Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management

Santo Domingo, Dominican Republic
16-18 November 1999

PROCEEDINGS

Karen L. Eckert
F. Alberto Abreu Grobois
Editors

March 2001

For bibliographic purposes this document may be cited as:

Eckert, K.L. and F. A. Abreu Grobois (eds.) 2001. Proceedings of the Regional Meeting: “Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management,” Santo Domingo, 16-18 November 1999. WIDECAST, IUCN-MTSG, WWF, and UNEP-CEP. xx + 154 pp

Copies of this document may be obtained free of charge, in English or in Spanish from:

Information Officer
WIDECAST Conservation Materials Distribution Center
P.O. Box 486, Kingshill
St. Croix, U.S. Virgin Islands 00851
e-mail: widecast@ix.netcom.com

About the cover

The designs for the cover were extracted from various Mexican pre-Columbian codices. The human figures, footprints, and the speech symbols were taken from the *Códice Boturini*, also known as *Tira de la Peregrinación*, which depicts the migration of the Mexicas (ancient Aztecs) towards the Valley of Mexico. The turtle figure in the center comes from an ancient Mayan codex. We felt that this symbolism, taken from pre-Colombian art, well reflected the nature and purposes of the people attending the workshop — bringing together many people, traveling from far and wide, to dialogue about marine turtles.

Marine Turtle Conservation in the Wider Caribbean Region: A Dialogue for Effective Regional Management

Santo Domingo, Dominican Republic
16-18 November 1999

PROCEEDINGS

Karen L. Eckert
F. Alberto Abreu Grobois
Editors

WIDECAST MTSG WWF UNEP

March 2001

It's been said that a civilization is a conversation over time.

We dedicate these chapters,
and the conversation they represent,
with much appreciation
to the memory of

Elvira Carrillo

friend,
colleague,
pure heart,
one of those individuals
who really knew
that "...there is no path.
The path is made as one walks."

SANTO DOMINGO DECLARATION

Resolution of the meeting,
Marine Turtle Conservation in the Wider Caribbean Region - A Dialogue for Effective Regional Management

16-18 November 1999
Santo Domingo, Dominican Republic

Forty-eight resource managers and scientists from 29 states and territories in the Wider Caribbean Region discussed a variety of topics relevant to the management of marine turtles and their habitats. These participants of this meeting have produced this declaration to provide recommendations on the conservation of marine turtles and their habitats in the WCR for consideration by governments, international organizations, non-governmental organizations, academic institutions, and other sectors of society.

The participants note that for the purposes of this Declaration:

The term "Wider Caribbean Region" (WCR) refers to the description established by the Parties to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention, UNEP 1983);

The term "conservation" refers to the management of human use of organisms or ecosystems to ensure such use is sustainable. Besides sustainable use, conservation includes protection, maintenance, rehabilitation, restoration, and enhancement of populations and ecosystems; and

The term "marine turtle" refers to any stage in the life cycle of the six species found in the WCR: *Caretta caretta, Chelonia mydas, Dermochelys coriacea, Eretmochelys imbricata, Lepidochelys kempii and Lepidochelys olivacea.*

RECOGNIZING that marine turtles comprise a unique part of the biological diversity of the WCR and an

DECLARACIÓN DE SANTO DOMINGO

Resolución de la reunión,
Conservación de Tortugas Marinas en la Región del Gran Caribe - Un Diálogo para el Manejo Regional Efectivo

16-18 de noviembre de 1999
Santo Domingo, República Dominicana

Cuarenta y ocho administradores de recursos naturales y científicos de 29 unidades geopolíticas en la Región Gran Caribe discutieron sobre tópicos relevantes para el manejo de las tortugas marinas y sus hábitats. Los participantes han generado esta declaración para proveer recomendaciones sobre la conservación de las tortugas marinas y sus hábitats en la RGC y someterla a la consideración de los gobiernos, organizaciones internacionales, organizaciones no-gubernamentales, instituciones académicas y otros sectores de la sociedad civil.

Los participantes, para fines de esta Declaración aclaran que:

El término "Región del Gran Caribe" (RGC) se refiere a la descripción establecida por las Partes en el Convenio para la Protección y el Desarrollo del Medio Marino en la Región del Gran Caribe (Convenio de Cartagena, PNUMA 1983);

El término "conservación" se entiende como el manejo del uso humano de organismos y ecosistemas que asegure la sustentabilidad de dicho uso. Además de uso sustentable, la conservación incluye protección, mantenimiento, rehabilitación, restauración y mejoramiento de poblaciones y ecosistemas; y

El término "tortuga marina" se refiere a cualesquiera de los estadios del ciclo de vida, de las seis especies que se encuentran en la RGC: *Caretta caretta, Chelonia mydas, Dermochelys coriacea, Eretmochelys imbricata, Lepidochelys kempii y Lepidochelys olivacea.*

RECONOCIENDO que las tortugas marinas son un componente único de la diversidad biológica en la integral part of the cultural, economic, and social aspects of the societies found therein;

RGC así como parte integral de los aspectos culturales, económicos y sociales de las sociedades de la región;

CONSIDERING that all marine turtles are characterized by the following specific biological aspects: slow growth, late maturity, long life, and high rates of mortality during early life stages, and that understanding these aspects is fundamental to the development of management programs;

CONSIDERANDO que todas las especies de tortugas marinas en la región se caracterizan por los siguientes atributos biológicos específicos: lento crecimiento y madurez tardía, larga vida, alta tasa de mortalidad durante las primeras etapas del ciclo de vida y, que es fundamental comprender estas peculiaridades para el desarrollo de programas para su manejo;

RECOGNIZING that marine turtles occupy unique positions in marine food webs, are fundamental to the health and structure of important marine ecosystems, and have complex life cycles which depend on a diversity of environments, including terrestrial, coastal, and epipelagic (open ocean) zones;

RECONOCIENDO que las tortugas marinas ocupan sitios únicos en las tramas tróficas, son fundamentales para la salud y estructura de importantes ecosistemas marino-costeros y, por su complejo ciclo de vida dependen de una diversidad de ambientes, tanto terrestres, costeros, como epipelágico (zona oceánica);

RECOGNIZING that marine turtles have both consumptive and non-consumptive use values to the nations and peoples of the WCR;

RECONOCIENDO que existen valores de usos consuntivos y no-consuntivos de las tortugas marinas en los países y para los pueblos de la RGC;

CONSIDERING that marine turtles, at various life stages, disperse and migrate over vast distances, including on to the high seas and through the jurisdictional waters of multiple Range States;

CONSIDERANDO que las tortugas marinas, durante varias etapas de su ciclo vital, se dispersan, efectúan extensas migraciones en alta mar y dentro de los límites de aguas de jurisdicción nacional de diferentes Estados del área de su distribución;

RECOGNIZING that in the WCR, in general, marine turtles are less abundant than they were in former times as indicated by historic and other evidence, and furthermore both historic and scientific information shows that many populations of marine turtles in the WCR have declined while at the same time both threats and pressures on marine turtles have generally increased;

RECONOCIENDO que en la RGC en general, las tortugas marinas son menos abundantes que anteriormente, evidenciado por datos históricos y de otras fuentes, y que además tanto información histórica como científica muestran que muchas de las poblaciones de tortugas marinas han declinado, mientras que en paralelo se han incrementado las amenazas y las presiones sobre las tortugas marinas en lo general ;

CONCERNED that in general there is insufficient scientific information available for management purposes, especially from long-term monitoring of marine turtles and their habitats in the WCR;

PREOCUPADOS porque en general hay poca información científica disponible para fines de manejo, en particular de proyectos de seguimiento a largo plazo sobre tortugas marinas y sus hábitats en la RGC;

CONSIDERING that marine turtles are recognized in the respective national legislations of the majority of States of the WCR as requiring special attention for fisheries and wildlife management and conservation activities;

CONSIDERANDO que en la mayoría de las legislaciones nacionales de los Estados de la RGC se establece que las tortugas marinas son especies con requerimientos de atención especial para los fines de su manejo y conservación;

CONSIDERING that all species of marine turtles that occur in the WCR are specifically included under special conservation categories (such as threatened, endangered and critically endangered) in diverse international and regional agreements, including the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), Cartagena Convention together with its SPAW Protocol, Inter-American Convention on the Protection and Conservation of Sea Turtles, and the Convention on the Conservation of Migratory Species of Wild Animals (CMS);

CONSIDERANDO que todas las especies de tortugas marinas de la RGC están específicamente incluidas bajo categorías especiales de conservación (como amenazadas, en peligro y en peligro crítico) en diversos acuerdos internacionales y regionales, incluyendo la Convención sobre el Comercio Internacional de Especies Amenazadas de Fauna y Flora Silvestres (CITES), el Convenio de Cartagena y su Protocolo SPAW, la Convención Interamericana para la Protección y Conservación de las Tortugas Marinas, así como la Convención sobre la Conservación de Especies Migratorias de Animales Silvestres (CMS);

CONSIDERING that the habitats of marine turtles are protected by numerous international agreements, including the United Nations Convention on the Law of the Sea, International Convention for the Prevention of Pollution from Ships (MARPOL), Cartagena Convention and its various Protocols, Inter-American Convention on the Protection and Conservation of Sea Turtles, and Convention on Biological Diversity;

CONSIDERANDO que los hábitats de las tortugas marinas están protegidos por numerosos acuerdos internacionales, incluyendo: la Convención de las Naciones Unidas sobre el Derecho del Mar, el Convenio Internacional para la Prevención de la Contaminación por los Buques, la Convención de Cartagena y sus Protocolos, la Convención Interamericana para la Protección y Conservación de las Tortugas Marinas y la Convención de Diversidad Biológica;

RECOGNIZING that the nations and peoples of the WCR exhibit environmental, historical, cultural, social, economic and political diversity;

RECONOCIENDO que en las naciones y pueblos de la RGC es manifiesta una diversidad ambiental, histórica, cultural, social, económica y política;

RECOGNIZING that throughout the WCR there are historical and cultural traditions of consumptive use of marine turtles, as well as other well- established forms of exploitation (both legal and illegal) such as for sources of food and commodities used in trade;

RECONOCIENDO que a lo largo de la RGC existen tradiciones culturales e históricas del uso de tortugas marinas para consumo, así como otras formas de explotación bien establecidas (tanto legales como ilegales) tales como fuentes de alimentación y productos para el comercio;

RECOGNIZING that, in addition to direct exploitation, mortality occurs as a result of numerous human activities which result in the incidental capture of marine turtles and the destruction of critical habitats; and

RECONOCIENDO que, aunado a la captura directa, existen otras fuentes de mortalidad producto de numerosas actividades humanas que ocasionan la captura incidental de las tortugas marinas así como la destrucción de hábitats críticos; y

RECOGNIZING that despite limited resources, government agencies, international organizations, non-governmental organizations and other stakeholders have endeavored to advance the conservation of marine turtles and their habitats at the local, national and regional levels;

RECONOCIENDO que a pesar de los recursos limitados las agencias gubernamentales, organizaciones internacionales, organizaciones no-gubernamentales y otros actores claves, se han esforzado para avanzar en la conservación de las tortugas marinas y sus hábitats a nivel local, nacional y regional;

RECOGNIZING that despite great diversity in social and economic development levels in the WCR, there are many initiatives nationally and internationally to

RECONOCIENDO que a pesar de la gran diversidad en niveles de desarrollo social y económico en la RGC, existen muchas iniciativas nacionales e conserve marine turtles and their habitats in the region; and

WISHING to congratulate the governmental authorities, intergovernmental agencies, non-governmental organizations, civil groups and individuals from diverse countries and sectors of society in the WCR for their efforts, investment and advances made to develop programs and actions to conserve marine turtles and their habitats;

WE UNANIMOUSLY RECOMMEND that appropriate authorities, organizations, civic groups and other stakeholders:

1. Identify, strengthen, promote, develop and maintain mechanisms for **enhancing dialogue, collaboration, information-sharing, and technology exchange** among diverse agencies, organizations, researchers and other stakeholders in the WCR;

2. **Promote greater community participation** in the identification of management priorities and actions, as well as in the development, implementation and evaluation of activities directed at the conservation of marine turtles and their habitats;

3. **Promote scientific research, assessment and monitoring** of marine turtles and their habitats, and **standardize methods of data collection and analysis**;

4. **Develop and implement national and regional management plans** based on the best available scientific information, and designed to restore and stabilize marine turtle populations and their habitats to levels that provide broad social, cultural, economic and environmental benefits to the peoples of the WCR;

5. **Promote the harmonization of national policies and legislation** concerning the conservation of marine turtles and their habitats throughout the WCR, and support efforts to **improve the implementation of relevant national, regional and global commitments**;

internacionales para conservar las tortugas marinas y sus hábitats en la región; y

DESEANDO felicitar a las autoridades gubernamentales, agencias inter-gubernamentales, organizaciones no-gubernamentales, grupos civilies e individuos de diversos países y sectores de la sociedad en la RGC por sus esfuerzos, inversiones, avances logrados para desarrollar programas y acciones para conservar las tortugas marinas y sus habitats;

RECOMENDAMOS UNÁNIMEMENTE que las autoridades con las atribuciones pertinentes, organizaciones, grupos civiles y otros actores clave realicen las siguientes acciones:

1. Identificar, fortalecer, promover, desarrollar y mantener mecanismos para **mejorar el diálogo, la colaboración, intercambio de información y tecnología** entre las diversas agencias, organizaciones, investigadores y otros actores claves en la RGC;

2. **Promover una mayor participación ciudadana** en la identificación de prioridades y acciones de manejo, así como en el desarrollo, ejecución y evaluación de actividades dirigidas a la conservación de las tortugas marinas y sus hábitats;

3. **Promover la investigación científica, la evaluación y el seguimiento** de las tortugas marinas y sus hábitats, y la **estandarización de métodos de colecta y análisis de información**;

4. **Desarrollar y llevar a cabo planes de manejo nacionales y regionales** basados en la mejor información científica disponible y orientados a recuperar y estabilizar las poblaciones de tortugas marinas y sus hábitats a niveles capaces de proveer amplios beneficios sociales, culturales, económicos y ambientales para los pueblos de la RGC;

5. **Promover la armonización de las políticas y legislación nacionales** relacionadas con la conservación de las tortugas marinas y sus hábitats en la RGC, así como apoyar los esfuerzos de los países de la RGC para **mejorar la aplicación adecuada de los compromisos nacionales, regionales y globales;**

6. **Identify, strengthen, develop and maintain mechanisms for providing the resources** required to design and implement these activities, including human, financial, logistic, and political resources;

7. Based on the recommendations of the Working Group, **"Determining Population Distribution and Status":**

- Identify (locate), characterize, and rank (as to intensity of use and importance for management) marine turtle nesting and foraging sites,
- Select Index Sites (primary nesting and foraging sites) for intensive monitoring,
- Determine the genetic identity of primary nesting and foraging assemblages,
- Identify (locate), characterize, and rank (as to intensity of use and importance for management) migratory corridors, mating sites, and "developmental" (juvenile) habitats,
- Identify, evaluate and rank threats to marine turtles and their habitats – both domestic and, to the extent practicable, throughout their ranges,
- Determine demographic trends for each population using statistically robust procedures over ecologically relevant time frames, and taking regional and global species-specific trends into consideration,
- Deduce changes in local population abundance from historical records (e.g., historical literature, early surveys, fisheries or trade statistics), and place these in the context of similar assessments conducted elsewhere in the populations' range,
- Derive population "status" (as distinct from population "trends" which are evaluated over shorter periods of time) from trend measurements (whether observed, estimated or inferred) taken from the population's full range for a period of at least two generations; thus "status" becomes a biologically meaningful

6. **Identificar, fortalecer, desarrollar y mantener mecanismos para proveer los recursos requeridos** para el diseño y ejecución de estas actividades, incluyendo recursos humanos, financieros, logísticos y políticos.

7. Sobre la base de las recomendaciones del Grupo de Trabajo, **"Determinación de la Distribución de las Poblaciones y su Estado de Conservación"**:

- Identificar (localizar), caracterizar y jerarquizar (de acuerdo a la intensidad de uso e importancia para el manejo) sitios de anidación y alimentación,
- Seleccionar Sitios Índice (sitios de anidación y de alimentación de primer orden) para fines de seguimiento intensivo,
- Determinar la identidad genética de las tortugas en sitios de anidación y alimentación de primer orden,
- Identificar (localizar), caracterizar y jerarquizar (de acuerdo a la intensidad de uso e importancia para el manejo) corredores migratorios, sitios de reproducción y hábitats de "desarrollo"(de juveniles),
- Identificar, evaluar y jerarquizar amenazas a las tortugas marinas y sus hábitats en el ámbito local, así como -dentro de lo posible- en toda su área de distribución,
- Determinar tendencias demográficas para cada población aplicando procedimientos estadísticos robustos a través de series de tiempo de relevancia ecológica y tomando en cuenta las tendencias regionales y globales de cada especie,
- Deducir cambios en la abundancia de la población local a partir de registros históricos (p. ej. prospecciones pioneras, estadísticas de captura o del comercio), y situarlas en el contexto de evaluaciones similares en otros sitios del área de distribución de esa población,
- Derivar el "estado de conservación" la de la población (diferenciando ésta de la "tendencia" poblacional que se evalúa sobre series de tiempo más cortas) a partir de determinaciones de tendencias (ya sea observadas, estimadas o inferidas) deducidas de la distribución completa de la población a lo largo de por lo

classification congruent with criteria used internationally (i.e., IUCN).

8. Based on the recommendations of the Working Group, **"Monitoring Population Trends"**:

- Select Index Beaches and Foraging Sites (primary nesting and foraging sites) for intensive monitoring,
- Collect baseline data by determining Absolute Abundance or by utilizing Indices of Abundance,
- Continue to collect data at Index Foraging Sites, using standardized collection and reporting protocols, for a minimum of 5 years,
- Continue to collect data at Index Nesting Beaches, using standardized collection and reporting protocols, for 5-10 years (defined as 5 years or a minimum of 3 multiples of the *average* remigration interval [1-3 years, depending on species], whichever is longer),
- Continue monitoring until a statistically significant change in abundance is detected or until population stability is demonstrated with statistical precision, remembering that minimum monitoring intervals are likely to be insufficient to generate statistically significant results if populations are small ,
- Recognize that trends are not predictive, but rather they demonstrate with a selected degree of mathematical precision that there has been a change in abundance over time and that its direction is negative or positive.

menos dos generaciones; asegurando así que el "estado de conservación" sea una clasificación con significado biológico y en congruencia con los criterios internacionales en uso (p.ej., IUCN).

8. Sobre la base de las recomendaciones del Grupo de Trabajo, **"Seguimiento de Tendencias Poblacionales"**:

- Seleccionar Playas Índice de Anidación y Sitios Índice de Alimentación (sitios de anidación y de alimentación de primer orden) para un seguimiento intensivo,
- Recabar datos básicos de referencia por medio de la determinación de Abundancia Absoluta o el uso de Índices de Abundancia,
- Desarrollar el acopio de datos en Sitios Índice de Alimentación, utilizando métodos normalizados de colecta y de protocolos de informes, por un mínimo de 5 años,
- Desarrollar y en algunos casos continuar el acopio de datos en Playas Índice de Anidación, utilizando métodos normalizados de colecta y de protocolos de informes, a lo largo de 5-10 años (período definido como el período más largo de 5 años o un mínimo de 3 veces el intervalo *promedio* de remigración [1-3 años, dependiendo de la especie]),
- Continuar el seguimiento hasta detectar un cambio estadísticamente significativo en la abundancia o hasta que se detecte una estabilidad poblacional demostrable con precisión estadística, recordando que es probable que los intervalos mínimos de seguimiento sean insuficientes para generar resultados estadísticamente significativos si las poblaciones son pequeñas,
- Reconocer que si bien las tendencias no tienen capacidad predicativa, en cambio demuestran con un grado determinable de precisión, que ha ocurrido un cambio en la abundancia sobre un tiempo dado y que la dirección del cambio es negativa o positiva

9. Based on the recommendations of the Working Group, "**Promoting Public Awareness and Participation**":

- Clearly identify target and stakeholder groups, and stakes,
- Determine the socio-economic importance or value of the resource to the various stakeholders, including communities and nations,
- Identify economic alternatives (options) in a collaborative manner (such alternatives might include activities totally divorced from the resource), as well as those involving non-consumptive or more sustainable consumptive use of the resource,
- Develop comprehensive medium- and long-term marine turtle public awareness programs focused on the respective stakeholder groups,
- Coordinate and harmonize policies and activities of the relevant sectors, including Governmental and non-governmental,
- Incorporate marine turtle (and general marine) education into the school curriculum,
- Identify, strengthen, establish, and maintain mechanisms for the exchange of experiences, information and collaboration (including the Internet and field visits) using various sectors of society,
- Determine ways in which program success can be measured and evaluated,
- Identify funding sources and develop funding strategies consistent with specific program objectives.

9. Sobre la base de las recomendaciones del Grupo de Trabajo, "**Promoción de la Concientización y Participación Pública**":

- Identificar de manera precisa grupos-objetivo y de interés, así como los intereses involucrados,
- Determinar la importancia socioeconómica o el valor de los recursos para los diversos grupos de interés, incluyendo las comunidades y las naciones,
- Identificar, a través de un proceso participativo, las alternativas (opciones) económicas (que pueden incluir actividades totalmente ajenas al recurso en sí, así como aquellas que involucren un consumo no extractivo o más sustentable del recurso,
- Desarrollar programas integrales de concientización pública a mediano y largo plazo, con temáticas sobre tortugas marinas y enfocados a cada grupo de interés,
- Coordinar y armonizar políticas y actividades de los sectores relevantes, incluyendo las del gobierno y organizaciones no-gubernamentales,
- Incorporar programas educativos sobre tortugas marinas (y temas marinos en general) a la currícula escolar,
- Identificar, fortalecer, establecer y mantener mecanismos para el intercambio de experiencias, información y colaboración (incluyendo el Internet y visitas de campo) con los diferentes sectores de la sociedad,
- Determinar formas y maneras para poder medir y evaluar el éxito de los programas,
- Identificar fuentes y desarrollar estrategias de financiamiento acordes con los objetivos específicos del programa.

10. Based on the recommendations of the Working Group, "**Reducing Threats on Foraging Grounds and Inter-nesting Habitats**":

- Determine past and present quantitative and qualitative status and extent of foraging and inter-nesting habitats,
- Develop criteria to rank threats to foraging grounds and inter-nesting habitats, and to turtles utilizing these habitats,

10. Sobre la base de las recomendaciones del Grupo de Trabajo, "**Reducción de Amenazas en Sitios de Alimentación y Hábitats Interanidatorios**":

- Determinar la condición cuali- y cuantitativa, histórica y reciente y, la extensión de los hábitats de alimentación e inter-anidatorio,
- Desarrollar criterios para jerarquizar las amenazas a los sitios de alimentación y hábitats inter-anidatorios, y a las tortugas que utilizan estos hábitats,

- Identify, characterize and rank (as to their impact on local populations) present and potential threats to each foraging area, as well as to marine turtles utilizing these habitats,
- Develop and incorporate marine turtle habitat management plans as part of national Integrated Coastal Zone Management (ICZM) plans,
- Design and implement independent management plans, as necessary, to mitigate priority threats to marine turtles,
- Assemble and review existing information, identify gaps, and initiate efforts to acquire necessary data,
- Design and implement monitoring protocols to evaluate the result(s) of management actions,
- Review legislation and law enforcement for adequacy and gaps,
- Promote regional cooperation in managing critical habitats.

11. Based on the recommendations of the Working Group, "**Reducing Threats at Nesting Beaches**":

- Identify threats through assessments, research, and the exchange of information,
- Consider threats not only to nesting beaches (habitat), but also to nests (eggs), hatchlings, and nesting females,
- Identify, characterize, and rank threats (many of which are described below), giving priority management attention to those with the greatest potential to exert a negative effect on the status of local breeding assemblages,
- Review existing legislation for adequacy, emphasize consistent law enforcement, improve inter-agency collaboration, and promote public awareness of and stakeholder participation in management program planning and implementation,

- Identificar, caracterizar y jerarquizar (de acuerdo a su impacto sobre poblaciones locales) amenazas actuales y potenciales para cada sitio de alimentación, así como a las tortugas marinas que utilizan estos hábitats,
- Desarrollar e incorporar planes de manejo para el hábitat de tortugas marinas a los planes nacionales de Manejo Integral de la Zona Costera (MIZC),
- Diseñar e implementar planes de manejo indepen-dientes, conforme sea necesario, para mitigar las amenazas prioritarias a las tortugas marinas,
- Compilar y revisar información existente, identificar vacíos de información e iniciar esfuerzos para adquirir la información necesaria,
- Diseñar e implementar protocolos de seguimiento para evaluar el/los resultado/s de las acciones de manejo,
- Revisar la legislación y su observancia, buscando vacíos e identificando deficiencias,
- Promover cooperación regional en el manejo de hábitats críticos.

