing the size of TEDs will reduce annual mortalities of leatherback sea turtles from 2300 to approximately 80 because of the average size of the turtles found in the shrimp trawls.

Various organizations were created to study sea turtles and search for possible methods of their preservation. One of the largest organizations is the Caribbean Conservation Corporation (CCC) which operates throughout the world. That non-profit membership organization was founded in 1959. It works to enact protective laws and

establish safe environment at nesting and feeding sites of sea turtles. The organization contributed in creating the Tortuguero National park in Costa Rica. In the United States, the CCC collaborates with other groups and agencies to establish the Archie Carr National Wildlife Refuge and continues its efforts to persuade the U.S. Congress and government agencies to purchase the lands necessary to complete the refuge. As advocates of sea turtles at the United Nations Convention on International Trade in Endangered Species, the CCC is involved in international efforts to protect one of the most important sea turtle nesting beaches in the world by helping prevent off-shore oil-drilling in Costa Rica. In 1993, the CCC started the Sea Turtle Survival League (STSL). The organization is a public education and advocacy program that addresses the threats that face U.S. sea turtle populations. Using the CCC's experience in conservation of sea turtles, the STSL is trying to improve the situation of turtle populations in the U.S., especially in Florida (CCC, 2003).

Another organization that operates in this field is the Archie Carr Center for Sea Turtle Research (ACCSTR) at the University of Florida. ACCSTR was established in 1986 by the University Board of Regents of the State of Florida. The mission of the ACCSTR is to conduct research in all aspects of sea turtle biology, to train graduate students, and to promote sea turtle conservation. The research results are reported to the scientific community, management agencies, and conservation organizations throughout the world (ACCSTR, 2003).

Conservation in Costa Rica

Sustainable Development

Sustainable development is a fairly new concept that developed from the environmental and conservational movement during the 1970s. Sustainable development

not only deals with conservation of Earth's resources, but also with the affects of human activities (UNESCO, 2001c). The core idea of sustainable development is to ensure the quality of everyone's life on earth now and also for the generation ahead. The key concept is ensuring that current developments do not jeopardize the needs of future generations. Therefore, when people make decisions about how to use the Earth's resources such as forests, water, minerals, gems, wildlife, etc., they must take into account not only how much of these resources they are using, but also what processes they used to get these resources and who has access to these resources (UNESCO, 2001c). The concepts of sustainable development link society, environment, economy and development.

Sustainable development is important to Costa Rica because it is a unique place with great diversity of both animal and plant species. Since Costa Rica does not have a military, part of the country's budget that would have gone into supplies and training goes towards financing national parks (Evans, 1999). Since 1970's twenty-five percents of Costa Rican territory were turned into conservation areas (Weitzner & Borrás, 2001). There are eighty national parks in Costa Rica that include three major conservation parks; Las Baulas, Santa Rosa, and Tortuguero. These parks are homes to thousands of animal and plant species, and also include some of the most important sea turtle nesting sites in Costa Rica (Costa Rica Outdoors, 2003b).

Since Costa Rica is still a developing country, it does not have all the funds and facilities that the United States has to preserve sea turtles. For instance, Costa Rican fisheries do not use TEDs, so turtles are often found caught in the shrimp trawls.

Parque Nacional Marino Las Baulas

Parque Nacional Marino Las Baulas de Guanacaste was developed and designed by MINAE in 1991. The location of the park is shown in Figure 8.

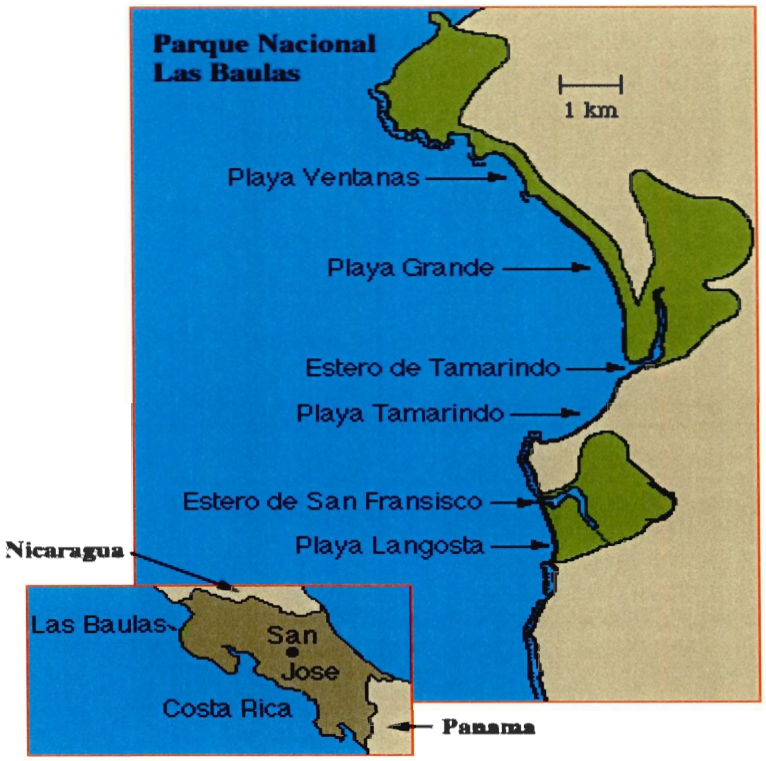


Figure 8. Location of Las Baulas National Park
Source: Las Baulas Leatherback Project (2003)

Built to protect leatherbacks, Las Baulas contains Playa Grande and Playa Langosta nesting beaches (Paladino, 2000). Playa Grande beach is the largest nesting place of leatherback turtles in Central America (Spotila, 2000; Costa Rica Outdoors 2003a). In the 1980s, the beach was the largest nesting site of leatherbacks in the Pacific Ocean. Unfortunately, population of nesting females has been rapidly declining. Figure 9 shows a histogram of the decline since 1988 to 2002.

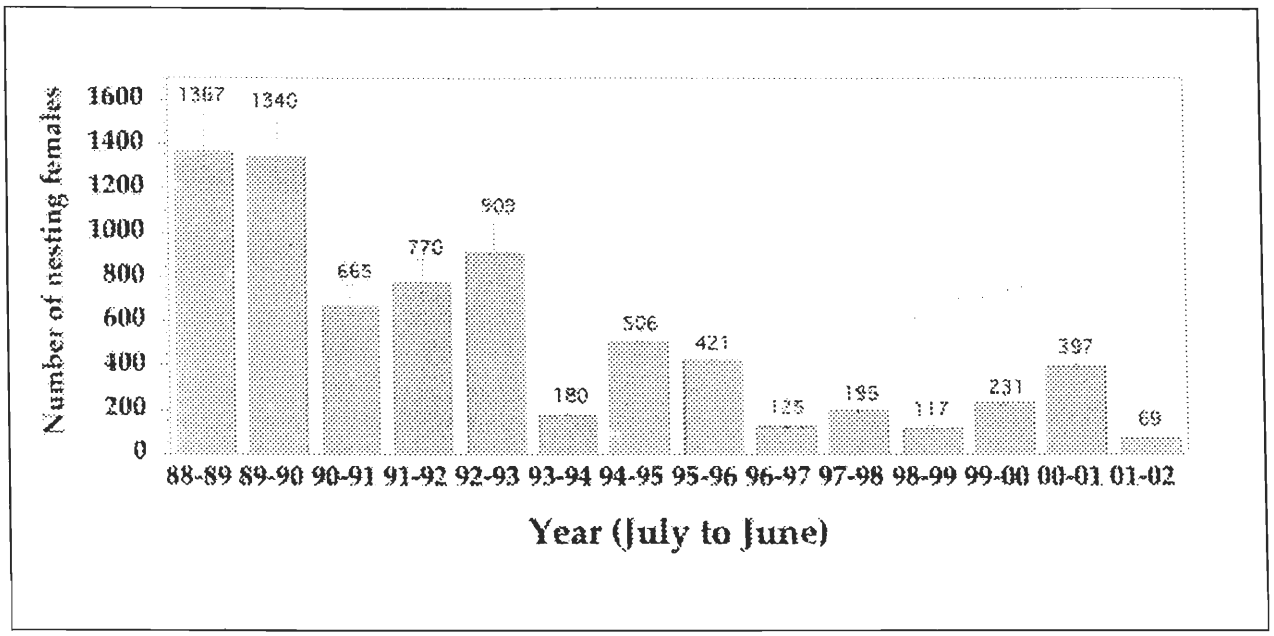


Figure 9. Numbers of Nesting Leatherback Turtles (*Dermochelys coriacea)* in Las Baulas
Source: Las Baulas Leatherback Project (2003)

The Las Baulas Project began in the 1980s and takes place in the National Park every year. The goals of the project are to study leatherback biology and population, to protect nesting females, and to develop effective management and conservation strategies in collaboration with Costa Rican authorities. By patrolling nesting beach and distributing conservation information among local communities people who take part in the project were able to reduce poaching from 90 percent in 1988 to 2 percent in 2002 (Las Baulas Leatherback Project, 2003). As part of the program volunteers also assist park guards in controlling tourists and other beach users and help researcher in undertaking the variety of research projects study turtle biology, including genetics and physiology. Undergraduate and graduate students from both the U.S. and Costa Rica take part in the project. Dr. Frank V. Paladino from Indiana Purdue University, Dr. James R. Spotila, and Dr. Richard Reina, both from Drexel University, Pennsylvania lead the project. The information collected during the studies is shared with MINAE and the general scientific community in order to

develop the most effective strategies for management and conservation of the endangered species population (Las Baulas Leatherback Project, 2003).

Turtles have battled many problems since their existence, and during the last few years, flooding of their nests caused the decrease in hatchling production. Salt from the water prevented the eggs' development and killed the embryos (Las Baulas Leatherback Project, 2003). To avoid the low hatchling production, people have been moving hatcheries higher on the beach and farther from the water. Conservation activities such as the former took place in Las Baulas from 2002 to 2003 helped to improve the number of nesting turtles in the National Park.

Santa Rosa

Another important national park in Costa Rica is Santa Rosa. It is located in Guanacaste Province, northwest Costa Rica (Figure 10). Santa Rosa is one of the most historically significant parks protecting 115 species of mammals, 253 birds, 100 reptiles, 3,000 species of butterflies and moths (Costa Rica Online, 2003).

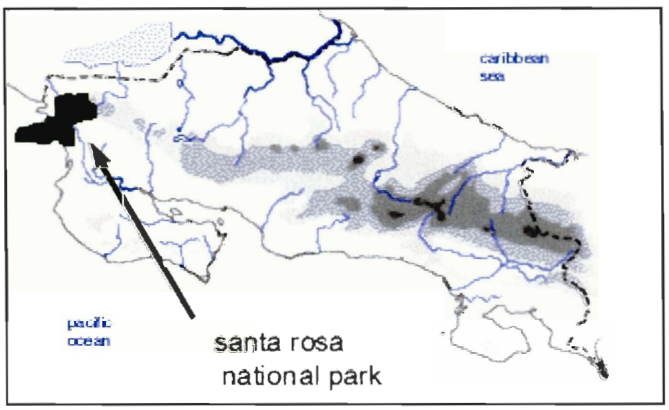


Figure 10. Santa Rosa National Park Location
Source: Costa Rica Online (2003)

Nancite and Naranjo beaches, located within Santa Rosa Park boundaries, are important nesting sites for the olive ridley, leatherback and Pacific green sea turtles (Costa Rica Online, 2003).

Parque Nacional de Tortuguero

The largest nesting sites of green turtles in the Western Hemisphere are along the Tortuguero black sand beaches on the Caribbean coast of Costa Rica (CCC, 2002a). The location of the park is shown in Figure 11.

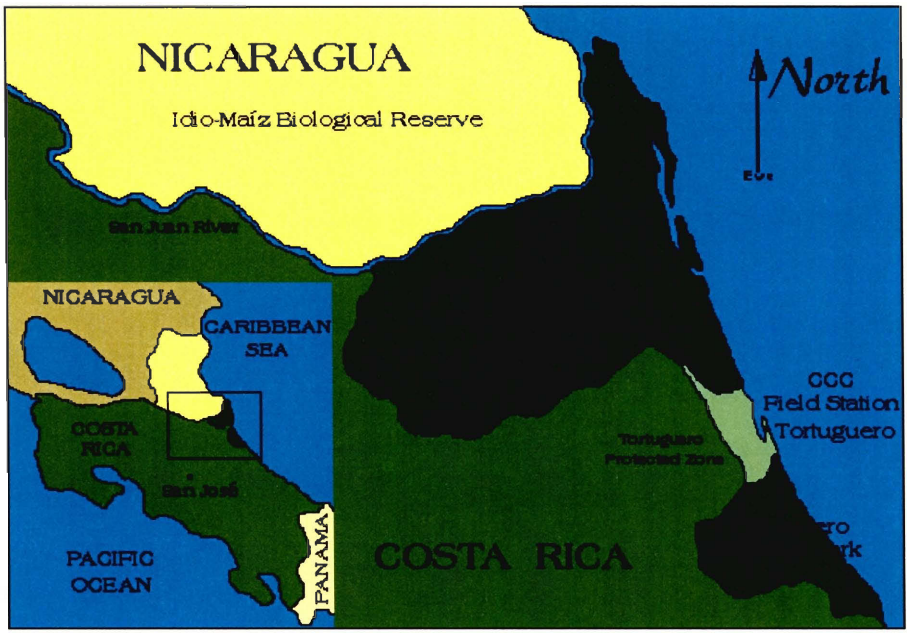


Figure 11. Location of Tortuguero National Park
Source: Caribbean Conservation Corporation (2001 b)

The park now includes over 19,000 hectares and protects 22 miles of nesting beach from the mouth of the Tortuguero River south to Parisimina. The Tortuguero Park and the Barra del Colorado Wildlife Refuge comprise the largest remaining adjoining tract of lowland wet tropical forest on Costa Rica's Atlantic Coast (CCC, 2001b).

Tortuguero beach also serves as a nesting place for loggerhead, hawksbill, and leatherback turtles (CCC, 2001a). The CCC has conducted research and protected sea

turtles in Tortuguero National Park since the 1950s. The cornerstone of their research from the CCC in Tortuguero is the Turtle Tagging and Monitoring Program, which revealed astonishing facts about sea turtles, much of what is known about them today was found through this program (STSL, 2002).

Gandoca/Manzanillo Wildlife Refuge

Another important sea turtle nesting site is located in Gandoca/Manzanillo Wildlife Refuge. It was established in 1985 with the help of Asociación ANAI, which is a non-profit organization in Costa Rica. Its main goal is wildlife conservation through sustainable development and to spreading environmental awareness (ANAI, 2003). The organization also focuses in trying to unite biodiversity conservation and the improvement of socio-economic lives present and future generations.

Gandoca/Manzanillo Wildlife Refuge is located on the Caribbean coast and includes Gandoca Beach that serves as nesting site for four species of sea turtles. Nothing was known about this nesting site until 1980 when uncontrolled poaching and egg harvesting by small local communities became a large threat to sea turtle population (ANAI, 2003). For that reason, protecting eggs and the nests became the original main goal of researchers and volunteers at the refuge. They achieved their goal by patrolling the beach at night and spreading the educational information among local people. By 1990, ANAI almost completely controlled poaching and approximately ninety percent of nests were protected (ANAI, 2003).

Volunteer Programs

Many organizations that conduct research at nesting sites in Costa Rica have volunteer programs for those who care about wildlife conservation. Volunteers have live

experience in working with sea turtles. Educational part of the program raises the public interest in sea turtles and awareness about the danger of extinction they are facing.

Common volunteer activities usually include nighttime tagging and identifying turtles, recording nest location, turtle size, and hatchling success due to nest site location. Other major daytime activities include data entry, nest relocation if necessary, development and maintenance of a hatchery. Depending on the project they are participating, some volunteer activities can also involve studies of metabolism, digestion, and growth of hatchlings, and the attachment of satellite, radio, and sonic telemetry devices to monitor interesting migrations as well as diving and behavioral physiology of sea turtles (Earthwatch Expedition, 2003).

Volunteers at the nesting sites are trained to conduct all assignments. They often attend lectures to learn how to tag turtles properly, as well as observe turtle behavior on the beach while assisting the individual scientists. They are also given several informal lectures during first days of the program. The lectures include the reason for, and methodology to be used in, each project, as well as the needs for conservation. Reprints of popular and scientific papers are handed out to familiarize volunteers with the topic of research. There are also visits to local schools and field trips for schoolchildren to the beach.

Volunteers also interact with the ecotourist traffic on the beach and help to educate the nightly visitors about turtle biology and conservation (Earthwatch Expedition, 2003).

Laws and Regulations

In 2002, the Special Permanent Commission of the Legislative Assembly passed the Law for Protection, Conservation and Recuperation of the Sea Turtle Populations.

The law declared that any research on sea turtles and their habitats is in the interest of the public and that the Costa Rican Ministry of Environment and Energy (MINAE) are responsible for this project. The law determines killing, hunting, capturing, slaughtering, or trading sea turtles is punishable with a prison term. This law also makes it illegal to keep sea turtles for commercial purposes, or to trade sea turtle products and sub-products (Silman, 2002).

By establishing environmental rules and regulations, the Costa Rican government is trying to improve the state of sea turtles and to preserve them for future generations because they are important to not only Costa Rica, but to the world.

The Impacts of Tourism on Costa Rica

Tourism is the second largest income for the country which is why it has a significant importance to Costa Rican economy (UNEP, 1994; Dulude, 2000). In 2001, approximately 80,000 tourists visited Tortugeuro Beach alone and over one million tourists visited Costa Rica (R. Silman, National Director, CCC, personal communication, May 26, 2003). Tourism revenue from the same year brought 1138 million dollars to the country budget (Dasenbrock, 2001).

Most of the tourists are attracted to Costa Rica by country's biodiversity. However, mass tourism in conservation areas can harm its inhabitants or increase damage to local ecosystems. It also means the usage of more resources such as energy and land (F. Paladino, Chair and Professor of Biology at Indiana Purdue University, personal communication, March 28, 2003).

Tourism can become the reason of wildlife degradation (UNEP, 1994). The level of degradation depends on the ratio between the number of tourists per unit and the level of protection in a conservation area. Hence, the less people are allowed in the park, the

less protection is required. Many National Parks in Costa Rica have so-called conservation area capacity, when only a certain number of tourists can visit a park during a certain time. This and other rules of using conservation areas in tourism purposes are established by MINAE and other organizations responsible for tourism and ecotourism management in the country, like Costa Rican Tourist Institute and National Tourist Board (MINAE, 1998; UNEP, 1994). When tourists are present on the territory of a protected area, they must be accompanied by a well trained guide and follow his instructions. However, tourists do not always visit areas with guides and can accidentally damage the land and habitats of species. Even so, guides cannot completely control tourists and the natural resources slowly deteriorate or become damaged. For instance, some tourists use flashlights on the beach during "turtle watch" tours or approach sea turtles too closely to take pictures, although both are clearly restricted. These actions can scare nesting females and cause them to terminate nesting and leave the beach without laying eggs. People walking along the beach can also trample eggs under their feet or compact the sand and trap the hatchlings.

The presence of tourists, their direct contact with turtles, and uncontrolled behavior at the nesting beaches can result in decrease of turtle nesting per year. Garbage left by tourists can be harmful to sea turtles. Vehicles on the beach can compress the sand and trap hatchlings in the nests. Tourists also increase the demand of sea turtle products because people that used to kill turtles for food would collect turtle eggs to sell them to tourists.

Therefore, tourism in conservation areas has to be planned very carefully and must be very well controlled.

The Inter American Convention for the Protection and Conservation of Marine Turtles

Most of the species of sea turtles that populate waters of the American continent lay their eggs on the beaches of one country and have feeding ground in another country. Therefore the governments of different countries from the American continents came to the decision to coordinate their efforts and those of international organizations to protect sea turtles during and between nesting seasons. This collaboration resulted in the creation of the Inter American Convention for the Protection and Conservation of Marine Turtles. The objective of this Convention is to promote the protection, conservation and recovery of the marine turtle populations and their habitats, taking into account the environmental, socio-economic, and cultural characteristics of the parties. The framework of action of the Convention is marine as well as continental.

After several years of negotiations, members of the Inter American Convention had their first meeting in Salvador in Bahía, Brazil. Among the countries were: Brazil, Costa Rica, Ecuador, Holland (Netherlands Antilles), Honduras, Mexico, Peru, United States of America, Venezuela, Belize, Nicaragua, and Uruguay. The scope of the Convention involves the entire American continent.

The Convention meeting of 2002 was held by the Costa Rican government. According to the Minutes of the first meeting (2002), the mandates established during the meeting include laws and regulations about capturing or killing turtles, as well as trading their eggs and any of their products. It also restricted human activities that may severely affect the marine turtles during their reproductive, incubating and migratory stages. The programs of sea turtle protection and conservation and the restoration of their habitats were discussed and found necessary for marine turtle survival. The issues of the

reduction of sea turtle capture and incidental deaths during the course of fishing activities were included in the meeting agenda.

All regulations included in the text of the Convention regarding the utilization of marine turtle products were limited to satisfy the subsistence economic needs of traditional communities.

Education

Education is the most effective means that society uses to confront the problems of the future. It is the means for propagating knowledge and developing skills, to surface desired behaviors, values, and lifestyles (UNESCO, 2001b). The future depends on the young minds of the present because society can only progress their ideas, inventions, and innovations.

Over time, education also powerfully affects cultures and societies, increasing their concern over unsustainable practices and their capacities to confront and master change. The potential of education is enormous. Not only it can inform people, but it can change them. It is not only a means for personal enlightenment, but also for cultural renewal.

Environmental Education

Environmental education is a learning process that increases people's knowledge and public awareness about environmental issues as well as develops skills necessary for environmental problem solving (UNESCO, 1978).