11. Sobre la base de las recomendaciones del Grupo de Trabajo, "**Reducción de Amenazas en Playas de Anidación**":

- Identificar amenazas a través de la evaluación, investigación y el intercambio de información,
- Considerar además de las amenazas a las playas de anidación (hábitat), aquellas que afectan las nidadas (huevos), crías y hembras reproductoras,
- Identificar, caracterizar y jerarquizar las amenazas (entre otras, las que se describen a continuación), dando atención prioritaria para su manejo, aquellas con el mayor potencial de ejercer un efecto negativo sobre la condición de las poblaciones reproductoras locales,
- Revisar la legislación existente para detectar deficiencias, enfatizar la aplicación consistente de la ley, mejorar colaboración entre agencias y promover la concientización pública y la participación de los grupos de interés en la planificación del programa de manejo y su aplicación,

- Eliminate illegal poaching of eggs and nesting females,
- Minimize egg depredation (using the least manipulative strategy),
- Control beach sand mining,
- Eliminate (or reduce to non-threatening levels) artificial beachfront lighting during peak nesting and hatching seasons,
- Prohibit irreparable damage to sandy beaches due to stabilization structures, such as seawalls or groynes
- Manage potentially threatening human commercial and recreational activities during nesting seasons,
- Prevent degradation to the incubating environs of known nesting beaches due to beach rebuilding and renourishment activities,
- Prevent irreparable damage to sandy beaches due to coastal construction of buildings and infra-structure,
- Reduce beach debris,
- Control pollution, including chemical, sewage and oil contamination, at known turtle nesting beaches
- Reduce, to the extent possible, the negative effects of natural disasters and phenomena.

12. Based on the recommendations of the Working Group, "**Strengthening the Regulatory Framework**":

- With regard to the regional (international) framework: stimulate and promote, on a practical level, cooperation among nations; harmonize national regulatory frameworks for the protection and management of natural resources, in particular marine turtles; and ensure that national obligations under international treaties and agreements are met on a timely and ongoing basis,
- With regard to the national regulatory framework: review existing legislation and regulations for gaps; strengthen the national legislative framework by using the best available scientific knowledge and taking into consideration stakeholders, enforcement capacity, pub-

- Eliminar el saqueo de huevos y hembras anidadoras,
- Minimizar la depredación de huevos (aplicando la estrategia con menor manipulación),
- Controlar la extracción de arena de las playas,
- Eliminar (o reducir a niveles que no impacten) la iluminación artificial de frentes de playa durante la temporada de máxima anidación y eclosión,
- Prohibir construcciones de estabilización, como las paredes de playa y los espigones que ocasionan daños irreparables a la playas,
- Manejar actividades comerciales y de recreo que signifiquen una amenaza potencial durante la temporada de anidación,
- Prevenir la degradación de playas por actividades de reconstrucción o relleno en áreas aledañas a playas de anidación conocidas,
- Prevenir el daño irreparable a playas arenosas por la construcción de edificios e infraestructura costera,
- Reducir la basura en playa,
- Controlar la contaminación, incluyendo aquella por sustancias químicas, aguas residuales y por petróleo, en playas de anidación conocidas,
- Reducir, en lo posible, el efecto negativo de desastres y fenómenos naturales.

12. Sobre la base de las recomendaciones del Grupo de Trabajo, "**Fortalecimiento del Marco Jurídico**":

- En relación a las estructuras legales regionales (internacionales): promover y estimular, a niveles factibles, la colaboración entre naciones; armonizar esquemas de normatividad nacional para la protección y manejo de los recursos naturales, en particular las tortugas marinas; y asegurar que las obligaciones nacionales bajo tratados y convenios internacionales se cumplan en tiempo y forma,
- Con relación al marco jurídico nacional: revisar la legislación y reglamentos vigentes y detectar vacíos; fortalecer el cuerpo normativo incorporando el mejor conocimiento científico disponible y tomando en consideración a los grupos de interés, capacidad de ejecución,

lic education, international and regional obligations, financial mechanisms, and existing laws pertaining to the conservation and management of marine turtles,

- With regard to public participation in the regulatory process: design and implement public education campaigns; and ensure continuous education to all sectors and stakeholders, relative to the provisions and obligations of environmental legislation.

educación pública, obligaciones internacionales y regionales, mecanismos de financiamiento y la legislación vigente que atañe a la conservación y manejo de las tortugas marinas,

- Con respecto a la participación ciudadana en el proceso normativo: diseñar e implementar campañas de educación para el público en general; asegurar la educación continua de todos los sectores y grupos de interés en la temática relacionada con las estipulaciones y obligaciones que en materia ambiental se contemplan en el marco legal.

Preface

Six species of sea turtle (leatherback, green, loggerhead, hawksbill, olive ridley, Kemp's ridley) are found in the Wider Caribbean Region, defined by the UNEP Caribbean Environment Programme to be "the marine environment of the Gulf of Mexico, the Caribbean Sea and the areas of the Atlantic Ocean adjacent thereto, south of 30 degrees north latitude and within 200 nautical miles of the Atlantic coasts of the States referred to in article 25 of the Convention" [1983 Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, or Cartagena Convention].

Caribbean sea turtles have cultural, ecological and economic value. The indigenous people of the region, as well as more recent settlers, use turtles for meat, eggs, shell, leather and oil. Archeological studies indicate more than 1,000 years of harvest. The negative effects of unregulated historical harvests are exacerbated by late 20th century sources of mortality that include high volume commercial trade and incidental capture in fishing gear, as well as the widespread loss or degradation of coastal habitats. All six species are now classified as *Endangered* or *Critically Endangered* by IUCN (World Conservation Union) and, with a few notable exceptions, most populations are considered depleted or declining.

Caribbean stakeholders are committed to reversing population declines and to ensuring that sea turtles once again fulfill their ecological roles and economic potential. Two decades ago the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) established a network of scientists, managers, conservationists, educators, and policymakers to draft comprehensive national recovery plans, facilitate local participation in research and conservation, promote effective conservation and management policy, and educate people throughout the region about sea turtles. Fisheries personnel and resource managers gathered in 1984 and again in 1987 to participate in the Western Atlantic Turtle Symposium (WATS) to discuss shared management concerns and to assemble a sea turtle database. These initiatives set the stage for new levels of cooperation and collaboration.

During the last decade, two important binding agreements have been negotiated in the region. In 1990, the Protocol to the Cartagena Convention concerning Specially Protected Areas and Wildlife (SPAW) was adopted in Kingston. Its annexes, listing species (including all Caribbean sea turtles) that require protection measures, were adopted in 1991. The SPAW Protocol came into force in 2000. Secondly, the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) was concluded after four rounds of negotiations in the region in 1996. Like the SPAW Protocol, the IAC is expected to enter into force soon. *Marine Turtle Conservation in the Wider Caribbean: A Dialogue for Regional Management* continues the Caribbean tradition of innovative leadership in sea turtle conservation.

The time has now come to begin the process of review and evaluation, and to ask whether our current national and international sea turtle management regimes are sufficient to promote population stabilization and species recovery. As evidenced by *Marine Turtle Conservation in the Wider Caribbean: A Dialogue for Regional Management*, it is increasingly clear that the realities of sea turtle biology, especially delayed maturity and migratory habits, will require a long-term and sustained commitment to population monitoring, conservation and management training, and information exchange. Equally clear is the need to develop guidelines for effective regional (international) management, in addition to national policy frameworks.

Regional management requires at the very least that parties conduct consistent and comparable data collection in monitoring locally occurring populations. Effective management and law enforcement also present a great challenge that must be met. While basic population monitoring and resource management capacity provide the underpinning of any successful national program, we must still recognize the multinational character of these species.

Herein lies our greatest challenge: maximizing benefits while sharing costs and responsibilities among range states for restoring the populations of Caribbean sea turtles.

We are encouraged by the results of this meeting, including the "Santo Domingo Declaration", and the fact that it has clearly laid the foundation for future work and a renewed commitment to resolving these issues. Recommendations endorsed by the participants, comprised of thirty-three delegates from twenty-seven governments and invited experts from eleven nations, emphasized the need to strengthen collaboration among stakeholders; promote greater community participation; support scientific research as well as population and habitat monitoring; and develop and implement national and regional management guidelines based on the best available science. As progress continues to be made in sorting out the complexities of regional management, the dedicated interest of Governments, intergovernmental bodies, NGOs and specialists throughout the Wider Caribbean Region ensures that effective solutions will be found.

Karen L. Eckert
F. Alberto Abreu G.
Editors

Acknowledgements

We are grateful to our gracious host, the Government of the Dominican Republic, for its official assistance and support. José Miguel Martinez Gurity, Undersecretary of Natural Resources (Department of Agriculture), was especially helpful in organizing the meeting.

The meeting sponsors, World Wildlife Fund (WWF), the Wider Caribbean Sea Turtle Conservation Network (WIDECAST), IUCN/ SSC Marine Turtle Specialist Group, and UNEP Caribbean Environment Programme, deserve enormous credit for bringing the meeting to fruition. Special thanks are due Miguel Jorge (WWF), Alessandra Vanzella-Khouri (UNEP/ CAR-RCU), and Nancy Daves (U. S. National Marine Fisheries Service) for their contributions during the planning stages.

We are also in debt to Yvonne Arias from Grupo Jaragua in Santo Domingo for her talent, enthusiasm and hard work both before and during the event. Ms. Arias, Laura Perdomo, and their team of dedicated colleagues handled a myriad of tasks with patience, style and good humor. We thank our translators, Robert McCollum and Agnes Boonefaes, for their patience and skill, Verna Sybesma (Curaçao) for transcribing the notes taken during the lively Plenary sessions, and Marydele Donnelly for assisting with finalizing these proceedings.

Finally, we offer our sincere appreciation to our invited experts for their professional presentations and assistance with Working Groups, and to our participants for their significant contributions in making this landmark meeting so successful.

Table of Contents

Welcome

José Miguel Martínez Guridy
Subsecretario de Estado de Recursos Naturales
República Dominicana

First of all, I congratulate you for coming to the Dominican Republic because we have been threatened by the arrival of a hurricane! The Government of the Dominican Republic is excited to be the host of this historic meeting. We are also pleased to have this opportunity to collaborate with Nelson Andrade of the United Nations Environment Programme and with Miguel Jorgé of World Wildlife Fund, who is well known in our country.

The Dominican Republic still has problems with marine turtle utilization, but we are trying hard to address this issue. Today we have established a decree to adjust the boundaries for four marine protected areas, which include habitat for sea turtles. We also have challenges to overcome with regard to legislation for marine turtles. To solve this, we want to establish a special Ministry to address the issues of environmental protection.

This is an important meeting with representatives from twenty-seven countries in attendance. It is the Dominican Republic's position that we will respect consensus, and that we will support the outcome of this meeting. It is our desire that these discussions on regional management be open discussions.

While you are here, we hope that you will enjoy our hospitality. Tomorrow night the government invites you to a special reception. We do not know what will happen outside in the next few days, but on the inside we look forward to the sessions ahead and to working with you on these issues which are so important to all of us.

Statement of Purpose

*F. Alberto Abreu G.
Instituto de Ciencias del Mar y Limnologia
Universidad Nacional Autónoma de México
México*

It is a dream come true to be participating in this meeting with old and new colleagues. The excellent response and healthy participation shown by the governments in this meeting reflect their willingness to engage in a regional approach to marine turtle conservation and management. Nonetheless, we need to point out that this workshop is not an inter-governmental meeting — it is a dialogue.

Coupled with the region's readiness to discuss important issues, we now have scientific and technological advances that allow new insights into the behavior and population dynamics of marine turtles, and provide tools that foster scientifically-based management of these migratory species.

Much like the region we represent, our group of some 50 participants is diverse. But, while our levels of experience are very different, we are alike in being committed to ensuring that marine turtles remain an important component of Caribbean biodiversity.

This meeting was conceived some months ago as a means to address issues raised in recent years, and continue the interest and momentum generated at government levels by the SPAW Protocol and the Inter-American Convention for the Protection and Conservation of Sea Turtles. For the first time in marine turtle conservation, countries are embracing the notion of working together as a cornerstone of any international agreement.

We should all be proud of the fact that, once again, the Caribbean region is at the "cutting edge" with regard to marine turtles. For this meeting we have brought together specialists who will provide their expertise on various themes and national participants who will provide a wealth of knowledge on their countries and the marine turtles found there.

We are here to begin discussions about developing recommendations for regional management and working methodology. We expect this to be the first in a series of regional meetings and workshops that should take place before we can reach our final goal.

We ask all participants to contribute fully and to share your experience(s) and local information. We need to identify areas where future efforts should focus, thereby promoting collaboration between countries and achieving the recovery of marine turtle populations. Quite simply, we need to transcend working in isolation and emphasize working together.

This meeting is specifically designed to aid managers and researchers to identify the basic requirements in the Wider Caribbean Region for the adequate management and recovery of marine turtle populations. We hope to achieve wide ranging discussions among participants in the following areas that will be major elements of a future regional management plan:

- Criteria for determining the status of marine turtle species;
- Minimal requirements for adequate monitoring and information-sharing for management purposes;
- Identifying, monitoring, and mitigating threats, both to marine turtles and to the habitats upon which they depend;
- Special problems involved in managing long-lived and highly migratory marine turtles; and
- Available national and international legislative instruments, and ways in which they can be used to conserve and manage marine turtles.

And so, our work begins.

Session I

Marine Turtles of the Wider Caribbean Region

General Natural History of Marine Turtles
John G. Frazier, Presenter

Cultural and Economic Roles of Marine Turtles
Didiher Chacón C., Presenter

Status and Distribution of Dermochelys coríacea
Karen L. Eckert, Presenter

Status and Distribution of Chelonia mydas
Cynthia Lagueux, Presenter

Status and Distribution of Caretta caretta
Félix Mancada Gavilán, Presenter

Status and Distribution of Eretmochelys imbricata
Diego F. Amorocho, Presenter

Status and Distribution of Lepidochelys kempii
René Márquez M., Presenter

Status and Distribution of Lepidochelys olivacea
Maria Ángela Marcovaldi, Presenter

General Natural History of Marine Turtles

J. G. Frazier
Conservation and Research Center
Smithsonian Institution
USA

Introduction

Marine turtles have captivated the human imagination for millennia, for many and diverse reasons. Providing nutritional, economic and spiritual sustenance to human societies around the globe, they are part of the cultural fabric of many coastal communities (Molina, 1981). For example, archaeological research in the Caribbean reveals marine turtle relicts associated with human sites in scores of localities, both continental and insular, that date from 1380 BC to 1715 AD. Marine turtles were clearly an important part of the diet and culture of many of these past societies (Wing and Reitz, 1982; Versteeg and Effert, 1987). In recent years, these animals have been a *cause célèbre* for numerous issues fundamental to modern societies, impinging on the ways in which humans view and interact with their environment. Marine turtles serve as test cases illustrating the complexities involved in developing, maintaining, and promoting programs for biological conservation and environmental protection. These reptiles have — by no design of their own — been in the forefront of highly charged issues such as international disputes about trade and environment (Frazier and Bache, in press).

To better understand the relationships between people and marine turtles, it is necessary to first understand some basic characteristics about these charismatic animals. The purpose of this paper is to provide a background of basic information on marine turtles, upon which more specific details and discussions can be constructed. The paper is structured using a series of central questions, which build sequentially on each other. The intention is to provide an overview of biological facts — non-negotiable issues that must be adequately addressed in any considerations and negotiations that deal with marine turtles and their habitats. It is important to emphasize that the approach here is to generalize, so that the summaries presented are not necessarily meant to apply to all turtles at all times, but rather to provide a simplified framework into which more detail can be assembled. For this reason, many references cited herein are review articles and not primary sources. For example, review articles (chapters) in *The Biology and Conservation of Sea Turtles* (Bjorndal, 1982, reprinted in 1995) and *The Biology of Sea Turtles* (Lutz and Musick, 1997) have been drawn upon repeatedly throughout this paper.

Taxonomy and Paleontology: How many kinds of marine turtles are there?

Marine turtle fossils date back to the Jurassic, some 200,000,000 years ago. In addition to two taxonomic families (Pleurosternidae and Thalassemyidae) from the Jurassic that included some species of marine turtles, paleontologists have described four taxonomic families in which all the species are characterized by clear adaptations for marine life: Cheloniidae, Dermochelyidae, Toxochelyidae, and Protostegidae. Over the span of eons, more than 50 genera of marine turtles have been described, with a total of over 100 species (see Pritchard, 1997). Hence, over millions of years, marine turtles have been a diverse and widespread group of animals.

Surviving today, we have what are referred to as "the living species of marine turtles" — these comprise seven species, organized into six genera, and two taxonomic families. One family, Cheloniidae, includes six of the seven living species of marine turtle: *Caretta caretta* (Linnaeus), *Chelonia mydas* (Linnaeus), *Eretmochelys imbricata* (Linnaeus), *Lepidochelys kempii* (Garman), *Lepidochelys olivacea* (Eschscholtz), and *Natator depressus* (Garman). Some people recognize an additional species, *Chelonia agassizii* (Bocourt), but this is not consistently accepted (Karl and Bowen, 1999). The other family, Dermochelyidae, includes just one living species of marine turtle, *Dermochelys coriacea* (Vandelli). It is this last-named species, the "leatherback," that is often the exception to the generalizations that apply to the rest of the marine turtles.

Systematics: What makes a turtle a turtle?

The classification of turtles, from generalized to specific characteristics, can be summarized as follows:

- Kingdom Animalia
  — has nuclear envelope, mitochondria, no chloroplasts nor cell wall, has fertilization and meiosis, internal digestion, and a nervous system
- Phylum Chordata
  — has a dorsal spinal chord
- Sub-Phylum Vertebrata — has a backbone
- Super-Class Tetrapoda — has four limbs
- Class Reptilia
  — lays cleidoic eggs that develop independently of water in the surrounding environment
  — has lungs and breathes air
  — the body is covered in scales
- Order Testudines
  — lives inside a bony shell
  — ribs are "inside-out" (outside the body, rather than inside)
  — backbone is shortened
  — has no teeth, but instead a beak made of keratin

Morphology: What makes a turtle a marine turtle?

Numerous characteristics, genetic and morphological, distinguish marine turtles from other types of turtles; several of these are relatively conspicuous. By far the most distinctive is the body shape, and particularly the front limbs, which are modified into flippers, relatively large in size, with the elongated finger bones forming a major part of the limb. The flippers provide strong "power strokes" with which the turtles "fly" through the water when swimming. This morphological adaptation is reflected in distinctive behavioral and physiological characteristics, giving marine turtles a remarkable ability to migrate over long distances, through water (Wyneken, 1997). As in freshwater turtles, the back limbs are modified into paddles with a membrane that spreads between the toe bones (although in marine turtles the hind limbs are often, mistakenly, called "flippers"). The shell, with the carapace above and plastron below, is dorsally flattened so that it is hydrodynamically streamlined. Unlike as in other kinds of turtles, the head is relatively large, and, like the limbs, cannot be withdrawn into the shell. Hence, marine turtles have lost the ability to protect the head and limbs by pulling them inside the shell, but they have gained more efficient hydrodynamic design. The "crutching" gait, in which all four limbs thrust simultaneously, is used by the larger marine turtles when they are on land, and is virtually unique to marine turtles (Lutcavage and Lutz, 1997; Wyneken, 1997).

Development: What are the life stages of marine turtles?

The life of a marine turtle can be categorized into distinct phases as it grows and develops. Starting at the beginning of the reproductive process, ***follicles*** are ovulated from the ovary into the infundibulum of the oviduct, and passing farther down, they are fertilized by sperm stored in the upper oviduct. ***Fertilized ova*** develop to the mid-gastrula stage (a hollow sac) while within the mother's oviduct. It takes at least a week for the ***egg*** to develop inside the oviduct, forming the completed structure with yolk, albumin and eggshell. The egg is nearly spherical resembling a Ping-Pong ball, and has a flexible parchment-like calcareous shell. Depending on the species, individual eggs weigh between 25 and 80 g, and are from 3.9 to 5.4 cm in diameter. Eggs hatch into baby turtles, or "***hatchlings***," which have average carapace lengths for each species between 4.1 and 6.0 cm, and weigh between 14 and 50 g, *Eretmochelys* weighing the least and *Dermochelys*, the most. It takes from 6 to 13 weeks for the eggs to hatch, the period determined mainly by the temperature of incubation (Van Buskirk and Crowder, 1994; Miller, 1997; Pritchard and Mortimer, 1999).

The hatchlings become ***juvenile*** turtles, and those that survive develop into ***adults***. The average carapace lengths of adult females vary by species, from about 65 to 180 cm and the total range of body weights for adults is from about 25 to 900 kg (Morgan, 1989; NRC, 1990; Márquez, 1994; Van Buskirk and Crowder, 1994). Hence, the adult weight can be some 5,000 times the egg weight, and as much as 11,000 greater in the case of *Dermochelys coriacea*. It is estimated that, depending on the species, population, and environmental variables, it takes from 10 to 60 years for a marine turtle to pass through these stages and to grow from fertilized ova into a mature adult (Bjorndal and Zug, 1995; Chaloupka and Musick, 1997).

Although it might seem simple to determine which animals are adults, in fact the term "adult" is frequently misused when applied to marine turtles. Correctly, it refers to animals that are sexually mature, a state that can be determined by either internal examination of the gonads or by knowing the history of an individual. However, these details are rarely available, and usually the decision to classify an adult is made on the basis of the turtle's body size. Nevertheless, identifying adult marine turtles by comparing them to some minimal size of known breeders is misleading, for individuals that are sexually immature can be larger than the smallest, or average, recorded breeding size (Limpus et al., 1994a, b).

Natural History: What is the life cycle?

Not only are marine turtles characterized by having long generation times, and delayed maturity, but their life cycles are remarkably complex. Each of the various growth phases (egg, embryo, hatchling, juvenile, and adult) has certain distinctive characteristics.

Eggs: Eggs are laid in a nest in the beach, above high tide. What is fundamental to understand is that *marine* turtles must nest in a ***terrestrial*** environment. Depending on the species, an average of about 50 to 140 eggs are laid in one nest, increasing in number from *Natator depressus* to *Eretmochelys imbricata* (Miller, 1997). On occasion, clutch size can be only 1 egg (Hirth, 1997), or as many as 250 eggs (Witzell, 1983).

Embryos: The eggs of a clutch incubate in the high beach, within the egg chamber dug by the female, between about 10 and 110 cm below the surface; the chamber is shallowest in *E. imbricata* and deepest in *D. coriacea* (Witzell, 1983; Benabib and Hernández, 1984). Incubation, which occurs without any parental care, lasts from 6 to 13 weeks, depending mainly on nest temperature. Embryos incubated at a constant temperature will survive and successfully develop within about a 10°C range, which has been reported variously as between 23-33°C (Miller, 1997), or alternatively between 25-27°C and 33-35°C (Ackerman, 1997). Outside this tolerance range embryos are not likely to survive.

During the second third of incubation, the incubation temperature determines the sex of the embryo. The temperature at which there is an equal proportion of males and females is known as the "pivotal temperature." Although pivotal temperatures vary between species, and to a lesser extent between populations, they are generally close to 29°C. With all species, increasing proportions of males are produced the farther critical incubation temperatures fall below the pivotal; increasing proportions of females are produced the more temperatures rise above the pivotal (Mrosovsky, 1994; Ackerman, 1997).

Hatchlings: Hatching success can be highly variable, with nearly all or none of the eggs in a clutch hatching; overall it has been estimated that some 80% of most clutches hatch successfully under natural conditions. Hatching occurs while the eggs are buried in the sand, and it takes from 1 to 7 days for the hatchlings to leave the nest. The process of digging out of the nest often involves "social facilitation," in which the movements of actively digging hatchlings stimulate others to become active and also dig; from within the underground nest chamber, they scrape the sand at the top, trample it down and gradually raise the chamber upwards in the beach (Miller, 1997). Emergence from the nest is usually at night, which helps hatchlings avoid a variety of diurnal predators, as well as hot and potentially fatal beach temperatures that may occur during the day (Lohmann et al., 1997; Miller, 1997). Clearly, hatchlings must contend with nocturnal predators if they emerge at night, but it is thought that these present less of a risk.

The term "incubation period" is generally used to refer to the period between egg laying and hatching (the true incubation period) ***plus*** the period between hatching and emergence from the nest (the "emergence period"). Emergence success (the portion of the clutch that hatches and survives to reach the surface of the beach) is highly variable; in some cases nearly all of the hatchlings make it out of the nest and in other cases they may all die within the nest, before emerging. Emergence success is commonly lower than hatching success, and overall it may be 70% or less.

Upon reaching the surface of the beach the hatchlings normally run toward the sea. During the emergence from the nest and race to the sea, hatchlings exhibit numerous unlearned ("innate") responses to several different stimuli and conditions; for example: gravity (negative geotaxis); temperature (reduced activity with high temperatures); light intensity (positive phototropotaxis); light color (attraction to lower wave wavelengths); light direction (sensitive to light less than 30° above the horizon); and object shapes (aversion to elevated silhouettes and certain shapes) (Lohmann et al., 1997). In other words, simplifying several complex behaviors: without previous experience, hatchlings dig up (against gravity), become inactive in the top layers of the nest when they encounter warm temperatures, and orient on the beach moving toward that part of the horizon (not above 30°) with the greatest light intensity and usually with light of the shortest wavelength; at the same time, they move away from objects and certain kinds of shapes on the horizon.

When they reach the water, hatchlings enter the beach surf, immediately diving through it. Once outside the surf, they swim offshore, usually heading into the waves. Hatchlings can evidently detect orbital movements, which allows them to orient into waves both on the surface and underwater; this may explain how they can maintain their seaward heading as they swim away from the beach, even in total darkness. After distancing themselves from the shore, hatchlings usually continue to maintain the same seaward heading that they took leaving the beach, even if the angle into the waves is not the same as it was when leaving the shore. Experiments show that in the initial stages of swimming away from the beach hatchlings can orient to the magnetic field of the earth, and that their magnetic compasses are sensitive to inclination, rather than polarity. The compass heading that they select after arriving well offshore is apparently influenced by the heading that they take when leaving the nest and swimming out to sea, while orienting to light cues and/or waves (Lohmann et al., 1997).

On arriving offshore, the hatchlings are dispersed in oceanic currents, at which point light and wave cues are of little use to them. Once out to sea, at least some hatchlings seem to have predetermined — and not learned — responses to two components of the Earth's magnetic field: inclination angle and field intensity. This would allow them to approximate latitude and global position, respectively (Lohmann et al., 1997; 1999). In contrast to these generalities, hatchlings of *Natator depressus* apparently do not become pelagic (Walker and Parmenter, 1990), and it is not known what behaviors these hatchlings exhibit when leaving the beach and entering the ocean.

During the first few days after leaving the nest, it appears that several critical innate behaviors help the hatchlings to survive. They have predetermined responses to light, wave wash ("gravity"), and waves (orbital movements —gravity). In addition, immediately after leaving the nest they acquire an ability to orient to the Earth's magnetic field (Lohmann et al., 1997). Survival of the animals is intimately tied to their making the "correct" responses to the right stimulus at the right time, and just slight "mistakes," which could be caused by even small modifications to their environment, can prove fatal to the young turtles.

Emergence from the nest marks the beginning of the "hatchling frenzy" or "swimming frenzy," a period of high and continuous activity, or "hyperactivity," that lasts for at least a day. During this period, hatchlings can swim as fast as 1.57 km/hr, which if maintained would yield nearly 40 km per day. During the "frenzy" phase, hatchling marine turtles show much more stamina than other reptiles. Activity during the "post-frenzy" period is also sustained, although not as intensely as during the swimming frenzy. Unlike other species, hatchlings of *Dermochelys coriacea* may swim actively at night during the post-frenzy period (Wyneken, 1997).

Recently hatched turtles rely on stored yolk as an energy source for the first few days, which enables them to swim continuously, without feeding. The hatchling phase lasts from hatching to the time when the animal begins to feed independently, and no longer relies primarily on the energy stores of the internal yolk sac (Musick and Limpus, 1997).

The hyperactivity of hatchlings appears to be a mechanism to get them from the beach to the open ocean in the shortest possible time, thereby reducing their chances of being attacked in coastal areas, where predators are relatively dense (Musick and Limpus, 1997). There are few systematic studies on hatchling mortality during the brief period from the beach to the open ocean, and although it is variable from beach to beach and season to season, in general mortality during the first few hours can be extremely high.

Juveniles: On entering the open ocean, the hatchling marine turtle begins the juvenile phase of its life cycle. This phase can be divided into two parts: first an oceanic and then a coastal phase. The respective areas where the turtles are found have been called "early juvenile nursery habitats" and "later juvenile developmental habitats." The former corresponds to what was once called the "lost year", but recent studies show that much more than a year is involved, and the pelagic phase may last 10 years or more, depending on species and populations (Chaloupka and Musick, 1997; Musick and Limpus, 1997). There is growing evidence that certain populations of juvenile turtles are dispersed in specific ocean gyres, and that the animals maintain the ability to use the Earth's magnetic field for orientation, as seems to be the case for hatchlings. This would enable them to adjust their position and stay within the gyres to which they pertain and thereby avoid straying into cold waters or being lost from the normal geographic distribution on which their life cycle depends (Lohmann et al., 1997, 1999).

Very little is known about the pelagic phase of juvenile marine turtles, but it is clear that the animals are capable of dispersing across ocean basins during the normal course of the life cycle. Oceanic areas of upwelling and convergence are characterized by having high rates of biological production, with tremendous richness and diversity of life; and these are likely to be prime feeding areas for pelagic juveniles (Musick and Limpus, 1997). Small juveniles of some species are known to associate with rafts of *Sargassum* and other flotsam, where they can hide, as well as find concentrations of prey. Food items for turtles in this life phase include gelatinous organisms and larvae of a wide variety of invertebrates, as well as terrestrial insects. Although some plant matter (mainly *Sargassum* parts) has been documented in their diet, pelagic juveniles are essentially carnivores (Bjorndal, 1997).

In general, during the oceanic phase the juveniles are dispersed passively in oceanic currents. Although they have been characterized as "swimming drift bottles", having no specific destination goals and depending on current regimes (Wyneken, 1997), recent work (Lohmann et al., 1997, 1999) indicates that turtles on the high seas may not be completely passive, but have the ability to orient with directed swimming to stay within certain ocean gyres. This phase, while they are developing on the high seas, may involve travels of tens of thousands of kilometers, carrying an individual turtle into and out of the territorial waters of many nations, as well as across the high seas. Little is known of rates of mortality during the pelagic phase; different demographic models indicate that it may vary between 20 and 60% per year (Crouse et al., 1987; Heppell et al., 1996).

After several years, most species of juvenile marine turtles leave the pelagic, open-ocean environment and enter coastal environments. In contrast to the early juvenile phase, the second part of the juvenile phase occurs in benthic (bottom) neritic (coastal) environments. The age and size (expressed in carapace length) at which this major transition occurs varies according to species, populations and environmental factors. For example, in the western Atlantic, juvenile *Caretta caretta* enter coastal environments when they reach 25-30 cm in carapace length, but in Australia the transition more typically occurs at 70 cm. Generally, for most species the transition from pelagic to neritic life style occurs when juveniles are between 20 and 50 cm long, with *Eretmochelys imbricata* and *Lepidochelys kempii* arriving at much smaller sizes than the other species. However, there is no consensus about sizes of juveniles that first take up residence in coastal habitats (Bjorndal, 1997; Musick and Limpus, 1997).

Three species present exceptions to these generalizations. *Natator depressus* evidently never takes up a pelagic existence, so there is no return to coastal environments from which it never departed. Once having left the beach, *Dermochelys coriacea* stays in the open ocean except for nesting; and although foraging often occurs seasonally in certain coastal areas, mainly in the temperate zone, there is no evidence of this species taking up residency in coastal areas. Some populations of *Lepidochelys olivacea* also seem to stay in pelagic environments, except for breeding (Pitman, 1990; Plotkin et al., 1995).

The juvenile turtles that do take up coastal residence in certain inshore areas seem to establish "home ranges." It appears that the smallest juveniles make use of relatively shallow environments, or those with structures, such as reefs, which allows them to hide from large predators. Once a juvenile has taken up coastal residence, it can exhibit considerable site tenacity to feeding areas, and some individuals may stay within the same few square kilometers for 8 to 20 years while they are maturing. In at least one population — *Caretta caretta* in eastern Australia — juveniles establish feeding sites that are maintained into adulthood. Juveniles and adults occur together in foraging areas of some populations of some species. There are differences, of varying degrees, between the species in the types of environments used for developmental habitats (Musick and Limpus, 1997).

Where seasonal variation in water temperature is strong, juveniles may make seasonal migrations, either north-south or inshore-offshore, to avoid cold temperatures, which can cause physiological stunning and death. Contrary to popular opinion, marine turtles are not restricted to tropical waters, but often occur in sub-tropical or temperate areas, at least seasonally. Once established in coastal environments, juveniles of most species reside in a series of different environments, or "developmental habitats," moving sequentially through them while maturing (Musick and Limpus, 1997). Hence, the developmental habitats for a single individual may take it through several different geopolitical units or countries, as well as through wide ranging latitudes, perhaps even to both northern and southern hemispheres. Little is known about rates of mortality of juveniles in coastal habitats, and different demographic models predict that about 30% per year may die (Crouse et al., 1987; Crowder et al., 1994; Heppell et al., 1996).

When juveniles transmute from a pelagic to a benthic life style, dramatic changes in diet occur. The variety of food items eaten by marine turtles in coastal environments is tremendous. Not only algae and marine angiosperms are consumed, but animals from virtually all phyla and classes of invertebrates are ingested, with truly astonishing examples such as sea horses, sea cucumbers, thick-shelled mollusks, and whip corals. The diets vary between species, but also between growth phase, locality, season, and behavioral and ecological factors. Nevertheless, on taking up residence along the coast, juveniles develop dietary specializations typical of each species. These can be generalized as follows: *Caretta caretta* — benthic mollusks; *Chelonia mydas* — algae and marine angiosperms; *Eretmochelys imbricata* — sponges; and *Lepidochelys kempii* — benthic crabs. The species that are exceptions to the oceanic-coastal transition generally have less defined diets: *Lepidochelys olivacea* — diverse items from both the surface and bottom; *Natator depressus* — surface and benthic invertebrates; *Dermochelys coriacea* — pelagic soft-bodied invertebrates, including jellyfish, ctenophores and salps, from both the surface and deep scattering layer (DSL). Hence, there are not likely to be marked dietary shifts in juveniles of these last three species as they mature (Bjorndal, 1997).

Feeding can include several remarkable behaviors. In Australia, *Caretta caretta* are documented excavating depressions in the substrate, exposing burrowing invertebrates on which the turtles prey. *Chelonia mydas* in some areas graze repeatedly on specific swatches of seagrass pastures, keeping them in a state of high productivity and digestibility. Dietary preferences of marine turtles may be influenced by early experience. However, the relative abundance of food items also affects feeding behavior, but there is no doubt that marine turtles can be very selective about what they eat. Feeding can be tied to tidal cycles, and may show diurnal peaks in activity. Each species is very efficient at living off its specialized food, and at least in some cases this is directly related to specialized microbial communities in the gut (Bjorndal, 1997). The shape and form of the beak gives an indication of what the turtles eat as large juveniles and adults: *Chelonia mydas* has a relatively broad beak, effective in grazing; *Eretmochelys imbricata* has a relatively narrow beak, effective at selecting items from within nooks and crannies in a coral reef; *Lepidochelys* has a strong, sharp-edged beak that can fracture hard-shelled invertebrates; *Caretta caretta* has a heavily fortified beak, effective at crushing thick-shelled prey; and *Dermochelys coriacea* has sharp cusps, one on either side of the mandible, that are useful in tearing soft-bodied prey.

Adults: After maturing, and growing into breeding condition, adults migrate from their feeding area to a nesting area, which is usually at or near their birthplace. The distance between feeding and breeding grounds can be thousands of kilometers. Marine turtles are famous for not only making lengthy migrations, but for their ability to return to specific beaches to mate and nest. It appears that turtles can return to, or near to, the beach on which they hatched, even after spending decades on the open ocean and in diverse environments thousands of kilometers from their natal beach. This phenomenon is known as "natal beach homing," but the mechanisms that are used to accomplish these incredible feats are not well understood. Navigational abilities were once thought to rely on chemical cues, but studies of the routes taken during migration indicate that chemical stimuli could not be used. Several studies using satellite transmitters have shown that turtles can head straight toward a relatively small target, from hundreds of kilometers away, and that they can reorient to a destination after being experimentally displaced. There is growing evidence that marine turtles have a "map sense" and that the Earth's magnetic field provides critical information for their navigational feats. Nonetheless, chemical cues may be important for the recognition of the natal beach, especially during the last leg of a trans-oceanic migration. Although the turtles seem to have no trouble finding their way home from across oceans, despite decades of study scientists still do not understand how (or why) they do this (Lohmann et al., 1997; 1999).

Most populations reproduce at specific places and certain times of the year, often during distinct breeding seasons. Hence, during breeding, marine turtles are concentrated in both time and space. In general, it is thought that the males arrive first, there is a peak in courtship and mating, and then the females begin nesting. One female usually nests several times during a single nesting season: the average number of clutches per female for each species varies from nearly 2 to 6, with the least in *Lepidochelys kempii* and most in *Dermochelys coriacea* (Miller, 1997). There are records of *Chelonia mydas* in Malaysia laying 10 nests in one season (Liew and Chan, in press) and

Dermochelys coriacea in Costa Rica laying 13 nests in one season (R. Reina, pers. comm.). The average interval between subsequent nestings varies from 9 to 30 days, depending on the species. A single excursion onto the nesting beach generally lasts from 1 to 3 hours, again depending on the species, although there are extreme cases of nesting being completed in less than 1 hour, and on the other extreme, some females may spend more than 7 hours on the beach. Nesting females customarily return to the same beach for each subsequent nest (Miller, 1999).

Most nesting occurs during the night; studies of the thermal biology of marine turtles indicate that if they nested during the day, the females would become heat stressed and could die. Exceptions to this are turtles with the smallest body sizes, *Eretmochelys imbricata*, *Lepidochelys kempii*, and *L. olivacea*, which can nest during the day and not be heat stressed, evidently because their smaller bodies are more efficient at losing heat (Spotila et al., 1997).

When finished reproducing, the adults migrate back to their respective feeding areas; males may depart earlier in the season than females. Based on tag returns, the distance of "post-nesting" migrations is often more than 2,000 km; these studies involved relatively short periods, rarely more than 2 or 3 months, between leaving the nesting grounds and recapture, as well as the calculation of straight-line distances between point of release and point of recapture (Meylan, 1982), so the values are certain to be underestimates. In satellite tracking studies of *Dermochelys coriacea*, post-nesting movements of more than 11,000 km over the course of one year have been reported (Eckert, 1998). Capture-recapture data of tagged females indicate that post-nesting migrations can begin with remarkable rates of movement, of more than 82 km per day (Meylan, 1982), which translates to an average of more than 3.4 km per hour sustained for a period of weeks. Examples of rapid, long distance displacements of turtles after they leave the nesting grounds are becoming more frequent as research efforts increase. For example, a female *Dermochelys coriacea* tagged in French Guiana was recovered in Newfoundland, having traveled no less than 5,000 km in no more than 128 days; this represents a direct straight line (minimum) movement of 39 km/day (Goff et al., 1994). What makes these rates even more remarkable is that migration routes of adults may involve extended distances moving across, or even against, ocean currents, as the animals head for their destinations (Wyneken, 1997). Nevertheless, it is important to distinguish between rates of displacement, or movement, and actual swimming speeds, because currents can have a major impact on rates of displacement, especially over long periods of time.

On returning to the feeding ground, turtles may take up the same home range and feeding site they occupied prior to embarking on their breeding migration. In some cases there are seasonal migrations, from one feeding area to another (Musick and Limpus, 1997). Most species do not nest every year, but every 2 or 3 years (Miller, 1997), although there is considerable variation, and close to a decade between nesting seasons may pass in some cases (Hirth, 1997). As a result, the composition of the "breeding population" is unique each year; there will be animals that are breeding for the first time in their lives, together with other animals that have bred previously, but with no fixed interval between breeding seasons.

Marine turtles have the capacity to continue migrating and breeding for at least 21 years (Pandav and Kar, 2000). Based on demographic studies, it has been concluded that once marine turtles reach adulthood, they potentially have high rates (over 90%) of annual survivorship (Frazer, 1984; Richardson et al., 1999; Kendall and Kerr, in press). Nonetheless, large numbers of adult turtles have been killed in directed harvests at nesting beaches all over the world, and this has resulted in unnaturally high adult mortality which has been devastating to diverse populations (King, 1982; Ross, 1982; Groombridge and Luxmoore, 1989; NRC, 1990). In today's "human-dominated world," mortality of adult turtles also occurs in hard-to-document high seas fisheries, and the impacts of these "out-of-sight" activities may be even more insidious than slaughtering nesting females on beaches (Eckert and Sarti, 1997; Crouse, 1999, 2000; Musick, 1999).

The most convenient and reliable way to estimate numbers of turtles in a population is to count nesting females during a nesting season. Yet even this apparently straightforward procedure is fraught with basic problems (Gerrodette and Taylor, 1999). In addition to the fact that each season there is a completely unique assemblage of individuals, there can be large and rapid variations from year to year, with no clear long-term trends. Further complications arise when trying to understand which animals are part of the same population (Chaloupka and Musick, 1997). It has been known for years that the individuals living together on a foraging ground often derive from very different nesting beaches. At the same time, the turtles that converge on a single nesting beach may arrive from divergent feeding areas. This mixing on feeding and nesting grounds is being deciphered with studies of genetic markers (Bowen and Karl, 1997), but it continues to complicate the identification of marine turtle populations. Because of the great distances traversed during their migrations, individual marine turtles routinely pass through the territorial waters of several different countries, as well as across the high seas. This obviously further complicates understanding about them, to say nothing of developing and implementing conservation programs (Frazier, 2000).

Other distinctive adaptations and characteristics of marine turtles

Marine turtles have remarkable capabilities for diving; among air-breathing vertebrates they have some of the longest and deepest dives. Routine dives may last for nearly an hour, and some voluntary dives have persisted for as much as 5 h (Lutcavage and Lutz, 1997). Dives as deep as 1,300 m are reported for *Dermochelys coriacea* (Eckert et al., 1989). Not only do the turtles breath-hold during dives, but usually they are also exercising. Marine turtles have several morphological and physiological adaptations that give them this tremendous capacity for diving and breath-holding. They have very efficient oxygen transport systems. The lungs are relatively large and provided with internal structures to facilitate efficient ventilation; hence, tidal volumes are very large. Blood transport systems for oxygen are extraordinary. Hemoglobin and myoglobin levels in *Dermochelys coriacea* are nearly as high as in mammals; not surprisingly, these turtles have the highest rate of oxygen consumption of any reptile. Just as remarkable is the fact that at least in one species, *Caretta caretta*, the brain can survive under anoxic conditions. Nevertheless, apparently marine turtles only enter an anaerobic state under emergency conditions, and it may take hours for them to fully recover physiologically. There are, however, considerable differences between species, both in terms of diving capability and diving adaptations (Lutcavage and Lutz, 1997).

Marine turtles spend varying amounts of time at the surface, engaged in activities that include basking, feeding, mating and orienting. Reported dive routines are highly variable, but generally turtles seem to spend at least 80% of the time submerged. Although they appear to have all the morphological adaptations required for diving, hatchlings have limited capacity to submerge, and need several months to develop buoyancy control (Lutcavage and Lutz, 1997).

At least two species of marine turtle, *Caretta caretta* and *Chelonia mydas*, (and possibly also *Lepidochelys kempii*) can become torpid with cold temperatures and may dig into the seabed, a phenomenon known as "brumation" (also called "hibernation") (Ogren and McVae, 1982; Musick and Limpus, 1997). However, cold temperature alone does not explain how this state is initiated, for the same temperatures in other cases are associated with some level of activity or with seasonal emigrations, in which the turtles move away to warmer waters (Lutcavage and Lutz, 1997). Low temperature has several effects on turtles, particularly on their blood physiology. It is not known how brumation affects the physiological state of marine turtles, but there are certain to be a number of specialized adaptations to deal with diverse problems that arise from prolonged breath hold and its many implications on the osmotic and ionic condition of blood. Temperature-related differences in the physiology of different species of turtles may explain latitudinal differences in their geographic ranges (Lutz, 1997).

Marine turtles live most of their lives in seawater, and must deal with continual and heavy salt loads. During the normal course of both feeding and drinking, they will take in large amounts of seawater, which could have adverse, or fatal, effects on the osmotic and ionic condition of the body. The most notable adaptation is the highly modified lachrymal gland, which can produce tears with osmotic concentrations that are six times that of blood, and twice that of seawater. Marine turtle tears are more concentrated than the salt gland excretions of both sharks and marine birds. Their lachrymal gland is highly convoluted, with structures that enable the turtle to concentrate not only salt, but also bicarbonate, bromine, calcium, magnesium, and potassium. At the same time, the tears have relatively low concentrations of glucose and protein. The gland is relatively large, twice the size of the brain in *Dermochelys coriacea*. In hatchlings the lachrymal gland is relatively larger than in adults: it is 0.4% of total body weight in hatchling *Chelonia mydas*. The tears, except in *Dermochelys coriacea*, may not be constant, but increase in both flow and concentration when the gland is stimulated, for example by a heavy salt load in the blood. Interestingly, the left and right salt glands may produce different rates and concentrations of tears. However, although marine turtles have the capacity to maintain the osmotic and ionic concentration of plasma relatively constant, if the animals are kept for several months in fresh water, there is a marked reduction in plasma sodium, so there is some flexibility in their physiological responses (Lutz, 1997).

Although they spend the vast majority of their lives in the ocean, marine turtles do come out onto dry land. Adult females come onto beaches to dig nests and lay eggs. In addition, at least one, and possibly two, species will haul out on isolated beaches to bask (Wyneken, 1997). The best studied cases are from Hawaii, where juveniles and adults of both sexes of *Chelonia mydas* will haul out onto remote beaches (Whittow and Balazs, 1982). This behavior is thought to be a form of thermoregulation, which allows the basking animals to increase their body temperature, and thereby enhance certain metabolic processes (Spotila et al., 1997). In some cases turtles may leave the sea to avoid large sharks, and females may crawl out onto beaches to get away from aggressive, courting males.

Marine turtles have the capability to maintain their body temperatures above the temperature of the surrounding water. A *Chelonia mydas* that was actively swimming had a body temperature 7°C above water temperature. More remarkable, *Dermochelys coriacea* are often found in boreal zones, with water temperatures as cold as 0°C; and there is a record of one animal with a body temperature 17°C above water temperature. The large body size results in considerable thermal inertia, but other features that allow body temperatures to be above the environment are: thick outer insulation, circulatory shunts that conserve body heat, and high rate of metabolism. Small-sized marine turtles, however, are liable to cold stunning when water temperature drops to 8°C and below (Spotila et al., 1997).

Marine turtles may be important in structuring some marine environments. Feeding on seagrass, or in algal beds, and selective predation on certain sponges living on coral reefs can alter the distribution and abundance of prey species, as well as the respective roles that they play in the ecosystem. This topic is poorly understood, and now that many marine turtle populations have been decimated, their ecological roles and impacts are even more difficult to decipher (Bjorndal, 1997; Jackson, 1997).

Summary of life history characteristics of marine turtles

Each of the living species of marine turtles has a remarkably complex and specialized life cycle. Individuals require a wide diversity of environments in order to mature, reach adulthood and complete the life cycle. Except *Natator depressus*, which seems to lack the pelagic phase, the environments on which all marine turtles depend include: terrestrial beaches, open ocean, and coastal and estuarine waters. Individual turtles disperse and migrate over vast distances, often tens of thousands of kilometers, during the normal course of life. These vast distances routinely take them across the high seas, as well as through the territorial waters of different countries. They take decades to mature: the time from egg until returning to the same beach to breed requires 10 to 50 or more years. Marine turtles are capable of living and reproducing for decades. Typically, they have a very high reproductive output: some 80 to 200 eggs are laid in one nest, as many as 14 nests may be laid in one season, and an individual may continue nesting for more than 20 years. In many ways, a female is an "egg machine." On the other hand, marine turtles have extremely high mortality during early phases of the life cycle. Many eggs do not survive to hatch, many hatchlings do not make it to the sea, and many hatchlings in the sea do not live more than a day. From one phase to another, fewer and fewer turtles remain in the population, and in the end, less than one out of 1,000, possibly less than one out of 10,000, eggs survive to produce an adult turtle. In many ways the survival of a marine turtle depends on it making the right responses at the right times, and encountering adequate conditions in specific environments. This may involve a specific response to light on the horizon and the successful run from the beach to the sea, the avoidance of a certain body of water on the high seas, the selection of a specific type of environment for feeding and refuge, or the response to certain cues emanating from a particular nesting beach.

Relevance of life history characteristics to conservation actions

The diversity of environments on which a single marine turtle depends during the course of its life cycle means that to be effective, conservation efforts for these animals must be relevant not only to nesting beaches, but also to many coastal and near-shore environments, as well as to certain areas of the high seas. The immensity of the spatial scale involved is emphasized even further by the fact that these animals range across ocean basins, routinely passing through the jurisdictional waters of different nations. Thus, in addition to many environments and large areas, conservation efforts must include international cooperation.