The broad environmental education movement started in the early 1970s, and initiated by the United Nations Conference on the Human Environment held in Stockholm in 1972 (UNESCO, 2001a). At the conference it was proposed to establish

environmental education as part of public education in all countries. As a result, in 1975 UNESCO and the United Nations Environment Program (UNEP) created the International Environmental Education Program (IEEP) that lasted until 1995. The motto of the program was "think globally, act locally" (UNESCO, 2001a). Based on it, many useful pedagogic techniques were developed. Among the tools of environmental education, program included field trips and classroom experiments.

Primary school students were chosen as the target audience for the program because children of this age group do not experience the process of segregation, which is common in secondary and high schools. Moreover, the children in this age group are believed to be more susceptible to presented information and receptive in developing lasting environmental values (Todd, 2002).

Pedagogical Methods

The basic idea of pedagogy is to begin at the same level as the students and start with problems about which they feel comfortable. This idea can be used as a basis to bring about more complex and global understanding. Before developing methods to teach, it is important to understand how the mind works.

How the Mind Works

During the late 1900s, studies of the human mind stirred up an important question: how do people learn? Multiple sciences and disciplines such as cognitive and developmental psychology, neurosciences, linguistics, and anthropology have advanced our understanding of how our minds work (Pellegrino, Chudowsky, & Glaser, 2001). It is important to understand how people think in order to educate them in a way that will maximize their learning.

Fundamental elements of cognition include short-term memory, which is a limited system and a long-term memory, which is a limitless storage of knowledge. The short-term memory, also called working memory is located in the frontal lobes of the brain, which is also a part of the cerebral cortex situated above the eyes. As seen in Figure 12, the long-term memory is scattered all over the cerebral cortex (Visual Transparencies to Educate (TTE-Visual), 2002). Most cognitive knowledge is processed and stored here. Another interesting fact about the cerebral cortex is the information is partly remembered by specialized areas, so the hearing system has an auditory memory, the observation system has a visual memory, a mathematical memory exists in a separate location and so on (TTE-Visual, 2002).

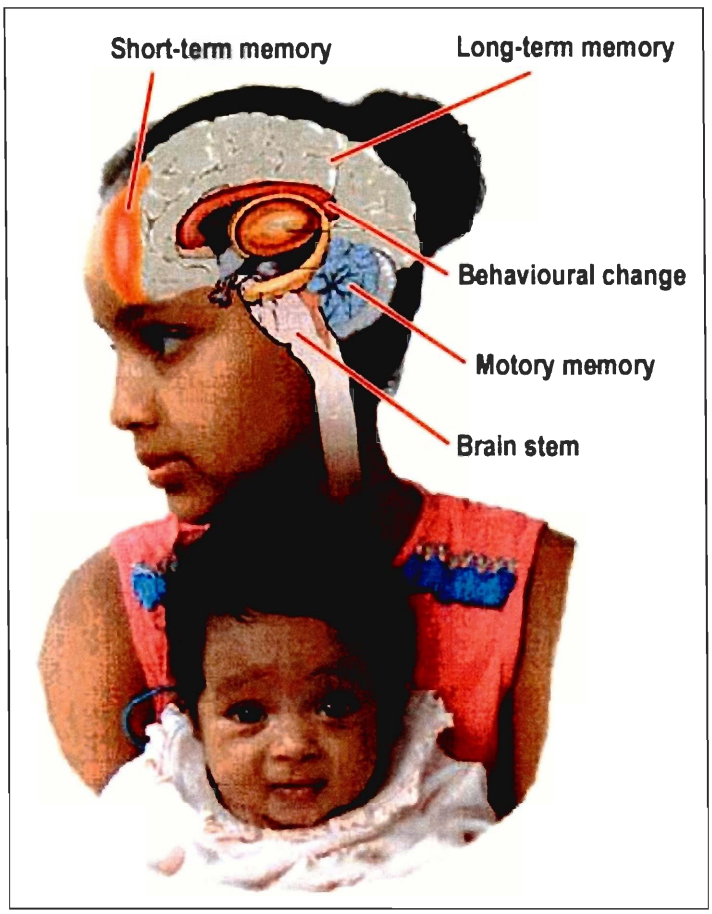


Figure 12: Structure of the Brain

Source: TTE-Visual, 2002

The last three memory sections of the brain are behavioral change, motory, and the brain stem. People learn behavioral changes when connections are altered in the limbic system, which is a cluster of organs covering the brain stem (TTE-Visual, 2002). The motor memory stores information when exercises are repeated and practiced. This section of the brain also stores reflex actions. The last portion, the brain stem, does not change often. Since it is the oldest part of the brain and rarely develops, any information stored here is permanent (TTE-Visual, 2002).

How People Learn

Since the 1960s there has been a research boom in scientific knowledge and evidence about how the mind works. Scientists have been refining their theories to develop new ones that can better explain the nature of the brain. Pellegrino, Chudowsky, & Glaser (2001) believe there are four perspectives to the mind and how it works. These four are: differential, behaviorist, cognitive, and situative. Differential and behavioral findings are the roots of understanding the mind while cognitive and situative are fairly new ideas to the neuroscience world (Pellegrino, Chudowsky, & Glaser, 2001).

The minds of children function the same way as adults, but since their brains are still developing, there are differences that surface. When students begin their school education they already have their own preconceived notions of the world. If they do not, they develop their ideas based on the information learned in class (Bransford, Brown, & Cocking, 2000). Both children and adults have the same mental capacity. Mental capacity is the ability to understand information, and is often measured by the

Intelligence Quotient Test. IQs generally do not fluctuate and are quite constant throughout one's lifetime. Thus, children can learn and understand even the most complicated information (Bransford, Brown, & Cocking, 2000). Since children have a less memory capacity than adults because their brains are still developing, it is more difficult for them to learn an abundance of information all at one time. Therefore educators have to develop specific strategies to use students' memory effectively (Bransford, Brown, & Cocking, 2000).

The important outcome of any learning process is the knowledge stored in long-term memory, and every teacher strives to influence neurological processes in the long-term memory. Therefore it is important to teach students how to organize their knowledge in their long-term memory by helping them develop the useful strategies to facilitate retrieval of knowledge from their memories. Active thinking about a subject, discussing, discovering, and carrying out related tasks, are productive means in the classroom to activate large areas of the brain. Repetition strengthens and increases the long-term potential (LTP) by making connections between brain cells which results in stronger memories (TTE-Visual, 2002). Fantasizing also creates connections with what is already known and facilitates recall of that memory in the future. Large images, projections, or newly revealed wall maps for example, arouse interest and activate large areas of the brain. An overall view offered in this way, is able to lace fragmented but already existing knowledge together. By these means, visual memory anchors are formed as an aid to further understanding and later recall. This is especially helpful in short introductions when we guide students' independent learning (TTE-Visual, 2002). Unfortunately, not all children learn the same way. Every child uses specific learning strategies and styles that can change with age (Pellegrino, Chudowsky, & Glaser, 2001).

Examples used by teachers to explain the subject can facilitate children's understanding of new information and relating it to mastered concepts. However examples make it more complicated to retrieve information from the memory later on because it is thought to be context-bound (Bransford, Brown, & Cocking, 2000). It is more important that students learn the concepts so that later they can transfer the knowledge into a real life situation. Transfer is an important part of the learning process. Sometimes people learn the subject but do not have the ability to transfer their knowledge to another matter. Researchers indicate that transfer is especially difficult when information is given in a single context rather than in a multiple contexts. Story telling is also a great example of how information can be presented in multiple contexts. It is a powerful way to organize lived and listened-to experiences, and it provides an entry into the ability to construe narrative from text (Bransford, Brown, & Cocking, 2000).

Since it is more important for students to understand concepts of particular subjects, it is better to cover few in-depth topics rather than covering superficially all aspects of a subject. When few aspects are presented in-depth, children tend to grasp the main matter of the topic. Furthermore, if more information is presented in a superficial way, the less information is retained (Donovan, Bransford, & Pellegrino, 1999).

It is also difficult to force people, not just students, to complete tasks in which they have no interest. It is important to motivate children to want to learn and enjoy their subjects. This task can be achieved by challenging the students by presenting problems that they must overcome. But it is important that the challenges are designed for the proper level. Tasks that are too easy become boring with time and students lose interest in the topic altogether. On the other hand, children can become frustrated if they cannot

solve the task and lose sight of the concepts at hand (Bransford, Brown, & Cocking, 2000).

The crucial part of education is to teach students when, where and why they can employ the information and to help them to see the implementation of their learning. If the usefulness of their education is clear, pupils are much more likely to want to learn the information required in their classes (Bransford, Brown, & Cocking, 2000). Other motivations can be social opportunities since many view education as the keystone for success.

Learning and remembering presented information requires more than just separate facts that do not relate. Students need to understand the subject in its matter to be able to recall the information and use it. Although children are capable of understanding complicated information, they will not be able to recall it over time if they cannot extract the meaning of it. Therefore, it is important to teach children how to organize information in a conceptual framework (Donovan, Bransford, & Pellegrino, 1999).

The ability to plan a task, to notice patterns, to generate reasonable arguments and explanations, and to draw analogies to other problems are all closely intertwined with factual knowledge (Donovan, Bransford, & Pellegrino, 1999). It is important to master these abilities because individuals learn better when new information relates to concepts that are already understood. Learning, according to cognitive theory, is the ability to combine knowledge and skills and procedure in ways that are useful for interpreting situations and solving problems (Pellegrino, Chudowsky, & Glaser, 2001).

Hands – On Learning

To simply state, hands-on learning is learning by doing. This method involves a child manipulating and engaging in in-depth investigations with objects, materials, and ideas (Haury & Rillero, 1994). From these experiments, learners are able to draw meaning and understanding. Hands-on activities transform students from passive learners to active ones. No longer sitting in classrooms listening to lectures or copying notes, students can perform experiments or role-play.

Also called tactile activities, this method is beneficial for learners of all ages, not just adolescents. The reason behind why the method works is simple. The brain has two separate memory storages located in different areas. One type of memory is semantic and the other is episodic (Nunley, 2002).

Semantic memory consists of facts and ideas that people intentionally remember (Nunley, 2002). When asked, "who gave the Americans the Statue of Liberty?" one must access the semantic memory to reply, "France." The answer to this question was taught to students and then later memorized. Any information, data, facts, and ideas are collected in the semantic memory.

If asked, "where were you last night?" or "what was your favorite part about your vacation?" one must retrieve information from the episodic memory. The answers to these questions were not memorized, yet people are still able to produce responses. Episodic memory consists of events that occurred, almost like one's autobiographic memory. The information found in this storage is unintentionally remembered (Nunley, 2002).

Tactile activities are more effective because they utilize both memory storages. By targeting both memory systems, there is a better chance of retention (Nunley, 2002).

Students exercise their semantic memory with the information given by their teacher, for example, your heart is located on your left side. Students can also remember the location by placing a model heart into the left-side of a model skeleton, thus using their episodic memory.

Visual Learning

Visual learning is learning with the use of visual aids, such as images and animations. Visual learning is especially important in the areas of science education because students must learn to think visually to best communicate their ideas to peers and the general public. Visual learning methods can reveal new methods of problem solving, provide a new way of thinking, and can enhance education (Brown, 2003).

There are many misconceptions about visual learning that educators must understand when teaching new concepts. The first is that people see what is in front of them and that what the educator sees is the same as the student. The tools used for analyzing and understanding linguistic and logical processes are adequate for analyzing and understanding visual processes. Teachers and educators must develop new style and form when using a new approach to teach students.

The learning model shown in Figure 12 shows how each side of the brain functions and the processes the brain goes through. By using visual aspects of various intelligences and learning styles, educators can develop exercises that promote the recognition, understanding, effective selection, retention, and use of appropriate cognitive modalities in one or more dimensions, in motion, and in interactive formats (TTE-Visual, 2002). Thus, learners can exercise their associative, imaginative, creative, and abstract thinking skills.

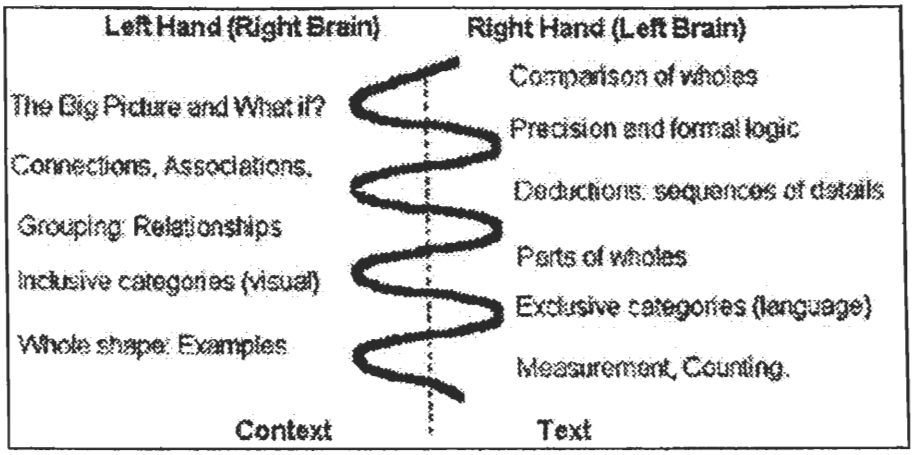


Figure 13: Left Brain/Right Brain Learning Model

Source: Brown, 2003

Visual perception involves several steps, which are: sensing information, remembering past experiences, and processing the information. An understanding of this process is essential to realizing the power of visual images that can move people emotionally and behaviorally, and influence one's conscious thought (TTE-Visual, 2002).

When first sensing, raw information is first gathered in the brain and then the cognitive and emotional systems begin to work simultaneously recalling multiple separate memories from the past. Then the brain relates the past experiences to the current situation, looking at the visual. This is repeated over and over while the brain maps a new understanding of the visual and event (Brown, 2003). Once the brain has finished making connections, the information can be processed and stored.

Visual learning works because it operates on a cognitive level. Neuroscientists are providing quantitative data that supports the intuitive sense about the complexity and significance of visual communication that has been advocated by many artists and scholars. By targeting the right side of the brain, preconscious visual systems are integrated with the left side of the brain which stores perceptual signals such as color, story, and aesthetics (Brown, 2003). When utilizing both parts of the brain, learners are

more likely to understand the concepts on some level and are more likely to retain the information.

Chapter 3. **METHODOLOGY**

The following methodology was the process we used to create an educational booklet that promotes sea turtle conservation and an annotated bibliography for Ministerio del Ambiente y Energía. The bibliography is a compilation of articles and current research dealing with sea turtles that will be used in the future for research purposes. Conducting interviews and literature searches were the main strategies used in completing our goals.

Annotated Bibliography

The references found in the annotated bibliography were used to make an educational booklet about sea turtle conservation. It also includes scientific articles that were not used in the project but will be of a help for students, educators, or researchers who are looking for more information on sea turtle research. For the purpose of further research, we decided to include lists of scientific journals and databases that contain a vast number of publications on sea turtle research.

We designed the bibliography so that it consists of two different sections. One section includes sources of information on sea turtle research only. The other is compiled of resources about cognitive levels of different age groups and pedagogical approaches. In the creation of the annotated bibliography, we followed the APA format.

Our sponsor, MINAE, plans to extend the educational program about sea turtles in the future. The bibliography will be important to them because it provides sources of research information and pave the directions for the future work in environmental education.

Educational Booklet

Target Audience

To determine the contents of the booklet, we conducted interviews with researchers working at organizations such as Asociación ANAI and Caribbean Conservation Corporation (CCC). These organizations are leaders in sea turtle research and conservation, conducting project work in Gandoca/Manzanillo Wildlife Refuge and Tortuguero National Park, respectively. Since their scientists and professionals frequently visit the nesting beaches, they constantly see which activities can harm marine turtles and who is responsible.

Our first task in creating the booklet was to find who was going to read it. When asked the main groups causing the most harm to marine turtles, the interviewees all replied similarly. One of the major groups causing harm to marine turtles is the commercial fisheries. Since the Inter-American Convention is currently in the process of passing laws against poaching and promoting the use of TEDs, we decided to target another group. After discussion with our liaisons and advisors, we agreed upon using the booklet for fifth graders.

Contents

The questions during the interviews varied, but there were seven common questions that we asked all researchers. It was necessary to determine at what age people should begin learning about environmental issues, mainly about species conservation issues and how important it is for Costa Ricans to know these aspects, since the country is so biodiverse. We were also interested in what researchers considered the best information to place in the booklet to make it most beneficial for sea turtles. Among our questions there were also some about the current research interviewees were involved in

and future plans of their organizations. There were also questions about how sea turtles are important to Costa Rica and to the environment.

Among the interviewees were D. Chacón, Marine and Wetlands Program Coordinator at Asociación ANAI, who is also one of the leading sea turtle researchers in Costa Rica; W. Quiros, technical assistant at ANAI. We also decided to interview Roxana Silman, National Director of Caribbean Conservation Corporation because this organization is the most experienced in sea turtle conservation and environmental education. It already published an educators' guide about sea turtles that we used as a reference in creation of our booklet. We also had an interview with F. Paladino, chair and professor of biology at Indiana Purdue University. We choose him as an interviewee because he is one of the leading researchers in the field and took part in foundation of Las Baulas National Park, and have been conducting research there since the 1980s.

From the interviews, we learned what information they felt would benefit the turtles most. This step was important in determining the contents because the audience of the booklet has a wide range and only the most pertinent information could be included.

For the booklet, we did not want to include information that the students could possibly know about sea turtles. It would be unnecessary to repeat information that they had previously learned from other sources. To determine what information students already knew about sea turtles, we conducted a survey in the fifth grade of the Escuela Anglo-Americana, which is located in San José. The survey aided us in deciding what information to include in the booklet along with what type of information students knew about sea turtles and ecology. The survey contained some questions about general ecological terms and specific questions about sea turtles. The survey is included in this report and can be found in Appendix B.

Cognitive Level

Most important to sea turtle conservation is for the students to understand the information presented before them. To find how complicated the information could be, we conducted more interviews and literature searches. From the interviews with the teachers, we asked for copies of the textbooks the students' use, works produced by the students, and workbooks used in the classroom. Using the same language and vocabulary levels from the received materials, we were able to duplicate a similar style into the booklet.

It is necessary that students also understand the information presented to them in the booklet. To make sure the language, terminology, and content were appropriate for the target age group, we conducted interviews with Marietta Coto, a sixth grade teacher and Vicky Hine, the director of the private Anglo-American school in San José. During the meeting with the director of the school, we gained a better understanding of the learning level for their sixth graders. Teachers provided us with copies of the students' produced work, textbooks, and workbooks to aid us in understanding sixth grade language comprehension. We also asked about their teaching methods, and how they keep their students' interested in the material.

For the same reason as the former, we made a field trip to the Museo de los Niños and interviewed Fabiola Rodríguez Diez, the current executive director of the museum.

Collecting Information

The information found in the booklet was compiled from multiple sources. After receiving a list of sea turtles specialists from our liaison, we conducted several interviews. The purpose of the interviews was to locate the projects currently taking place in Costa Rica. After the first few interviews, we used the snowball method to

identify other researchers we could contact. The data and findings from their researches were included in the booklet to show how people are working to improve the state of sea turtles.

Information on volunteer and students' educational programs at nesting sites was obtained from the website of Las Baulas National Park and from conversation with Jorge Gamboa, the technical assistant of Programa Nacional de Humedales at MINAE. We looked for the description of volunteer programs at Las Baulas National Park because this park is under the MINAE management and therefore, the book and bibliography we produced will be most likely implemented there.

Testing the Booklet

After the booklet was created, we planned to conduct pre- and post-test in three public schools from different socio-economic backgrounds to ensure the content of the booklet was appropriate for the cognitive level of the students. The purpose of the pretest was to determine how well students understood the booklet. By comparing the results of the first survey and the pre-test, we were going to determine how much information students learned from the booklet. According to the obtained information we were going to make changes to the booklet so that students could understand all information presented in it.

Unfortunately, all public schools were closed because the teachers went on strike. Unable to test the booklet, we were forced to alter the direction of our project. In collaboration with our liaisons and advisors, we decided to change audience from the fifth grade students to volunteers who work at the conservation areas. We agreed that volunteers at the project centers are a good target because they are also tourists.

Discussed earlier in the Background and Literature Review chapter, ecotourism is a powerful educational tool because participants are able to work hands-on with sea turtles.

Due to this change, we had to adjust the language of the booklet, so that it could be used by people of older age group, seventh grade students and higher. To do so, we took out colloquial and juvenile language and added more information about sea turtle conservation programs in Costa Rica that would be too complicated for the fifth graders.

Chapter 4. **RESULTS AND ANALYSIS**

The result of our project was the creation of an educational booklet about sea turtles and an annotated bibliography of the sources cited in our work.

Annotated Bibliography

The annotated bibliography we produced is a useful source of information about sea turtle research and education. It can be employed by teachers and older students for in-depth learning of the subject. It can also be a reference source for further work in developing educational program about sea turtles in Costa Rica. Researchers and park guides at conservation areas can use the bibliography to update their knowledge, since it lists recent published articles as well as databases and scientific journals

Target Audience

Through our literature searches and discussions with our liaisons, we found that there are three main groups that cause harm to sea turtles and conservation. We found that fishermen cause harm because of the long line fishing nets used to catch fish and shrimp. Also finding that the general public and tourist are a concern, we felt it would be best to target both groups since legislators are working to force TEDs in commercial fisheries.

It is important to educate children because they are more susceptible for presented information than adults. Moreover, they are believed to develop long lasting environmental values. Children often share the information learned in the classroom or on field trips with family, relatives, and friends. If MINAE educates children at this age, the organization will be reaching much more than just the students that attend the learning programs.

Educating tourists is necessary because every year more and more tourists visit nesting sites to see sea turtles. Larger groups of tourists are harder for park guides to control. Educating more people about general rules of behavior on the nesting beach will decrease the likelihood of tourists causing harm to sea turtles. Therefore, it is important to keep tourist groups small so park guides can have better control over the actions of the tourists. Educating tourists is also a form of promoting ecotourism which is important to any tourist area because it is specifically designed to benefit the local community.

Interviews

From the questions asked during the interviews we received the following information. The questions for the interviews were previously discussed in details in the Methodology chapter.

All information about ANAI was obtained from the interviews with D. Chacón, Marine and Wetlands Program Coordinator at ANAI and W. Quiros, the technical assistant at the same organization. R. Silman, National Director of Caribbean Conservation Corporation, kindly provided us with information concerning CCC.

From the interviews with the researchers above we discovered that the youngest age group ANAI provides an educational program for is from age ten to twelve, while CCC is in the process of developing the environmental textbook for children approximately eight years old. All interviewees agreed that the earlier children begin to learn concepts of conservation the better. W. Quiros stated that younger children should not learn specific concepts, but should be aware of the issues.

Each of the interviewed researchers had different view on what information is the most important for children to know. W. Quiros believes that for the purpose of successful conservation students first of all should learn about threats sea turtles are

facing. According to R. Silman, environmental education has to start with the explanation of the basic concepts and also to provide the information on the natural resources of the country, as well as why they are so important and organizations that are trying to conserve it.

The conservation of sea turtles is important to Costa Rica for different reasons. As it is previously discussed in the Background and Literature Review Chapter, they are essential part of different marine and beach ecosystems and help to maintain it in a stable way. D. Chacón states that marine turtles also have significant economical importance to the country since Costa Rica is among the ecotourism-based countries. According to his words, ecotourism profits approximately ¢35.280.000,00 ($90,000.00) a year, while poachers make about ¢1.960.000,00 ($5,000.00) per year from selling the eggs for approximately ¢250 ($0.64) per egg, depending on the location and type of the egg. The ANAI's plan for the future is to decrease the poaching and egg harvesting in the area of Gandoca/Manzanillo Refuge. One of the ways they are doing it is recruiting poachers to become park guides.

CCC is planning to expand their volunteer program by attracting more local people. There are more international than local volunteers at CCC nesting sites every year. Moreover, most of the local volunteers drop the program after the few days and rarely stay until the end. Therefore, the CCC is working to find the way to attract more local people to their volunteer programs.

From the interview with Marietta Coto, sixth grade teacher at the private Anglo-American school, we learned that students can learn even complicated information. Moreover, challenging tasks stimulate and motivate their studying. Schoolteachers widely use sensory detail method, which involves brining characters and subject to life

through visual aids and imagination. This method helps students to understand material and memorize it better. Teachers also consider that the best way to present information to children is by using short sentences, easy vocabulary, visual aids, games and hands-on activities.

Educational Booklet

One of the major purposes of the booklet is to raise interest of sea turtles in younger people and to instill in them the respect and admiration of wildlife, and the importance of its conservation.

The booklet was originally supposed to be for fifth graders and to be tested in different public schools. However, teachers of public schools went on strike and schools were closed. For that reason, we could not test the book as it was planned. Therefore, together with our liaison we came to the decision to produce a booklet that can be used at nesting sites to educate volunteers and local school students.

Before we knew that any changes were going to be made to our project, we had already conducted a survey in the fifth grade of private Anglo American School in San José. The purpose of the survey was to find out what students already knew about sea turtles and therefore to determine what information we had to include into the booklet, and what information had to be covered in more details.

Twenty-five fifth grade students took part in the survey. Before they proceeded to the test, we asked if anyone previously saw a sea turtle before. Two thirds of the students raised their hands indicating that they already saw sea turtles at least once. Despite this, only half of students knew the average size of turtles. It was important to ask if the students learned about sea turtles from other sources that may explain why they performed better on the test or why they knew some answers and did not know others.

Twenty-four students knew that turtles were marine animals but only fourteen out of twenty five could remember that turtles were reptiles. Only four students were able to remember the names of two species of sea turtles. It also appeared to be that students did not know about sea turtle specific diet. Despite this, 11 students new that sea turtle's diet includes sea grass, they did not consider any other possible answers. It confirmed our decision to include general descriptive information about sea turtles in the booklet as well as their diet, behavior patterns, and lifecycle.

The test indicated that 60 percent of the students, or sixteen of twenty-five, were familiar with the term "extinction" but were not able to explain the meaning of "ecosystem." As a result, we decided to include wide explanation of ecosystem term in the booklet and not to emphasize on extinction. The booklet included definitions of these two words and some other ecological terms.

Although all of the students were aware that sea turtles are facing extinction, only 60 percent thought leaving garbage on the beach is the only human activity that can cause harm to sea turtles. As a result, we found it important to include information about natural and human threats. The information is intended to prevent any harmful activities. It is important to inform students about what can be harmful to sea turtles so they will not participate in the activities when visiting nesting beaches.

Also included in the survey was a question asking students to explain the importance of sea turtles. Eighty-eight percent of the students stated they were aware that sea turtles are important, but none could justify their thinking. Adding more to the booklet, we included information about the importance of sea turtles to not only Costa Rica, but to the world.

Based on the results of the survey, we decided to cover the following topics in the booklet. It provides general information on sea turtles and description of all six species that nest in Costa Rica. It also tells reader about major threats sea turtles are facing and explains the impact of each of them on sea turtle possible extinction. There is also a section that focuses on sea turtle conservation in Costa Rica. It includes information about conservational organizations and nesting sites they are conducting the research at.

After the changes were made to the project, we had to adjust the language of the booklet, to make it appropriate for an older age group. The style and complexity of information presented in the booklet is suitable for school age children, from twelve to seventeen years old. Despite a simplified language, information presented in the booklet is quite advanced and has high environmental and conservational values. Therefore, the book can also be used to provide information to eighteen to twenty years olds. The booklet is useful for educational purposes at volunteer centers because it contains general information on the most important topics of sea turtle conservation.

The book exists in both languages English and Spanish, which facilitates teachers' task of explaining the subject to volunteers, since volunteers come form different countries and not everyone speaks Spanish.

Pedagogical Methods

After researching about teaching and learning methods, we found many people respond to certain methods. It is important to first find at what level the student thinks and learns because any new material must build from the learned knowledge.

Lecture is the least effective way of reaching students because they quickly lose interest. To engage students in any particular topic, it is necessary to tap into the emotional learning systems and connect as many of the senses as possible, such as sight.

It is important to use visual aids such as animations and pictures because more senses are made in the brain and people are more likely to learn the information.

Since many people do not have long attention spans, it is crucial to simplify all the information taught. One method of teaching is to break down a large topic into multiple small components and teach each separately. While teaching, it is best to eliminate as many distractions as possible. This will allow students to pay more attention to the particular subject. Using physical materials and 3-D objects for experience and experimentation not only interests people in the particular topic, but it also enhances the chance of retention. Color, shapes, angles, and 2-D or 3-D presentations utilize the aspects grasped immediately by the emotional system to further cognitive goals.

When approaching content experientially, educators allow individual discovery and exploration to occur. Students are able to imagine the contents of the material and relate the information to concepts that are already mastered and understood. When relating the information, students are more likely to understand the new material and are also more likely to remember. Moreover, when connecting new topics to old ones, pupils are not just memorizing the information, they are learning the concepts behind the material. In learning, it is important to stop children from memorizing because it is unlikely the students will remember the information in the future.

Motivation is a great tool that can push the learning process forward. If students do not want to learn the information, then they will not. One method of motivation is challenging the children. Information that is found too easy can often lead pupils to become bored and lose interest. But it is also important not to make the learning process too difficult. Otherwise, students will lose hope in trying to understand the necessary knowledge.

Annotated Bibliography

Park guides and other professionals who are working at the conservation areas are encouraged to use the annotated bibliography of sources we used to complete the project to enhance their knowledge on the specific subject they are interested in. The bibliography also includes additional sources of scientific information that can be used for further in-depth research of a particular topic.

The annotated bibliography we produced contains URLs to the websites used in our work, lists of topics covered at each of the websites, as well as the overall description of the homepage. It also articles that we referred to during our research and those that might be useful for further investigation of the subject. Some useful books are also included.

The annotated bibliography can be used in future work in creation of sea turtle educational program since it contains sources of information on both sea turtle research and pedagogical approaches. Students, teachers, and researchers can also use it to locate the information they might need for their research because it contains list of databases and scientific journals that have a large number of articles about sea turtles.

For the convenience of the user, the bibliography is broken into two parts. One of them contains only sources of information about sea turtles and their conservation both in the U.S. and Costa Rica. The other part includes sources we used to study people's cognitive levels and pedagogical approaches that are commonly used.

Chapter 5. **CONCLUSIONS AND RECOMMENDATIONS**

Although many organizations are working hard to educate local communities near the nesting and feeing grounds of marine turtles, there is still no structured program that teaches the communities the necessary information. The main goal of our project was to raise the awareness of sea turtle endangerment in the general public and tourists. The following recommendations will provide MINAE with a base on which to build an educational program in Costa Rica.

Educational Booklet

The educational booklet we produced can be used as a guide for many educational programs about sea turtles. The booklet is for school age students, from twelve to seventeen years old. The common recommendation for any employment of the booklet is to use it as an educators' guide for primary school students and as reading material for secondary school students.

For education of older students, we recommend the creation of an educational turtle-watching tour, while for younger pupils, educational day camps can be established in the National Parks.

Educational Turtle-Watching Tour

One of our recommendations for MINAE is the establishment of educational turtle-watching tour for school students. These tours should include nesting beach visiting, turtle watching, as well as on site lecturing about sea turtles, their behavior patterns, and threats they are facing. We recommend the following structure for these tours.

Before going to the beach, park guide or volunteer who is working with the program should give a short lecture to students on general safety rules that they have to abide by while on the nesting beach. Among the rules, the following should also be mentioned; approaching sea turtle too close, trying to handle or catch it, using flashlights or taking pictures with flash. For more security on children's behavior, we recommend to place a number of signs on the beach with crossed drawings of restricted activities. It is aiso important to explain children why certain activities are prohibited. For instance, flashes from cameras can hurt the sea turtle's eyes and scare her as a result she will not lay the eggs. These explanations will play an educational role. According to Bransford et al. (2000) examples connected to the context of presented information will help children to remember the information. If presented correctly, short scientific facts may be included in the examples. It is imperative that the information be short and fun to learn. For example, hardly anyone knows that flashlight can be used at the nesting beach, but only if it is a red light, since the red light does not hurt turtle eyes. Even the youngest children can understand the most complicated information, if it is presented in the simplified way (Bransford, Brown, & Cocking, 2000). Therefore, the chances that children will remember and understand the concepts of conservation will increase if taught at a younger age. They will also be more likely to practice the concepts at an older age since they are more susceptible to any information learned at a young age.

While on the beach, participants in the program could observe sea turtles and the guides can teach about the species that are nesting, other species and location of their nesting sites, facts about sea turtle nesting behavior, and their lifecycle. For example, hardly anyone knows that sea turtles, depending on the species, nest only once in several

years but make more that one nest during the nesting season. It will be interesting also for children to know that turtles have lived before the dinosaurs.

If all information described above is presented to children in the form of one long lecture, children will soon get bored and will not pay attention to it and subsequently will not remember anything they have learned from the tour (Marietta Coto, sixth grade teacher, private Anglo-American School, personal communication May 25, 2003). Therefore, we recommend guides and teachers, who will lead these groups to provide any information using several short lectures rather than one long information session. It is important that the students intake the information slowly so that they may understand the importance of each fact learned. Some of the teaching methods mentioned and described in the Results and Analysis Chapter can be used for the tour.

The tours do not have to be led only by professional educators. They can also be held by volunteers who can use our booklet, as an informational guide. The booklet contains the most important information that can benefit marine turtles, so it does not matter which information is chosen to be discussed during the tour. Therefore, administration of the park does not have to spend additional funds to train educators for these tours.

To motivate students to attend such educational tours, the first ones can be mandatory. They can be part of a school environmental education program. Students can also receive a credit for visiting such sessions and tours if they pass, for example, a test on the subject that was discussed during the tour. The benefit of including the educational tour in the curriculum is that students will be learning the information both visually and tactilely.

It is also important to understand that these tours are different from the existing programs such as the EcoTeach or Earth Watch programs. These programs can last for one week or longer and participants must apply. The turtle-watch tours suggested by our group will only be a day long event available for any person willing to participate.

Establishment of Summer Educational Centers

The summer educational centers can be established in the national parks where school students can learn about particular environmental or conservational issues researchers are most concerned about. We recommend that these centers should be established in the form of a day care or day camp for children who come to the conservation area with their parents.

Many people do not visit conservation areas because they cannot bring their children with them. Not only are there no facilities to keep the children entertained, but the activities allowed during the nesting season are not fun for the young ones. Therefore, the establishment of an educational day program in national parks will bring more tourists to nesting sites and subsequently increase the income of the park. It can be structured much like a day camp where the children can enjoy activities, storytelling, and Moreover, it will also be a big achievement in sea turtle educational and conservational program. These classes should involve role playing, games and other kinds of educational activities. We see it as a good way to provide education on local environmental issues because there will be no interference with school programs and curriculums. Depending on the age of children participating in the program, our booklet can be used as educational guide or textbook.

We choose school age children as our target audience because they are most receptive to the information they learn than other age groups (Todd, 1992). They also tend to develop long lasting environmental values. Moreover, educating children we also educate their families and friends as well, since children tend to share all new learned information with people they know.

The educational tours and summer classes will not only increase the interest in sea turtles among public, but also can become the first step in sea turtle educational program in Costa Rica.

Sea Turtle Website

It would be useful for MINAE to build a website devoted solely to sea turtles. This page should contain general information about sea turtles, habitat, biology, and behavior patterns. To go with the environmental education programs, it would be useful to include a "Kid's Corner" or a section designed specifically for children. Here, young ones can play games that teach them facts about sea turtles. It is important that the information used in the kid's corner contains many pictures and videos. Some of the activities included can be painting, to stimulate the right brain. To learn biology of sea turtles, children could drag body parts of a turtle to the correct location. This uses both visual and interactive learning. It would also be convenient for adults if there were printable pages that they can give to their children. These pages can be used for coloring, word puzzles, mazes, or any simple game about sea turtles.

For the general sea turtle page, all nesting sites for specific species should also be listed in this page along with the organizations conducting research at the particular sites. Since there is already a slew of information about sea turtles found online, links to particular websites with the information can be found. The purpose of the general page is

not to teach an older audience about marine turtles, but to provide the resources that may answer their particular question. Including links to the organizations conducting the research or providing programs will be most beneficial for the general public looking for information. It is also important to constantly update the website for tourists and visitors looking for up to date information about the facilities and events. Including the information about the volunteer programs will advertise and attract students and possible sponsors to the nesting sites in Costa Rica.

APPENDIX A: Sponsor Information

El Ministerio del Ambiente y Energía (MINAE) of Costa Rica is the national organization responsible for the management, coordination, and implementation of all issues regarding natural resources (OAS, 2003). These responsibilities include the conservation, promotion, control, and the investigation of natural resources, such as mining and power (MINAE, 1998). Planning to move towards sustainability in the environment and the economy, Costa Rica's government formed MINAE to improve the quality of life for its citizens.

Ministry of Natural Resources, Energy, and Mines (MIRENEM), later known as MINAE, was created in 1982 as a response to a series of social demands to develop an institutional framework adequate to the protection of the country's natural resources. In November of 1995, the promulgation of the Environment Organic Law defined a more specific range of activities for MIRENEM regarding the field of natural resources, and its name became Ministry of Environment and Energy (MINAE) (INBio, 2003).

Within MINAE there are several departments that are also called dependencies. MINAE's main objectives for these departments are to consolidate its main purpose into a more precise goal. Each branch specializes in a specific environmental issue. For example, Instituto Meteorológico Nacional (IMN) specializes in meteorology, Dirección General de Hidrocarburos (DGH) focuses on hydrocarbon usage, Fondo Nacional de Financimento Forestal (FONAFIFO) raises money for forest financing, and Dirección General de Geologia y Minas concentrates on mining and geology (Dodd, Jaramillo, & Morin, 2001).

Sistema Nacional de Areas de Conservación (SINAC) is the general director of the dependencies under MINAE. This management system is responsible for carrying out the Ministry's biodiversity-related activities throughout the country, which includes

promoting issues on improving environmental legislation, facilitating environmental education, and handling conservation of natural resources (INBio, 2003; SINAC, 2002). SINAC is also responsible for species preservation in Costa Rica. One of the major concerns of SINAC now is conservation of sea turtles in Costa Rica. By 1996, it administered all biodiversity in Costa Rica, which includes all eleven conservation areas (Vaughan & Rodriguez, 1996). The purpose of SINAC is to manage and promote sustainable use of natural resources while maintaining economic and social development in Costa Rica.

Under MINAE, SINAC is also a member of the National Council for Conservation Areas. The main purpose of the National Council is to decide guidelines for the Conservation Areas and also to organize the structure of them. SINAC includes the Executive Directors Office and the Conservation Areas. The responsibility of the Conservation Areas includes the implementation of policies as well as the plans of the National Council (MINAE, 2002). The Executive Office consists of regional and sub regional directors which enforce current laws within the region's boundaries. The organization of MINAE and SINAC is shown in Figure 1.

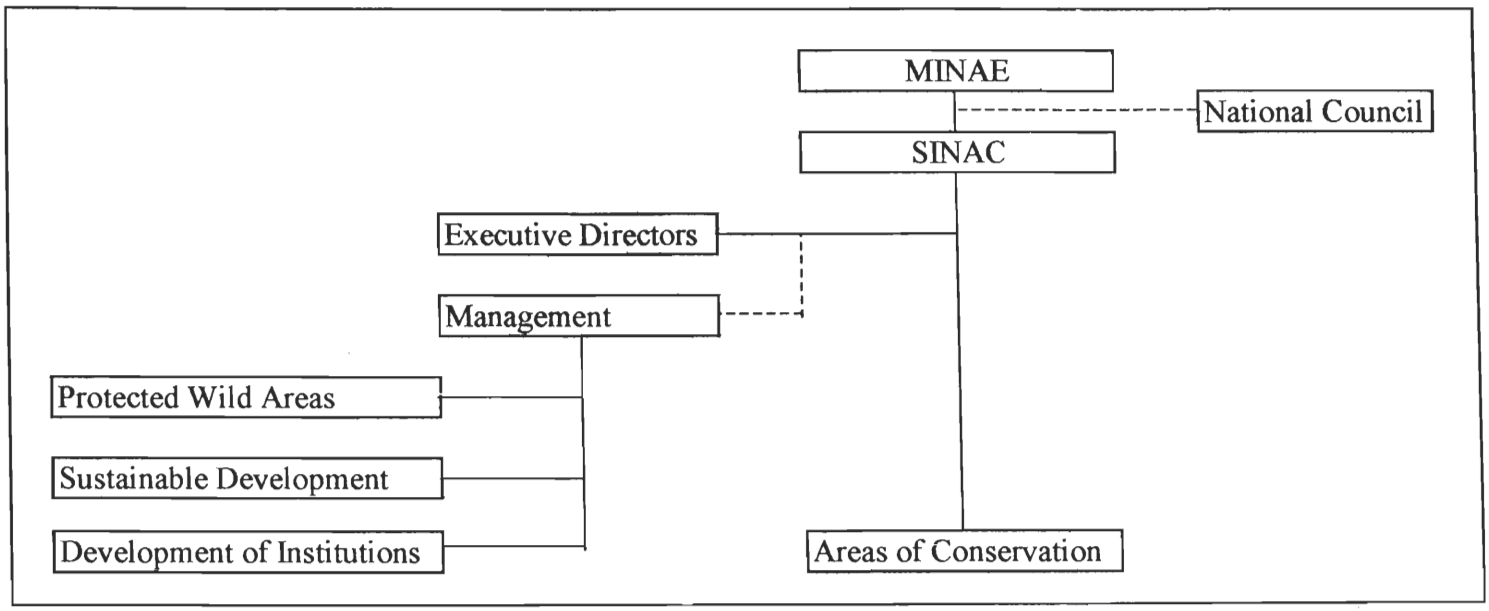


Figure 14. MINAE and SINAC Structure

Source: MINAE (n.d.)

APPENDIX B: Survey on the Existing Knowledge About Sea Turtles

Name: _____

Directions:
For multiple choice questions: choose all that apply, there may be more than one answer or none at all.

For open response questions, please **don't guess** if you don't know the answer, just put: —

1. How many different kinds of animals and plants are in Costa Rica?
   a) Hundreds
   b) Thousands
   c) Don't know

2. Do you think plants and animals need each other to live? For example if blooming plants disappeared, do you think anything will happen to birds?