Adding to the ecological, spatial and political complexity, are other characteristics typical of marine turtles that invoke tremendous time scales. For example, these animals may require decades — perhaps half a century — to reach maturity, and they have the potential to live and continue breeding for decades. The high reproductive output, with a single female potentially producing more than a thousand eggs in a single season and reproducing for more than two decades, often deceive people into thinking that the remarkable fecundity of marine turtles allows them to sustain high rates of mortality. But in fact, very few of the eggs survive to be adults, so the survival of adults and large juveniles, in particular, is critical to the status of a marine turtle population. Any significant source of mortality to adults and large juveniles is likely to pose a serious threat; if the problem is unseen — such as on the high seas from fishing activities — it can be especially insidious, because it will most likely be undocumented and unknown. These factors, particularly the slow rate of maturation and long life, mean that conservation actions must be faithfully maintained and regularly evaluated persistently and patiently for decades, if not for centuries.

Furthermore, many basic aspects of marine turtle biology are poorly understood, making it impossible to predict accurately even simple phenomena from year to year. Dramatic variations in the numbers of turtles that nest annually are common, and moreover, each year the nesting "population" is made up of a unique pool of individuals, some of which are nesting for the first time, and others of which have survived and returned after previous breeding seasons. There is as yet no way to predict either the composition or the size of a nesting "population" from year to year; and the numbers of nesters or nests recorded in certain years may belie the effort and efficiency in beach patrolling and other conservation actions. For these reasons it is essential to evaluate long-term trends, and regard short-term observations as only tentative indicators.

Total population estimates are a major challenge because there is little systematic information on juveniles, males, or non-breeding females. Hence, despite the many problems and shortcomings, the *least inaccessible* segment of the population that is *least difficult* to estimate is the "annual nesting population," and often this is approximated indirectly by estimating annual production of clutches, eggs, nests or nesting signs. Rarely are accurate numbers of nesting females available (even for a single nesting season), much less reliable estimates of the other sectors of the population. This means that many decisions about conservation and management must be made with information that is grossly insufficient.

The fact that the sex of a marine turtle is determined by the temperature of incubation, means that management practices involving the embryonic phase must take into account sand temperature, shading and other details that are often not attended to. Because the survival of a marine turtle depends on it making the right responses at the right times — often relying on innate behaviors — and encountering adequate environments, it is not just the turtles that need to be protected. Even seemingly slight modifications to the environment can have devastating effects to large numbers of marine turtles, so that successful marine turtle conservation depends intimately on environmental protection.

It must be recognized that the biological requirements of the species involved are non-negotiable, just as much as the fact that there is gravity on planet Earth. Consequently, the effectiveness of conservation activities is directly related to the degree to which they are able to meet these biological requirements. However, decisions about the design, implementation and maintenance of conservation programs are made within the political arena, and reflect the complex interplay between societies and their cultural, political and economic activities – not necessarily scientific opinion or expert recommendations. Hence, to be successful, conservation actions must be relevant to the societies in which they are carried out, for in the end biological conservation depends on political decisions made within social and economic contexts (Frazier, 1999).

In short, because of their biological characteristics, marine turtle conservation is highly complex, difficult to predict accurately, and requires long-term commitments. In many ways the status of these charismatic animals serves as a barometer of how well modern societies are taking care of the environment upon which we all depend.

Author's note: Unfortunately, there are no uniform standards in reporting the sizes of marine turtles after they pass the hatchling phase: some studies use measurements taken over the curve of the shell, while others report point-to-point values taken with calipers; and in many cases it is not explained how measurements were taken (Chaloupka and Musick, 1997; Music and Limpus, 1997). This is to say nothing of the unreported (Bolton, 1999) — sometimes significant (Frazier, 1998) — error in marine turtle measurements. Hence, for the purposes of this general paper, to avoid detailed deliberations and endless conversions from one measurement type to another, only broad generalities have been referred to assuming curved carapace length (CCL).

Acknowledgements

Preparation of this presentation benefited from valuable comments by S. Bache, D. Crouse, K. Eckert and L. Sarti M., as well as support from the World Wildlife Fund.

Literature Cited

Ackerman, R. A. 1997. The nest environment and the embryonic development of sea turtles, p.83-106. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Benabib N., M. and J. A. Hernández. 1984. Conservación de las tortugas marinas en la playa de Mexiquillo, Michoacán. Informe final de Biología de Campo, Facultad de Ciencias, Universidad Nacional Autónoma de México, México D. F.

Bjorndal, K. A. (ed.) 1982 The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C. 569 pp (reprinted in 1995, with new final section "Recent Advances in sea turtle biology and conservation", 615 pp.)

Bjorndal, K. A. 1997. Foraging ecology and nutrition of sea turtles, p.199-231. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Bjorndal, K. A. and G. R. Zug. 1995 (rev. ed.). Growth and age of sea turtles, p.599-600. *In*: K. A. Bjorndal (ed.), The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C.

Bolton, A. B. 1999. Techniques for measuring sea turtles, p.110-114. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4.

Bowen, B. W. and S. A. Karl. 1997. Population genetics, phylogeography, and molecular evolution, p. 29-50. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Chaloupka, M. Y. and J. A. Musick. 1997. Age, growth and population dynamics, p.233-276. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Crowder, L. B., D. T. Crouse, S. S. Heppell and T. H. Martin. 1994. Predicting the impact of turtle excluder devices on loggerhead sea turtle populations. Ecological Applications 4(3): 437-445.

Crouse, D. 1999. The Consequences of Delayed Maturity in a Human-Dominated World. American Fisheries Society Symposium 23: 195-202.

Crouse, D. 2000. After TEDs: What's next?, p. 105-106. *In*: F. A. Abreu-Grobois, R. Briseño-Dueñas, R. Marquez-Millán and L. Sarti-Martínez (compilers). Proc. 18th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-436. U.S. Dept. Commerce.

Crouse, D. T., L. B. Crowder and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology 68(5):1412-1423.

Eckert, S. A. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year-long tracking of leatherback sea turtles, p.44-46. *In:* S. P. Epperly and J. Braun (eds.), Proc. 17th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-415. U.S. Dept. Commerce.

Eckert, S. A. and L. Sarti M. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Eckert, S. A., K. L. Eckert. P. Ponganis and G. L. Kooyman. 1989. Diving and foraging behavior of leather back sea turtles *Dermochelys coriacea*. Canadian Journal of Zoology 67: 2834-2840.

Frazer, N. 1984. Survivorship of adult female loggerhead sea turtles, *Caretta caretta*, nesting on Little Cumberland Island, Georgia, USA. Herpetologica 39: 436-447.

Frazier, J. 1998. Measurement error: The great chelonian taboo, p.47-49. *In*: R. Byles and Y. Fernandez (compilers), Proc. 16th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-412. U.S. Dept. Commerce.

Frazier, J. 1999. Community based conservation, p.15-18. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4.

Frazier, J. 2000. Building support for regional sea turtle conservation in ASEAN and the Asian region: Learning from the Inter-American Convention for the Protection and Conservation of Sea Turtles, p. 277-303. *In*: N. Pilcher and G. Ismail (eds.) Sea Turtles of the Indo-Pacific: Research, Management and Conservation. ASEAN Academic Press. London.

Frazier, J. and S. J. Bache. In press. Sea turtle conservation and the "big stick": the effects of unilateral U.S. embargoes on international fishing activities. *In*: A. Mosier and M. Coyne (compilers), Proc. 20th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-xxx. U.S. Dept. Commerce.

Gerrodette, T. and B. L. Taylor. 1999. Estimating population size, p.67-71. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4.

Goff, G. P., J. Lien, G. B. Stenson and J. Fretey. 1994. The migration of a tagged leatherback turtle, *Dermochelys coriacea,* from French Guiana, South America, to Newfoundland, Canada in 128 days. Canadian Field Naturalist 108 (1): 72-73.

Groombridge, B. and R. Luxmoore. 1989. The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. CITES Secretariat, Lausanne, Switzerland. 601 pp.

Heppell, S. S., L. B. Crowder and D. T. Crouse. 1996. Models to evaluate headstarting as a management tool for long-lived turtles. Ecological Applications 6(2): 556-565.

Hirth, H. F. 1997. Synopsis of the Biological Data on the Green Turtle *Chelonia mydas* (Linnaeus 1758). Biological Report 97(1):1-120. U.S. Dept. Interior, Fish and Wildlife Service. Washington, D. C.

Jackson, J. B. C. 1997. Reefs since Columbus. Coral Reefs. 16 Supl.: 823-832.

Karl, S. A. and B. W. Bowen. 1999. Evolutionary significant units versus geopolitical taxonomy: Molecular systematics of an endangered sea turtle (genus *Chelonia*). Conservation Biology 13(5): 990-999.

Kendall, W. and R. Kerr. In press. Estimating probability of breeding for sea turtle populations based on capture-recapture data. *In*: A. Mosier and M. Coyne (compilers), Proc. 20th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-xxx. U.S. Dept. Commerce.

King, F. W. 1982. Historic review of the decline of the green turtle and the hawksbill, p.183-188. *In*: K. A. Bjorndal (ed.), The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C. (reprinted in 1995).

Liew H.-C. and E.-H. Chan. In press. Assessment of the population of green turtles nesting at Redang Island, Malaysia, through long-term tagging analysis. *In*: A. Mosier and M. Coyne (compilers), Proc. 20th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-xxx. U.S. Dept. Commerce.

Limpus C. J., P. J. Couper and M. A. Read. 1994a. The green turtle, *Chelonia mydas*, in Queensland: population structure in a warm temperate feeding area. Mem. Queensland Museum 37(1):139-154.

Limpus, C. J., P. J. Couper and M. A. Read. 1994b. The loggerhead turtle, *Caretta caretta*, in Queensland: population structure in a warm temperate feeding area. Mem. Queensland Museum 37(1):195-204.

Lohmann, K. J., B. E. Witherington, C. M. F. Lohmann and M. Salmon. 1997, p.107-135. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Lohmann, K. J., J. T. Hester and C. M. F. Lohmann. 1999. Long-distance navigation in sea turtles. Ethology, Ecology and Evolution 11: 1-23.

Lutcavage, M. E. and P. L. Lutz. 1997. Diving physiology, p. 277-296. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Lutz, P. L. 1997. Salt, water, and pH balance in sea turtles, p. 343-361. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Lutz, P. L. and J. A. Musick (eds.). 1997. The Biology of Sea Turtles. CRC Press, New York. 432 pp.

Márquez M., R. 1994. Synopsis of Biological Data on the Kemp's Ridley Turtle, *Lepidochelys kempi* (Garman, 1880). NOAA Tech. Memo. NMFS-SEFSC-343. U.S. Dept. Commerce. 91 pp.

Meylan, A. 1982. Sea turtle migration – Evidence from tag returns, p.91-100. *In*: K. A. Bjorndal (ed.), The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C. (reprinted in 1995).

Miller, J. D. 1997. Reproduction in sea turtles, p.51-81. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Molina, S. 1981. Leyendo en la tortuga (recopilación). Martin Casillas Editores; Mexico. 173 pp.

Morgan, P. J. 1989. Occurrence of leatherback turtles (*Dermochelys coriacea*) in the British Isles in 1988, with reference to a record specimen, p.119-120. *In:* S. A. Eckert, K. L. Eckert and T. H. Richardson (compilers), Proc. 9th Annual Workshop on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFC-232. U.S. Dept. Commerce.

Mrosovsky, N. 1994. Sex ratios of sea turtles. Journal of Experimental Zoology 270: 16-27.

Musick, J. A. 1999. Ecology and conservation of long-lived marine animals. American Fisheries Society Symposium 23: 1-10.

Musick, J. A. and C. J. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles, p.137-163. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

NRC (National Research Council). 1990. Decline of the Sea Turtles: Causes and Prevention. National Academy Press, Washington, D. C. xv + 259 pp.

Ogren, L. and C. McVae, Jr. 1982. Apparent hibernation by sea turtles in North American waters, p.127-132. *In*: K. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C. (reprinted in 1995).

Pandav, B. and C. S. Kar. 2000. Reproductive span of olive ridley turtles at Gahirmatha rookery, Orissa, India. Marine Turtle Newsletter 87: 8-9.

Pitman, R. L. 1990. Pelagic distribution and biology of sea turtles in the eastern tropical Pacific, p.143-148. *In:* T. H. Richardson, J. I. Richardson and M. Donnelly (compilers), Proc. 10th Annual Workshop on the Biology and Conservation of Sea Turtles. NOAA Tech. Memo. NMFS-SEFC-278. U.S. Dept. Commerce.

Plotkin, P. T., R. A. Byles, D. C. Rostal and D. W. Owens. 1995. Independent vs. socially facilitated migrations of the olive ridley, *Lepidochelys olivacea*. Marine Biology 122:137-143.

Pritchard, P. C. H. 1997. Evolution, phylogeny, and current status, p.1-28. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, external morphology, and species identification, p. 21-38. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4.

Richardson, J. I., R. Bell and T. H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3(2): 244-250.

Ross, J. P. 1982. Historic decline of the loggerhead, ridley, and leatherback sea turtles, p.189-195. *In*: K. A. Bjorndal (ed.). The Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C. (reprinted in 1995).

Spotila, J. R., M. P. O'Connor and F. V. Paladino. 1997. Thermal biology, p.297-314. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Van Buskirk, J. and L. B. Crowder. 1994. Life-history variation in marine turtles. Copeia 1994: 66-81.

Versteeg, A. H. and F. R. Effert. 1987. Golden Rock: The first Indian village on St. Eustatius. St. Eustatius Historical Foundation No. 1. 21 pp.

Walker, T. A. and C. J. Parmenter. 1990. Absence of a pelagic phase in the life cycle or the flatback turtle, *Natator depressus* (Garman). Journal Biogeography 17:275-278.

Whittow, G. C. and G. H. Balazs. 1982. Basking behavior of the Hawaiian green turtle (*Chelonia mydas*). Pacific Science 36(2):129-139.

Wing, E. S. and E. J. Reitz. 1982. Prehistoric fishing economies of the Caribbean. New World Archaeology 5(2): 13-22.

Witzell, W. N. 1983. Synopsis of Biological Data on the Hawksbill Turtle *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis No. 137, Rome. iv + 78 pp.

Wyneken, J. 1997. Sea turtle locomotion: Mechanisms, behavior and energetics, p.165-198. *In*: P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Cultural and Economic Roles of Marine Turtles

Didiher Chacón Chaverri
Programa Marino
Asociación ANAI
Costa Rica

Dr. Archie Carr once wrote "…the green turtle population under study [at Tortuguero, Costa Rica] has seemed to embody most of the problems and complexities that plague any effort to intervene on behalf of a migratory animal that is at once economically valuable, prone to cross international boundaries in its reproductive travel, and heavily exploited on both its breeding and feeding grounds." (Carr, 1971). I hope that by the end of this meeting, we will see the wisdom of his words.

All of us present at this meeting are part of a bioregion where the common factors are ocean resources. The Wider Caribbean Region unites the biological influences of both North and South, giving us a magnificent biodiversity in continental and marine areas. The convergence is also reflected in our cultural heritage. Archaeological remains show that the native peoples of the Caribbean have been using biological resources, such as sea turtles, since the third millenium BC.

Mosseri (1998) refers to the relationship between ancient cultures and sea turtles as follows: "Thus nature seems to have given them in one single gift the way to satisfy many needs, since one and the same animal is nourishment, container, house and vessel." Sea turtles also play an important role as mystic elements in different cultures. It was undoubtedly a special relationship between the aborigines and their environment that led them to worship natural deities. Sea turtles were chosen as the subject for legends, to embody the spirit of the good as well as the bad. They were also messengers of the gods (Chacón et al., 2000).

Pottery, stone sculpture, and valuable jewelry are proof that indigenous peoples used sea turtles as part of their cultural heritage. The early inhabitants of the tropical area of the Americas were definitely attracted by and valued these reptiles. Today this rich cultural heritage in which sea turtles play a very important role resides mostly in the stories, fables, and legends which are transmitted orally from one generation to another.

While the artistic and mystic usage of sea turtles is not measured by economic values, from a nutritional standpoint the situation is quite different. Indigenous groups (e.g., Caribs, Wayuú. Kunas, Miskito, Guajiros, Ramas, Garifunas, Nöbes, and others) have long relied upon sea turtles as an important source of protein in their diet. Upon the arrival of Europeans to the Americas at the end of the 1400s, the only documented use of sea turtles was that practiced by native peoples. The record shows that in some places this use was intensive, and in others it occurred on a less intensive subsistence basis.

The emphasis on using sea turtles for nutrition changed with advances in transportation and storage. In the late 16th century, commercial trade in meat began. Settlements along some coastal communities reflect human migration to sea turtle nesting areas. Stories abound of the Miskito moving throughout Central America looking for sea turtles. By the 17th century, indigenous groups were selling green turtles (*Chelonia mydas*) to the British who kept them alive on their voyages to Europe in order to feed sailors, settlers, slaves, and European consumers.

Turtle use patterns by indigenous peoples changed with the arrival of European settlers to the Caribbean region (use pattens became more commerical), but today there are indigenous groups that still survive by using sea turtles on a subsistence basis. What will happen to local indigenous economies with turtle-eating customs if the turtles disappear?

With the expansion of European colonization in the Caribbean, changes in the environment and the displacement and eradication of many indigenous cultures was a rapid and profound process. The new inhabitants placed an increased demand on the environment, including larger quantities of sea turtles. The English, French, African, Meztizo and Indigenous use of the environment commingled, and in this process not only the native use patterns but the individuals themselves were exposed to foreign influence.

In the middle of the 18th century a mix of European and African cultures flourished in our region. New economies developed, some based on sea turtles. Whereas indigenous peoples had once used and eaten substantial quantities of turtles, they were considered only a source of nourishment and not an important source of revenue. New cash economies placed a high value on sea turtles, and encouraged greater exploitation. As a result, sea turtle populations declined. By this time the populations of Bermuda and Grand Cayman were intensely exploited.

According to anthropologist Paula Palmer, "The Miskito and Afro-Caribbean turtle hunters visited several sites in Central America and the Caribbean from the beginning of the second half of the 17th century, rowing or sailing from Bocas del Toro (Panama) and from the coast of Nicaragua, and would arrive in March and stay until September catching sea turtles with harpoons. They worked the whole turtle through: they collected the shells and sold them in Bocas del Toro, to be exported to Germany to be made into combs and buttons." (Palmer, 1986)

As I interpret these facts, turtle use for subsistence was not a threat when compared to more modern commercial exploitation. Moreover, the preservation and protection of contemporary indigenous cultures requires the conservation of their natural systems, particularly those related to the species they eat. Besides their mystical significance and their artistic and gastronomic importance, sea turtles have been a main attraction for the migration of people who, in search of such a precious animal, have moved along the coasts and islands to harvest turtles thus giving them a unique historical value.

From this perspective, turtle eggs and meat are not only important in terms of nutrition, they also play an important role in the coastal communities because turtle hunting (*tortuguear*) is a way of life, a lifestyle, a culture beyond protein intake. According to Nietschman (1982), the green turtle has been the most exploited species in the Caribbean and, for example, is responsible for 70 percent of the animal protein intake of the Miskito in Nicaragua.

Subsistence and commercial hunting together with egg harvesting are common activities in the Caribbean, and have led to significant declines in sea turtle populations over the last two centuries. Indiscriminate and uncontrolled exploitation has reduced important populations to critical levels, and has altered and destroyed habitats that are vital to these species.

We have heard and we will continue to hear about the importance of these reptiles within their ecological systems, as a source of animal protein for human consumption, and, more recently, for their role in other commercial markets. This is why I wish to discuss the two perspectives in which the use of sea turtles has been framed. The first is an ethical perspective; the second, a pragmatic perspective.

The ethical debate is based in simple terms on whether man should adopt homo- or bio- centric positions. Do we, as human beings, have the "right" to use sea turtles for our own purpose or benefit, or do these reptiles have their own particular rights, such as that of species-level survival?

The pragmatic debate thrives in the dichotomy between the use of sea turtles and their conservation. I must admit that sea turtles were used, are used, and will continue to be used by people, and this should lead us to conservation efforts that involve human communities.

At this moment we should ask ourselves: How intensive is their use? What is the level of sustainable use? The major issue will be how to balance a sustainable biological community in the face of human use. Exploitation requires control in order to avoid a situation where declining resources increase the purchasing price and thus higher market prices, resulting in more intensive exploitation, and so on.

We must also ask ourselves: How important are sea turtles for people? What is the impact of their use on societies? The use of sea turtles can be categorized as consumptive or non-consumptive. People may value sea turtles for commercial, recreational, scientific, aesthetic and spiritual reasons.

Debate over the use of sea turtles must not be confused with an economic justification of the use of sea turtles. We must accept the use itself as one of the topics in the subject of conservation, and acknowledge all values currently attributed to sea turtles. We can assign a value to a certain use, but not all values can be measured with economic terms. Because sea turtle products are found in markets, they have been given an economic value. Frequently this results in confusion among terms such as "value", "use" and "commerce". Clearly if sea turtles are being used for some purpose, they have value, but it can be a tangible or an intangible (e.g., mystical, spiritual) value (see also Frazer, this volume).

Unfortunately, when use is associated with economic value we enter the economic sphere where economic considerations prevail, although in my opinion the current value of these species cannot be described solely in economic terms since the value of sea turtles transcends mercantile descriptions. The various economic uses of sea turtles in the Caribbean region might be described as follows:

Subsistence — restricted to individuals collecting or hunting for their own consumption, with distribution to the immediate social and geographic area. This is the economy of the gatherer and his dependents.

Local markets — restricted to low-scale sale, within the boundaries of the immediate town or county, limited by minimal investment and the intent of increasing family revenues.

Ranching or farming — refers to raising turtles in captivity for scientific reasons, tourism, or gastronomical or consumer purposes, all commercial. It is characterized by significant capital investment.

Commercial — differs from the local market category in that it has a larger scale and higher investment. It is a group or corporate effort.

Recreation, image and fashion — use is defined directly or indirectly by tourism. Turtles are photographed or filmed, and profits are made from their image (e.g., currency, postal stamps, T-shirts, magazines, logos, advertisement).

Obviously the boundaries between categories are, in many cases, hazy, but I have made an attempt to categorize all types of sea turtle use by the inhabitants of the Caribbean region. Tables 1 and 2 summarize both historical and contemporary uses of sea turtles.

Of all reptiles, turtles' eggs are the most important source for industrial and nutritional use. Oil production and the belief that they have medicinal and aphrodisiac properties cause their high exploitation. Before fully entering the task of quantifying the use of eggs, as well as other turtle products, I must acknowledge that records of the economic role of sea turtles are scant, disperse and inconsistent. Nevertheless, the record indicates the following:

The price of eggs varies from US$ 0.02-US$ 5.00 per unit in the region. Most eggs are collected for domestic use and local markets, though there is also evidence of transborder commerce. There is proof that there is a black market for eggs from Central America into the United States, and it is possible that Caribbean turtles are being brought into this murky commerce.

Berry (1987) wrote that between 80-100% of leatherback turtles in the Caribbean coast of Costa Rica were being harvested for human consumption. The same thing is happening today from the shores of Trujillo in Honduras, Playa Negra in Costa Rica, and Changuinola and San San in Panama. In the last example, the harvest accounts for US$ 15,000-20,000 in the black market of Changuinola and Puerto Almirante.

In 1989 Guatemala reported 300-800 hawksbill nests, 50-90 green turtle nests, and 25-50 leatherback nests in its small Caribbean coast, all exploited for consumption. Now, ten years later, hawksbill nesting rates do not exceed 100 [nests per year], and reports for other species are rare.

Turtles have also been exploited in the region for the production of leather. According to Redford and Robinson (1991) sea turtle leather comes primarily from the olive ridley (*Lepidochelys olivacea*) and green turtles. Historically the trade has been significant from Eastern Pacific colonies, but olive ridleys in the Wider Caribbean Region have not been harvested for their skins (Reichart, 1993). Turtle leather utilization in the region has been restricted to the sale and export of green turtle skins from the Cayman Turtle Farm since its establishment in 1968.

Carapace exploitation, focusing on hawksbill (*Eretmochelys imbricata*) turtles, represents another source of revenue. During the second half of the 20th century (1970-1992) approximately 754 metric tons of carapaces were exported to Japan from around the world at an average rate of 33 tons per year, requiring the death of some 712,000 turtles during that period (53% of which came from Latin America and the Caribbean). Some 5,000 shells were collected and marketed between 1986 and 1987 from Honduras and Nicaragua. More specific still, Japanese Customs Statistics report that 14,519 kg of hawksbill scutes (carapace plates) were imported from Nicaragua between 1970 and 1986, the equivalent of some 13,000 turtles (Milliken and Tokunaga, 1987).

Nowadays many countries of the region, for which I can personally attest, such as Costa Rica, Nicaragua, Honduras and Panama, have domestic exploitation of sea turtle shell, including green turtle shell. Despite the fact that it is illegal in several places, it is readily available, especially to tourists. Tourists, in the urge to take souvenirs home for family and friends, buy and transport shell products across borders.