_____

_____

3. Do you know what an *ecosystem* is? If yes, try to explain.

_____

_____

_____

4. Do you know what *extinction* means? If yes, try to explain.

_____

_____

_____

5. What are sea turtles?
   a) Air breathing reptiles
   b) Mammals
   c) Fish
   d) Don't know

6. Where do they spend most of their life time:
   a) In the ocean
   b) On the land
   c) Don't know

7. How many different kinds of sea turtles nest in Costa Rica?

_____

8. Please list any of their names if you can remember.

_____

_____

_____

_____

9. How big can sea turtles grow to be?
   a) 10 meters
   b) 5 meters
   c) 2 meters
   d) Don't know

10. How many years do sea turtles live for?
   a) 10 years
   b) 30 years
   c) 60 years
   d) 100 years
   e) Don't know

11. What do sea turtles usually eat?
   a) Sea grass and weeds
   b) Jelly fish
   c) Mollusks
   d) Crabs
   e) Insects
   f) Fish
   g) Small marine animals
   h) All of the above
   i) None of the Above

12. What are some natural enemies of grownup and baby sea turtles? (draw arrows)

   a) Big fish
   b) Sharks — Grownup sea turtles
   c) Crabs
   d) Birds — Baby sea turtles

e) Big animals on the beach

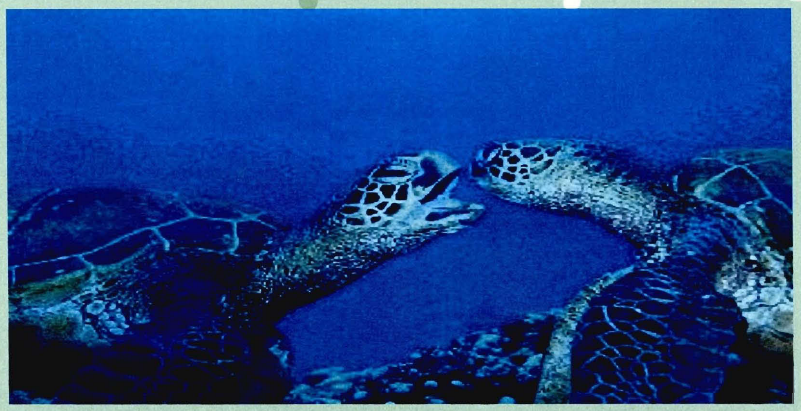
13. Which of the human activities below can **cause harm** to turtles?
    a) Cars
    b) Light on the beach at night
    c) Fishing
    d) Creating shadows on the beach
    e) Garbage in the water
    f) Don't know

14. Which of the following beach activities cause **no harm** to turtles?
    a) Try to catch or ride sea turtles
    b) Play games and swim
    c) Use flashlights
    d) Dig into the sand
    e) Collect the eggs or move them
    f) Don't know

15. What should you do if you see an injured sea turtle on the beach in a National Park?
    a) Find the guide or someone else who works in the National Park
    b) Try to move it or bring it to the place where someone can take care of it
    c) Don't do anything
    d) Try to bring it back to water
    e) Don't know

16. Do you think sea turtles are important? Explain why.

APPENDIX C: Educational Booklet about Sea Turtles (English)



The Exciting World of Sea Turtles

An Educational Booklet for Primary and Secondary School Students

Getting Started

Costa Rica is known worldwide for its variety of plant and animal species. Tourists from all over the world come here to see animals and plants that cannot be seen anywhere else in the world. Costa Rica is special because it is one of few countries that has been able to maintain this diversity of wildlife by the means of a national system of protected conservation areas. Despite the efforts of many people and organizations to conserve wildlife, it becomes harder and harder for all the different species to survive.

It is important to protect all these plants and animals. They maintain biodiversity and the stable state of ecosystems in the country. An ecosystem is an organized community where each member depends on the other. These members are also called organisms that populate the same habitat in other words, they live together in the same place. Ecosystems can be small, such as a particular rain forest, or big, like the whole world.

Let's put this in perspective. There is a rainforest and everything inside the rainforest, all the animals, birds, and plants, as well as all insects and small organisms that you cannot even see, including **microorganisms** like bacteria and fungi, all belong to the same ecosystem. But that's not all! The ecosystem can also include the climate because it is the result of the life activity of all these animals, plants, and microorganisms.

If one of the "links" falls out, the chain will break apart. What do you think will happen if all insects disappear from the rainforest? You may be more comfortable, but what about all birds that eat these insects? They will have no food to eat and all of them will die. "I don't care, birds don't do anything to the forest," some might say, "so nothing will happen if they all disappear."

If you meet such people, tell them that along with other animals, birds bring organic waste and nutrients in their egg shells to the forest. These nutrients give strength to plants so that they can grow big and strong.

Now that you have a better understanding of why all the different living organisms (even microorganisms) are important, we can move on to another subject.

A Brief History

Did you know that sea turtles have existed for over 150 million years? This means that sea turtles lived during the same time as dinosaurs. Miraculously, sea turtles have survived through Earth's evolutionary changes while all the dinosaurs vanished. Can you imagine how long they have been on Earth? Just think, humans have only been around for about 4 million years and modern humans have been around for approximately 200,000 years.

A long time ago, indigenous tribes used sea turtles primarily for food, eating their eggs and meat. As the population of humans grew, so did the popularity of sea turtle products. It was not until the end of the 16th century that sea turtle trade began and the use of its beautiful shell became a popular item to make jewelry and ornaments. This caused sea turtle numbers to decline quickly. At the same time, more people began to occupy beaches and use waters where the turtles fed. As a result, sea turtles suffered from losing their nesting and feeding grounds.

Sea Turtles

Even though sea turtles spend the majority of their lifetime in water, they are air-breathing reptiles. They can spend several hours under water and only come out to breath. Sea turtles mostly live in tropical and subtropical waters, which mean they prefer warmer climates. This is because their body temperatures depend on the environment around them, except for leatherbacks who can also survive in the cold waters of the northern seas and oceans.

There are several species of sea turtles, but they all share similar features. For example, they all have streamlined bodies and flippers that help them swim in the ocean with great skill and elegance. Have you ever seen

sea turtles swim? Just imagine them gliding through the water or wandering the ocean floors for food.

The shells that cover their body consist of an upper part, called the carapace and a lower part, called the plastron. Their shells are covered with scales, also known as scutes. The only turtles without scutes on their shells are leatherbacks. You can identify different kinds of sea turtles from the patterns and number of scutes they have on their shells.

Instead of having teeth to chew, all marine turtles have very powerful jaws that they use to crush and grind their food. Sea turtles regularly eat seaweed, mollusks, jellyfish, sponges, and sea grass.

Turtles also do not have ears, but do have eardrums that are covered with skin. To make up for their poor hearing abilities, marine turtles have keen senses of smell. Sea turtles also have excellent vision under water, but are nearsighted otherwise.

Sea turtles spend most of the daytime at their feeding grounds in the water and sleep on the bottom of the ocean. However, they do have to exit the water to lay their eggs in the sand. An interesting fact about sea turtles is that they nest on the same beach where they were born, which is called the **natal beach.** Their natal beach can be thousands and thousands of kilometers away from their feeding grounds. It is amazing how far they can migrate. It is even more amazing that they can find the tiny strip of beach where they were born just to lay more eggs. No one, not even scientists, can really understand exactly how sea turtles are able to navigate to their natal beach. However, scientists do believe that sea turtles have a special ability that can sense the magnetic fields on Earth. These magnetic fields act like compasses that orient the turtles. But even this knowledge does not fully explain turtles' navigational skills.

Life Cycle

Nesting Behavior

Except for some populations of Hawksbills, only during the nesting

season most sea turtles swim near the coastline. Afterwards, males return to the open ocean while females remain near the shore to lay eggs. All species lay their eggs by excavating a hole in the sand to make a nest and throwing sand over it to mask it from predators. A sea turtle, depending on the species, lays about 80-200 eggs in each nest. Although a female can nest several times in a season, she will only visit the beach every one to three years.

Growing Up

Depending on the species, eggs are incubated for approximately two months. The temperature of the sand on the nesting beach influences the development of the eggs. Eggs that are kept in cooler sand tend to produce more males, while eggs in warmer sand result in more females. Shadows created on the beaches result in more males because the sand is so much cooler.

As soon as hatchlings break out of their shells, they dig themselves out from the nest and rush towards the ocean. Ocean currents carry hatchlings to their feeding places where food is abundant and few enemies populate. Young turtles stay there for several months or even years until they reach their adulthood. After reaching their mature age, sea turtles return to land to nest. It can take from 15 to 50 years for a marine turtle, depending on the species, to reach the mature reproductive age. Some scientists believe that certain species of sea turtles can live over one hundred years!

Species Found in Costa Rica

There are six species of sea turtles that nest in Costa Rica. They are the following: green, leatherback, loggerhead, black, hawksbill and olive ridley.

Green Turtle (*Chelonia mydas*)

Green turtles are named not for their green shell and flippers, but for the green color of their body fat. Female green turtles average more than 90 centimeters in carapace length, and average about 150 kilograms in weight. Young green turtles eat worms, aquatic insects, sea grasses,

and algae. Adult greens eat only sea grass and algae, making it the only sea turtle that is strictly herbivorous. Most nest in the Caribbean basin and Florida, but graze on the vast beds of sea grass throughout the tropics. The largest nesting site for green turtles in the Western Hemisphere is in Tortuguero, Costa Rica.

Black Turtle (*Chelonia Mydas agassizi*)

The shells of these sea turtles are almost black, which is how they received their names. Black turtles populate only the Eastern Pacific and nest in Mexico, Costa Rica, and Galapagos islands. In the Galapagos they feed and also find adequate nesting sites making it unnecessary to migrate long distances.

Loggerhead (*Caretta caretta*)

Loggerheads received their name from their extra-large heads. Adult loggerheads weigh up to 175 kilograms and have a reddish-brown carapace and a dull brown to yellow plastron. Fully grown, a loggerhead's carapace is typically 82 to 105 centimeters long. Loggerheads feed mostly on shellfish that live on the bottom of the ocean. Using their powerful jaws to crush the hard bodies, they also eat horseshoe crabs, clams, mussels, and other invertebrates.

Leatherback (*Dermochelys coriacea*)

The leatherback is the only sea turtle that lacks a hard shell. It is named for its large, elongated shell which is composed of a layer of thin, tough, and rubbery skin that is strengthened by thousands of tiny bone plates. Seven narrow ridges run down the length of the carapace, which is typically blue-black with many white spots. The lower shell is whitish to black and marked by five ridges. The leatherback is also the largest turtle in the world. Typically, they grow to about 1.3 to 1.75 meters in length and weigh up to 600 kilograms. Scientists have recorded a male leatherback that was 2.75 meters long!

Hawksbill (*Eretmochelys imbriacata*)

Hawksbill turtles are named after hawks because their heads resemble the beaks on these birds. It is one of the smallest sea turtles, measuring 76 to 91 centimeters and weighing 40 to 60 kilograms. The hawksbill has a narrow head and jaws that are shaped like a beak. This allows hawksbills to reach food from small crevices in coral reefs. They eat sponges, anemones, squid, and shrimp, which all live near coral reefs. Hawksbills are the most tropical of all sea turtles. The best places to find these turtles are near coastal reefs, rocky areas, and lagoons. Although they nest on beaches throughout the Caribbean, they are found in large numbers only in Australia.

Olive Ridley (*Lepidochelys olivacea*)

The olive ridley is named for its olive green colored shell. In Costa Rica, local people call it *Carpintera* because of the hammer-like thumping ritual it performs after nesting to compact its nest. However, many people also know it as Lora because of its parrot-like beak. It is a small turtle, usually less than 50 kilograms. Being omnivorous, the olive ridley feeds on crustaceans, mollusks, and tunicates. They inhabit tropical and subtropical coastal bays of the Pacific, Indian, and Atlantic Ocean. In some places, like in Ostional and Nancite beaches in Costa Rica, the Olive ridley exhibits a nesting extravaganza known as "arribada", when many thousands of turtles come to nest in mass for several days and night.

Threats

Natural Threats

Adult sea turtles do not have many natural enemies. Their most frequent enemies are sharks. While baby sea turtles often become victims of crabs and birds even before they reach the water, those creatures are not the reason for sea turtle endangerment. Many other predators, such as vultures and raccoons destroy nests to eat eggs. They have harmed sea turtles as long as they have existed, but sea turtles only became

endangered when the first Europeans came to America and sea turtle products were commercialized.

Human Threats

Poaching and Egg Collection

It is prohibited to collect eggs and kill or harm sea turtles in many countries that have sea turtle nesting or feeding sites, but governments have a hard time controlling poachers. Since marine turtles have flippers, they are not skilled travelers on land. This makes it easy for poachers to kill turtles on the beach. Eggs are also left unattended for approximately two months before they hatch. Since sea turtles are so vulnerable to attack, it is easy for poachers to reach them, and difficult for officials to control poaching.

People covet marine turtles for different reasons, mostly for their shells, meat, and eggs. It is believed that the meat and eggs from marine turtles are healthful, but in reality; sea turtle eggs have more cholesterol than chicken eggs. Using the shells to make jewelry and ornaments, poachers would sell these costly valuables. For example, the uncontrolled hunting for Hawksbills resulted in a massive decline in their population. Their numbers dwindled so low that they are listed as critically endangered.

Pollution

Since the development of human technology, pollution has become an issue. Many turtles have died because of ocean pollution caused by oil, gas, heavy metals, pesticides, or any other chemical spills. These pollutants may have caused diseases that are killing sea turtles in great numbers.

Garbage in the water can also result in turtle death. Sea turtles often ingest garbage mistaking it for food, blocking their intestines. This prevents turtles from digesting the food, and they eventually die from starvation. The most common and dangerous type of garbage found in water is plastic. Leatherback turtles commonly swallow balloon pieces and plastic bags mistaking them for their favorite food, jellyfish.

Beach Development and Artificial Light

Hatchlings generally leave the nest at night. They reach the ocean by following the brightest source of light on the beach, which is the reflection on the water from the moon and stars. Any artificial light on or near the beach can deceive baby turtles and direct them away from the ocean. As a result, they easily become victims of predators, die from dehydration, or are overrun by cars. Artificial light sources can come from hotels, roads, beach lines, or flash lights. These sources can also scare nesting females and prevent them from laying eggs or even coming onto the beach.

Another problem that sea turtles face is beach development. As tourism grows in Costa Rica and elsewhere, it is necessary to build more hotels, and establish different facilities on or near the beach, which takes up their nesting beaches. The beaches become dirty and require cleaning as more people visit them. To accomplish this, heavy equipment and chemicals are used in Florida, for example, to replace sand and kill any harmful bacteria. These chemicals can penetrate the eggshells and prevent embryonic development. The heavy vehicles on beaches destroy nests or compact the sand and trap hatchlings in the nests.

Commercial Fisheries

Fishing for sea turtles is prohibited in many countries. The problem is that turtles are often caught in gill and long line nets that belong to commercial fisheries. Once in the gill nets, turtles can drown because they are unable to swim to the surface for air. Leatherback turtles are most commonly trapped in the fishing long lines because their migratory routes in the Pacific are invaded by gill nets and long lines. To prevent the incidental capture of sea turtles, fisheries in the United States are required to use Turtle Excluder Devices (TED), which allows turtles to escape the shrimp net.

Things You Should Not Do

Many things can hurt sea turtles, even though it may not be on purpose. Here

are a few things you should not do when you are near a sea turtle.

DO NOT:

- ❖ Use flashlights on the beach. It can disturb sea turtles and cause them to terminate nesting.
- ❖ Take pictures using flash, for the same reason as lights. The camera flash is even worse than regular flashlights because the light is more concentrated and harsh, therefore causes more disturbance to sea turtles. Instead, you can use red lights that do not harm the turtle's eyes.
- ❖ Approach the sea turtle too closely. You can scare her and cause her not to nest. Also, stay away from her head, turtles that have strong jaws, like Loggerheads, that can seriously harm you.
- ❖ Leave garbage on the beach, especially plastic bags and balloons. These items can find their way into the ocean where sea turtles can mistake them for food.
- ❖ Dig in the sand of the nesting beach. You can accidentally disturb nests and damage turtle eggs.
- ❖ Transfer eggs or put different objects in nests. Foreign objects can carry bacteria or fungi that can harm the embryos in the eggs.
- ❖ Try to catch, ride, or handle sea turtles. These activities are illegal, but you can also hurt the animal or yourself.
- ❖ Disturb tracks left by sea turtles. Scientists use these to determine which sea turtles came to nest on the beach.

Why are Sea Turtles Important?

Biodiversity

Biodiversity is all living things on Earth and the differences that make each species unique. It is important because when numerous and various species of plants and animals co-exist, the same plants and animals use each

other to help themselves. Sea turtles help biodiversity because when they come out of the ocean, they bring nutrients to the beach. The eggshells also contain nutrients that are left behind from the hatchlings. These include lipids, proteins, and nitrogen. Absorbing the nutrients, many different plants are able to grow. These plants are not only important to biodiversity, they also prevent erosion, which is the removal of sand from a beach by a gradual process.

Sea turtles fulfill important ecological roles in maintaining the biodiversity of coral reefs and marine grass beds. They also transfer energy between the ocean and the marine environments such as nesting beaches and adjacent areas. Their disappearance could seriously impact other species of flora and fauna ehich depend on sea turtles and their eggs for survival.

Ecosystems

Sea turtles are also important because they are a part of a marine ecosystem. Scientists believe that ecosystems are somewhat of an organized community where each member in the community depends on the other. If sea turtles become extinct, it will affect other marine creatures. Sea turtles are especially important to ecosystems because they are migratory animals and therefore have an impact all over the world. If sea turtles go extinct the whole world's ecosystem will be affected.

Green turtles, for example, are one of the very few animals that eat sea grass. They act as grazing animals that cut the vegetation short and help maintain the health of the sea grass beds. Since there are now fewer green turtles, more sea grass beds are left uncut, so the beds do not grow as well. Sea grass beds are important because they serve as habitat for many species of fish, shellfish, and crustaceans that live and feed there.

Another example is the Leatherbacks. As the only consumers of jellyfish, the decline in their numbers has resulted in an increase of jellyfish. This creates a strain on other small

marine organisms that major marine animals feed on.

Conservation Areas in Costa Rica

It is important to save sea turtles in Costa Rica because the country is a home to some of the world's largest nesting sites. In order to conserve sea turtles, several marine national parks were founded in Costa Rica. The major National Parks are Las Baulas, Santa Rosa on the Pacific, and Tortuguero and Cahuita on the Caribbean coast. The wildlife national refuges are Gandoca/Manzanillo on the Caribbean and Ostional and playa Hermosa on the Pacific. Two private nature reserves were created in Pacuare.

National Parks

Las Baulas

Parque Nacional Marino Las Baulas de Guanacaste is located on the Pacific coast of Costa Rica, approximately 100 kilometers from the border with Nicaragua. It includes Playa Grande, Ventanas, and Langosta nesting beaches as well as a large marine part of the Tamarindo bay area. The extensive mangroves in this area were declared a Ramsar Site, which is a wetland of international importance, in 1993. The park was developed and designed by Ministerio del Ambiente y Energía (MINAE) and has been under its control since 1991 to protect the third most important Leatherback nesting site in the world. Sadly, Leatherback population that nest in this area significantly decreased because of massive egg harvesting during the 1980's drowning of thousands leatherbacks in the long lines and gillnets invaded their migratory routs in the recent days.

No one may enter the park without the company of a specially trained guide, especially at night during nesting season.

Santa Rosa

Another important National Park in Costa Rica is Santa Rosa. It is located in the Guanacaste Province, which is the northwest region of Costa Rica. Santa Rosa is one of the most significant parks, protecting115 species

of mammals, 253 birds, 100 reptiles, and 3,000 species of butterflies and moths.

This Park includes Nancite and Naranjo beaches, which are important nesting sites for the olive ridley, leatherback, and Pacific green sea turtles.

Tortuguero

The largest nesting site for green turtles in the Western Hemisphere is at Tortuguero, which is a black sand beach located in the northeast region of Costa Rica. This national park is included in the vast Northeast Caribbean Area, also awarded Ramsar Site status.

The park now includes over 19,000 hectares (46,900 acres) and protects 35 kilometers of nesting beaches. Tortuguero serves also as a nesting place for loggerhead, hawksbill, and leatherback turtles.

Cahuita

This is a small marine park created to protect the largest coral reef in Costa Rica where Hawksbill and Green sea turtles pasture along the grass beds. Recently Hawksbill nesting at the park has been identified, not in great numbers, but much more than previously believed. The health of the coral reef is undergoing difficult times because of climatic change, sedimentation, and the rising of the reef's stratum during the earthquake of 1991. Until only recently, researchers documented the largest nesting population of Hawksbill sea turtles in Costa Rica on this national park.

National Wildlife Refuges

Ostional

Located on the seaward coast of the Nicoya Peninsula in Guanacaste, Ostional is famous for its "arribadas" of Olive ridley sea turtles, which sometimes include hundreds of thousands sea turtles. Because of this mass nesting, a lot of eggs do not develop and their decay results in contamination of the beach with bacteria and fungi that affect healthy eggs. Therefore, only a small percentage of eggs hatch.

A village near Ostional has the legal rights granted by MINAE to harvest and sell a significant percentage of the eggs from the *arribadas,* making it one of the most interesting sea turtle sustainable projects worldwide. The villagers make a living with the sale of turtle eggs and at the same time their harvesting of eggs serves the interests of the turtles by removing organic matter that otherwise would pollute the beach even more.

Playa Hermosa

An abundance of nesting Olive ridley sea turtles prompted local people at Playa Hermiosa to seek legal protection for this beautiful beach on the Central Pacific.

Government officials, local and international volunteers patrol the beach and move the nest to the protected hatchery.

Gandoca-Manzanillo

This wildlife refuge protects both ecosystems marine and terrestrial, as Cahuita National Park. A coral reef is included in its marine area, where significant research is conducted. The total area is a Ramsar Site. For several years, ANAI, in coordination with MINAE, has conducted a project to protect the sea turtle's nest.

However, its vast black sand beach and extensive lagoon together with the northeast portion of the larger San-san wetlands in Panama are a part of the lower reaches of the Sixaola river drainage, where abundant Leatherback nesting occurs as well as some by Hawksbill and Green sea turtles.

Private Reserves and Other Projects

Pacuare Reserve and Estación Las Tortugas

Nine kilometers of prime Leatherback, Hawksbill, Green sea turtles' nesting beach are protected by two private reserves; Pacuare Reserve with six kilometers and Estación Las Tortugas with three.

Osa Peninsula

Several medium sized sea turtle nesting beaches, specially used by Olive ridleys and some Black and Leatherback sea turtles, are located near Corcovado National Park. At present, beach protection and sea turtle biometrics are conducted on three of these beaches, Carate, Río Oro, and Peje Perro, with the cooperation of local people.

Parismina

The Naval Police that patrols the nesting beaches of sea turtles along the Caribbean coast of Costa Rica started a hatchery with eggs confiscated from poachers along the ample black sand beach of Parismina. Their efforts have attracted people from local communities as well. Some of the Naval Police officers are trained biologists who are deeply dedicated to the welfare of sea turtles.

Punta Banco

Located on the Golfo Dulce side of Punta Burica in southwest Costa Rica, this is a unique project, since indigenous people participate in it. Guayme participate in collecting eggs laid by Olive Ridley and protecting them in a hatchery until their release into the ocean.

Pretoma is the organization coordinating and administrating this project together with local Guaymi leaders.