Turtle hunting is another important aspect of some coastal Caribbean communities. Lagueux (1998) reported that in Nicaragua slightly over 10,000 green turtles are harvested each year. From 1969 to 1976, three green turtle packing plants locally consumed and exported close to 10,000 sea turtles in Nicaragua; 445,500 kg were exported to the United States (Nietschmann, 1982).

In Costa Rica, between 1985 and 1998, 1,800 turtles were legally exploited each year, translating, in 1998 alone, to a minimum income of US$ 270,000 and up to US$540,000 (if illegal catch is included). That is a value of US$ 150 per live (fresh) turtle.

Non-consumptive use can also be characterized by high profits. One of the most popular activities of ecotourism is to observe nature. It gives ecotourists great satisfaction when they have a high probability of observing wildlife. Thus many sea turtle nesting grounds have been plagued by tourists anxious to observe the egg-laying and hatching process. The full economic value of such activities has been only slightly studied.

At many sites, sea turtle nesting is a predictable process. Furthermore, the same beach can be visited by several species of sea turtles at different times of the year, facilitating mulitple tours for tourists. Gutic (1994) estimated that in Playa Grande (Costa Rica) the recreational capitalized value was US$ 31 million for the sea turtles and the estuary near the beach. He estimated a capitalized value of US$ 34,910 for *each* leatherback sea turtle nesting during the 1992-1993 season. In this endeavor 288 locals are employed by tourism, although 72% of the revenue remains in the hotel industry (largely held by non-locals).

Table 1. Sea turtle use, by species, in the Wider Caribbean Region

Green	Meat
	Eggs
	Calipee
	Flippers
Loggerhead turtle	Eggs
	Meat
Leatherback	Eggs
	Meat
	Oil
Hawksbills	Meat
	Eggs
	Shell
Kemp's Ridley	Eggs
	Meat
Olive Ridley	Eggs
	Meat

In 1991 and 1992, 14,000-20,000 visitors arrived to the small town of Tortuguero (Costa Rica) per year, precisely during the nesting months for the green turtle. These tourists provide some US$ 4 million in annual income to the town. Another indicator of the non-consumptive economic value of sea turtles is that in 1986, Tortuguero had two hotels and 60 hotel beds. Today Tortuguero has more than 300 beds in nine hotels. The trend clearly shows the financial boom, including immigration, development and employment opportunities, that a nesting beach can generate.

The economic valuation of the income generated by sea turtles in Playa Grande and Tortuguero are good examples of the commercial value of sea turtles in ecotourism. Furthermore, some communities

Table 2. Historical and present day uses of sea turtles and their products in the Wider Caribbean Region

Product Type	Use	Values
Eggs	Human consumption, direct or indirect (such as in baking) Animal consumption Oil	Eggs are widely believed to have medicinal and aphrodisiac properties
Meat	Human consumption Animal consumption Cooking oil Cosmetics	Meat is widely believed to have aphrodisiac and dermatological properties
Oil	Medicinal purposes	
Skin	Leather (e.g., shoes, handbags, wallets, belts, handicrafts, home ornaments)	
Calipee	Human consumption (soup)	Associated with good nourishment and improving intelligence
Flippers	Human consumption	Fin soup is believed to have special nutritional powers
Bones	Arts and crafts Jewelry Fertilizer	
Shell	Home ornaments Jewelry General handicrafts Miscellaneous (e.g., buttons, combs, glasses, and others)	The shell is associated with good luck charms and mystically taking something from the depths of the sea

have also attributed a charismatic value to this group of animals, and this value must also be quantified.

It is paramount that governments include the real income that sea turtles and their associated micro-economies generate. Only in this way can we understand the economic role these ancient creatures play, not only in family incomes but also in other segments and different market scales.

Even if the turtles have not asked us for payment for the use of their image, other economic areas where they are involved include:

- Promotional and educational films
- Clothing
- Postcards, almanacs, calendars and other printed materials
- Corporate, government, and other logos

As you have heard in this hurried and general description, ranging from before the arrival of Europeans to the Americas and up to the present time; from fins to eggs; and all along and around the Caribbean Sea, sea turtles have left their mark in the social and economic history of this region. But, will this history continue?

For additional information on this subject, the reader is referred to Chacón et al. (2000) and Rebel (1974).

Literature Cited

Berry, F. 1987. Aerial and ground surveys of *Dermochelys coriacea* nesting in Caribbean Costa Rica, p.305-310. *In*: L. Ogren (Editor-in-Chief), Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. U. S. Dept. Commerce, Miami.

Carr, A. 1971. Research and conservation problems in Costa Rica, p.29-33. *In*: Marine Turtles: Proceedings of the 2nd Working Meeting of Marine Turtle Specialists, 8-10 March 1971, Morges, Switzerland. IUCN, Morges.

Chacón C., D., N. Valerín, M. Cajiao, H. Gamboa and G. Marín. 2000. Manual de Mejores Prácticas de Conservación de las tortugas marinas en Centroamérica. PROARCA-Costas, PROARCA-CAPAS, USAID-G/CAP, CCAD. San José, Costa Rica. 130 pp.

Gutic, J. 1994. Ecoturismo basado en tortugas marinas brinda beneficios económicos para la comunidad. Noticiero de Tortugas Marinas 64:10-11.

Lagueux, C. 1998. Demography of marine turtles harvested by Miskitu Indians of Atlantic, Nicaragua, p.26-27. *In*: R. Byles and Y. Fernández (eds.), Proceedings of the 16th Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-412. U. S. Dept. Commerce, Miami.

Milliken, T. and H. Tokunaga. 1987. The Japanese Sea Turtle Trade 1970-1986. A Special Report by TRAFFIC-JAPAN for the Center for Environmental Education Washington, D.C. 171 pp.

Mosseri, C. 1998. Explotación de Tortugas Marinas durante la Edad de Bronce en Omán. Noticiero de Tortugas Marinas 81:7-9.

Nietchmann, B. 1982. The cultural context of sea turtle subsistence hunting in the Caribbean and problems caused by commercial exploitation, p.439-445. *In*: K. A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D. C.

Palmer, P. 1986. “Wa happen man”: la historia de la costa talamanqueña de Costa Rica, según sus protagonistas. San José. Instituto del libro. 402 pp.

Rebel, T. P. 1974. Sea Turtles and the Turtle Industry of the West Indies, Florida, and the Gulf of Mexico, Revised edition. University of Miami Press, Miami. 250 pp.

Redford, K. and J. Robinson. 1991. Subsistence and Commercial Uses of Wildlife in Latin America, p.6-24. *In*: Neotropical Wildlife Use and Conservation. Univ. Chicago Press, Chicago.

Reichart, H. A. 1993. Synopsis of Biological Data on the Olive Ridley Sea Turtle *Lepidochelys olivacea* (Esch Scholtz, 1829) in the Western Atlantic. NOAA Tech. Memo. NMFS-336. U.S. Dept. of Commerce. 78 pp.

Status and Distribution of the Leatherback Turtle, *Dermochelys coriacea*, in the Wider Caribbean Region

Karen L. Eckert
Wider Caribbean Sea Turtle Conservation Network (WIDECAST)
USA

Identity and Description

The generic name *Dermochelys* was introduced by Blainville (1816). The specific name *coriacea* was first used by Vandelli (1761) and adopted by Linneaus (1766) (Rhodin and Smith, 1982). The binomial refers to the distinctive leathery, scaleless skin of the adult turtle. The people of the Wider Caribbean know *Dermochelys* by a variety of common names, the most prevalent being leatherback in English, laúd (or tora) in Spanish, tortue luth in French, and tartaruga de couro in Portuguese.

The leatherback turtle is the sole member of the monophyletic family Dermochelyidae. It is further unique in being the largest (Morgan, 1989), deepest diving (Eckert et al., 1989) and most widely distributed (71ºN to 47ºS; Pritchard and Trebbau, 1984) sea turtle. Caribbean-nesting females typically weigh 250-500 kg. A record male specimen, weighing nearly 1,000 kg, died from net-entanglement in Wales, U.K., a decade ago (Morgan, 1989). Leatherbacks lack a bony shell. The smooth black skin is spotted with white; the proportion of light to dark pigment is variable. The somewhat flexible carapace is strongly tapered, typically measures 130–175 cm (along the curve), and is raised into seven prominent ridges. Deep cusps form tooth-like projections on the upper jaw.

Hatchlings are covered with small polygonal scales and are predominately black with mottled undersides. Flippers are margined in white, with the forelimbs extending nearly the length of the body. There are no claws. Rows of white scales appear as stripes along the length of the back. Typical carapace length is 60 mm. Typical (yolked) egg diameter ranges from 51-55 mm.

For additional information, the reader is referred to Pritchard and Trebbau (1984), NMFS/ FWS (1992), Eckert (1995), Boulon et al. (1996), Girondot and Fretey (1996), and Pritchard and Mortimer (1999).

Ecology and Reproduction

Adult leatherbacks exhibit broad thermal tolerances. They are commonly reported in New England waters and northward into eastern Canada. Core body temperature in cold water has been shown to be several degrees C above ambient. This may be due to several features, including the thermal inertia of a large body mass, an insulating layer of subepidermal fat, counter-current heat exchangers in the flippers, potentially heat-generating brown adipose tissue, and a relatively low freezing point for lipids.

Stomach contents from animals killed in various parts of the world indicate that the diet is mostly cnidarians (jellyfish, siphonophores) and tunicates (salps, pyrosomas). Surface feeding on jellyfish has been observed at several locales around the world. Foraging on vertically migrating zooplankton in the water column has been proposed based on the diving behavior of Caribbean-nesting females (Eckert et al., 1986). The specialized medusae diet places the leatherback atop a distinctive marine food chain based on nannoplankton, and largely independent of the more commonly recognized trophic systems supporting whales or tuna, for example (Hendrickson, 1980).

Nesting grounds are distributed circumglobally (approximately 40ºN to 35ºS). Gravid females are seasonal visitors to the Wider Caribbean region (males are rarely encountered) and observations are largely confined to peak breeding months of March to July. Mating is believed to occur prior to or during migration to the nesting ground (Eckert and Eckert, 1988). Females generally nest at 9-10 days intervals, deposit an average of 5-7 nests per year, and remigrate at 2-3+ year intervals. As many as 11 nests per year have been observed to be deposited by a single female in the Caribbean Sea (St. Croix: Boulon et al., 1996) and as many as 13 per year in the Eastern Pacific (Costa Rica: R. Reina, pers. comm. *in* Frazier, this volume). Because relatively large numbers of nests are made by each turtle, and not all crawls result in a nest (that is, not all crawls result in the successful deposition of eggs), a tally of 100 crawls may translate into 70-80 nests – or the sum reproductive effort of only 10-15 females.

Females prefer to nest on beaches with deep, unobstructed access; contact with abrasive coral and rock is avoided. Nesting typically occurs at night. Approximately 70-90 yolked eggs are laid in each nest, along with a variable number of smaller yolkless eggs. Sex determination in leatherback hatchlings is temperature dependent and the "pivotal temperature" (approximately 1:1 sex ratio) has been estimated to be 29.25º-29.50ºC in Suriname and French Guiana (Mrosovsky et al., 1984; Rimblot-Baly et al., 1986-1987). As is the case with all sea turtle species, warmer incubations favor females.

Research has shown that females engage in virtually continuous deep diving in the general vicinity of the nesting ground, traversing inshore waters only to and from the beach. Dives become progressively deeper as dawn approaches. Typical dives are 12-15 minutes in duration and rarely extend beyond 200 m in depth, but dives exceeding 1,000 m have been documented in the Caribbean Sea (Eckert et al., 1986, 1989). Leatherbacks swim constantly, traveling 45-65 km per day during internesting intervals and 30-50 km per day during long distance post-nesting migration (S. Eckert, HSWRI, pers. comm.). After nesting, females leave the Caribbean basin. This is known from tag returns (e.g., leatherbacks tagged whilst nesting in French Guiana have been recaptured in North America, Europe and Africa: Pritchard, 1973; Girondot and Fretey, 1996), post-nesting satellite-tracking studies from Trinidad (Eckert, 1998) and French Guiana (Ferraroli et al., in press), and studies of barnacle colonization on females nesting in St. Croix (Eckert and Eckert, 1988).

Neither the dispersal patterns of hatchlings nor the behavior and movements of juveniles are known. Preliminary evidence, based on a global assessment of sightings records, suggests that juveniles may remain in tropical latitudes until they reach approximately 100 cm in carapace length (Eckert, 1999). Survivability, growth rate, age at maturity and longevity in the wild have not been determined for this species.

Distribution and Trends

The largest colony in the Wider Caribbean Region is at Ya:lima:po, French Guiana, near the border with Suriname. As is typical of long-term databases at well-studied nesting beaches, the French Guiana database demonstrates strong fluctuations in the number of nests laid each year, ranging (since 1978) from more than 50,000 nests to fewer than 10,000 (Girondot and Fretey, 1996). The number of nests laid at Ya:lima:po since 1992 has been steadily declining (Chevalier and Girondot, 2000). While the nature and extent of the decline is difficult to interpret (due to the highly dynamic nature of the beaches and the shifting pattern of nesting that results), the trend is clear. By averaging data across years (reducing the effects of annual fluctuations), we can see that the mean number of nests laid per year between 1987 and 1992 was 40,950 and the mean number of nests laid per year between 1993 and 1998 was 18,100, a decline of more than 50%. Drift/gillnet fishing in the Marconi Estuary is implicated in the population's demise (J. Chevalier, DIREN, pers. comm.).

As erosion has degraded nesting beaches in French Guiana, the colony there has spilled over into Suriname where sandy beach habitat is expanding due to coastal processes. There were fewer than 100 leatherback nests laid in Suriname in 1967, but annual numbers have risen steadily to a peak of 12,401 nests in 1985 and have fluctuated widely since (Reichart and Fretey, 1993). A minimum of 4,000 nests were laid in Suriname in 1999, of which about 50% were lost to poaching (STINASU, unpubl. data).

Nesting on a more moderate scale is reported from Guyana, Venezuela, and Colombia. Sea turtles have been heavily utilized on the nesting beaches in Guyana for many generations. The most important nesting area is the North-West District, especially Almond Beach. Aerial surveys in 1982 indicated that "most of the turtles nesting on this beach are being slaughtered by fishermen and probably all eggs are harvested" (Hart, 1984). Pritchard (1986) estimated that 80% of females were killed each year as they attempted to nest. In 1989 an intensive tagging program began in collaboration with local communities, and rates of mortality have since declined. The number of nests laid at Almond Beach fluctuates among years and ranged from 90-247 between 1989-1994; the populations appears to be stable (P. Pritchard, Chelonian Research Inst., unpubl. data). There are no historical data for Venezuela, but the Paria Peninsula appears to be the most important nesting site at the present time. Current information suggests that Querepare and Cipara (believed to be the most important of the Paria Peninsula's seven known nesting beaches), are each visited by perhaps 20-40 females per year (H. Guada, WIDECAST-Venezuela, pers. comm.).

The Acandí region (Gulf of Urabá), specifically Playona Beach, is the most important nesting site (for leatherbacks) in Colombia. During 11 weeks of monitoring 3 km of nesting beach at Playona in 1998, 71 females were tagged and 162 nests confirmed (Duque et al., 1998). In 1999, 180 females were tagged and 193 nests confirmed (Higuita and Páez, 1999). The status of the colony is unknown, but these tagging records roughly confirm previous estimates of 100 (Ross, 1982) and 200-250 (USFWS, 1981) females nesting per year. Current threats to the colony are considered serious, and include direct harvest, incidental catch by fisheries, pollution, upland deforestation, and coastal development (D. Amorocho, WIDECAST-Colombia, pers. comm.).

In Panama, "concentrated nesting" [nests/yr was not reported] occurs both in the western sector in Bocas del Toro Province (principally on Playa Chiriquí and Changuinola) and also in eastern Panama at Playa Pito and Bahía Aglatomate (Meylan et al., 1985; Pritchard, 1989). More recent surveys have confirmed 150-180 nests per year on Colon Island (D. Chacón, Asoc. ANAI, pers. comm.). Local experts characterize leatherback nesting in Panama as declining; surveys are needed to confirm the speculation. Between Costa Rica and Escudo de Veraguas (Bocas del Toro Province), some 35-100 gravid females are killed each year and egg poaching is estimated at 85%. Most of the leatherbacks are killed in the vicinity of the Changuinola River, where the meat is later sold in Changuinola and the banana plantations for US$ 0.25 per lb (D. Chacón, pers. comm.).

Costa Rica has seen dramatic declines in some areas (Hirth and Ogren, 1987) due largely to egg poaching, which still approaches 100% outside of protected areas. An estimated 70% of all leatherback nesting in Caribbean Costa Rica occurs within the protected areas of Gandoca-Manzanillo Wildlife Refuge, Pacuare Nature Reserve, and Tortuguero National Park, where the combined number of nesting females per year is 500-1,000, making it the third largest known breeding assemblage in the Wider Caribbean Region. The population at Gandoca-Manzanillo Wildlife Refuge is increasing, with the number of nests per year ranging from 200 to more than 1,100 between 1990-1999 (D. Chacón, unpubl. data). Similar increases are not reported from Tortuguero, however, where nesting continues to decline (Campbell et al., 1996).

In Honduras there is a small rookery (25-75 nests/yr) at Plapaya Beach which has been protected by MOPAWI and the Garifuna community since 1995 (D. Chacón, pers. comm.). Nesting is not known to occur in Belize (Smith et al., 1992). Nesting is described as "rare" in Mexico, where perhaps fewer than 20 nests are laid along the entire Caribbean and Gulf of Mexico coastline each year (L. Sarti, INP, pers. comm.).

With the exception of Trinidad (and perhaps the Dominican Republic, for which I have no data), nesting in the insular Caribbean is predictable but occurs nowhere in large numbers, by which I mean more than 1,000 nests (or approximately 150 females) per year. There is considerable anecdotal evidence that nesting has dramatically declined throughout the eastern Caribbean. In the British Virgin Islands, for example, six or more females nested *per night* on beaches on the northeast coast of Tortola in the 1920's. The turtles were harvested primarily for oil, which was (and is) used medicinally. In 1988 a single nest was recorded in Tortola; in 1989 there were none (Cambers and Lima, 1990). Recently nesting appears to be on the rise, presumably benefiting from a local moratorium enacted in 1993 and long-standing protection in the neighboring U. S. Virgin Islands. There were 28 crawls (successful and unsuccessful nesting events, combined) on Tortola in 1997, 10 in 1998 and 39 in 1999, suggesting a local nesting assemblage of 2–6 turtles per year (M. Hastings, BVI Ministry of Natural Resources, pers. comm.).

Where there is little protection, declining trends persist. The theft of eggs and the killing of egg-bearing females have combined to diminish once thriving colonies in St. Kitts and Nevis (Eckert and Honebrink, 1992), St. Lucia (d'Auvergne and Eckert, 1993), Tobago (W. Herron, Environment Tobago, pers. comm.) and elsewhere in the insular Caribbean. In Grenada, for example, despite a closed season that embraces most of the nesting season, information dating back nearly two decades documents the killing of a significant number of nesting females each year and an illegal egg harvest that local observers describe as near 100% (Finlay, 1984, 1987; Eckert and Eckert 1990). On islands where nesting appears to have been historically rare or occasional (e.g., Anguilla, Antigua, Barbados, Jamaica, the Netherlands Antilles), present trends are impossible to estimate.

The news is better in some areas where protection measures have been strong. Nesting at the Sandy Point National Wildlife Refuge, USVI, where leatherbacks have been protected for nearly three decades, is showing a clearly upward trend. An average of 26 females nested (with an average of 133 nests laid) each year between 1982-1986 [1982 being the first year of full beach coverage and tagging] and an average of 70 females nested (with an average of 423 nests laid) each year between 1995-1999, a near tripling over the course of two decades (R. Boulon, USNPS, pers. comm.). Similar trends are seen at Culebra National Wildlife Refuge (Playa Resaca and Playa Brava), Puerto Rico, where an average of 19 females nested (with an average of 142 nests laid) each year between 1984-1986 and an average of 76 females nested (with an average of 375 nests laid) each year between 1997-1999 (M. Rivera and T. Tallevast, USFWS, pers. comm.).

The two primary nesting sites in Trinidad, Matura Beach (east coast) and Grande Riviere (north coast), were declared protected areas in 1990 and 1997, respectively. Systematic tagging began at Matura in 1999 and 862 females were tagged, but beach coverage was incomplete and it is likely that somewhat more than 1,000 females nested on nearly 10 km of beach that year (Sammy, 1999). A similar number of females (800-1,000 per year) are believed to nest at Grande Riviere (S. Eckert, HSWRI, pers. comm.). The status of the nesting colony in Trinidad is unknown. Community-based beach patrols have reduced the number of females killed each year to near zero (down from an estimated 30-50% per year on the east coast and near 100% on the north coast in the 1960's and 1970's), but high levels of incidental catch offshore have the potential to decimate the colony (see Conclusions).

Threats

In some Wider Caribbean countries, gravid leatherbacks are killed for meat, oil, and/or eggs during nesting. In some cases (e.g., Tortola [BVI], Grenada, Guyana), long-term local harvests have had dire population consequences for local nesting assemblages. In other cases the harvest occurs in a range state, as is the case between Costa Rica and Panama. Since only adult females are encountered, there is no harvest of juveniles. The oily meat is not widely favored and is typically prepared by sun-drying or stewing. The oil is used for medicinal purposes, generally in cases of respiratory congestion, and is believed by some to have aphrodisiac qualities. The harvest of eggs seems nearly ubiquitous in unprotected colonies.

A serious threat to this species in the Wider Caribbean region and greater Atlantic ecosystem is incidental capture and mortality at sea. The fisheries most likely to unintentionally ensnare leatherback turtles are longlines and tangle nets (setnets, gillnets, driftnets). Published accounts are scarce, but the capture of leatherbacks by longlines, for example, is documented in the northeastern Caribbean Sea (Cambers and Lima, 1990; Tobias, 1991; Fuller et al., 1992), Gulf of Mexico (Hildebrand, 1987), and the eastern U.S. and Canada (NMFS, 2000; Witzell, 1984). In the southern latitudes of the Wider Caribbean Region the world's largest leatherback colonies are clearly threatened by incidental capture in gillnets. Eckert and Lien (1999) estimate that more than a 1,000 leatherbacks are captured each year (logically including multiple captures of the same individual) offshore the nesting beaches in Trinidad; all indications are that mortality rates are high. Drift/gillnets are also considered a serious threat in the Guianas.

The ingestion of persistent ocean debris, notably plastic bags which are often mistaken for jellyfish and ingested, is a pervasive threat throughout the species' global range (Balazs, 1985; Witzell and Teas, 1994). As is the case with other sea turtle species, habitat loss in the form of increasingly developed coastal areas (particularly sandy beaches which would otherwise contribute important nesting habitat) is also a threat to species survival.

Conservation Status

The leatherback is classified as Endangered by the World Conservation Union (Baillie and Groombridge, 1996). They are included in Annex II of the Protocol to the Cartagena Convention concerning Specially Protected Areas and Wildlife (SPAW); Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES); Appendices I and II of the Convention on the Conservation of Migratory Species (Bonn Convention); and Appendix II of the Convention on European Wildlife and Natural Habitats (Bern Convention) (Hykle, 1999). The species is also listed in the annexes to the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere, a designation intended to convey that their protection is of "special urgency and importance". Only one Wider Caribbean country, Suriname, maintains a CITES reservation on *Dermochelys*, but "the exemption is mostly a matter of principle", there being no international trade in leatherback turtles or their products (Reichart and Fretey, 1993).

Conclusions

Based on information compiled for this presentation it is clear that leatherbacks nesting in the Eastern Caribbean have, on balance, experienced dramatic declines since World War II (WWII). The situation in Central and South America is less clear; some populations are rising, some are declining. Potentially important sites in Colombia, Panama and the Dominican Republic have not been adequately surveyed. The largest colony in the region (Ya:lima:po, French Guiana) is widely characterized as declining (high levels of incidental catch offshore have been implicated); however, it is not possible to accurately assess this population until nesting trends from related colonies in eastern French Guiana and Suriname are taken into account. The status of the nesting colony in Trinidad is unknown; tagging for the purpose of population assessment has only just begun. It is obvious that killings on the nesting beach have dramatically declined (in Trinidad) in recent years, but, again, high levels of incidental catch offshore are a serious concern. In Costa Rica the trends are mixed, with the most serious threats being egg poaching and the illegal killing of adult females in neighboring Panama.

What is very clear is that the Western Tropical Atlantic, including the Caribbean Sea, is the primary nursery ground for this species in the greater Atlantic ecosystem. The pivotal role that the Wider Caribbean Region plays in reproduction emphasizes the urgency with which Caribbean governments should approach the challenges of management and conservation. Hunting of this species in Caribbean waters is perilous to its long-term survival since by definition only egg-bearing females are killed (males and juveniles apparently being so rare in the region that they are virtually never encountered). Uncontrolled egg poaching on shore and undocumented but almost surely unsustainable levels of incidental capture at sea combine to warn us that while rising trends are a welcome sign in some areas, historical declines are still the norm in most countries. With fewer than five known "large" colonies (>1,000 nests/ yr), and the two largest colonies experiencing high levels of mortality at sea, it is not unimaginable that we could loose this species in the Caribbean basin.

Why such grave concern? We need only look at the rookeries that, until recently, were among the largest leatherback nesting colonies in the world. Terengganu Beach, Malaysia, incubated more than 10,000 nests in 1956, in contrast to fewer than 100 nests per year, on average, during the decade of the 1990's. Major causes of decline are mortality associated with fisheries operations in the high seas as well as within the territorial waters of Malaysia, and a long history of sanctioned egg collection involving nearly 100% of all eggs laid (Chan and Liew, 1996).

The rookery now supports less than .05% of post-WWII nesting levels.

Eastern Pacific rookeries have experienced devastation on a comparable scale, but over a much shorter time. In the early 1980's, the beaches of Pacific Mexico were visited by more than 50,000 gravid females per year, laying uncounted hundreds of thousands of nests. Mexico was assumed to support more than half of all leatherback nesting on Earth. By 1999, in less than 20 years, the population was reduced to 250 turtles nesting per year (Sarti et al., 1996). What happened, and why so quickly? In an effort to support a dwindling fishing industry, Chile, and later Peru, instituted an artisanal gillnet fleet which grew exponentially until the early 1990's. One estimate suggests that this fishery killed as many as 3,000 large juvenile and adult leatherbacks each year on their southeastern Pacific foraging grounds (Eckert and Sarti, 1997). As a result, nesting in the Mexico (and other Eastern Pacific sites) declined at a staggering rate of some 20% per year during the 1990's (Sarti et al., 1996; Spotila et al., 2000).

The lessons of Mexico are that (i) what seem to be almost infinitely large populations can be destroyed so quickly as to preclude intervention by the relevant resource agencies and (ii) such threats can take place so far away that they are unknown to local resource managers. Mexico invested millions of Pesos in protecting leatherback sea turtles at their nesting beaches, and it was all for naught because of the management decisions of a distant Range State. Recognizing these essential linkages is what this meeting is all about. I consider it a great privilege to be here.

Literature Cited

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion, p.387-429. *In:* R. S. Shomura and H. O. Yoshida (eds.), Proc. Workshop on Fate and Impact of Marine Debris. NOAA Tech. Memo. NMFS-SWFC-54. U. S. Department of Commerce.

Boulon, R. H., Jr., P. H. Dutton and D. L. McDonald. 1996. Leatherback turtles (*Dermochelys coriacea*) on St. Croix, U. S. Virgin Islands: Fifteen years of conservation. Chelonian Conservation and Biology 2(2):141-147.

Cambers, G. and H. Lima. 1990. Leatherback turtles disappearing from the BVI. Marine Turtle Newsletter 49:4-7.

Campbell, C. L., C. J. Lagueux and J. A. Mortimer. 1996. Leatherback turtle, *Dermochelys coriacea*, nesting at Tortuguero, Costa Rica, in 1995. Chelonian Conservation and Biology 2(2):169-172.

Chan, E. H. and H. C. Liew. 1996. Decline of the leatherback population in Terengganu, Malaysia, 1956-1995. Chelonian Conversation and Biology 2(2):196-203.

Chevalier, J. and M. Girondot. 2000. Recent population trend for *Dermochelys coriacea* in French Guiana, p.56-57. *In*: F. A. Abreu-G. et al. (compilers), Proc. 18th International Sea Turtle Symposium. NOAA Tech. Memo. NMFS-SEFSC-436. U. S. Department of Commerce.

d'Auvergne, C. and K. L. Eckert. 1993. WIDECAST Sea Turtle Recovery Action Plan for St. Lucia (K. L. Eckert, Editor). CEP Technical Report No. 26. UNEP Caribbean Environment Programme, Kingston, Jamaica. *xiv* + 66 pp.

Duque, V., V. P. Páez and J. Patiño. 1998. Ecología de anidación de la tortuga caná (*Dermochelys coriacea*), en la Playona, Golfo de Urabá chocoano, Colombia, en 1998. Unpubl. ms.

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/ CAR WG.19/ INF.7. Prepared by WIDECAST for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11–13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Eckert, K. L. and S. A. Eckert. 1988. Pre-reproductive movements of leatherback sea turtles (*Dermochelys coriacea*) nesting in the Caribbean. Copeia 1988:400-406.

Eckert, K. L. and S. A. Eckert. 1990. Leatherback sea turtles in Grenada, West Indies: A survey of nesting beaches and socio-economic status. Prepared for the Foundation for Field Research, and the Grenada Ministry of Agriculture, Lands, Forestry and Fisheries. St. George's, Grenada. 28 pp. +appendices.

Eckert, K. L. and T. D. Honebrink. 1992. WIDECAST Sea Turtle Recovery Action Plan for St. Kitts and Nevis. CEP Technical Report No. 17. UNEP Caribbean Environment Programme, Kingston, Jamaica. *xiii* + 116 pp.

Eckert, S. A. 1998. Perspectives on the use of satellite telemetry and other electronic technologies for the study of marine turtles, with reference to the first year long tracking of leatherback sea turtles, p.294. *In:* S. P. Epperly, and J. Braun (eds), Proc. 17th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-415. U. S. Dept. Commerce.

Eckert, S. A. 1999. Global distribution of juvenile leatherback sea turtles. Hubbs-SeaWorld Research Institute Tech. Rept. 99-294:1-13.

Eckert, S. A. and J. Lien. 1999. Recommendations for Eliminating Incidental Capture and Mortality of Leatherback Turtles, *Dermochelys coriacea*, by Commercial Fisheries in Trinidad and Tobago: A Report to the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Hubbs-Sea World Research Inst. Tech. Rept. 2000-310:1-7.

Eckert, S. A., and L. M. Sarti. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Eckert, S. A., K. L. Eckert, P. Ponganis and G. L. Kooyman. 1989. Diving and foraging behavior of leatherback sea turtles (*Dermochelys coriacea*). Canadian Journal of Zoology 67:2834-2840.

Eckert, S. A., D. W. Nellis, K. L. Eckert and G. L. Kooyman. 1986. Diving patterns of two leatherback sea turtles (*Dermochelys coriacea*) during internesting intervals at Sandy Point, St. Croix, U.S. Virgin Islands. Herpetologica 42(3):381-388.

Ferraroli, S , S. Eckert, J. Chevalier, M. Girondot, L. Kelle and Y. Le Maho. in press. Marine behavior of leatherback turtles nesting in French Guiana. *In*: Proc. 20th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-xxx. U.S. Dept. Commerce.

Finlay, J. 1984. National Report for the Country of Grenada, p.184-196 (Vol. 3). *In*: P. R. Bacon et al. (eds.), Proc. Western Atlantic Turtle Symposium, 17-22 July 1983, Costa Rica. Univ. Miami Press.

Finlay, J. 1987. National Report for the Country of Grenada. Presented to the Second Western Atlantic Turtle Symposium, 12-16 October 1987, Puerto Rico. 16 pp. Unpubl.

Fuller, J. E., K. L. Eckert, and J. I. Richardson. 1992. WIDECAST Sea Turtle Recovery Action Plan for Antigua and Barbuda. CEP Technical Report No. 16. UNEP Caribbean Environment Programme, Kingston, Jamaica. *xii* + 88 pp.

Girondot, M. and J. Fretey. 1996. Leatherback turtles, *Dermochelys coriacea*, nesting in French Guiana, 1978-1995. Chelonian Conservation and Biology 2(2):204-208.

Hart, S. 1984. The National Report for the Country of Guyana to the Western Atlantic Turtle Symposium, p.209-215. *In*: P. Bacon et al. (eds.), Proc. Western Atlantic Turtle Symposium, 17-22 July 1983, San José, Costa Rica. Vol. 3, Appendix 7. Univ. Miami Press, Miami, Florida.

Hendrickson, J. R. 1980. The ecological strategies of sea turtles. American Zoologist 20:597-608.

Higuita, A. M. and V. P. Páez. 1999. Proporciones sexuales neonatales y demografia de la población de tortuga caná (*Dermochelys coriacea*) anidante en la Playona, Chocó durante la temporada de 1999. Unpubl. ms.

Hildebrand, H. 1987. A reconnaissance of beaches and coastal waters from the border of Belize to the Mississippi River as habitats for marine turtles. Final Report, NOAA/NMFS/SEFC Panama City Lab (purchase order #NA-84-CF-A-134). 63 pp.

Hirth, H. F. and L. H. Ogren. 1987. Some aspects of the ecology of the leatherback turtle, *Dermochelys coriacea*, at Laguna Jalova, Costa Rica. NOAA Tech. Report NMFS 56:1-14.

Hykle, D. 1999. International conservation treaties, p.228-231. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu G. and M. A. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Meylan, A., P. Meylan and A. Ruiz. 1985. Nesting of *Dermochelys coriacea* in Caribbean Panama. J. Herpetol. 19(2):293-297.

Morgan, P. J. 1989. Occurrence of leatherback turtles (*Dermochelys coriacea*) in the British Islands in 1988 with reference to a record specimen, p.119-120. *In*: S. A. Eckert, K. L. Eckert, and T. H. Richardson (compilers), Proc. 9th Annual Conference on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232. U.S. Department of Commerce.

Mrosovsky, N., P. H. Dutton and C. P. Whitmore. 1984. Sex ratios of two species of sea turtles nesting in Suriname. Can. J. Zool. 62:2227-2239.

NMFS. 2000. Reinitiation of consultation on the Atlantic pelagic fisheries for Swordfish, Tuna, Shark and Billfish in the U.S. exclusive economic zone (EEZ): proposed rule to implement a regulatory amendment to the Highly Migratory Species Fishery Management Plan; reduction of bycatch and incidental catch in the Atlantic pelagic longline fishery. National Marine Fisheries Service, Silver Spring. U. S. Dept. Commerce. 113 pp.

NMFS / FWS. 1992. Recovery Plan for Leatherback Turtles, *Dermochelys coriacea*, in the U.S. Caribbean, Atlantic, and Gulf of Mexico. NOAA National Marine Fisheries

Service, Washington, D.C. 65 pp.

Pritchard, P. C. H. 1973. International migrations of South American sea turtles (Cheloniidae and Dermochelyidae). Anim. Behav. 21:18-27.

Pritchard, P. C. H. 1986. Sea turtles in Guyana, 1986. Florida Audubon Society. 14 pp. Unpubl. ms.

Pritchard, P. C. H. 1989. Leatherback turtle (*Dermochelys coriacea*): status report, p.145-152. *In*: L. Ogren (Editor-in-Chief), Proc. Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. U. S. Dept. Commerce.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu G. and M. A. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Pritchard, P. C. H. and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Contrib. Herpetol. No. 2.

Reichart, H. A. and J. Fretey. 1993. WIDECAST Sea Turtle Recovery Action Plan for Suriname (K. L. Eckert, Editor). CEP Tech. Rept. No. 24. UNEP Caribbean Environment Programme, Kingston, Jamaica. *xiv* + 65 pp.

Rhodin, A. G. J. and H. M. Smith. 1982. The original authorship and type specimen of *Dermochelys coriacea*. J. Herpetol. 16:316-317.

Rimblot-Baly, F., J. Lescure, J. Fretey, and C. Pieau. 1986-1987. Sensibilité à la température de la différenciation sexuelle chez la tortue luth, *Dermochelys coriacea* (Vandelli 1761); application des donneés de l'incubation artificielle à l'étude de la sex-ratio dans la nature. Ann. Sci. Nat., Zool., Paris 13e Série, 1986-1987(8):277-290.

Ross, J. P. 1982. Historical decline of loggerhead, ridley and leatherback sea turtles, p.189-209. *In*: K. A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Inst. Press, Washington, D.C.

Sammy, D. 1999. Final Tagging Project Report: Matura Beach 1999. Submitted to the Canadian High Commission, Port of Spain. 19 pp. + appendices.

Sarti, L. M., S. A. Eckert, N. T. Garcia, and A. R. Barragan. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74:2-5.

Smith, G. W., K. L. Eckert and J. P. Gibson. 1992. WIDECAST Sea Turtle Recovery Action Plan for Belize. CEP Technical Report No. 18. UNEP Caribbean Environment Programme, Kingston, Jamaica. *xiii* + 86 pp.

Spotila, J. R., R. D. Reina, A. C. Steyermark, P. T. Plotkin and F. V. Paladino. 2000. Pacific leatherback turtles face extinction: Fisheries can help avert the alarming decline in population of these ancient reptiles. Nature 405:529-530.

Tobias, W. 1991. Turtles caught in Caribbean swordfish fishery. Marine Turtle Newsletter 53:10-12.

USFWS. 1981. Recovery Plan for St. Croix Population of the Leatherback Turtle, *Dermochelys coriacea*. Region 4, U. S. Fish and Wildlife Service.

Witzell, W. N. 1984. The incidental capture of sea turtles in the Atlantic U. S. Fishery Conservation Zone by the Japanese Tuna Longline Fleet, 1978-1981. Marine Fisheries Review 46(3):56-58.

Witzell, W. N. and W. G. Teas. 1994. The impacts of anthropogenic debris on marine turtles in the Western North Atlantic Ocean. NOAA Tech. Memo. NMFS-SEFSC-355. U. S. Department of Commerce.

Karen L. Eckert and F. Alberto Abreu Grobois, Editors (2001)
Sponsored by WIDECAST, IUCN/SSC/MTSG, WWF,
and the UNEP Caribbean Environment Programme

Status and Distribution of the Green Turtle, *Chelonia mydas,* in the Wider Caribbean Region

Cynthia J. Lagueux
Wildlife Conservation Society
USA

Identity and Description

The generic name *Chelonia* was introduced by Brongniart (1800). The specific name *mydas* was first used by Linnaeus (1758). Common Caribbean vernacular names include green (or green-back) turtle in English, tortuga verde in Spanish, tortue verte in French, and tartaruga verde in Portuguese (Eckert, 1995), referring to the predominately green color of its body fat.

The green turtle is the largest of the hard-shelled sea turtles and is the second largest (after *Dermochelys*) of the seven species. Adults commonly attain weights of 150 kg and generally measure from 95 to 120 cm in carapace length. The color of the broadly oval carapace is light to dark brown, sometimes shaded with olive, with radiating streaks of yellows, browns, greens, and black. The plastron or belly is whitish cream to a light yellow in color. There are five vertebral scutes and four pairs of costal (lateral) scutes on the carapace which do not overlap one another. There is a single claw on each flipper. The anteriorly rounded head is characterized by a blunt beak with serrated cutting edges and a single pair of enlarged scales between the eyes.

Green turtle hatchlings weigh about 26 g and are about 5 cm in shell length. Hatchlings are uniquely marked with a blue-black color above and white margins on the trailing edge of the flippers and around the carapace. The plastron of hatchlings is typically a creamy white color. The hatchling gait on land is asymmetrical (alternating flipper movements), as opposed to the symmetrical gait of the adult.

For additional information, the reader is referred to Parsons (1962), Carr et al. (1978), Groombridge and Luxmoore (1989), NMFS/ FWS (1991), Eckert (1995), Hirth (1997), and Pritchard and Mortimer (1999).

Ecology and Reproduction

The green turtle is a circumglobal species found in tropical and sub-tropical waters. After leaving their natal beaches, individuals spend several years in the open ocean becoming widely dispersed by ocean currents. During this period they are omnivorous, feeding opportunistically at the ocean surface (Carr and Meylan, 1980; Carr, 1986). In the Caribbean, once juveniles reach approximately 20–25 cm in carapace length they move to coastal waters where they shift to an herbivorous diet (Bjorndal and Bolten, 1988). The benthic vegetarian feeding habit of juvenile and adult green turtles is unique among the sea turtles. The principal food item of Caribbean populations is *Thalassia testudinum*, commonly known as turtle grass (Mortimer, 1976).

Green turtles are estimated to take 27-50 years to reach sexual maturity (Limpus and Walter, 1980; Balazs, 1982; Frazer and Ehrhart, 1985; Frazer and Ladner, 1986), the longest age to maturity estimate for any sea turtle species. During the decades prior to adulthood, juveniles move long distances between areas of developmental habitat. Genetic studies show that mature females return to their natal beach to nest throughout their reproductive life (Meylan et al., 1990). Both males and females make long seasonal migrations between foraging and nesting sites, migrations that often span thousands of kilometers. Thus, during the life cycle of green turtles, animals from a single population can traverse an entire ocean basin, making them a truly international resource.

Gravid females typically spend two and one-half hours on the beach for nesting. Individuals return to nest at 2–4 year intervals, depositing an average of three clutches of eggs (and as many as nine) at 12–14 day intervals throughout the nesting season (which at most Wider Caribbean localities peaks in June, July and August). Clutch size varies widely, and there is a relationship between clutch size and carapace length (summarized by Hirth, 1997). The average clutch size at the well-studied rookery at Tortuguero, Costa Rica is 112 eggs (range: 3-219) (Bjorndal and Carr, 1989). Eggs average 44 mm in diameter. After 55-60 days of incubation, hatchlings emerge from the sand and orient toward the open horizon of the sea.

For decades female green turtles have been flipper tagged on the nesting beach. Tag returns provide us with information about the distribution of mature females away from the nesting beach, as well as documenting their highly migratory habits (see Hirth, 1997, for a review). Females tagged while nesting at Tortuguero, Costa Rica have been recovered from foraging grounds and along migratory pathways in Belize, Colombia, Cuba, USA (Florida), Honduras, Jamaica, Martinique, Nicaragua, Panama, Puerto Rico, Colombia (San Andres), Venezuela, and Mexico (Yucatán), with the majority of tag returns coming from the foraging ground off the coast of Nicaragua (Carr et al., 1978). Similarly, females tagged while nesting at Aves Island, Venezuela have been recaptured in Brazil, Carriacou, Colombia, Cuba, the Dominican Republic, Grenada, Guadeloupe, Guyana, Haiti, Martinique, Mexico, Nevis, Nicaragua, Puerto Rico, St. Kitts, St. Lucia, and Venezuela, with the majority of these tag returns coming from the coasts of Nicaragua and the Dominican Republic (Solé, 1994).

More recently, immature and adult green turtles have been tagged in developmental and foraging habitats, as well as along migratory pathways. Immature and adult green turtles tagged in Caribbean Panama, a developmental habitat and migratory pathway, have been recovered predominantly in Nicaragua (Meylan and Meylan, unpubl. data). Immatures tagged in developmental habitat in Bermuda have been recaptured from throughout the Caribbean, with the majority from Nicaragua (Meylan et al., in prep.). The accumulation of recovered tags from an area can indicate the importance of that area to different life stages of green turtles. The coastal waters of Caribbean Nicaragua are clearly important to the survival of this species, since immature and adult green turtles tagged in nearly a dozen countries throughout the Wider Caribbean Region have been recaptured there (Lagueux and Campbell, unpubl. data).

Distribution and Historical Considerations

Throughout history, the green turtle has been prized for its meat and calipee, the cartilagenous material found on the inside of the plastron. Green turtle meat and eggs sustained the crews of ships during the period of exploration, expansion, and settlement of the New World (Carr, 1954; Parsons, 1962). Because of unsustainable use, all Wider Caribbean green turtle populations are depleted and some nesting populations are locally extinct. There are several examples throughout the world of green turtle populations that have been destroyed due to over-harvesting, two examples are given below.

The first example is from Bermuda where there was once a large assembly of nesting and foraging green turtles (Ingle and Smith, 1949; Parsons, 1962). However, in spite of legislation adopted in 1620 to protect against the taking of juveniles, by the end of the 1700s the green turtle population was so reduced that a commercial harvest was no longer profitable (Garman, 1884b cited in Carr, 1952; Parsons, 1962), and the nesting population was destroyed. Even today there are no green turtles nesting in Bermuda.

The second example is from the Cayman Islands. The Caymans were once known for what was probably the largest green turtle rookery in the Atlantic system. In 1503, during Columbus' final voyage to America, he named these islands Islas Tortugas. At one time, there were so many turtles migrating towards the Cayman Islands during the nesting season that lost ships could navigate towards the islands by the sound of swimming turtles (Long, 1774 cited in Lewis, 1940). For almost 200 years boats from many nations arrived at the Cayman Islands to harvest nesting females (Parsons, 1962). By the early 1800s, the population had become so depleted that Cayman turtlers sailed to the south of Cuba, then to the Gulf of Honduras and finally to the Caribbean coast of Nicaragua in search of ever-decreasing stocks of turtles to harvest (Lewis, 1940; Carr, 1954; Parsons, 1962; King, 1982). Today, there is no longer a viable wild nesting green turtle population in the Cayman Islands.

It has been over 200 years since the demise of the nesting populations in Bermuda and the Cayman Islands and still they have not recovered. Is there anything we can learn from these examples? If we agree that it is important to maintain biologically healthy green turtle populations, can we learn from the mistakes of our ancestors and implement the actions necessary to halt the continued decline of Caribbean green turtle populations?

Today the largest green turtle nesting colonies in the Wider Caribbean Region occur at Tortuguero, Costa Rica and Aves Island, Venezuela, with the Tortuguero rookery by far the largest (Carr et al., 1982). Much smaller nesting rookeries are scattered throughout the region. These include Florida, Mexico (Tamaulipas, Veracruz and the Yucatán Peninsula), Belize, Panama, the coastline of northern South America, and at selected sites in the Eastern Caribbean (Carr et al., 1982).

The largest foraging aggregation of juveniles and adults is found on the extensive seagrass beds along the Caribbean coast of Nicaragua. Smaller foraging aggregations have been documented in Florida, the Yucatán Peninsula, Panama, the Guajira Peninsula of Colombia, the Lesser Antilles, Puerto Rico, Cuba, Jamaica, Grand Cayman, Bermuda and the southern Bahamas (Carr et al., 1982).

Conservation Status

Green turtles are classified as Endangered by the World Conservation Union (Baillie and Groombridge, 1996) and are protected by various international agreements. They are listed in Annex II of the SPAW Protocol to the Cartagena Convention (a Protocol Concerning Specially Protected Areas and Wildlife), Appendix I of CITES (Convention on International Trade in Endangered Species of Wild Flora and Fauna), and Appendices I and II of the Convention on Migratory Species (CMS). The species is also included in the annexes to the Western Hemisphere Convention, a designation intended to convey that their protection is of "special urgency and importance" (Eckert, 1995). Recently, the governments of Costa Rica and Panama signed a cooperative agreement toward the conservation of marine turtles on their Caribbean coasts.

International laws, classifications, and agreements, however, do not adequately protect nesting and foraging green turtle populations and their habitats. Both legal and illegal green turtle fisheries and egg harvesting still continue.

Conclusions

Tag recoveries from females tagged on their nesting beaches, and adult and immature turtles tagged on their foraging grounds or along migratory pathways make it evident that regional cooperation is not only important but imperative for the conservation of green turtles. Because of the highly migratory nature of this species, conservation efforts of one nation can be negated by the lack of, or ineffective actions of other nations. Thus, we must work together, within countries, between nations, and on a regional level to ensure our conservation efforts are the most effective for the recovery of green turtle populations throughout the wider Caribbean.

Acknowledgements

I would like to thank Anne Meylan and Blair Witherington for allowing me to use their unpublished data, and Karen Eckert and Anne Meylan for the use of their slides for the presentation. I am grateful for the review and comments of Cathi Campbell in the preparation of the presentation and text.

Literature Cited

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Balazs, G. H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago, pp. 117-125. *In:* K.A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C. 583 pp.

Bjorndal, K. A. and A. B. Bolten. 1988. Growth rates of immature green turtles, *Chelonia mydas*, on feeding grounds in the southern Bahamas. Copeia 1988 (3):555-564.

Bjorndal, K. A. and A. Carr. 1989. Variation in clutch size and egg size in the green turtle nesting population at Tortuguero, Costa Rica. Herpetologica 45(2):181-189.

Carr, A. 1952. Handbook of Turtles: The Turtles of the

United States, Canada, and Baja California. Cornell University Press, New York. 542 pp.

Carr, A. 1986. New perspectives on the pelagic stage of sea turtle development. NOAA Tech. Memo. NMFS-SEFC-190. U.S. Dept. Commerce. 36 pp.

Carr, A. and A. B. Meylan. 1980. Evidence of passive migration of green turtle hatchlings in *Sargassum*. Copeia 1980(2):366-368.

Carr, A., M. H. Carr and A. B. Meylan. 1978. The ecology and migrations of sea turtles, 7. The West Caribbean green turtle colony. Bulletin of the American Museum of Natural History 162(1):1-46.