Organizations in Costa Rica

Ministerio del Ambiente y Energía (MINAE)

MINAE is a government organization that deals with environmental issues. Included in its responsibilities is the administration of national parks, wildlife refuges and other conservation areas.

Ministerio de Suguridad Publica

This organization is responsible for controlling the civil police and naval forces.

Asociación ANAI

ANAI is a non-profit organization that deals with conservation of plants and animals. ANAI focuses its work in

Greater Talamaca, which is a biodiversity hotspot and in the Gandoca/Manzanillo Wildlife Refuge. The refuge is located on the southeastern Caribbean coast of Costa Rica, where it serves as a nesting site for four species of sea turtles. Recently, direct efforts have been taken to prevent erosion and safeguard the nesting beach.

Caribbean Conservation Corporation (CCC)

The CCC is an international organization, founded in 1959 to protect sea turtles and their habitat. The cornerstone of their research is the Turtle Tagging and Monitoring Program, which revealed astonishing facts about sea turtles, much of what is known about them today was found through this program.

Estación Las Tortugas

Protecting three kilometers of prime leatherback nesting beach in Pacuare in the Caribbean, it is the first sea turtle reserve created by a Costa Rican family, the Rodrigués-García's. More than two dozen members of this family monitor and protect nesting Leatherbacks, their eggs, and hatchlings under the supervision of trained biologists. The family also provides facilities to volunteers who come to Estación Las Tortugas with Eco-teach program. Funds generated from these visits represent a significant contribution to the financial success of this program. The small sea turtle museum was established lately.

Endangered Wildlife Trust

Adjacent to Estación Las Tortugas, Pacuare Reserve was created by the British, Endangered Wildlife Trust, in 1989. It protects six kilometers of prime Leatherback nesting beach with scant of Green and Hawksbill sea turtles. The Ecology Project International (EPI) brings volunteers from Costa Rica's private and public schools as well as from the U.S. to the reserve to protect and study sea turtle, biometrics under the guidance of a resident trained biologist. The scientific projects of these young people are brought together and

exhibited in the Annual Sea Turtle Student Symposium.

Leatherback Trust

Recently created, the Leatherback Trust brings together the expertise of international and local biologists and conservationists, in an effort to protect and augment the remnants of the Leatherback population nesting at Baulas National Park.

Internationally, the Trust's scientific arguments before the USA government helped to remove the USA long line fishery from the Leatherbacks migration rout in Hawaiian waters.

PRETOMA

For many years, indefatigably Pretoma has spearheaded the Costa Rican effort to fit Turtle Excluder Devices in all the shrimp vessels of the local fleet. Success is variable. However, because conditions in the ocean in Costa Rica are quite different from those of the Gulf of Mexico, where TEDs were first used, Pretoma has produced a new contraption, which carries the name of TICO TED. The TICO TED exhibits larger spaces between the bars, which helps in preventing the logging of the TICO TED with large wooden debris, found in great abundance in Costa Rica's marine environment.

Together with the Guaymí communities, Pretoma administrates the Olive ridley project at Punta Banco. Additionally, it has embarked on an international effort to prevent the total distribution of sharks, which the same as sea turtles are long-living species taking many years for individuals to reach maturity.

Salvamento Internacional de la Tortuga Marina

Recently created, this Costa Rican foundation protects Carate, Rio Oro, and Peje Perro beaches at the Osa Peninsula, and carries biometrics research on sea turtles. The most abundant nesting sea turtles here are Olive ridleys. Black turtles and Leatherbacks occasionally nest here, making approximately one thousand nests during the nesting season.

Together, these beaches comprise more than eight kilometers.

International Collaboration

Most of the species of sea turtles that populate waters of the American continents lay their eggs on the beaches of one country and feed in the waters of another country. As a result, governments from thirteen different countries came together to coordinate their efforts in the protection of sea turtles. Calling it the Inter American Convention for the Protection and Conservation of Marine Turtles, this group is trying to pass international laws that will protect sea turtles during all their life stages and their habitats. The idea behind this goal is that no matter how hard countries work to protect sea turtles on their beaches, if people are killing them in international waters, their efforts are essentially useless.

How You Can Help!

If you hear somebody saying that any kind of animal or plant is not important, tell him or her, what you learned from this book!

Tell people how important sea turtles are to Costa Rica, the world, and to you!

If you are on a nesting beach and you see someone trying to hurt a sea turtle or to steal the eggs from the nest, call a park guide immediately.

Tell your friends and relatives not to leave garbage on the beach and watch out for balloons.

If you come across an injured sea turtle, do not just walk away. Find someone who is trained to help it or someone who can help you to find such person. But NEVER try to move the turtle or do anything else by yourself. You can injure yourself and the sea turtle.

Tell your friends everything you know about sea turtles and different organizations that are trying to save them. Maybe they'll become interested enough to volunteer for one of the sea turtle conservation project.

Be aware of what you are doing on the beach that serves as a nesting site for sea turtles.

Glossary

Basin – an enclosed or partly enclosed area of water.

Biodiversity – all living things on Earth and the differences that make each species unique.

Carapace – the dorsal or upper part of the turtle shell.

Ecosystem – organized community where each member in the community depends on the other.

Embryo – an animal at any stage of development prior to birth.

Endangered species – a species or organism that is in danger of extinction.

Environment – all physical, chemical, and biological factors (as climate, soil, and living things) that surround an organism.

Erosion – the removal of sand from a beach by a gradual process.

Evolution – a process of continuous change from a simpler state to a higher or more complex state; the historical development of a biological group.

Extinct – when the last living individual of a species dies, causing the species to no longer exist.

Hatchling – a baby sea turtle that just emerged from its shell.

Habitat – a place where a plant or animal naturally lives.

Herbivore – an animal that eats only plants.

Incubate – the process in which eggs develop into hatchlings.

Invertebrate – an animal that is lacking a spinal cord.

Lagoon – an area where fresh water and salt water mix with a weak tidal flow and standing water.

Migration – the act of moving from one place to another.

Natal Beach – a beach where a turtle was born.

Nutrients – minerals that are necessary for healthy plant or animal growth.

Plastron – the ventral or lower portion of the turtle shell.

Poach – to hunt illegally.

Population – organisms that have the same biological characteristics.

Progeny – the offspring of an animal or plant.

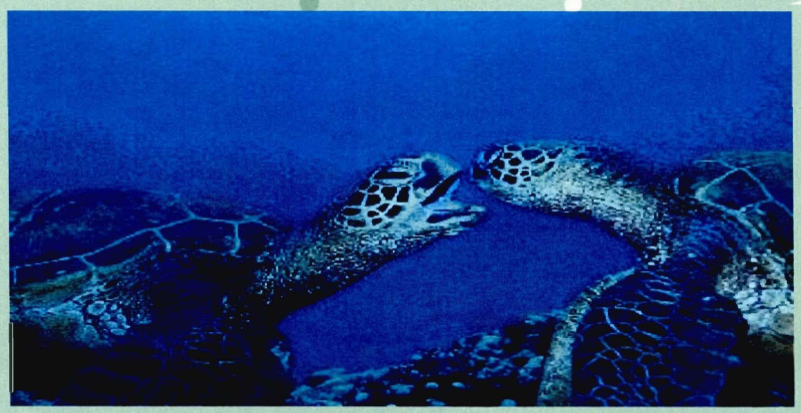
Ramsar Site – a wetland of international importance.

Threatened species – species that have an uncertain chance for survival; likely to become an endangered species.

Scute – the hard scales covering a turtle's shell.

Western Hemisphere – the half of the earth comprising the American continents and surrounding islands and waters.

APPENDIX D: Educational Booklet about Sea Turtles (Spanish)



El Mundo Excitado de las Tortugas Marinas

Un Folleto para los Estudiantes de la Escuela Primaria y la Escuela Secundaría

El Principio

Costa Rica es mundialmente conocida por su gran variedad de especies de plantas y animales. De todas partes del mundo vienen turistas aquí para admirar animales y plantas únicas en el mundo. Costa Rica es especial por ser uno de los pocos países que ha logrado conservar su biodiversidad por medio de un sistema nacional de áreas de conservación. A pesar de los esfuerzos de muchas personas y organizaciones para proteger la vida silvestre, la supervivencia de las diferentes especies se hace cada vez más difícil.

Es importante proteger todas estas plantas y animales porque conservan la biodiversidad y la sostenibilidad de los ecosistemas. Además, son muy importantes también para el país. Un ecosistema es como una comunidad organizada donde cada miembro depende de los otros para sobrevivir. Estos miembros se denominan organismos y viven juntos en el mismo lugar o hábitat. En otras palabras, conviven juntos en el mismo sitio. Los ecosistemas pueden ser de dimensiones variables; por ejemplo, pequeños, como una naranja en descomposición, un árbol, o un humedal. También hay otros más complejos que están compuestos por un número mayor de ecosistemas, como es un bosque lluvioso tropical o vastos e inmensos como el mismo mundo.

Pongamos lo anterior en perspectiva. Tenemos un bosque lluvioso y todo allí, los animales, los pájaros, y las plantas además de los insectos y otros microorganismos que no podemos ver, tales como bacterias, y hongos, pertenecen al mismo ecosistema. ¡Pero eso no es todo! También puede incluirse el clima, que es el resultado de la actividad de la vida de esos animales, plantas y microorganismos.

Si alguno de estos "eslabones" se derrumba, se rompe la cadena. ¿Qué cree usted que sucedería si todos los insectos del bosque desaparecieran? Estaríamos talvez más cómodos. ¿Pero

qué pasaría con los pájaros que se alimentan de estos insectos? No tendrían con qué alimentarse y morirían. *¿Y qué? De por si los pájaros no hacen nada con el bosque,* dirían algunos, *por lo tanto nada pasaría sí ellos desaparecieran.*

Si usted se encuentra con gente así, dígale que lo mismo que los otros animales, los pájaros son importantes porque dispersan las semillas por el bosque y lo reforestan y además aportan desechos orgánicos y nutrientes de las cáscaras de sus huevos.

Ahora usted ya sabe que todos los organismos vivientes, hasta los microorganismos, son importantes. Entonces, avancemos a otro tema.

Una Breve Reseña

¿Sabía usted que las tortugas marinas han existido desde hace más de 150 millones de años? Esto quiere decir que las tortugas marinas vivieron al mismo tiempo que los dinosaurios. Milagrosamente, las tortugas marinas han sobrevivido a través de los cambios evolutivos de la Tierra mientras que los dinosaurios desaparecieron. ¿Se imagina todo el tiempo que han estado en la Tierra? Nada más piense que los seres humanos han existido desde hace quizás 200,000 años. Estos datos cambian constantemente y retroceden los inicios de la humanidad cada vez más y más atrás. ¡Aún así, las tortugas han estado aquí muchísimo antes que nosotros!

Hace mucho tiempo, los indígenas usaron la carne y los huevos de las tortugas marinas principalmente como alimento. A medida que la población humana creció, también lo hizo la popularidad de los productos de las tortugas. No fue sino a finales del Siglo Dieciséis durante la conquista del continente americano que se inició el comercio de productos de tortugas marinas por los europeos y la bella concha de carey se convirtió en un artículo muy popular para confeccionar joyería y adornos. Esto provocó una reducción considerable en las poblaciones de tortugas marinas. Simultáneamente, más y más gente invadió las playas de desove y las aguas donde se alimentaban las

tortugas. Y el resultado ha sido que las tortugas sufrieron al perder sus sitios de desove y alimentación.

Las Tortugas Marinas

Aunque las tortugas marinas pasan la mayor parte de sus vidas en el agua, ellas son reptiles que respiran el oxígeno por medio de sus pulmones. Pueden pasar sumergidas muchas horas y salir a la superficie nada más que para respirar. La gran mayoría de las tortugas marinas prefieren las aguas tropicales y subtropicales. Esto quiere decir que les gusta el clima caliente. Y esto es debido a que la temperatura de su cuerpo depende del ambiente que las rodea, con excepción de las tortugas baula o canal que soportan temperaturas muy frías en las regiones oceánicas cerca de los polos. Hay varias especies de tortugas marinas, pero todas ellas comparten algunos rasgos similares. Por ejemplo, sus cuerpos son aerodinámicos con aletas que les permiten nadar en los océanos con gran pericia y elegancia. ¿Ha tenido la oportunidad de observar a una tortuga marina nadando? Imagínela deslizándose por el agua o merodeando en el fondo del mar en busca de alimento.

Las conchas que cubren su cuerpo se denominan **caparazón** el de arriba y **plastrón** el de abajo y están recubiertos de placas llamadas escudos también. Las únicas tortugas marinas sin escamas en sus conchas son las baula. Las tortugas marinas se pueden identificar por los patrones diferentes de sus conchas y el número de sus escudos.

En vez de dientes para masticar, todas las tortugas marinas ostentan poderosas mandíbulas que utilizan para triturar los alimentos. Las tortugas cotidianamente ingieren algas y hierbas marinas, moluscos, medusas, y esponjas.

Las tortugas no tienen oídos, pero sí tímpanos recubiertos de piel. Su pobre audición es compensada por un agudo sentido del olfato. Tienen excelente visión submarina pero son miopes cuando salen a la playa.

Las tortugas marinas invierten la mayor parte del día alimentándose en el

mar y descansando en el fondo del océano. Sin embargo, las hembras grávidas salen a la playa a desovar. Un dato curioso sobre las tortugas es que regresan a desovar en la misma playa donde nacieron, la que se denomina playa natal. Esa playa natal puede ubicarse miles y miles de kilómetros de distancia de sus sitios de alimentación. Las distancias de sus migraciones son increíbles. Pero es aún más increíble que puedan ubicar la diminuta porción de playa donde nacieron para volver a desovar allí. Nadie conoce, ni siquiera los científicos, cómo es que las tortugas se orientan hacia su playa natal. Sin embargo, algunos científicos creen que las tortugas poseen un sentido especial que les permite orientarse utilizando los campos magnéticos de la tierra. Estos campos magnéticos actúan cual compases que orientan a las tortugas. Pero esta teoría aún no explica completamente la pericia para navegar de las tortugas.

Ciclo de Vida

Comportamiento de Desove

Exceptuando algunas poblaciones de carey, las tortugas marinas se concentran cerca de la costa durante la época del desove. Posteriormente, los machos regresas a mar abierto mientras que las hembras permanecen cerca de la playa. Todas las especies desovan cavando un hueco en la arena para construir un nido para sus huevos y después lo tapan con arena para esconderlo de los depredadores. Dependiendo de la especie, las tortugas marinas desovan entre 100-200 huevos en cada nido. Aunque las hembras desovan repetidas veces durante una misma temporada, algunas especies desovan todos los años mientras que otras lo hacen cada dos o tres años.

Madurando

Dependiendo de la especie, los huevos se incuban durante aproximadamente dos meses. La temperatura de la arena en la playa influencia el desarrollo de los embriones. Aquellos huevos que se

desarrollan en arena más fría, producen más machos, mientras que los huevos incubados en arena más cálida, producen más hembras. Las sombras sobre la playa enfrían la arena y los huevos allí incubados producen más machos.

Tan pronto como los neonatos rompen la cáscara del huevo, salen del nido y corren hacia el rompiente del mar. Las corrientes marinas los transportan a sus sitios de alimentación donde la comida es abundante y escasean los depredadores. Las pequeñas tortugas permanecen allí por meses y hasta años, a veces hasta alcanzar la madurez y regresan entonces a la playa para desovar. Para que una tortuga marina alcance la madurez reproductiva, pueden transcurrir 15 ó hasta 50 años, dependiendo de la especie. Algunos científicos creen que algunas tortugas pueden llegar a vivir más de 100 años.

Las Especies de Costa Rica

Seis especies de tortugas marinas desovan en Costa Rica. Estas son la verde o blanca, la baula o canal, la cabezona, la tortuga negra o tora, la carey y la lora o carpintera.

La Tortuga Verde o Blanca (*Chelonia mydas*)

Las tortugas verde se han llamado así por el color verde de su grasa corporal y no por el color de su caparazón. El caparazón de las hembras adultas mide en promedio algo más de 90 centímetros de largo y las tortugas pueden llegar a pesar hasta 150 kilogramos. Las tortugas juveniles comen gusanos e insectos acuáticos y hierbas y algas marinas. Las tortugas adultas se alimentan solamente de hierbas y algas marinas convirtiéndose en las únicas tortugas estrictamente herbívoras. La mayoría desova en la cuenca del Caribe y la Florida, pero se alimenta en los extensos pastizales de hierbas marinas de los trópicos. El sitio más importante para el desove de las tortugas verde o blanca en el Hemisferio Occidental, es Tortuguero en Costa Rica.

Tortuga Negra o Tora (*Chelonia Mydas agassizi*)

El caparazón de estas tortugas es casi negro, de allí el nombre con que se le conoce. Esta especie se encuentra únicamente en el Pacífico oriental y desova en México, Costa Rica y las islas Galápagos. En esas islas, las tortugas negra encuentran alimento y playas para desovar lo que hace innecesario para ellas migrar largas distancias.

Cabezona
(*Caretta caretta*)

Por el gran tamaño de su cabeza, estas tortugas reciben ese nombre. De adultas pueden llegar a pesar hasta 175 kilogramos y ostentan una coloración café-rojiza en el caparazón y café-amarillento en el plastrón. En su madurez, miden típicamente de 82 a 105 centímetros. Las cabezona se alimentan principalmente de moluscos y crustáceos del lecho marino y usan sus poderosas mandíbulas para triturar los cuerpos rígidos de sus presas. También consumen cangrejos herradura, ostras, almejas y mejillones además de otros invertebrados.

Baula o Canal
(*Dermochelys coriacea*)

La baula o canal es la única tortuga marina que carece de un caparazón rígido. Se conoce con ese nombre debido a su caparazón grande y alargado que consiste de una capa delgada de piel muy fuerte y flexible, artesonada por miles de diminutos huesitos. Siete quillas longitudinales se encuentran a lo largo de su caparazón, que es típicamente negro azulado con manchas blancas. El plastrón también es blancuzco con negro y marcado por las cinco quillas. La baula o canal es la tortuga más grande del mundo. Puede llegar a medir de 1.3 a 1.75 metros y pesar hasta 650 kilogramos. ¡Los científicos han registrado una baula macho con una medida de 2.75 metros de largo! Se encuentra conservada en el Museo de Historia Natural de Gales.

Carey
(*Eretmochelys imbriacata*)

El nombre en inglés de las carey, *Hawksbill*, se refiere a su cabeza que termina en un pico similar al de los halcones. Es una de las tortugas

marinas más pequeñas, y mide de 76 a 91 centímetros con un peso promedio de 40 a 60 kilogramos. Las Carey ostentan una cabeza angosta con quijadas semejantes a un pico. Esto les permite alcanzar alimentos en los intersticios de los arrecifes. Se alimentan de esponjas, anémonas, calamares y camarones. Las carey son las más tropicales de todas las tortugas marinas. Sus sitios preferidos son los arrecifes, las áreas rocosas y las lagunas; esta es la razón de sus famosos escudos de carey, durísimos y resistentes a los golpes y abrasiones. Aunque desovan en muchas playas en la cuenca del Caribe, hoy en día solamente en Australia se congregan en grandes cantidades.

Tortuga Golfina o Carpintera (*Lepidochelys olivacea*)

Se deriva el nombre en latín de las tortugas lora o carpintera del color verde oliva de su caparazón. Pero en Costa Rica se le llama carpintera por el ritual con que concluye el desove, golpeando repetidamente con los lados de su caparazón su nido recién hecho. Sin embargo, también se le conoce como tortuga lora por la forma de pico de su cabeza. La carpintera es una tortuga pequeña que pesa generalmente menos de 50 kilogramos. Omnívoras, se alimentan de crustáceos, moluscos y tunicados. Habitan las bahías tropicales y subtropicales de los océanos Pacífico, Indico y Atlántico. En algunas playas como Nancite y Ostional en Costa Rica, las tortugas lora o carpintera anidan en agregaciones espectaculares conocidas como "arribadas", donde cientos de miles de ellas desovan simultáneamente durante varios días y noches.

Amenazas

Amenazas Naturales

Las tortugas marinas adultas no cuentan con muchos enemigos naturales, siendo el tiburón su más asiduo depredador. Aunque es cierto que las jóvenes tortugas son presa frecuente de los cangrejos y de los pájaros incluso antes de llegar al mar, no son estas criaturas las responsables de la situación de amenaza que sufren

las tortugas. Muchos otros depredadores como zopilotes y mapaches destruyen los nidos para comerse los huevos. Esto ha existido siempre; pero las tortugas marinas se convirtieron en especies amenazadas solamente cuando los primeros europeos llegaron al continente americano y se inició el comercio de productos de tortugas marinas.

Amenazas Antropomórficas

Captura y Saqueo de Huevos

En muchos países que cuentan con playas de desove y sitios de alimentación para las tortugas marinas, es prohibido colectar sus huevos, matarlas o maltratarlas. Debido a que las tortugas marinas tienen aletas, no son aptas para correr sobre la playa. Esto las convierte en presas fáciles para los cazadores que matan a las tortugas en la playa. Los huevos, a su vez, permanecen incubándose sin ninguna protección durante aproximadamente dos meses antes de eclosionar. Debido a que las tortugas son tan vulnerables, es muy fácil cazarlas y muy difícil para los oficiales gubernamentales controlar la matanza.

Las tortugas marinas son perseguidas por diferentes razones, principalmente por su caparazón, su piel, sus huevos y su carne. Se cree que la carne y los huevos de las tortugas marinas son saludables, cuando en realidad contienen más colesterol los huevos de las tortugas que los de gallina. Los pescadores de tortugas usan los escudos de carey para crear valiosas joyas y adornos. Por ejemplo, la captura sin controles de las carey ha resultado en una disminución considerable de sus poblaciones. Quedan tan pocas que la especie ha sido declarada como en grave peligro.

Contaminación

A partir del desarrollo de la tecnología, la contaminación se ha convertido en un problema. Muchas tortugas han muerto como consecuencia de la contaminación del mar por derrames de petróleo, gas, metales pesados, pesticidas y otros químicos vertidos. Estos contaminantes

provocan enfermedades y están diezmando las poblaciones de tortugas marinas, especialmente las tortugas verde o blanca de la Florida y las Hawaii.

La basura en el mar también provoca la muerte de las tortugas que la ingieren confundiéndola con alimento. La basura obstruye sus intestinos impidiendo la digestión lo que resulta en la muerte de las tortugas por inanición. El tipo de basura más común y dañino en los océanos es el plástico. A menudo, las tortugas, principalmente las baula, confunden desechos de globos y plásticos con su alimento favorito, las aguas malas.

Desarrollo Urbano de las Playas e Iluminación Artificial

Generalmente, los neonatos salen del nido durante la noche. Llegan al mar tras el punto más brillante del horizonte que es el reflejo de la luna y las estrellas sobre el agua. Cualquier otra luz artificial sobre la playa o cerca de la misma, puede confundir a las pequeñas tortugas y alejarlas del océano. Consecuentemente, son presa fácil de los depredadores, mueren deshidratadas o arrolladas por vehículos automotores. Las luces artificiales pueden provenir de hoteles, carreteras, rampas de playa o reflectores. Estas fuentes de luz también pueden asustar a las hembras reproductoras e impedir que desoven o se acerquen a la playa.

Otro problema que enfrentan las tortugas es el desarrollo urbano de las playas de desove. A medida que crece el turismo en Costa Rica, es necesario construir más hoteles y crear diferentes actividades recreativas en o cerca de las playas, lo que invade esos sitios de desove. En la medida que una mayor cantidad de personas visita las playas, es imperativo mantenerlas limpias y atractivas. Para lograrlo, en la Florida, por ejemplo, se utiliza equipo pesado y productos químicos para eliminar bacterias peligrosas. Estos químicos pueden penetrar el cascarón de los huevos e interferir con el desarrollo embrionario de los huevos. Además, el equipo pesado destruye los nidos y compacta la arena

atrapando a los neonatos dentro de sus nidos.

Pesquerías

Capturar tortugas marinas es prohibido en muchos países. El problema radica en que las tortugas son a menudo atrapadas incidentalmente en las redes agalleras y de palangre de las pesquerías comerciales. Si una tortuga queda atrapada en un anzuelo de línea larga, le será imposible subir a la superficie a respirar. Son las tortugas baula las que con mayor frecuencia quedan atrapadas, porque en algunos casos su ruta migratoria está invadida por una flota tras otra de las pesquerías agalleras y de palangre. Para evitar la captura incidental de las tortugas, las pesquerías del camarón de los Estados Unidos de América están obligadas a usar el Dispositivo Excluidor de Tortugas (DET), en sus redes, que permite a las tortugas escapar una vez atrapadas y así evitar morir por inmersión. Costa Rica está avanzando en el proceso de colocar DETs en todos los barcos de su flota camaronera.

Lo Que Usted No Debe Hacer

Aunque no sea a propósito, muchas cosas pueden perjudicar a las tortugas marinas. Seguidamente, le indicamos algunas que usted no debe hacer cuando esté cerca de una tortuga.

NO:

- Use focos en la playa. Puede molestar a la tortuga y provocar que ésta abandone la playa sin desovar.
- Tome fotografías con "flash", por la misma razón que las luces en la playa. Las cámaras con "flash" son aún más impactantes que los focos porque su luz es más concentrada y poderosa y provoca una mayor interferencia a las tortugas. Use focos forrados en celofán rojo, que no molesta la vista de la tortuga.
- Se acerque mucho a la tortuga. La puede asustar e impedir el desove. Además, manténgase alejado de su cabeza porque

tortugas con mandíbulas poderosas como las cabezona, lo pueden maltratar severamente.

- Tire o deje basura en la playa, especialmente bolsas plásticas y globos. Estos artículos pueden llegar hasta el océano y ser confundidos como comida por las tortugas.
- Escarbe la arena de la playa. Podría accidentalmente destruir un nido y maltratar sus huevos.
- Traslade los huevos o coloque objetos extraños en el nido. Los objetos podrían estar contaminados con bacterias y hongos y dañar los huevos o los embriones.
- Trate de retener, montar o tocar a las tortugas marinas. Estas actividades, además de ser ilegales, podrían maltratar al animal lo mismo que a usted.
- Interfiera con las huellas de las tortugas. Los científicos las necesitan para determinar cuales especies desovan en la playa.

¿Por qué son Importantes las Tortugas Marinas?

Biodiversidad

La biodiversidad es todos los organismos vivientes de la Tierra y las diferencias que hacen que cada especie sea única. Es importante porque cuando co-existen variedad de especies de plantas y animales, cada uno necesita de los otros para sobrevivir. Las tortugas marinas contribuyen con la biodiversidad porque, entre otros, trasladan nutrientes a las playas. Asimismo, los cascarones de los huevos que quedan en los nidos después que han salido los neonatos, contienen lípidos, proteínas y nitrógeno. Al absorber estos nutrientes, muchas plantas tienen la oportunidad de crecer. Estas plantas son importantes no solamente para la biodiversidad sino también para evitar la erosión de las playas que es un proceso gradual de pérdida de la arena.

Las tortugas marinas cumplen papeles ecológicos importantes en ecosistemas tan diversos como los

arrecifes coralinos y los pastos marinos y también transportan energía entre el mar y hábitat terrestres tales como playas de anidación y sus alrededores Su desaparición podría afectar seriamente a otras especies de flora y fauna que dependen de las tortugas marinas y sus huevos para su propia supervivencia.

Ecosistemas

Las tortugas marinas son importantes también porque forman parte del ecosistema marino. Los científicos creen que los ecosistemas son algo así como una comunidad organizada donde cada miembro de la comunidad depende del otro. Si las tortugas marinas se extinguieran, ello afectaría a otros organismos marinos. Las tortugas marinas son especialmente importantes porque son animales migratorios y por ello su impacto es global. Si se extinguieran, los ecosistemas del mundo entero se verían afectados.

Por ejemplo, las tortugas verde o blanca son uno de los pocos animales que se alimentan de pastos marinos, mencionados anteriormente. Pastan, podando la vegetación y ayudando así a mantener saludables los lechos de pastos marinos. Como cada vez hay menos y menos tortugas, los lechos de pastos marinos permanecen sin podar ocasionando un desarrollo sin control que afecta el ecosistema. Los lechos de pastos marinas son importantes porque sirven de hábitat para muchas otras especies de peces, moluscos y crustáceos que se alimentan allí.

Las baula constituyen otro ejemplo. Al ser uno de los pocos depredadores de medusas (junto con el pez Mola mola), su disminución en los océanos provoca el aumento de éstas generando problemas para otros organismos menores que a la vez son el alimento de animales marinos mayores.

Áreas de Conservación en Costa Rica

Es importante proteger a las tortugas marinas en Costa Rica porque es el sitio de reproducción de seis especies de ellas y aquí se encuentran algunas de las playas de desove más importantes del mundo. Para

protegerlas, se han creado varios parques nacionales marinos en el país. Los cuatro más significativos son Las Baulas y Santa Rosa en el Pacífico y Tortuguero y Cahuita en el Caribe. Los Refugios Nacionales de Vida Silvestre que protegen poblaciones de tortugas marinas son Gandoca-Manzanillo en el Caribe y Ostional y Playa Hermosa en el Pacífico. Además, dos reservas privadas han sido creadas en el Caribe de Costa Rica para proteger a las tortugas baula o canal.

Aún sin una declaratoria de área silvestre protegida, existen elementos legales para realizar la protección de los nidos en las playas costarricenses. Ejemplo de lo anterior, proyectos muy interesantes se desarrollan en distintas partes del país, como en Parismina en el Caribe y punta Banco en el Pacífico, donde se protege a las tortugas marinas que desovan allí, trasladando sus huevos a viveros protegidos.

Parques Nacionales

Las Baulas

El Parque Marino Las Baulas de Guanacaste está ubicado en la costa Pacífica de Costa Rica, aproximadamente a 100 kilómetros de la frontera con Nicaragua. Incluye Playa Grande, Ventanas y Playa Langosta y una porción marina en la bahía de Tamarindo. Asimismo, los manglares que se ubican dentro de este territorio forman parte del área protegida, y fueron declarados como Sito Ramsar en 1993. El parque fue desarrollado y diseñado por el Ministerio del Ambiente y Energía (MINAE), y ha estado bajo su control desde su creación en 1991. Entonces, la población de baula desovando en estas playas representaba la tercera más importante mundialmente. Tristemente, desde entonces esa población ha colapsado como resultado directo de la extracción masiva de huevos durante la década de los años 1980s y anteriormente, además de la muerte incidental de miles de baulas en las redes de línea larga y

agalleras que invaden su ruta migratoria en el Pacífico sur.

Nadie está autorizado a entrar al parque sin la compañía de un guía especialmente entrenado, particularmente durante la noche en la temporada cuando desovan las tortugas.

Santa Rosa

Otro importante parque nacional en Costa Rica es Santa Rosa. También está ubicado en Guanacaste en el noroeste del país. Santa Rosa es uno de los parques más importantes pues protege 115 especies de mamíferos, 253 especies de aves, 100 especies de reptiles y 3,000 especies de mariposas y polillas del bosque seco.

Este parque incluye las playas Naranjo y Nancite, ambas importantes sitios de desove para las tortugas golfina o carpintera, las baula o canal y las negra o tora. Es en Nancite donde las tortugas lora o carpintera también se congregan en espectaculares "arribadas."

Tortuguero

El sitio más importante del hemisferio occidental para el desove de las tortugas verde o blanca, es en las playas de arenas negras del Parque Nacional Tortuguero. Esta área silvestre protegida es parte integral del Sitio Ramsar, denominado Caribe Noroeste.

El parque incluye 19,000 hectáreas (46,900 acres), y protege 35 kilómetros de playa donde desovan tortugas cabezona, carey, baula o canal y verde o blanca, lo que la hace importante para más de una especie. Este parque, debido al abundante desove de las tortugas verde o blanca en sus playas protegidas, es la razón para mantener una población viable de tortugas verde o blanca, la más importante del hemisferio occidental.

Cahuita

Este pequeño parque nacional fue creado para proteger el arrecife coralino más importante de Costa Rica, donde tortugas carey y verde o blanca se alimentan en sus lechos de pastos marinas y en sus arrecifes. La salud de

este arrecife está comprometida debido a los cambios climáticos, a la sedimentación y al alzamiento del arrecife provocado por el terremoto de 1991. En los últimos años, se ha descubierto que la mayor población de tortugas carey de Costa Rica, anida en esta área protegida.

Refugios Nacionales de Vida Silvestre

Ostional

Ubicado en la costa Pacífica de la Península de Nicoya, Ostional es conocida mundialmente por las "arribadas" de tortugas carpintera o golfina, que algunas veces suman cientos de miles de individuos. Esta situación provoca que la playa Ostional esté tan contaminada con materia orgánica proveniente de los huevos destruidos por las mismas tortugas, que bacterias, hongos y virus destruyen la mayoría de los huevos y solamente un pequeño porcentaje logra desarrollarse.

Una asociación comunitaria está autorizada por el MINAE a recolectar un porcentaje importante de los huevos de las "arribadas", convirtiendo a este proyecto en uno de los más interesantes ejemplos a nivel mundial de desarrollo sostenible. Los pobladores viven de la venta de los huevos de las tortugas pero al mismo tiempo sirven los intereses de las tortugas limpiando la playa de materia orgánica excesiva que de otra manera contaminaría la playa aún más.

Playa Hermosa

Una cantidad significativa de tortugas lora o carpintera anidando solitariamente, inspiró a los pobladores de esta bellísima playa a buscar protección legal para ella. Oficiales gubernamentales con la ayuda de voluntarios locales e internacionales protegen la playa y trasladan los huevos a un criadero protegido.

Gandoca-Manzanillo

Este refugio básicamente protege los mismos ecosistemas, marino y terrestre, que el Parque Nacional Cahuita. En su parte marina, incluye un importante arrecife de coral, donde en los últimos años se han realizado una serie de importantes hallazgos

científicos. Todo el área está declarada como Sitio Ramsar. En el Refugio se desarrolla un programa de protección de las playas en época de desove, el cual ha sido liderado por ANAI desde hace varios años en coordinación con el MINAE. Sus amplias playas negras y su importante laguna, al igual que el sistema de humedales de San-san en Bocas del Toro en Panamá, forman parte de un ecosistema más amplio compuesto por la cuenca baja del río Sixaola, donde desovan números significativos de tortugas baula y algunas carey y verde o blanca.

Reservas Privadas y Otros Proyectos

Reserva Pacuare y Estación Las Tortugas

Nueve kilómetros de playa para el desove de las tortugas baula están bajo la protección de estas dos reservas privadas. La Reserva Pacuare cuida seis kilómetros y la Estación Las Tortugas tres, donde también desovan las carey, las tortugas verde o blanca y ocasionalmente las cabezona.

Península de Osa

Varias playas de mediano tamaño pero aptas para el desove de tortugas marinas, principalmente carpinteras o loras, se ubican en la Península de Osa, cerca del Parque Nacional Corcovado. Actualmente, en tres de ellas, Carate, Río Oro y Peje Perro, se realizan proyectos de protección y biometría de las tortugas conjuntamente con pobladores locales.

Parismina

La Policía Naval tiene a su cargo el patrullaje de las tortugas marinas a lo largo de las costas costarricenses. Hace un tiempo sus efectivos iniciaron un vivero con los huevos decomisados. El proyecto ha evolucionado y hoy en día lo manejan conjuntamente la comunidad de Parismina y la Policía Naval, que cuenta con biólogos entrenados y profesa un profundo compromiso por las tortugas.

Punta Banco

Ubicada en la cara costarricense de Punta Burica cerca del Golfo Dulce

en el Pacífico suroeste, en Punta Banco se protege el desove solitario de tortugas carpintera o lora. Es único en Costa Rica ya que está administrado conjuntamente por los indígenas Guaymí y PRETOMA, organización que lo coordina.

Las Organizaciones de Costa Rica

Ministerio del Ambiente y Energía (MINAE)

MINAE es una institución gubernamental, rectora de los asuntos ambientales. Incluidas en sus responsabilidades está la administración de los parques nacionales y los refugios nacionales de vida silvestre, además de las otras áreas protegidas y la conservación de la biodiversidad.

Ministerio de Seguridad Pública

Es responsable de la seguridad del país y controla los cuerpos de policía civil y naval. Estos últimos se desplazan en los litorales y mares patrimoniales de Costa Rica y durante las temporadas de desove de las tortugas marinas patrullan esas playas en el Caribe y el Pacífico.

Asociación ANAI

ANAI es una organización sin fines de lucro dedicada a la conservación de plantas y animales. ANAI enfoca su trabajo en la Baja Talamanca, un sitio clave para la biodiversidad del Refugio Nacional de Vida Silvestre Gandoca Manzanillo, en el sureste de Costa Rica. En sus playas desovan cuatro especies de tortugas marinas, principalmente las baula. Conjuntamente con los pobladores, los biólogos de ANAI, además de voluntarios locales e internacionales, trasladan los huevos a viveros protegidos. Recientemente ANAI se ha abocado a luchar con la erosión de esas playas para rescatar las playas de desove.

Caribbean Conservation Corporation (CCC)

La CCC es una organización internacional fundada en 1959. Su misión es proteger a las tortugas marinas y su hábitat. El punto medular de su investigación consiste en su programa de marcación y monitoreo, el cual ha rendido datos espectaculares respecto a las tortugas marinas. En

realidad, mucho de lo que hoy en día se sabe sobre ellas es el resultado de ese programa.

Estación Las Tortugas

Creada para proteger tres kilómetro de playas fundamentales para el desove de las tortugas baula en Pacuare, en el Caribe de Costa Rica, es la primera reserva de tortugas marinas creada por una familia costarricense. Más de dos docenas de los miembros de este grupo se dedican a monitorear y proteger a las tortugas baula y trasladar los huevos en riesgo a un vivero protegido, bajo la supervisión de biólogos profesionales. La familia es responsable de preparar las más deliciosas comidas y brindar los servicios a los grupos de jóvenes voluntarios, principalmente provenientes de los Estados Unidos de América, que llegan a la Estación con la empresa EcoTeach. Los fondos generados por esa visitación representan un aporte fundamental para el éxito económico de este programa. En el presente, un pequeño museo de tortugas está construyéndose en la Estacón.

Endangered Wildlife Trust

Contiguo a la Estación Las Tortugas, la Endangered Wildlife Trust mantiene la Reserva Pacuare de 800 hectáreas de humedales, creada en 1989 para proteger fundamentalmente nueve kilómetros de playas de desove para las tortugas marinas, especialmente las baula. Allí desovan también las tortugas verde o blanca, las carey y ocasionalmente las cabezona. El programa Ecology Project Internacional (EPI), transporta voluntarios de los colegios públicos y privados costarricenses lo mismo que de los Estados Unidos de América, para realizar proyectos de investigación sobre la biometría de las tortugas, bajo la supervisión de biólogos residentes. Cada año, EPI organiza un Simposio Estudiantil Anual, donde los estudiantes que han participado en el proyecto montan una exhibición de afiches sobre sus investigaciones.

Se ha constatado que la misma población de tortugas baula que desova en el Caribe de Costa Rica, es sacrificada en las playas panameñas donde desovan en grandes cantidades. Por ello, la Endangered Wildlife Trust ha establecido una nueva estación en la playa de Soropta, para iniciar la protección de las baulas en Panamá.

PRETOMA

Sin tregua y durante muchos años PRETOMA ha liderado el esfuerzo costarricense para que todas las embarcaciones de la flota camaronera nacional coloquen los DETs (excluidores de tortugas marinas). Como las condiciones oceánicas costarricenses son muy diferentes a las del Golfo de México, donde se usaron los DETs por primera vez, PRETOMA ha creado un nuevo dispositivo que lleva el nombre de TICO TED (su acrónimo en inglés). Básicamente el TICO TED presenta mayores espacios entre las barras, lo que impide se obstruya con basura de deriva, principalmente los grandes troncos que en abundancia flotan en el ambiente marino costarricense.

Conjuntamente con la población indígena Guaymì, Pretoma administra el proyecto de protección de las tortugas marinas golfina o carpintera que desovan solitariamente en Punta Banco de Punta Burica, en el suroeste de Costa Rica. Además, ha iniciado un gran esfuerzo internacional para evitar la total destrucción de los tiburones en aguas costarricenses, que al igual que las tortugas son especies longevas de lento crecimiento, igual al factor de crecimiento k.

Salvamento Internacional de la Tortuga Marina

De reciente creación, esta fundación costarricense realiza proyectos de protección y biométricos en las playas de la Península de Osa, Carate, Río Oro y Peje Perro. Entre las tres, alcanzan una extensión de más de 8 kilómetros.

Aunque la inmensa mayoría de los aproximadamente 1,000 nidos de tortugas marinas que se registran en

una temporada pertenece a las tortugas lora o carpintera, también desovan allí las baula y las negra o tora.

Colaboración Internacional

La mayoría de las tortugas marinas que habitan los océanos de los continentes americanos, desovan en un país pero se alimentan en otro. Consecuentemente, los gobiernos de doce países del continente americano han unido sus esfuerzos para coordinar de la mejor manera la protección y conservación de las tortugas. La Convención Interamericana para la Protección y Conservación de las Tortugas Marinas, está integrada actualmente por un grupo de gobiernos que intenta aprobar legislación internacional para proteger a las tortugas marinas durante todos sus ciclos de vida. La Convención Interamericana brinda protección a las tortugas marinas lo mismo en sus hábitat marino que continental.

La idea detrás de este objetivo es que no importa cuanto se esfuerce un país determinado por proteger sus tortugas en las playas, si otros las están destruyendo e impactando sus poblaciones en aguas internacionales por la pesca incidental, por ejemplo, todos esos esfuerzos serían esencialmente inútiles.

Cómo Puede Usted Ayudar

Si escucha a alguien decir que alguna planta o animal no es importante, cuéntele a esa persona lo que usted ha aprendido de este librito.

Cuéntele a la gente lo importantes que son las tortugas marinas para Costa Rica, para el mundo y también para usted.

Si se encuentra en una playa de desove y se percata de alguien que está molestando a una tortuga o tratando de robarle los huevos, llame inmediatamente a un guarda.

Cuéntele a sus amistades y a sus familiares que no deben dejar basura tirada en las playas y que deben especialmente evitar los globos desechados.

Si usted encuentra una tortuga herida, no se aleje indiferentemente. Busque a alguien entrenado que lo pueda ayudar. JAMAS intente moverla

usted solo o hacer cualquier cosa para la que usted no está entrenado. De esa forma puede maltratar aún más a la tortuga y a usted mismo. Cuéntele a sus amistades todo lo que usted sabe sobre las tortugas marinas y las diferentes organizaciones que tratan de ayudarles. Quizás tengan interés en ser voluntarios en alguno de los proyectos de conservación de tortugas marinas.

Esté atento a su comportamiento en las playas que podrían ser sitios de desove para las tortugas marinas.

Glosario

Biodiversidad – todos los seres vivos sobre la Tierra y las diferencias que hacen únicas a las especies.

Caparazón – la porción dorsal de la concha de una tortuga.

Cuenca – un área de agua cerrada o parcialmente cerrada.

Ecosistema – una comunidad organizada donde cada miembro depende de los otros.

Embrión – un animal en cualquier fase del desarrollo antes de nacer.

Erosión – la pérdida de arena de una playa a través de un proceso gradual.

Escudo – las escamas duras que cubren el caparazón de una tortuga.

Escudo – las escamas duras que cubren el caparazón de una tortuga.

Especie amenazada – una especie u organismo amenazada de extinción.

Evolución – un proceso continuo de cambio de sencillo o peor a un estado superior o complejo; el desarrollo histórico de un grupo biológico.

Extinto – cuando el último individuo de una especie muere, provocando la no existencia de esa especie.

Hábitat – sitio donde vive una planta o un animal.