Carr, A., A. Meylan, J. Mortimer, K. Bjorndal and T. Carr. 1982. Surveys of sea turtle populations and habitats in the Western Atlantic. U. S. Department of Commerce NOAA Tech. Memo. NMFS-SEFC-91. 91 pp.

Carr Jr., A. F. 1954. The passing of the fleet. AIBS Bulleting 4:17-19.

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/ CAR WG.19/ INF.7. Prepared by WIDECAST and adopted by the Third Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Frazer, N. B. and L. M. Ehrhart. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985(1):73-79.

Frazer, N. B. and R. C. Ladner. 1986. A growth curve for green sea turtles, *Chelonia mydas*, in the U.S. Virgin Islands, 1913-14. Copeia 1986(3):798-802.

Groombridge, B. and R. Luxmoore. 1989. The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. CITES Secretariat, Lausanne, Switzerland. 601 pp.

Hirth, H. F. 1997. Synopsis of the Biological Data on the Green Turtle, *Chelonia mydas* (Linnaeus 1758). Biological Report 97(1):1-129. U. S. Department of Interior.

Ingle, R. M. and F. G. W. Smith. 1949. Sea Turtles and the Turtle Industry of the West Indies, Florida and the Gulf of Mexico, with Annotated Bibliography. University of Miami Press, Florida. 107 pp.

King, F. W. 1982. Historical review of the decline of the green turtle and the hawksbill, pp. 183-188. *In:* K.A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington D.C. 583 pp.

Lewis, C. B. 1940. The Cayman Islands and marine turtles. Bull. Inst. of Jamaica Sci. Ser. 2:56-65.

Limpus, C. J. and D. G. Walter. 1980. The growth of immature green turtles (*Chelonia mydas*) under natural conditions. Herpetologica 36(2):162-165.

Meylan, A. B., B. W. Bowen and J. C. Avise. 1990. A genetic test of the natal homing versus social facilitation models for green turtle migration. Science 248:724-727.

Meylan, P., A. B. Meylan and J. A. Gray-Conklin. in prep. The ecology and migrations of sea turtles, 8. Tests of the developmental habitat hypothesis.

Mortimer, J. A. 1976. Observations on the feeding ecology of the green turtle, *Chelonia mydas*, in the western Caribbean. Masters thesis, University of Florida, Gainesville. 100 pp.

NMFS/FWS. 1991. Recovery Plan for U. S. Populations of the Atlantic Green Turtle. U. S. Department of Commerce, National Marine Fisheries Service, Washington D. C. 52 pp.

Parsons, J. J. 1962. The Green Turtle and Man. University of Florida Press, Gainesville. 126 pp.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In:* Karen L. Eckert, Karen A. Bjorndal, F. Alberto Abreu G. and Marydele Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Solé, G. 1994. Migration of the *Chelonia mydas* population from Aves Island, pp. 283-286. *In:* K. A. Bjorndal, A. B. Bolten, D. A. Johnson and P. J. Eliazar (compilers), Proceedings of the 14th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-351. 323 pp.

Karen L. Eckert and F. Alberto Abreu Grobois, Editors (2001)
Sponsored by WIDECAST, IUCN/SSC/MTSG, WWF,
and the UNEP Caribbean Environment Programme

Status and Distribution of the Loggerhead Turtle, *Caretta caretta*, in the Wider Caribbean Region

Félix Moncada Gavilán
Centro de Investigaciones Pesqueras
Ministerio de la Industria Pesquera
Cuba

Identity and Description

The generic name *Caretta* was introduced by Rafinesque (1814). The specific name *caretta* was first used by Linnaeus (1758). The name *Caretta* is a Latinized version of the French word "caret", meaning turtle, tortoise, or sea turtle (Smith and Smith, 1980). Smith and Smith (1980) suggested that the Indo-Pacific and Atlantic populations were differentiated at the subspecific level, but this conclusion has been challenged by Hughes (1974) and Pritchard and Trebbau (1984). In recent synopses of the biological data available on this species, Dodd (1988, 1990) considered *C. caretta* to be monotypic. In the Wider Caribbean, the species is referred to as loggerhead in English, cabezon and caguama in Spanish, and caouanne in French (excerpted from Eckert, 1995).

The loggerhead turtle is identifiable by the relatively large size of its head, thick carapace (often encrusted with barnacles and other epifauna), and reddish-brown pigmentation of the skin and carapace. In general there are five vertebral scutes and five pairs of non-overlapping costal (lateral) scutes on the carapace. There are two claws on each flipper. Adults can reach a size of 120 cm (straight carapace length) and weigh up to 200 kg (Pritchard et al., 1983), but more typical is an adult of 105 cm in straight carapace length and about 180 kg (Pritchard and Mortimer, 1999). The species is widely distributed in the subtropical and tropical waters of the Atlantic, Pacific and Indian Oceans. Atlantic sightings are documented as far north as Terranova Island (Squires, 1954) and northern Europe (Brongersma, 1972), and as far south as Argentina (Frazier, 1984).

Hatchlings are uniformly reddish- or grayish-brown with a scute pattern identical to the adult. The typical straight carapace length is 45 mm, ranging from about 38-50 mm. Egg diameter ranges from 39-43 mm, with about 100-130 eggs laid per nest (see Pritchard and Mortimer, 1999).

Distribution

The most important nesting grounds for this species in the Wider Caribbean Region are mainly located along the southeastern coast of the USA, principally in the state of Florida which hosts the second greatest nesting aggregation of this species in the world, surpassed only by the most important, located in Masirah Island, Oman, in the Indian Ocean. Of the total number of nestings documented in the USA each year, 93% are in Florida (FL), 5% in South Carolina (SC), and about 1% in each of Georgia (GA) and North Carolina (NC) (Figure 1). Nesting declined in these areas during the 1980's (Ehrhart, 1989). Today the south Florida population is considered to be stable or improving. Witherington and Koeppel (1999) reported that the number of nests laid in Florida rose from 49,422 in 1989 to 85,985 in 1998. Based on 4.1 nests/female/yr (Murphy and Hopkins, 1984) this annual nesting population has increased from 12,054 to 20,972 females. In contrast, the northern population (Georgia, South Carolina, North Carolina) is considered to be stable or declining, and the status of the Florida panhandle population cannot be determined at this time (TEWG, 2000).

Other important nesting grounds are located on the Yucatan Peninsula (particularly along the coast of Quintana Roo in the Caribbean Sea), the islands and keys of the Cuban Archipelago, and Colombia's Caribbean coast. Surveys for the Quintana Roo beaches in the early 1990's suggested annual nestings of 1,300-2,200 (Zurita et al., 1993), with a

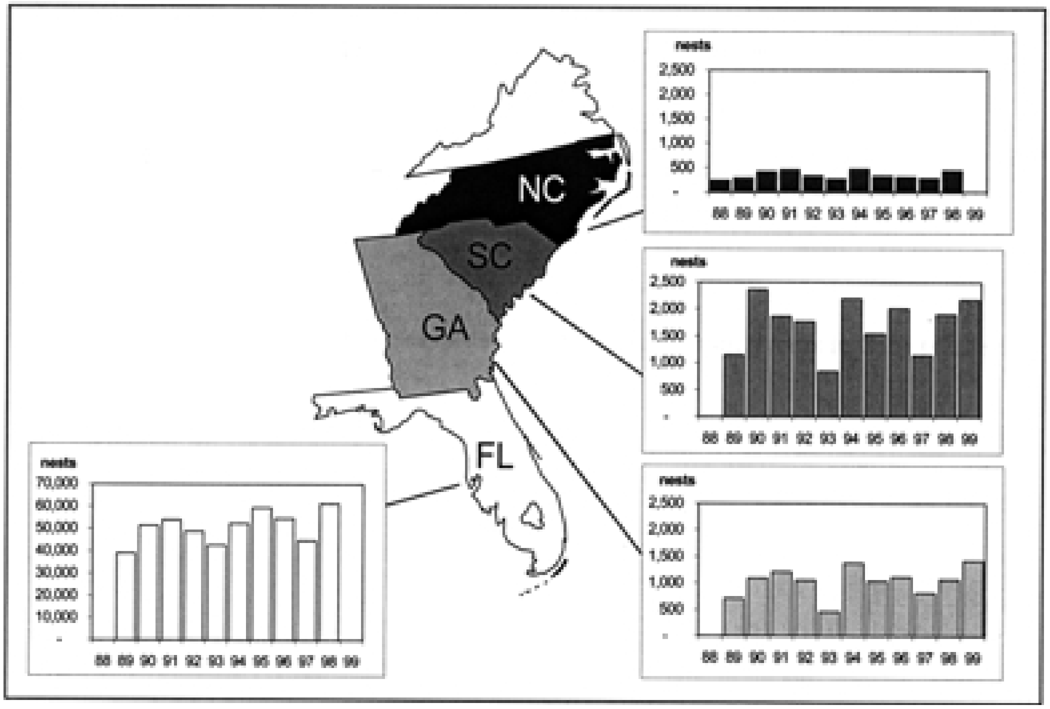

Figure 1. Loggerhead sea turtle (*Caretta caretta*) nesting trends in the USA by state, based on Index Beach data. Index Beaches account for about 70% of all nesting in Florida, about 53% in North Carolina, 50% in South Carolina, and over 90% in GA. Source: E. Possardt, U.S. Fish and Wildlife Service.

slightly increasing trend (R. Márquez, INP-México, pers. comm.). About 2,000 loggerhead nests per season were once known at beaches near Santa Marta in Colombia (Márquez, 1990), where Kaufmann (1975) estimated an annual population of 400 to 600 nesting females. By the mid-1980's only eight nesting females were reported in the same region (D. Amorocho, WIDECAST-Colombia, pers. comm., 1999), evidence of a drastic decrease in this population.

In the Cuban Archipelago (Figure 2), loggerheads nest mainly in the southwestern region, specifically in the Guahanacabibes Peninsula and on the islands and keys of the Canarreos Archipelago. The most important area is "El Guanal" beach (south of Pinos Island); other important areas are the San Felipe Keys, Largo del Sur Key and Rosario Key. Together these areas host about 70% (approximately 250 nests) of the annual nesting for this species in the entire Cuban Archipelago. Some additional nesting occurs in the northern coast of the island and in some keys of the Sabana-Camagüey Archipelago (e.g., Cruz Key). Isolated nesting has been recorded in the southeastern region in the Doce Leguas keys.

Rare and isolated nesting is reported in the Lesser Antilles, along the Mexican Gulf (Tamaulipas and Veracruz), in Central America (Belize and Guatemala), and along the Atlantic coast of South America from Venezuela to Brazil (summarized by Dodd, 1988). More recent evidence suggests that low levels of nesting also occur in Honduras where, for example, the Rio Platano Biosphere Reserve protects approximately 10 loggerhead nests each year (E. Possardt, U.S. FWS, pers, comm.).

Ecology

Loggerhead turtles are highly migratory, undertaking transoceanic journeys as young juveniles and routinely moving between nesting and foraging grounds as adults. It is widely held that hatchlings emerging from nests laid along the southeastern coast of the USA leave their native beaches to take shelter in open sea accumulations of *Sargassum*

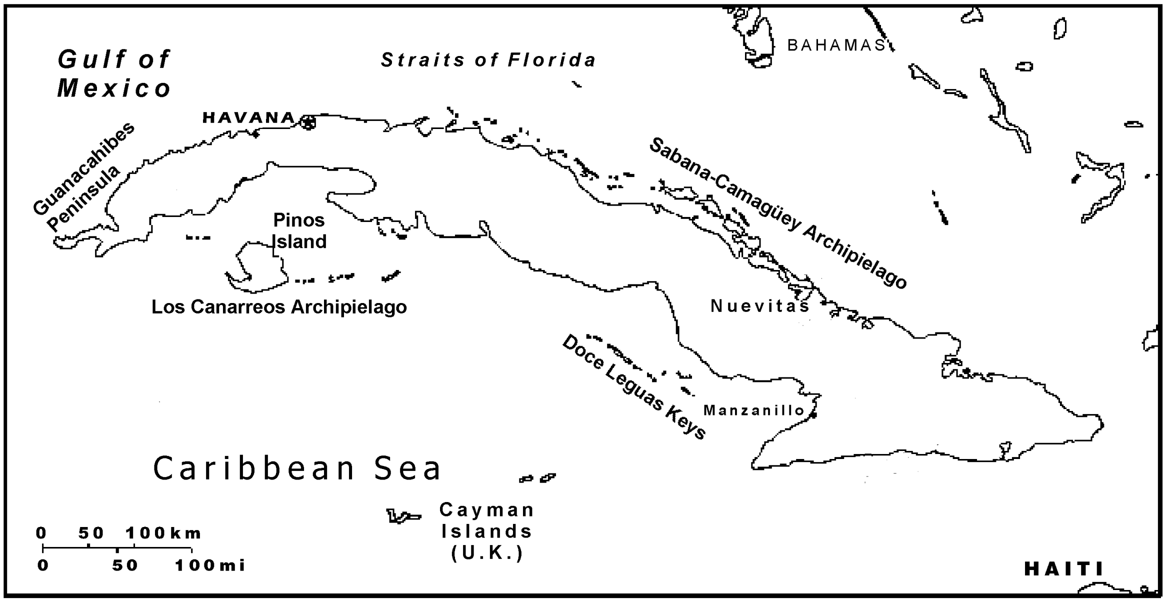

Figure 2. Major loggerhead sea turtle (*Caretta caretta*) nesting areas in Cuba (see text).

weed. The young turtles are transported passively by a branch of the Gulf Stream that carries them to the eastern part of the Atlantic Ocean. Later they move south with the North Atlantic Gyre, to the Azores and Canary Islands, and ultimately return as large juveniles with the Northern Equatorial Current to western Atlantic foraging grounds where they specialize on mollusks and crustaceans in nearshore habitats (Figure 3).

Tagging and recapture studies conducted in Florida, Cuba and the Yucatan Peninsula (Mexico) have demonstrated that this species can travel long distances in relatively short periods of time, traveling either with or against ocean currents. For example, nesting females tagged while nesting in Florida have been recaptured on the Cuban ocean platform, mainly along the north coast of Pinar del Rio, an area rich in species of benthic invertebrates (Murina et al., 1969) known to be part of the diet for this species (cf. Bjorndal, 1985). Nesting females tagged in Cuba ("El Guanal" beach, south of Pinos Island) have been reported in foraging areas near Nicaragua (Moncada, 1998); and loggerheads tagged in Yucatan have been recaptured in Cuba and other areas of the region (Moncada, 1998; R. Márquez, INP-México, pers. comm., 1999).

Conservation Status

The loggerhead turtle is included in Annex II of the SPAW Protocol to the Cartagena Convention in the Caribbean Region. It is classified as "Endangered" by IUCN (the World Conservation Union; Baillie and Groombridge, 1996) and is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), which prohibits international commerce. The species is also included in Appendices I and II of the Convention on Conservation of Migratory Species and in the annexes to the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere.

Literature Cited

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Bjorndal, K. 1985. Nutritional ecology of sea turtles. Copeia 1985:736-751.

Brongersma, L. D. 1972. European Atlantic Turtles. Zool. Vert. (Leiden) No. 121.

Carr, A. 1987. New perspectives on the pelagic stage of sea turtle development. Conserv. Biol. 1(2): 103-121.

Dodd, C. K. 1988. Synopsis of the Biological Data on the

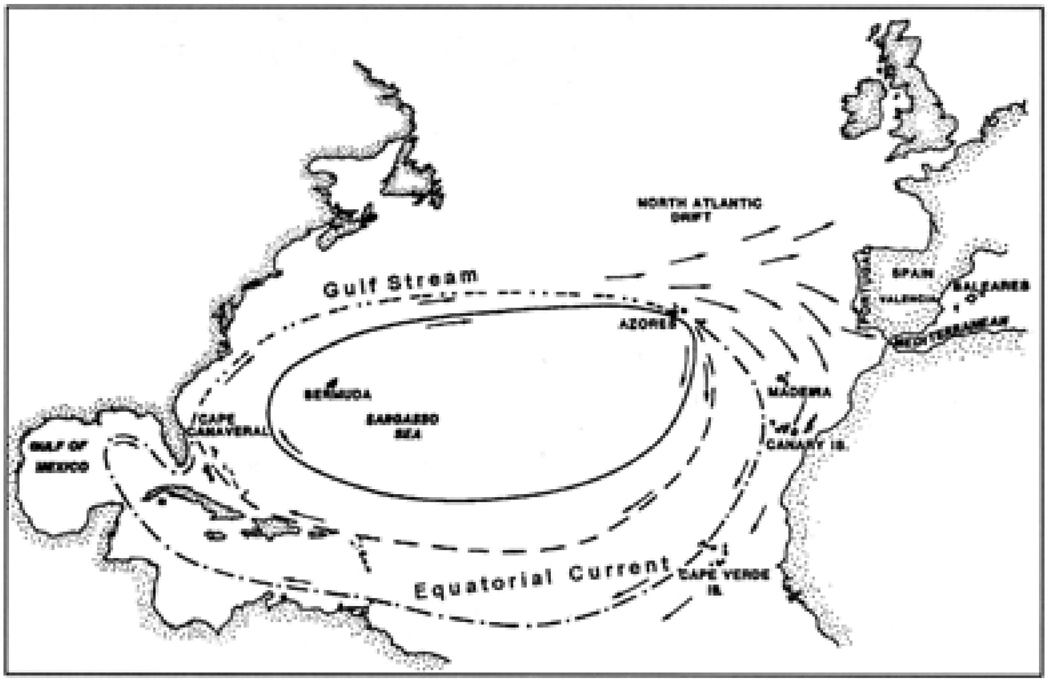

Figure 3. Oceanic transport routes for juvenile loggerhead sea turtles, *Caretta caretta*. Source: Musick and Limpus, 1997 (adapted from Carr, 1987).

Loggerhead Sea Turtle, *Caretta caretta* (Linnaeus 1758). U.S. Fish Wildl. Serv., Biological Report 88 (14):1-110.

Dodd, C. K., Jr. 1990. Reptilia: Testudines: Cheloniidae: *Caretta caretta*, p.483.1-483.7. *In*: C. H. Ernst (ed.), Catalogue of American Amphibians and Reptiles. Soc. Study Amphibians and Reptiles publication.

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP(OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST and adopted by the Third Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Ehrhart, L. 1989. Status Report of the Loggerhead Turtle, p.122-139. *In*: L. Ogren (Editor-in-Chief), Proc. Second Western Atlantic Turtle Symposium, 12-16 October 1987, Mayagüez, Puerto Rico. NOAA Tech. Memo. NMFS- SEFC-226. U. S. Dept. Commerce, Miami.

Frazier, J. 1984. Las tortugas marinas en el Océano Atlántico Sur Occidental. Asoc. Herpetol. Argentina.

Hughes, G. R. 1974. The sea turtles of south-east Africa. I. Status, morphology and distribution. Oceanogr. Res. Inst. Invest. Rept. No. 35. Durban, South Africa. 144 pp.

Kaufman, R., 1975. Studies on the loggerhead sea turtle *Caretta caretta caretta* (Linné), in Colombia, South America. Herpetologica 31(3):323-6

Márquez M., R. 1990. FAO Species Catalogue, Vol. 11. Sea Turtles of the World: An Annotated and Illustrated Catalogue of Sea Turtle Species Known to Date. FAO Fisheries Synopsis, 125 (11):1-81.

Moncada G., F. 1998. Migraciones de la Tortuga verde (*Chelonia mydas*), la caguama (*Caretta caretta*) y el carey (*Eretmochelys imbricata*) en aguas cubanas y áreas adyacentes. Tesis de Maestría defendida en el Centro de Investigaciones Marinas. Universidad de la Habana.

Murphy, T. M. and S. R. Hopkins. 1984. Aerial and ground surveys of marine turtle nesting beaches in the southeast region, United States. Final Report to NMFS-SEFC. 73 pp.

Murina, V., D. Chujchin, O. Gómez and G. Suarez. (1969). Distribución cuantitativa de la macrofauna bentónica del sublitoral superior de la plataforma cubana (Región suroccidental). Acad. Cien. Cuba. Serie Oceanológica 6:1-14.

Musick, J. A. and C. Limpus. 1997. Habitat utilization and migration in juvenile sea turtles, p.137-163. *In*: P. L. Lutz and J. A. Musick (Eds.) The Biology of Sea Turtles.

CRC Press, New York.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In:* Karen L. Eckert, Karen A. Bjorndal, F. Alberto Abreu-Grobois and Marydele Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Pritchard, P. C. H. and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles, Contrib. Herpetol. No. 2.

Pritchard, P., P. Bacon, F. Berry, A. Carr, J. Fletemeyer, R. Gallager, S. Hopkins, R. Lankford, R. Márquez, L. Ogren, W. Pringle, Jr., H. Reichart and R. Witham. 1983. Manual of Sea Turtle Research and Conservation Techniques (Second Edition), K. Bjorndal and G. Balazs (eds.). Center for Environmental Education, Washington D.C.

Smith, H. M. and R. B. Smith. 1980. Synopsis of the Herpetofauna of Mexico. Vol. 6: Guide to Mexican turtles. Bibliographic addendum III. John Johnson, North Bennington, Vermont. 1044 pp.

Squires, H. J. 1954. Records of marine turtles in the Newfoundland area. Copeia 1954: 68.

TEWG [Turtle Expert Working Group]. 2000. Assessment Update for the Kemp's Ridley and Loggerhead Sea Turtle Populations in the Western North Atlantic. NOAA Tech. Memo. NMFS-SEFSC-444. U.S. Department of Commerce.

Witherington, B. and C. M. Koeppel. 1999. Sea turtle nesting in Florida, USA, during the decade 1989-1998: an analysis of trends. p. 94-96. *In*: H. J. Kalb and T. Wibbels (compilers), Proceedings of the Nineteenth Annual Symposium on Sea Turtle Biology and Conservation. U.S. Department of Commerce. NOAA Tech. Memo. NMFS-SEFSC-443, 291 pp.

Zurita, J., R. Herrera and B. Prezas, 1993. Tortugas marinas del Caribe, p.735-751. *In*: Biodiverdidad Marina y Costera de México. Salazar-Vallejo, S.I y N.E. González (Eds.). Com. Nal. Biodiversidad y CIQRO, México. 865 pp.

Status and Distribution of the Hawksbill Turtle, *Eretmochelys imbricata,* in the Wider Caribbean Region

*Diego F. Amorocho
Wider Caribbean Sea Turtle Conservation Network (WIDECAST)
Colombia*

Identity and Description

The generic name *Eretmochelys* was introduced by Fitzinger (1843). The specific name imbricata is attributed to Linnaeus (1766) and refers to the over-lapping nature of the carapace scutes (see Eckert, 1995a). Common Caribbean vernacular names include hawksbill (English), carey (Spanish), tartaruga de pente (Portuguese), and tortue imbriqueé (French).

The genus is currently considered to be monotypic. Two subspecies, *E. i. imbricata* in the Atlantic Ocean and *E. i. squamata* in the Pacific Ocean, have been described on the basis of differences in coloration and carapace shape (see Witzell, 1983 for review). However, the criteria have proven unreliable in distinguishing the two forms and subspecific designations are rarely used (Meylan, 1984; Pritchard and Trebbau, 1984).

The following combination of characteristics distinguishes the hawksbill from other sea turtles: two pairs of prefrontal scales between the eyes; thick, posteriorly overlapping scutes on the carapace; five vertebral scutes and four pairs of costal (lateral) scutes on the carapace; two claws on each flipper; and an alternating (asymmetrical) terrestrial gait. The head is relatively narrow and elongate. The beak tapers to a point, giving the animal a "bird-like" appearance.

The carapace is heart-shaped in the youngest turtles and becomes more elongated (oval) as the turtle matures. The sides and rear portions of the carapace are typically serrated in all but very old animals. The epidermal scutes that overlay the carapace bone are commonly referred to as "tortoiseshell" or "bekko" and are prized in commerce. These scutes are often richly patterned with irregularly radiating streaks of brown and black on an amber background. The scutes of the plastron are usually clear yellow, with little or no dark pigmentation.

The hawksbill is a small to medium sized turtle. The average size of a nesting female typically does not exceed 95 cm (straight carapace length, SCL) for Caribbean nesting assemblages, and often this average value is closer to 85-90 cm SCL. Weight data are uncommon, but it appears that adults average 80-85 kg in the Caribbean Sea. Hatchlings are uniform in color, usually gray or brown. They average 42 mm SCL (range: 39–46 mm) and range in weight from about 14–20 g.

For informative summaries and greater detail, see Carr et al. (1966), Witzell (1983), Pritchard and Trebbau (1984), Meylan (1984), Groombridge and Luxmoore (1989), NMFS/ FWS (1993), Eckert (1995a, b), Van Dam (1997), and Pritchard and Mortimer (1999).