Hemisferio occidental – la mitad de la Tierra que incluye el continente norteamericano y las islas y océanos asociados.

Herbívoro – un animal que solamente come plantas.

Huevero – coger huevos ilegalmente.

Incubar – el proceso que convierte a los huevos en pequeñas tortugas.

Invertebrado – un animal que carece de espina dorsal.

Laguna – un área donde se mezclan agua dulce y agua salada y exhibe un proceso débil de mareas.

Medio ambiente – todos los factores físicos, químicos y biológicos (como el clima, el suelo y los seres vivos), que rodean a un organismo.

Migración – el acto de trasladarse de un lugar a otro.

Nutriente – minerales necesarios para la salud de un animal o una planta.

Pequeña tortuga – una tortuga bebé recién salida del huevo.

Plastrón – la porción ventral de una tortuga recubierta de hueso..

Playa natal – la playa de nacimiento de una tortuga.

Población – organismos que comparten las mismas características biológicas.

Progenie – la descendencia de un animal o una planta.

Sitio Ramsar – humedales de importancia mundial.

APPENDIX E: Annotated Bibliography of Sources Cited in This Work

Annotated Bibliography of Sources Used to Create Educational Booklet
Sea Turtles and Their Conservation in the U.S. and Costa Rica

Websites

Archie Carr Center for Sea Turtle Research

http://accstr.ufl.edu/

Official Archie Carr Center for Sea Turtle Research website provides information about the organization, history of its foundation, conservational and educational programs, ACCSTR resources, and information about the research conducted by people working for the organization. Research focuses on all aspects of the biology of sea turtles, training graduate students, and furthers sea turtle conservation through the communication of the research results to the scientific community, management agencies, and conservation organizations throughout the world.

Asociación ANAI

http://www.anaicr.org/

This website is the official website for Asociación ANAI which is a Costa Rican based research organization. This website provides information about the research the organization is conducting along with background information about sea turtles and deforestation. This site is a helpful introduction to the former topics, but it does not go into depth about the information. There is also volunteer information provided in this webpage for anyone interested in the projects that the organization conducts.

Caribbean Conservation Corporation

http://www.cccturtle.org

Caribbean Conservation Corporation (CCC) website is a good source of information about sea turtle events around the world and for research news from different countries. Here one can find information about the sea turtle conservation, research on related marine and coastal wildlife, training, advocacy, education, and protection of natural areas. It also has an abundance of educational material that can be used by both teachers and those who just wish to learn more about sea turtles.

http://cccturtle.org/species_world.htm

This site is useful for finding general descriptive information about sea turtles that nest in the U.S. The website includes the outlook of seven sea turtle species, their habitat, migratory and nesting behavior as well as information on their biology, and life cycle. It also has links to migratory maps and important nesting sites for all species throughout the world.

http://www.cccturtle.org/cccwelc.htm
This webpage is dedicated to the Caribbean Conservation Corporation organization; its goals, objectives, and overall mission statement. It also includes the history of CCC foundation, information on its research, including the links to the websites of particular projects, education and training.

http://www.cccturtle.org/news.htm
This website includes the earliest and most recent publications about sea turtles and their conservation, as well as facts about recent states of sea turtles, problems, and new threats they are facing. The information is not limited to the United States, articles come from sources all around the world.

http://www.cccturtle.org/overview.htm
Another useful section of the CCC web page, it is useful for those who are looking for more descriptive information about sea turtles. "An Introduction to Sea Turtles" contains general information about sea turtles, their description, habitat, growth and development, impacts of humans on their population, status of different species as well as a descriptive definition of extinction. This section also includes information about how people can help.

http://www.cccturtle.org/program1.htm
This webpage contains information about research and programs that CCC leads in Tortuguero National Park, Costa Rica The web page contains a description of the National Park, information on the project, the goals and objectives of the project, what has been completed, as well as a collection of photographs, results, and volunteer information.

http://www.cccturtle.org/velador.htm
This section of CCC website features articles that have been published in the *Velador*, the official Newsletter of the Caribbean Conservation Corporation The newsletter is issued quarterly, and is also distributed to CCC members. The articles generally describe news about events and research that the CCC recently conducted throughout the world. This website is useful for collecting information on the latest news in sea turtle research and the community.

Costa Rica Online

http://ourworld.compuserve.com/homepages/costarica/parkmain.htm
This website contains the links to the information about all the National Parks in Costa Rica. Each link leads to a different page with descriptive information of a particular park. It also includes some brief information on the location of a particular park, its size, characteristics, fauna, flora, economical and ecological importance of the park, and contact information. This website can be found through Costa Rica Online website:
http://ourworld.compuserve.com/homepages/costarica/cro_main.htm .

Another section of National Marine Fisheries Service website is Sustainable fisheries, including protected resources, habitat conservation, new technology used in conservation programs, law enforcement.

http://www.nmfs.noaa.gov/prot_res/
This is the official website of NOAA Fisheries Office of Protected Resources. The site provides a wide range of information relevant to all marine species that are designated as threatened or endangered within the U.S. It also contains wide range of information about conservation programs and preservation strategies of these species, including articles and publications on the topic as well as links to the official government documents and reports from researchers' fieldwork.

http://www.nmfs.noaa.gov/prot_res/PR3/Turtles/TEDS.html
This webpage includes a description and the usage of Turtle Excluder Devices (TED) in the U.S. as well as regulations for its utilization and links to documents and webpages with wider explanation of the need to use TEDs and other information relevant to the topic. It also contains links to information about marine endangered species conservation, marine biodiversity, international activities on protection of marine endangered species as well as economic and environmental cooperation.

http://www.nmfs.noaa.gov/prot_res/PR3/Turtles/turtles.html
This section of the NMFS/NOAA website contains links to different sources about sea turtles, protection and conservation of the species in the U.S. This site also includes links to other directories with species information, turtle conservation, sea turtle regulatory actions in the U.S., reports and publications of NOAA, and links to other organizations that work with sea turtles. It also contains links to information about other endangered marine species, coral reefs biodiversity, marine mammals' conservation programs, report and publications on topic.

SEA TURTLE.ORG

http://www.seaturtle.org
This website is a sea turtle information resource that contains links to turtle journals, image library, links to the websites with research information and project description. It also has a discussion board and e-mail service for those who would like to share sea turtle news with colleagues and others who are interested in sea turtles. It contains links to the newsletter, Symposium, bookstore, resources, image library, list of articles, discussion forums, turtle directory, helping sea turtle information.

Broward County Sea Turtle Program

http://www.co.broward.fl.us/bri00600.htm#Sea

The website for the Broward County Sea Turtle Program includes species descriptions of all nesting turtles in the U.S., including their nesting behavior, migratory patterns, and biology. It also includes information about the projects and their progress.

Sea World

http://www.seaworld.org

This website is a useful source of sea turtle information for teachers and educators. It contains the animal resources with description of different marine animals, biodiversity directory, articles about recent research and projects, teacher resources and guides, educational programs, career information, and others. Educational material can be also purchased here. The website can be very interesting for children since it has a lot of games and other entertainment activities.

http://www.seaworld.org/infobooks/SeaTurtle/home.htm

Sea World provides public with general information about all marine species, including the physical characteristics, nesting habits, behavior, diet, and natural history of sea turtles. The information is quick and easy to reference if anyone needs a quick fact about sea turtles or any other marine animal.

***Earth Trust**

http://earthtrust.org/wicurric/turtles.html

Earth Trust provides descriptive information about green sea turtles. Here one can learn about their biology, diet, and reproductive patterns. There is also detailed information that includes green turtle natural history and factors that are affecting their population.

***Euro Turtle**

http://tofino.ex.ac.uk

Euro Turtle promotes conservation and education about sea turtles in the Mediterranean The site includes species accounts, identification keys, biology, and a photo gallery. There are also games on the site that children can use as well as animated photos of a turtles' skeletal structure.

***Sea Turtle Incorporation**

http://seaturtleinc.com

This website contains information about organization, its goals and mission statement, news about sea turtles, turtle pictures show and shop.

http://seaturtleinc.com/turtles.html

Sea Turtle, Inc. focuses on education and research of sea turtles. They have a rehabilitation center located in South Padre Island, Texas, U.S.A. The site

includes species descriptions of the turtles that nest in Texas as well as research information that the center conducts.

***Starfish**

http://www.starfish.ch

The Starfish website is a German website for kids (educational info), in contains information about the reef life, collection of over 950 pictures, links to other websites about marine life.

http://www.starfish.ch/reef/reptiles.html

This website offers a description of different species of marine turtles. The page includes illustrations of turtles and links to photos. The information found on this site can be found at any other site, but the photos are interesting. This site also includes information about sea snakes.

U.S. Department of State

http://www.state.gov/r/pa/ei/bgn/2019.htm

This is the official website of the U.S. Department of State. The site contains official information about Costa Rica, its geography, population, government information and history review, political conditions, economy status, foreign politics and relationships between Costa Rica and the U.S. as well as travel and business information. The website also contains links to other resources that are useful in finding more information about the country and its international relationships with other nations.

Articles

* **Bacon, P., Berry, F., Bjorndal, K., Hirth, H., Ogren, L., Weber, M. (1983, July). Proceedings of the Western Atlantic Turtle Symposium. Symposium on Sea Turtle Research of the Western Atlantic (Populations and Socioeconomics), 17-22, San Jose, Costa Rica. Volume 1. Western Atlantic Turtle Symp. San Jose (Costa Rica). Miami, FL: Univ. of Miami Press.**

Following details of the inaugural speeches and list of participants, program activities discussed at the Symposium are outlined. Panel sessions covering individual species of turtles, research techniques and planning, habitat alteration impacts, utilization, conservation, culture, enforcement and regulations, status of species, and management options are detailed.

Baker, K. P. (2000). Studies in behavioral and physiological conservation: I. Evidence for phonotaxis in leatherbacks and geomagnetic orientation in olive ridley sea turtle hatchlings; II. Water relations in eggs and growth of the *scheltopusik* limbless lizard. Unpublished M.A. thesis, State University of New York College at Buffalo, Buffalo.

The beach environment determines the suitability of sea turtle nesting areas and provides both visual and non-visual sea finding cues to emerging hatchlings. Artificial beach lighting, beach development, and human activity on the beach may affect the sea finding ability of hatchlings and have important management implications for sea turtle conservation strategies. Phonotaxis in endangered leatherback and olive ridley sea turtle hatchlings was studied to determine whether hatchlings could localize and discriminate among airborne surf sounds and those of a pure tone, highway traffic, and music sounds which could pose conflicting cues in sea-finding behavior. Leatherback and olive ridley hatchlings were collected from nests during January and February 1998, and tested within experimental sound arenas 1.5 km from Playa Grande in Las Baulas de Guanacaste National Park, Costa Rica. Results showed leatherback hatchlings exhibited positive phonotaxis towards surf sounds. Surf sounds were then tested with a 10 degree slope as a conflicting cue. Leatherback hatchlings oriented down a 10 degree slope more than towards surf sounds when confronted with conflicting cues. Olive ridley hatchlings did not exhibit phonotaxis to surf sounds in total darkness, but rather exhibited geotaxis, crawling in a southwesterly compass direction with or without sound present.

*Bjorndal, K. A. (1980). **Demography of the breeding population of the green turtle, Chelonia mydas, at Tortuguero, Costa Rica.** ***Copeia*** **3, 525-530.**

Life history parameters are presented for 14 cohorts of adult female C. mydas, tagged at Tortuguero. Survivorship, instantaneous death rate and net reproductive rate are calculated for each of the cohorts. Adult survivorship between breeding seasons is low due to human exploitation. This reduced survivorship greatly decreases the net rate of reproduction. The effect of reduced survivorship and net rate of reproduction on population stability and the survival outlook for the Tortuguero colony is discussed.

*Bjorndal, K. A., Carr, A., Meylan, A. B., Mortimer, J. A. (1985). **Reproductive Biology of the Hawksbill *Eretmochelys Imbricata* at Tortuguero, Costa Rica with Notes on the Ecology of the Species in the Caribbean.** ***Biol. Conserv.*** **34, 4, 353-368.**

From 1955 through 1983, 246 hawksbills *Eretmochelys imbricata* have been tagged as they came ashore to nest at Tortuguero, Costa Rica, a beach they share with a large colony of green turtles Chelonia mydas. Nesting hawksbills average 82 cm in straight carapace length and grow at a mean rate of 0.3 cm year-1. Mean clutch size is 158 eggs; clutch size is poorly correlated with female body size. Average time from egg deposition to hatchling emergence is 58.5 days. Mean emergence success of hatchlings is 58.3% in all clutches and 91.6% in clutches that produced hatchlings. The internesting interval averaged between 16 and 17 days. Site- fixity of females both within and between seasons was examined; a greater degree of site-fixity was exhibited between seasons than within. The distribution of hawksbill nesting activity at Tortuguero is spatially similar to, but temporally different from, that of the green turtle. There is increasing evidence form tag returns that the Tortuguero hawksbill may also share the feeding grounds of the Tortuguero green turtle in the Miskito Cays, Nicaragua. Notes on the movements and feeding habits of juveniles on their feeding grounds are included. Following a decline from 1956, there has been no consistent trend in the number of hawksbills nesting at Tortuguero since 1972. However, the mean carapace length of hawksbills has shown a steady decline, suggesting that the population is not demographically stable. The stability of an entire population cannot be determined from monitoring the number of nesting turtles each year.

* **Bjorndal, K. A., Wetherall, J. A., Bolten, A. B., Mortimer, J. A. (1999). Twenty-six years of green turtle nesting at Tortuguero, Costa Rica: an encouraging trend**
***Conservation Biology*, 13, 1, 126-134.**

The green turtle (Chelonia mydas) population that nests at Tortuguero, Costa Rica, is the largest in the Atlantic by at least an order of magnitude. Surveys to monitor the nesting activity on the northern 18 km of the 36-km beach were initiated in 1971 and extended to the entire beach in 1986. Front the survey data, we estimated the total number of nesting emergences on the northern 18 km for each year from 1971 through 1996. Evaluation of the trend in nesting emergences indicated a relatively consistent increase from 1971 to the mid-1980s, constant or perhaps decreasing nesting during the late 1980s, and then resumption of an upward trend in the 1990s. Evaluation of trends in sea turtle nesting populations requires many years of data because of the large degree of annual variation in nesting numbers The trends reported in this study must be evaluated with caution for several reasons. First, if the mean number of nests deposited by each female each year (clutch frequency) varies significantly among years, changes in the number of nesting emergences among years could reflect changes in the number of nesting females, clutch frequency, or both. Second, we only assessed the trend in one segment of the population (mature females), which may or may not represent the trend of the entire green turtle population and which, because of late maturity, may not reflect changes in juvenile mortality for many years. Third, survey frequency, and thus confidence in annual estimates varied among years. The upward population trend must be assessed from the perspective of the catastrophic decline that the Caribbean green turtle populations have experienced since the arrival of Europeans. If careful management is continued in Costa Rica and adopted throughout the region, the collapse of the Caribbean green turtle populations-which seemed imminent in the 1950s-can be avoided.

* **Campbell, L. M. (1998). Use them or lose them? Conservation and the consumptive use of marine turtle eggs at Ostional, Costa Rica.**
***Environmental Conservation*, 25, 4, 305-319.**

'Sustainable use' of wildlife resources and 'community based conservation' are two themes recurrent in contemporary statements of wildlife conservation policy and their use is in response to the 'deep conservation crisis' which has in part arisen from exclusionary and restrictive conservation practices. The extent to which the legal harvest of marine turtle eggs in Ostional, Costa Rica, is an example of sustainable use and community based conservation is evaluated in this paper. Field research using in-depth interviewing and a household questionnaire was undertaken in Ostional during 1994 and 1995, to investigate local perceptions of the egg harvesting project, both positive and negative. Socio-economic benefits from, and legal and administrative structures supporting, the project were found fundamental to community support for a limited egg harvest and allowed for

community participation in, and control of, resource use. Participation and control were key to local support for conservation of nesting marine turtles and their eggs. Attempts to use wildlife sustainably must be considered on a case by case basis, to account for the biological nature of the wildlife resource and environment in question and for local socio-economic, political, and historical conditions. Nevertheless, some of the lessons learned from the attempt to implement sustainable use and community based conservation in Ostional may be more widely generalized, and may help inform other efforts to reconcile wildlife conservation objectives with local development needs.

*Chacon, D., McLarney, W., Ampie, C., Venegas, B. (1996). **Reproduction and conservation of the leatherback turtle *Dermochelys coriacea* (Testudines: Dermochelyidae) in Gandoca, Costa Rica. *Revista de Biologia Tropical*, 44, 2B, 853-860**

The leatherback turtle was studied in Gandoca, an important nesting beach on the southeastern Caribbean coast of **Costa Rica** (82 degree 37' W; 09 degree 37' N). In 1994, a total of 530 nests were recorded during the nesting season (February/July) and 160 leatherbacks were tagged; five were remigrants from the 1992 season and 15 carried tags from elsewhere. Eighty eight females only nested once. Mean curve carapace measurements were length 153.8 cm and width 112.0 cm. A hatchery received 82 clutches, with 6277 normal eggs. Their mean incubation period was 62.24 days (range: 56-68 days). Average hatching rate was 55.10% (S.D.: 25.04, range 15-96%). Extensive erosion, beach debris and poaching activity represent the main hazards for nesting in Gandoca.

*Chaverri, D. C. (1999). ***Dermochelys coriacea* (Testudines: Dermochelyidae) nesting in Playa Gandoca, Costa Rica (1990 through 1997). *Revista de Biología Tropical*, 47 (1-2), 225-236.**

The nesting of the leatherback sea turtle was studied in Gandoca Beach, an important nesting beach on the southeastern Caribbean coast of Costa Rica, in the Gandoca/Manzanillo National Wildlife Refuge. Nesting was recorded from 1990 to 1997 (each February through July). Nearing peaked in April and May (depending on the year); 16 biological parameters were recorded and part of the rookery was tagged. During this period 1 045 females were studied and 3 484 nests were recorded; 534 nests was the yearly mean, (range 226-1 135), 20.8 % of the nests were relocated to hatcheries, as a conservation effort to prevent loss of nears. Mean curve carapace length was 154.65 cm and width 112.83 cm. Mean normal number of eggs/nest was 79.28 and 35 yolkless. Each turtle laid an average of 2.5 nests per season with an internesting interval of 9 days. In 1997, 39% of the nesting females had been previously tagged in Gandoca Beach and a few also in Colombia (Uraba Gulf), Pacuare and Tortuguero (Costa Rica). Poaching activity, beach: debris and extensive erosion represent the main hazards that are leading to a decline of the sea turtles in Gandoca.

*Chevalier, J., Godfrey, M. H., Girondot, M. (1999). **Significant difference of temperature-dependent sex determination between French Guiana (Atlantic) and Playa Grande (Costa Rica, Pacific) leatherbacks (Dermochelys coriacea).** ***Annales des Sciences Naturelles*** **20, 4, 147-152.**

Temperature-dependent sex determination has been recently characterized for leatherbacks (Dermochelys coriacea) from Playa Grande, on the Pacific coast of Costa Rica. The authors concluded that the pattern of TSD in leatherbacks from Pacific Costal pica is the same as for leatherbacks from French Guiana, in the Atlantic. However, no statistical tests were performed to validate their conclusion. Here, we use a maximum-likelihood test to look for a possible difference between the populations. We found that the pattern of temperature- dependent sex determination in Atlantic and Pacific leatherbacks was significantly different. The temperature producing 50% of each sex was not significantly different in both groups, but the range of temperatures producing both sexes was significantly narrower for the French Guiana population. We hypothesize that this difference could reflect a lower genetic polymorphism for temperature-dependent sex determination in this population. A low genetic diversity in the Guiana population compared to the Playa Grande population has been already observed for mitochondrial haplotypes. Our results emphasize the importance of statistical analyses in studies of temperature-dependent sex determination.

*Eckert, S. A. (2002). **Swim speed and movement patterns of gravid leatherback sea turtles (Dermochelys coriacea) at St. Croix, U.S. Virgin Islands.** ***Journal of Experimental Biology*** **205, 23, 3689-3697.**

Swim speed, dive behavior and movements were recorded for seven female leatherback sea turtles, *Dermochelys coriacea*, during a single internesting interval near St. Croix in the U.S. Virgin Islands. Modal speeds range from 0.56 to 0.84 m/s, maximum speed range 1.9 to 2.8 m/s. Sea turtles swim continuously throughout the day and night. There were two swim speeds patterns: the most common was slightly u-shaped, with high speeds at their initiation and conclusion of the dive, and the last common was continuous high-speed swimming. The u-shaped speed patterns were coincident with vertical diving by the turtles, while the second pattern occurred during the day time, with the turtle swimming within two meters of the surface. This latter swim behavior appeared to be designed to maximize efficiently for long-distance travel. The hypothesis that leatherbacks rest or bask at midday during the internesting interval is refuted by this study.

*Fowler, L. E. (1979). **Hatching success and nest predation in the green sea turtle, Chelonia mydas, at Tortuguero, Costa Rica.** ***Ecology***, **60, 5, 946-955.**

Green turtle hatching success and nest predation were investigated at Tortuguero, Costa Rica, during July-Nov 1977. Forty-two percent of 350 study area nests and 57% of 237 beach survey nests produced emerging young 38% and 24%, respectively, were destroyed by dogs, coatis, and vultures. The mean emergence percentage for the successful study area nests was 83%. About 13% of all eggs deposited did not hatch. A mean incubation period of 62 d and a mean clutch size of 104 eggs were recorded. Emergence success was not influenced by other recorded parameters (nest position on beach, rainfall, turtle's tag year, time of season, incubation period, and clutch size). Incubation period was related to nest position and clutch size. Dogs, coatis, and black and turkey vultures were the chief predators at Tortuguero dogs did the most damage. Dogs and coatis found nests at all stages of development, but destroyed more nests containing hatchlings than nests containing unhatched eggs. Predation was related to nest position, but not to nest density. Nests were destroyed in equal proportion on the entire 35.4 km of beach. Predator activity was not consistent throughout the season proportionally more nests were destroyed near the end of the nesting season than during the beginning.

Frazer, N. B. (1992). Sea Turtle Conservation and Halfway Technology. ***Conservation Biology*****, 6, 179-184.**

Some of the attempts to conserve sea turtles involve "halfway technology," which does not address the causes of or provide amelioration for the threats turtles face. Programs such as beadstarting captive breeding and hatcheries may serve only to release more turtles into a degraded environment in which their parents have already demonstrated that they cannot flourish. Furthermore, captive programs may keep turtles from serving important ecological functions in the natural environment, or place them at some disadvantage relative to their natural counterparts once released. Such programs can be contrasted with more appropriate technologies that directly address and correct particular problems encountered by sea turtles without removing them from their natural habitat. For example, installing turtle excluder devices in shrimp trawl nets will reduce mortality of adults and larger juvenile sea turtles, and using low pressure sodium lightning on the beaches may prevent hatchlings and nesting females from becoming disoriented. In the final analysis, people need clean and productive marine and coastal environment. Without a commitment to such long-term goals, efforts to protect sea turtles will be futile.

Green, D. (1984). Long Distance Movements of Galapagos Green Turtles.** ***J. Herpetol**, 18, 2, 121-130.**

Turtles (23) were recovered from 5844 green turtles (C. m. agassizi) tagged in the Galapagos Islands between 1970 and 1979. Three recoveries are from Costa Rica, 4 from Panama, 1 from Columbia, 5 from mainland Ecuador and 10 from Peru. As with other green turtle populations, the Galapagos breeding colony (or at least part of it) undertakes long-distance movements to and is recruited from distant and widespread feeding grounds. Minimum distances range from 1233-2143 km and the times between last recorded sighting and recapture from 98 days to 3183 days. One turtle, recaptured off the coast of mainland Ecuador after nesting in Galapagos and re-released, subsequently renested in Galapagos, representing 1 of the few documented instances of 2 way migration. Three of the recoveries are males; only 2 other males have made longer recorded 1 way journeys. The recapture rate of 0.5% for males and 0.4% for nesting females is lower than for green turtles elsewhere.

* **Hays, G. C., Broderick, A. C., Godley, B. J., et. al. (2002). Biphasal Long-Distance Migration in Green Turtles. *Animal Behavior* 64, 6, 895-898.**

Sea turtles have recently been shown to have the sensory ability to use magnetic information for guidance in the opened ocean, although the importance of different potential navigational cues remains unknown. Between May and August 2001, researchers satellite-tracked green turtles, *Chelonia mydas*, during their 2000 kilometer postnesting migration from Ascension Island to Brazil, following five individuals both during their transoceanic crossing and while on the Brazilian coast. None of the turtles traveled directly to its final destination but, instead, they were extended (up to 795 kilometers) movements along the coast after the oceanic crossings. The extent of movement along the coast was unrelated to the oceanic crossing route. For example, individuals whose final destination was in the North of Brazil would not follow a more northerly oceanic crossing than those with a more southerly final destination. These observations showed that green turtles returning from Ascension Island do not swim directly to their final destination, but instead conduct migration into distant phases, a fairly direct open ocean crossing, following which they turn north or south along the coast to reach their final destination. This long-distance migration may therefore be conducted without turtles needing to resort to sophisticated navigational skills. These previously unidentified long coastal movements may heighten the risk of turtles being captured by fishermen.

* **Hirth, H. F., Samson, D. A. (1987). Nesting Behavior of Green Turtles (*Chelonia Mydas*) at Tortuguero, Costa Rica. *Caribbean Journal of Science*, 23 (3-4), 374-379.**

The nesting behavior of green turtles, Chelonia mydas, was studied during the 1985 nesting season at Tortuguero, Costa Rica. Inexperienced and experienced

nesters exhibited similar patterns of nesting and they spent about 118 minutes in the construction and camouflaging of a nest. The total nesting time was not influenced by size of the turtle, past nesting experience, nesting site or weather conditions. With a few notable exceptions the times spent by inexperienced and experienced turtles in each of five distinct stages of nesting were not significantly different. Proportionately more time was spent in covering and concealing the nest than in any other stage of nesting and the value of this behavior is discussed. Data from this and other studies indicate strong natural selection for a fixed nesting behavior in green turtles. It is recommended that humans refrain from disturbing green turtles until their entire nesting behavior is completed, and then only if necessary.

*Montero, W. G., Pena, J. C. (1996). **Growth, feed conversion, and mortality of *Eretmochelys imbricata* (Reptilia: Chelonidae) in artificial ponds in Costa Rica. *Revista de Biologia Tropical* 44-2B, 847-851.**

Growth rates, feed conversion and mortality of cultured Eretmochelys imbricata (hawksbill turtle) were studied in concrete raceways by feeding with fresh fish meal (tilapia) and in duplicate (tanks of 21 m). The turtles were 11 months old at the beginning of the experiment, with an average carapace straight length of 23.64 +- 1.94 cm, an average carapace curved length of 24.15 +- 1.94 cm and an average weight of 1527 +- 2.54 g. The experiment was carried out during six months. The equation of Von Bertalanffy for the growth of E. imbricata was LRC = 3.5 + ((82.0 -3.5) (1 - e-0.67432(t))). The relationship between carapace straight length -weight was W = 5.207 times 10- 3 LRC-3.8807 (r = 0.99). The feed conversion was 1.54 +- 0.74 and the mortality was zero during the study.

*Mora, J. M., Robinson, D. C. (1982). **Discovery of a blind olive ridley turtle (Lepidochelys olivacea) nesting at Playa Ostional, Costa Rica. *Rev. Biol. Trop*, 30-2, 178-179.**

The finding of a blind olive ridley turtle (L. olivacea) laying eggs at Playa Ostional, Guanacaste, Costa Rica, suggests that these turtles use olfactory signals to recognize their birth beach. Besides this imprinting system, that behavior can be explained by the 'social facilitation model'. However, other data support imprinting as the most important factor.

*Mora, J. M., Robinson, D. C. (1984). **Predation of sea turtle eggs (Lepidochelys) by the snake Loxocemus bicolor Cope. *Rev. Biol. Trop*, 32-1, 161-162.**

The fact that the snake Loxocemus bicolor Cope includes in its diet eggs of the sea turtle Lepidochelys olivacea Eschscholtz is reported. The predation behavior of the snake is discussed, based on observations carried out at Ostional beach, Costa Rica.

*Nordheimer, J. (2002). **Biologists Try to Follow Well-Traveled Turtles' Journeys.** ***New York Times*** **151, 52160.**

With the help of satellite technology, researchers are gaining insight into the migratory patterns of adult female sea turtles. Scientists were surprised and dismayed that some of the tracked female leatherbacks preferred foraging in prime shrimping waters off the coasts of Georgia and Florida. Their research findings could help sea turtle conservation efforts.

Paladino, F. V. (2000). Are Leatherbacks Doomed to Extinction? Found at: http://users.ipfw.edu/paladino/

Dr. Frank Paladino and Dr. James Spotila report significant decline in Leatherback (*Dermochelys coriacea*) population in Las Baulas National Park during past eleven years This decline was the result of uncontrolled egg harvesting, loss of nesting beaches, and accidental leatherback deaths in long line and shrimp nets found all along their migratory routs in the waters near the Galapagos, Easter Islands, and coasts of Ecuador, Chile. The combined effect of all these factors resulted in rapid decline of many sea turtles, billfish and other large marine species along the Central America coast. The ruling by the WTO and the reluctance of many countries to sign the International Sea Turtle Conservation Convention that is designed to protect these animals has led to the current poor state of affairs. These rulings and lack of concern will lead to leatherback extinction.

Reina, D.R., Mayor, P.A., Spotila, J.R., Piedra, R., Paladino, F.V. (2002). Nesting Ecology of the Leatherback Turtle, *Dermochelys coriacea*, at Parque Nacional Marino Las Baulas, Costa Rica: 1988-1989 to 1999-2000. *Copeia*, 3, 653-664.

The data on nesting ecology was collected and individual turtles were identified at Parque Nacional Las Baulas, Costa Rica, one of the few remaining nesting sites for Pacific leatherbacks, from 1988-1989 to 1999-2000. Individual female turtles were tagged with flipper tags and later with Passive Integrated Transponder (PIT) tags that permitted permanent identification. During the full calendars years of 1990 and 1995, over 93% of nests were laid between the beginning of October and the end of February. The following results were found; 92.4+-1% of nesting attempts resulted in successful oviposition, with a mean clutch size of 64.7+-1.4 yolked and 38.5+-1.0 yolkless eggs (n=1389). Mean standard curved carapace length and curved carapace width during the surveyed years ranged from 144.4+-0.6 cm to 147.6+-0.3 cm and from 103.9+-0.3 cm to 105.5+-0.6 cm, respectively. Reproductive output as determined by estimated clutch frequency (ECF) ranged from 4.3+-0.2 to 7.9+-0.3 clutches per female per nesting season. The mean period between nesting seasons for an individual turtle was 3.7+-0.2 years; only

15% of turtles tagged in 1993/1994 returned to nest again within six years. The nesting population declined from 1367 adult females in 1988/1989 to 231 in 1999/2000. The decline in the nesting population was apparently because of the low incidence of turtles returning to nest in more than one season.

*Seminoff, J. A., Resendiz, A., Nichols, W. J. (2002). **Diet of East Pacific Green Turtles (*Chelonia mydas*) in the Central Gulf of California, Mexico.** ***Journal of Herpetology*, 36, 3, 447-453.**

The diet of green turtle (*Chelonia Mydas*) was studied at Bahía de Los Angeles in the Gulf of California, Mexico. From 1995 to 1999 researchers collected esophageal lavage and fecal samples from stranded life-captured sea turtles and analyzed stomach contents from stranded carcasses encountered in the study area. Foods ingested did not vary with carapace length. Turtles consumed diverse marine algae, with the filamentous red alga Gracilariopsis lemaneiformis the most abundant; other common genera included Gracilaria, Codium, Ulva, and Chaetomorpha. Turtles also augmented their diet with animal matter; 25 nonalga food items were identified, included sponges, tube worms, sea pens, and sea hares. Substratum and anthropogenic debris such as plastic bags and nylon cord were commonly recovered in diet samples.

*Southwood, A.L., Andrews, R.D., Lutcavage, M.E., Paladino, F.V., West, N.H., George, R.H., Jones, D.R. (1999). **Heart rates and diving behavior of leatherback sea turtles in the Eastern Pacific Ocean.** ***Journal of Experimental Biology*, 202, 9, 1115-1125.**

Heart rates and diving behavior of leatherback sea turtles (Dermchelys coriacea) were monitored at sea during the internesting interval. Instruments that recorded the electrocardiogram and the depth and duration of dives were deployed on six female leatherback turtles as they laid eggs at Playa Grande, Costa Rica. Turtles dived continually for the majority of the internesting interval and spent 57-68 % of the time at sea submerged. Mean dive depth was 19+/-1 m (mean +/- S.D.) and the mean dive duration was 7.4+/-0.6 min. Heart rate declined immediately upon submergence and continued to fall during descent. All turtles showed an increase in heart rate before surfacing. The mean heart rate during dives of 17.4+/-0.9 beats min (-1) (mean +/- S.D.) was significantly lower than the mean heart rate at the surface of 24.9+/-1.3 beats min (-1) ($P<0.05$). Instantaneous heart rates as low as 1.05 beats min (-1) were recorded during a 34 min dive. The mean heart rate over the entire dive cycle (dive + succeeding surface interval; 19.4+/-1.3 beats min (-1)) was more similar to the heart rate during diving than to the heart rate at the surface. Although dive and surface heart rates were significantly different from each other, heart rates during diving were 70% of heart rates at the surface, showing that leatherback turtles do not experience a dramatic bradycardia during routine diving

Spotila, J. R., Reina, R. D., Steyermark, A. C., Plotkin, P. T., Paladino, F. V. (2000). Pacific leatherback turtles face extinction. *Nature,* 405, 529-530.

The dwelling numbers of leatherback turtles are signaling a threat to biodiversity in the oceans. A mathematical model based on researchers' assessment of a once-large leatherback population predicts that unsustainable adult mortality, apparently due to human fishing activity, will soon drive this population to extinction.

***Spotila, J. R., Standora, E. A., Morreale, S. J., Ruiz, G. J. (1987). Temperature dependent sex determination in the green turtle *Chelonia mydas*: Effects on the sex ratio on a natural nesting beach. *Hepertologica*, 43, 1, 74-81.**

Temperatures of natural nests of green turtles, *Chelonia mydas*, determined the sex of hatchlings at Tortuguero, Costa Rica. The beach could be divided into three distinct thermal zones: Zone 1--Low Beach, above high water mark up to sparse vegetation; Zone 2--Mid-Beach, area of sparsely vegetated sand up to dense jungle vegetation; Zone 3--High Beach, area of dense vegetation. At depths of 30 and 50 cm, sand temperatures in the High Beach were significantly lower than those in the Low Beach and Mid-Beach. Temperatures < 28.5 C produced males and temperatures > 30.3 C produced primarily females. Nests in the Low and Mid-Beach produced 72.0% and 87.0% female hatchlings while nests in the High Beach produced significantly fewer (7.4%) females. There were no seasonal trends in soil temperatures or sex ratios of hatchlings. The primary sex ratio computed for the entire beach for the 1977 nesting season was 67:33 female: male.

***Tisdell, C., Wilson, C. (2002). Ecotourism for the Survival of Sea Turtles and Other Wildlife. *Biodiversity and Conservation*, 11, 9, 1521-1538.**

This paper discusses generally why humans should bother to conserve sea turtles. In doing so, it considers both economic and non-economic reasons and outlines threats to the existence of sea turtles and ways in which tourism may either contribute to the conservation or decline of their population. Turtle-based ecotourism at Mon Repos in southern Queensland is described. As a result of a survey conducted by the authors, it is shown that turtle-based ecotourism has positive social (indirect) consequences for the conservation of sea turtles. Furthermore, it is argued that ecotourism populations at Mon Repos have positive direct impacts on the sustainability of population of sea turtles. However, using a simple model, it is emphasized that this impact in limited because sea turtles are migratory. A model is also developed to capture the possible relationship between turtle populations and the sustainability of ecotourism dependant on turtle populations, and is extended to other wildlife species. Significant independence exists between sustainability of these two variables. The theory is

related to Ciriacy-Wantrup's social social safe minimum conservation standard for species' survival.

*Wortman, G. (2000). **The urge to conserve: Examining the relationship between people and natural resources. Unpublished M.A. thesis. Prescott College, Prescott, Arizona.**

This thesis looks at the different relationships people around the world have with their natural resources, from how these resources affect their prosperity and working lives to how they have shaped social and cultural values. It first covers aspects of conservation theory and then focuses on three case studies--conservation of leatherback sea turtles (Dermochelys coriacea) in southern **Costa Rica**, Seri Indian fishing of swimming crabs (Callinectes bellicousus) in northern Mexico and an urban restoration project in San Francisco, USA. The aim is to determine how the relationship people have with their resources corresponds with local attitudes to conservation, and to examine how local attitudes to conservation can be translated into practical action to conserve biodiversity in a manner that serves the needs of environment and local people alike.

Books

Chacón, D. (2002). Assessment about the Trade of the Sea Turtles and their products in the Central America isthmus. San José: Red Regional Para la Conservatión de las Tortugas Marinas en Centroamérica (RCA).

This book describes the legal framework related to sea turtles in the region of Central America; the status of sea turtle populations based on the best possible and most recent information; and the trade international trafficking of sea turtle productions in the region. The purpose is to enable national authorities to recognize and deal with important problems. The document proves that sea turtle situation is not ideal. Because turtles are a migratory biodiversity resource, with a relatively slow recuperation rate and, in many cases, populations are moving both in and out of the Central American region, any decision concerning use or exploitation of sea turtles must be taken with the consideration of how that decision will affect the nations with whom the resource is shared.

Recommended Databases

Archie Carr Center for Sea Turtle Research database

http://webluis.fcla.edu/cgi-bin/cgiwrap/fclwlv3/wlv3/DGref/DBST/CM2/P1basic

It is useful source of all kinds of information about sea turtles.
It contains all publications including articles, dissertations, and symposium meetings' information that were issued all around the world. We highly recommend this database for those who are looking for in depth information about sea turtles and all information related to them.

Marine Turtle Newsletter

http://www.seaturtle.org/mtn/

This website is a section of sea turtle.org website. The newsletter contains information about sea turtle world news, publications, research, including earlier and most recent publications, and links to other useful websites. The structure of the website resembles a database, which makes it is easy to navigate through it. It is valuable resource of articles and other information about sea turtles.

Recommended Scientific Journals

The following list contains the names of journals that print articles with sea turtle news most often.

- **Animal Behavior**
- **Biodiversity and Conservation**

- **Biological Conservation**
- **Caribbean Conservation Corporation Newsletter *Velador* (URL: http://www.cccturtle.org/velador.htm)**
- **Conservational Biology**
- **Copeia**
- **Ecology**
- **Environmental Conservation**
- **Heperthological Review**
- **Journal of Experimental Biology**
- **Journal of Hepertology**
- **Nature**

Cognitive Levels and Pedagogical Approaches

Websites

ACM SIGGRAPH

http://www.siggraph.org/

ACM SIGGRAPH is a special interest group on Computer Graphics education. The website includes an education directory, projects the committee are currently working on, learning materials and activities as well as links to other related webpages.

http://www.siggraph.org/education/vl/vl.htm

This site is a paper about visual learning in science and engineering education. It offers methods and strategies on how to best utilize visuals in a learning environment. By also including information about how the brain processes the visual information, it is able to justify the recommended strategies and offer much information about visual learning.

Layered Curriculum

http://www.help4teachers.com/

Layered Curriculum offers information about a new method of teaching. Here, you can find books and tips about the new method. This website also includes a newsletter as well as a "Parent's Corner" that parents can use to teach their children at home. There are also current updates on research about teaching methods and workshops that educators can participate in.

http://www.help4teachers.com/hands/htm

This site contains information about how hands-on teaching works. It is a short article, but to the point about how the brain processes tactile activities.

U.S. Environmental Protection Agency

http://www.epa.gov/enviroed/webguide.html

The U.S. Environmental Protection Agency website includes the general information about environmental education, its main purposes, goals and objectives, as well as history of its establishment.

http://www.epa.gov/enviroed/eedefined.html

It contains wide range of information about environmental education in the US, its main programs, students and teachers opportunities as well as the Recourses page with links to other websites with more information on environmental education.

UNESCO

http://www.unesco.org/education/esd/english/education/contrib.shtml .

This is a section from the official UNESCO website, which provides information on education in different spheres, including environmental education. It also includes material about studying at different age and different countries as well as what impact education has on people's lives. The website includes links to other web pages that can be a useful source of case studies, news of education, and more resources on the topic.

TTE-Visual Transparencies to Educate

http://www.tte-online.com/index.html

This website offers visual products in specific subjects such as geography, history, and physics. It also contains research information about visual learning and efficiency in education.

http://www.tte-online.com/visual-learning/4-LONG-TERM-memory.html

This site offers background information about how the brain processes visuals and how the long term memory works in the brain. It also offers methods and strategies on how to better facilitate learning with visuals that can be used in the classroom.

Books

Bransford, J.D., Brown, A.L., & Cocking, R.R. (Ed) (2000). How People Learn: Brain, Mind, Experience, and School. Washington, D.C.: National Academy Press.

This is the expanded edition of *How People Learn.* The original volume, published in April 1999, was the product of a study conducted by the Committee on Developments in the Science of Learning. Following its publication, the Committee on Learning Research and Educational Practice was formed to carry that volume an essential step further by exploring the critical issue of how better to link the findings of research on the science of learning to actual practice in the classroom. The results of that effort were captured in How People Learn: Bridging Research and Practice, published in June 1999. The present volume draws on that report to expand on the findings, conclusions, and research agenda presented in the original volume. During the course of these efforts, a key contributor and one of the most eloquent voices on the importance of applying the science of learning to classroom practice was lost.

Donovan, M.S., Bransford, J.D., & Pellegrino, J.W. (Ed) (1999). How People Learn: Bridging Research and Practice. Washington, D.C.: National Academy Press.

This report synthesizes research on human learning. The research put forward in the report has important implication for how our society educates: for the design of curriculum, instructions, assessment, and learning environments. Authors were trying to determine how research and practice are generally linked. A small number of teachers were engaged to design experiments with researchers or explore research on their own. They constituted a direct link between research and practice. However, for the most part, the influence of research on practice was filtered through educational materials, through pre-service and in-service teacher education, through public policy, and through public opinion – often gleaned from mass media reporting and from people's own experiences in schools. The influence of research on these mediating arenas was determined as weak. The research base on learning and teaching has not been consolidated in a way that gives consistent, clear messages in formats that are useful for practice. As a result, the various mediating arenas that influence practice are often not align either with research findings or with each other. In synthesizing a broad body of research, *How People Learn* provides research-based messages that are clear and directly relevant to classroom practice.

Pellegrino, J. W., Chudowsky, N., & Glaser, R. (Ed.) (2001). Knowing what Students Know: The science and Design of Educational Assessment. Washington, DC: National Academy Press.

Educational assessment is an integral part of the quest for improved education. It provides feedback to students, educators, parents, policy makers, and the public about the effectiveness of educational services. Education stakeholders are questioning whether current large-scale assessment practices are yielding the most useful kinds of information for informing and improving education. Meanwhile, classroom assessments, which have the potential to enhance instruction and learning, are not being used to their fullest potential.
Advances in the cognitive and measurement sciences, make this an opportune time to rethink the fundamental scientific principles and philosophical assumptions serving as the foundations for current approaches to assessment. Advances in the cognitive sciences have broadened the conception of those aspects of learning that are most important to assess, and advances in measurement have expanded the capability to interpret more complex forms of evidence derived from students' performance.

* - sources that were not used in the work but are useful for further investigation of the topic

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