Ecology

Hawksbills utilize different habitats at different stages of their life cycle. It is widely believed, based on sightings, strandings and gut content analyses, that post-hatchling hawksbills are pelagic and find shelter in weedlines associated with convergence zones. *Sargassum* and floating debris, such as Styrofoam, tar balls and plastic bits (common components of weedlines), are consistently found in the stomachs of young turtles. Hawksbills reenter coastal waters when they reach about 20–25 cm carapace length.

Coral reefs provide foraging grounds for young juveniles, as well as subadults and adults. Reef ledges and caves provide shelter during periods of rest and refuge from predators. Hawksbills are also found around rocky outcrops and high-energy shoals, as well as mangrove-fringed bays and estuaries (NMFS/ FWS, 1993). Sponges are the principal diet of hawksbills once they take up residence in coastal waters. A high density turtle population may play a significant role in maintaining sponge species diversity in nearshore benthic communities in the Caribbean (van Dam and Diez, 1997).

Meylan (1988) found that sponges contributed 95.3% of the total dry mass of all food items in the digestive tract samples from 61 animals from seven Wider Caribbean countries (19 sites in the Lesser Antilles, the Dominican Republic and Caribbean Panama). Investigators have also found an almost exclusive dietary preference for sponges by hawksbills feeding on the Cuban coastal shelf (Anderes Alvarez and Uchida, 1994). The predominance of specific taxa in the digesta suggests a degree of selectivity, perhaps related to distinctive properties of the sponges with respect to spongin and collagen (Meylan, 1985). This highly specific diet, with prey species dependent on filter-feeding in hard-bottom communities, makes the turtle vulnerable to deteriorating conditions on coral reefs.

Reproduction

Data from tag returns, satellite telemetry, and genetic analyses indicate that adult Caribbean hawksbills can travel long distances between foraging and nesting grounds (e.g., Meylan, 1999; Bass, 1999a). Hawksbills typically nest on low- and high-energy beaches in tropical latitudes. Females may select small pocket beaches and, because of their small body size and agility, they can cross fringing reefs that limit access by other species. There is a wide tolerance for nesting substrate and nests are typically placed under woody vegetation.

Hawksbills exhibit strong site fidelity to specific breeding grounds, returning at 2–5 year intervals throughout their reproductive years. A period of courtship and mating is followed by a nesting season that occurs mainly between July and October; in some locations nesting is recorded year-around. Egg-laying is principally nocturnal, although rare daytime nesting does occur. Only gravid females emerge from the sea. The entire nesting process (including emergence from and return to the sea) lasts 1–3 hours (NMFS/FWS, 1993).

In Antigua, West Indies, the region's most comprehensive long-term demographic study of nesting hawksbills, individuals deposit an average of five nests per nesting season at intervals of 14-16 days. Tagged females have been observed to lay as many as 12 clutches of eggs per season (Melucci et al., 1992). Clutch size is variable, averaging 155 eggs in Antigua (Richardson et al., 1999), 137 eggs in Mexico (Isla Aguada, Yucatán) (Frazier, 1991), and 136 eggs in Brazil (Marcovaldi et al., 1999). Eggs are approximately 40 mm in diameter. Incubation is variable depending on ambient temperature, but generally lasts about 60 days.

As in other sea turtles, sex determination is largely temperature-dependent with cooler temperatures favoring males and warmer temperatures favoring females (Mrosovsky et al., 1995). Hatch success is relatively high, with typically greater than 75% of the eggs producing hatchlings that reach the sea. mtDNA analysis has shown that Caribbean nesting populations can be distinguished genetically, and that foraging "populations" are mixed assemblages consisting of individuals drawn from multiple nesting grounds (Bass, 1999; Díaz-Fernández et al., 1999).

Threats

Hawksbills face the same threats that endanger all sea turtles, including marine debris and pollution, the illegal harvest of eggs and turtles, increased use and development of the coastal zone, beachfront lighting, incidental catch, etc. (Eckert, 1995b, c). Sadly, they are also singled out for their own special threat: humans find their shells highly attractive. Experts believe that the killing of hundreds of thousands of wild hawksbills in recent decades to service the shell trade has contributed substantively to population declines in the Caribbean and worldwide (Milliken and Tokunaga, 1987; Canin, 1991; WIDECAST, 1992; Meylan and Donnelly, 1999).

Conservation Status

The hawksbill is listed as Critically Endangered by the World Conservation Union (Baillie and Groombridge, 1996). The species is listed on Annex II of the Protocol to the 'Cartagena Convention' concerning Specially Protected Areas and Wildlife (SPAW Protocol), Appendix I of the Convention on

International Trade in Endangered Species of Wild Fauna and Flora (CITES), and Appendices I and II of the Convention on Migratory Species (CMS). The species is also included in the annexes to the Western Hemisphere Convention, a designation intended to convey that their protection is of "special urgency and importance."

A global status review by IUCN concluded that the hawksbill was suspected or known to be declining in 56 of 65 geopolitical units where information was available (Groombridge and Luxmoore, 1989). The review stated, "the entire Western Atlantic-Caribbean region is greatly depleted." Despite evience of population increases at some sites supporting long-term demographic studies, such as the increases in the Yucatán Peninsula of Mexico (Garduno et al., 1999), current levels of nesting may be far lower than previously estimated. Meylan (1999b) recently reported declining populations in 22 of 26 geopolitical units for which "some status and trend information is available."

Despite widespread protective legislation, an unsustainable and virtually unregulated level of legal and illegal take (for meat, eggs, shell) continues unabated in many countries and poses a significant threat to the survival of the species in the region. Hawksbills also are especially vulnerable to habitat loss because they rely upon coral reefs, one of the most endangered marine habitats (Meylan and Donnelly, 1999). Nearly all countries in the Caribbean host fewer than 100 nesting females per year (Meylan, 1989, 1999). The most recent federal status review of the hawksbill turtle in the United States recognized that numerous threats still exist, despite two decades of protection by the U.S. Endangered Species Act (Eckert, 1995b); hawksbills in other countries face many of these same threats, though they are less comprehensively documented.

Conclusions

Priority actions need to be undertaken at national and international levels if Caribbean populations of hawksbill sea turtles are to be conserved for the future. These include the identification, protection and long-term monitoring of essential feeding, resting and nesting areas; the identification, status assessment and long-term monitoring of critical life stages; identification, quantification and mitigation of important sources of mortality; support for law enforcement; an emphasis on international cooperation and the sharing of information; and increased public awareness and participation in sea turtle (and general marine) conservation and management initiatives (Eckert, 1995a; WIDECAST, 1998).

Literature Cited

Anderes Alvarez, B. L. and I. Uchida. 1994. Study of the hawksbill turtle (*Eretmochelys imbricata*) stomach contents in Cuban waters, p.27-40. *In*: Study of the hawksbill turtle in Cuba I. Ministry of Fishing Industry, Havana.

Bass, A. L. 1999. Genetic analysis to elucidate the natural history and behavior of hawksbill turtles (*Eretmochelys imbricata*) in the Wider Caribbean: a review and re-analysis. Chelonian Conservation and Biology 3(2):195-199.

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Canin, J. 1991. International trade aspects of the Japanese hawksbill shell ("bekko") industry. Marine Turtle Newsletter 54:17-21.

Carr, A. F., H. Hirth and L. Ogren. 1966. The Ecology and Migrations of Sea Turtles, 6: The Hawksbill in the Caribbean Sea. American Museum Novitates 2248:1-29.

Díaz-Fernández, R., T. Okayama, T. Uchiyama, E. Carrillo, G. Espinosa, R. Márquez, C. Diez and H. Koike. 1999. Genetic sourcing for the hawksbill turtle, *Eretmochelys imbricata*, in the Northern Caribbean Region. Chelonian Conservation and Biology 3(2): 296-300.

Eckert, K. L 1995a. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Eckert, K. L. 1995b. Hawksbill Sea Turtle, *Eretmochelys imbricata*, p.76-108. *In*: Pamela T. Plotkin (ed.), Status Reviews of Sea Turtles Listed Under the Endangered Species Act of 1973. NOAA/ Natl. Marine Fisheries Service, Silver Spring, Maryland. U. S. Dept. Commerce, Miami. 139 pp.

Eckert, K. L. 1995c (Revised ed.). Anthropogenic threats to sea turtles, p.611-612. *In*: Karen A. Bjorndal (ed.), Biology and Conservation of Sea Turtles. Smithsonian Institution Press, Washington, D.C.

Frazier, J. 1991. Una evaluación del manejo de nido de tortugas marinas en la Península de Yucatán, p.37-76. *In*:

J. Frazier, R. Vázquez, E. Galicia, R. Durán and L. Capurro (eds), Memorias del IV Taller Regional sobre Programas de Conservación de Tortugas Marinas en la Península de Yucatán. Universidad Autónoma de Yucatán; Mérida, México.

Garduñno-Andrade, M., V. Guzmán, E. Miranda, R. Briseño-Dueñas and F. A. Abreu-Grobois. 1999. Increases in hawksbill turtle (*Eretmochelys imbricata*) nestings in the Yucatán Peninsula, Mexico, 1977-1996: data in support of conservation? Chelonian Conservation and Biology 3(2):286-295.

Groombridge, B. and R. Luxmoore. 1989. The Green Turtle and Hawksbill (Reptilia: Cheloniidae): World Status, Exploitation and Trade. CITES Secretariat, Lausanne, Switzerland. 601 pp.

Marcovaldi, M. A., C. F. Vieitas and M. H. Godfrey. 1999. Nesting and Conservation Management of Hawksbill Turtles (*Eretmochelys imbricata*) in Northern Bahia, Brazil. Chelonian Conservation and Biology 3(2):301-307.

Melucci, C., J. I. Richardson, R. Bell and L. A. Corliss. 1992. Nest site preference and site fixity of hawksbills on Long Island, Antigua, p.171-174. *In*: M. Salmon and J. Wyneken (eds.), Proc. 11th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-302. U. S. Department of Commerce, Miami.

Meylan, A. 1984. Biological Synopsis of the Hawksbill Turtle, *Eretmochelys imbricata*, p.112-117. *In*: Peter Bacon *et al.* (eds.), Proceedings of the Western Atlantic Turtle Symposium. Volume 1. RSMAS Printing, Miami, Florida.

Meylan, A. 1985. The role of sponge collagens in the diet of the hawksbill turtle, *Eretmochelys imbricata*, p.191-196. *In*: A. Bairati and R. Garrone (eds.), Biology of the Invertebrate and Lower Vertebrate Collagens. Plenum Publ. Corp. New York.

Meylan, A. 1988. Spongivory in hawksbill turtles: a diet of glass. Science 239:393-395.

Meylan, A. 1989. Status Report of the Hawksbill Turtle, p.101-115. *In*: L. Ogren (Editor-in-Chief), Proc. 2nd Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. U. S. Department of Commerce. 401 pp.

Meylan, A. B. 1999a. International movements of immature and adult hawksbill turtles (*Eretmochelys imbricata*) in the Caribbean region, Chelonian Conservation and Biology 3(2):177-184.

Meylan, A. B. 1999b. Status of the hawksbill turtle (*Eretmochelys imbricata*) in the Caribbean Region. Chelonian Conservation and Biology 3(2):177-184.

Meylan, A. and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as Critically Endangered on the 1996 IUCN Red List of Threatened Animals. Chelonian Conservation and Biology 3(2):200-224.

Milliken, T. and H. Tokunaga. 1987. The Japanese Sea Turtle Trade 1970-1986. Prepared by TRAFFIC (JAPAN) for the Center for Environmental Education, Wash. D.C. 171 pp.

Mrosovsky, N., A. Bass, L. A. Corliss and J. I. Richardson. 1995. Pivotal and beach temperatures for hawksbill turtles nesting in Antigua, p.87. *In*: J. I. Richardson and T. H. Richardson (compilers), Proc. 12th Annual Symposium on Sea Turtle Biology and Conservation. NOAA Tech. Memo. NMFS-SEFSC-361. U. S. Department of Commerce, Miami. 274 pp.

NMFS/FWS. 1993. Recovery Plan for the Hawksbill Turtle, *Eretmochelys imbricata*, in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, St. Petersburg, Florida. U. S. Department of Commerce. 52 pp.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu G. and M. A. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Pritchard, P. C. H. and P. Trebbau. 1984. The Turtles of Venezuela. Society for the Study of Amphibians and Reptiles.

Richardson, J. I., R. Bell and T. H. Richardson. 1999. Population ecology and demographic implications drawn from an 11-year study of nesting hawksbill turtles, *Eretmochelys imbricata*, at Jumby Bay, Long Island, Antigua, West Indies. Chelonian Conservation and Biology 3(2):244-250.

Van Dam, R. P. 1997. Ecology of Hawksbill Turtles on Feeding Grounds at Mona and Monito Islands, Puerto Rico. Dissertation. University of Amsterdam. 118 pp.

Van Dam, R. P. and C. E. Diez. 1997. Predation by hawksbill turtles on sponges at Mona Island, Puerto Rico, p.1421-1426. *In*: H. A. Lessios and Ian G. Macintyre (eds.), Proceedings of the 8th International Coral Reef Symposium, 24-29 June 1996, Panamá. Volume 2. Smithsonian Tropical Research Institute, Balboa, Panamá.

WIDECAST. 1992. An introduction to the international trade in endangered sea turtles and their products in the

Wider Caribbean Region, and a plea for all countries to join CITES. Prepared for the CITES Implementation Training Seminar, Port of Spain, 14-18 September 1992. Unpubl. 19 pp.

WIDECAST. 1998. General Criteria for a Regional Management Plan for Sea Turtles. Prepared for the 14th Meeting of the CITES Animals Committee Meeting, Caracas, 25-29 May 1998. Unpubl. 8 pp.

Witzell, W. N. 1983. Synopsis of Biological Data on the Hawksbill Turtle, *Eretmochelys imbricata* (Linnaeus, 1766). FAO Fisheries Synopsis No. 137. United Nations, Rome. 78 pp.

Status and Distribution of the Kemp's Ridley Turtle, *Lepidochelys kempii*, in the Wider Caribbean Region

René Márquez M.
Programa Nacional de Investigación de Tortugas Marinas
SEMARNAP / INP
México

Description

Family Cheloniidae, *Lepidochelys kempii* Garman (1880)

Common names: tortuga lora, bastarda, Kemp's ridley, tartaruga bastarda, tortue de Kemp

The Kemp's ridley sea turtle is the smallest of the sea turtles. An adult weighs between 30-50 kg, with a straight carapace length (SCL) of 50-78 cm. The color of the carapace in an adult is olive green; the underside (plastron) is yellowish white. The form of the carapace is semicircular. The head is triangular, with a thick and somewhat hooked beak, not serrated. There is a pore in each inframarginal scute of the bridge.

The spherical, white-shelled eggs measure 34-45 mm in diameter and weigh 24-40 g. Hatchlings are uniformly black in color, averaging 44 mm SCL and approximately 17.2 g in weight. The hatchlings show three dorsal longitudinal ridges and four in the plastron, with a small sharp protrusion or spine on each scute (with age these protrusions disappear). In immature stages, the turtles have an almost black dorsal surface and a white underside.

For additional information beyond that provided in this brief overview, the reader is referred to Wibbels (1984), Ross et al. (1989), Márquez (1989, 1990, 1994), Caillouet and Landry (1989), Chávez et al. (1990), Byles (1993), Eckert et al. (1994), and Pritchard and Mortimer (1999).

Biology

The species occurs mainly in the Gulf of México and adults can be found throughout the continental shelf (Figure 1).

It is not known where the hatchlings go immediately upon entering the water, but they can be observed moving along the coast. Based on documented sightings in oceanic waters, we assume that the first migration of these immatures is directed toward pelagic areas, and I believe that the young turtles stay within the Gulf Stream for two or three years. A large number of immatures are carried out of the Gulf of México by the Gulf Stream and distributed along the eastern seaboard of the USA (Figure 1). Quite a few continue their trip to European coasts; it is uncertain whether these turtles can or will ever return to their place of origin.

It is believed that when turtles reach approximately 25 cm SCL, they begin their return to the Gulf of México. Seasonal migrations along the eastern seaboard of the USA are known to occur. If individuals remain too long in their northern feeding zones as temperatures decrease during the fall and winter months, they may experience "cold-stunning" and wash ashore dead or dying on beaches along Cape Cod, Long Island Sound, Chesapeake Bay, Carolina Sound, etc. (Richard Byles, in litt. 1999).

Reproduction

Most marine turtles nest during the night but, for some reasons of adaptation, this species nests during daylight hours (Hildebrand, 1963). Nesting occurs mainly along the long sandy coastal strip around Rancho Nuevo in Tamaulipas, México (Figure 2), and especially when strong winds blow. Nesting occurs from April to July and the hatchlings appear from May to August or September.

Females reach sexual maturity at 10 to 12 years of age and at a minimum size of 55 cm SCL. The maximum observed size among breeders is 78 cm SCL. It is interesting to mention that while the average annual size (SCL) has remained constant at

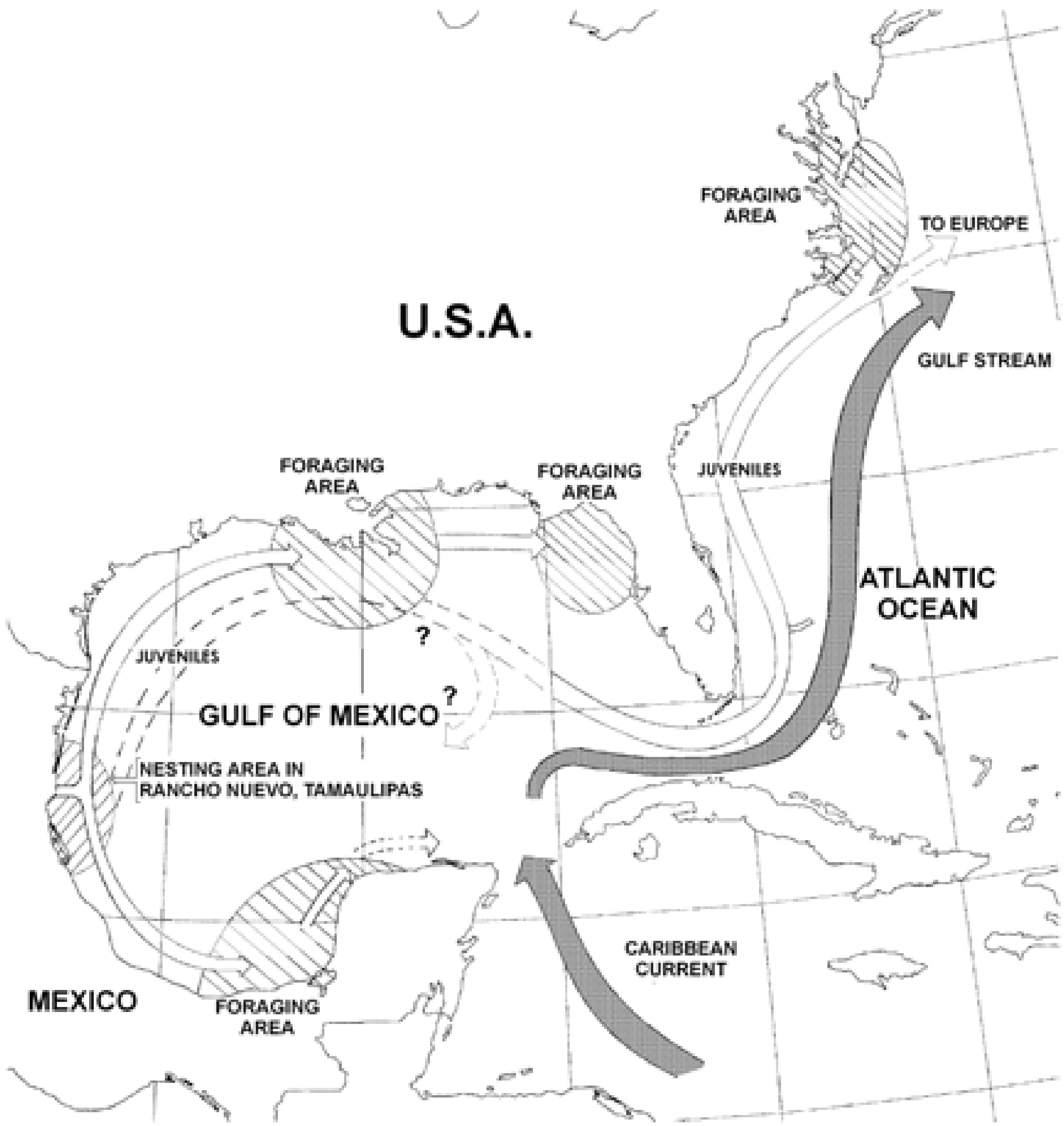

Figure 1. Kemp's ridley distribution to and from the main nesting beach at Rancho Nuevo, México, with nesting areas and possible migration routes. Source: Adapted from R. Márquez and *USA Today*, 1996.

63-66 cm, the average number of eggs per clutch has decreased- in the 1960s the average clutch size was 110-112 eggs, while in the 1990s this has fallen to an average of 90-95 eggs (Márquez, 1994). This observation may reflect the presence now of a greater proportion of young turtles within the breeding population than in the past.

Secondary Nesting Grounds

As a result of conservation initiatives begun in 1966, the breeding population of Kemp's ridley is beginning to show signs of recovery after years of decline in the second half of the 20th century. As a result, small breeding colonies have reappeared in locations where they had disappeared, such as Veracruz (e.g., Lechuguillas, El Raudal, Tecolutla) where an average total of more than 100 nests are now laid per year. Smaller numbers of nests are also reported from other beaches in Veracruz and Campeche. Furthermore, there are few but frequent nestings in the USA (e.g., Florida, South Carolina). As a result of consistent field conservation efforts in México, several years of an imprinting and headstart experiment in the USA (Johnson et al., 1999), and the mandatory use of Turtle Excluder Devices (TEDs) in the Gulf of México, a very small population has apparently re-established itself on Padre Island, Texas, as well (Shaver and Caillouet, 1998).

Population Status

In the first years that turtles were protected (1966), Rancho Nuevo (between bars of El Tordo and El Carrizo) witnessed the arrival of over 2,000 females (Márquez, 1994, 1996). In spite of conservation activities, nesting reached its lowest levels between 1985 and 1987, with an annual average of 750 nests laid. However, as of 1988 there has been a steady increase in the number of nests which translates to an overall 8% annual increase (Figure 3) in Rancho Nuevo alone. If we take into consideration all other monitored nesting grounds in the state of Tamaulipas, the increase is even greater (12%; Márquez et al., 1999) (Figure 4). At the present time, Kemp's ridley is classified as "Endangered" by law in México and the USA, and is classified as "Critically Endangered" by IUCN (Baillie and Groombridge, 1996). The species is included in Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and Appendices I and II of the Convention on the Conversation of Migratory Animals.

Conservation Program

The beach at Rancho Nuevo became known to the scientific community in 1963 through a documentary filmed made in 1947 by Ing. Herrera (Hildebrand, 1963). Based on that film, an estimated 40,000 gravid females were on the beach nesting on that day in May 1947. In 1966, three years after the film was made public, the government of México established the first sea turtle camp at Rancho Nuevo. The camp was responsible for research and monitoring activities along 20 km of beach. With the advent of a bi-national (México-USA) program, activities were extended to 45 km of beach between 1978-1988; between 1989-1990, as nesting increased outside of the protected area, the size of the protected area was doubled again. From 1991-1996, several temporary campsites were added in Tamaulipas, thus enlarging the site to more than 120 km of beach. Since 1997 the effort has officially expanded to the state of Veracruz, and with it over 200 km of nesting sites came under protection.

Other Conservation Measures

Rancho Nuevo was declared a "Natural Reserve" in 1977, ensuring continuity to research and conservation activities. In 1978, Kemp's ridley was included in the MEXUS-Gulf Program, which is a scientific collaboration program between México and the USA, and this brought an improvement in research, conservation, and facilities.

The joint program also included experimental activities with Kemp's ridley hatchlings. In 1978 an experimental "imprinting and headstart" program began with an annual shipment of 2000 eggs, which were transferred from Rancho Nuevo to Padre Island (Texas) for incubation. A smaller number of hatchlings was also sent. Both the hatchlings obtained in Padre Island and those from eggs hatched in México were sent directly to the National Marine Fisheries Service (NMFS) laboratory in Galveston, Texas. Survival rates were high and immatures were released into the Gulf of México at 9-10 months of age. The last year of the experiment (i.e., the transfer of eggs to the USA) was in 1992, when the program was characterized as "very expensive with dubious results." Despite this, it was deemed important to continue the cooperative program, although the annual donation from México to the USA was reduced to 200 hatchlings.

Due to the high turtle mortality rate as a result of shrimping fleets from both countries, at the end of the 1980s the use of Turtle Excluder Devices (TEDs) was recommended. The devices became mandatory in 1992 for the USA shrimp fleet, and in April 1994 for the Mexican fleet. The use of TEDs also became mandatory (under U.S. law) for all

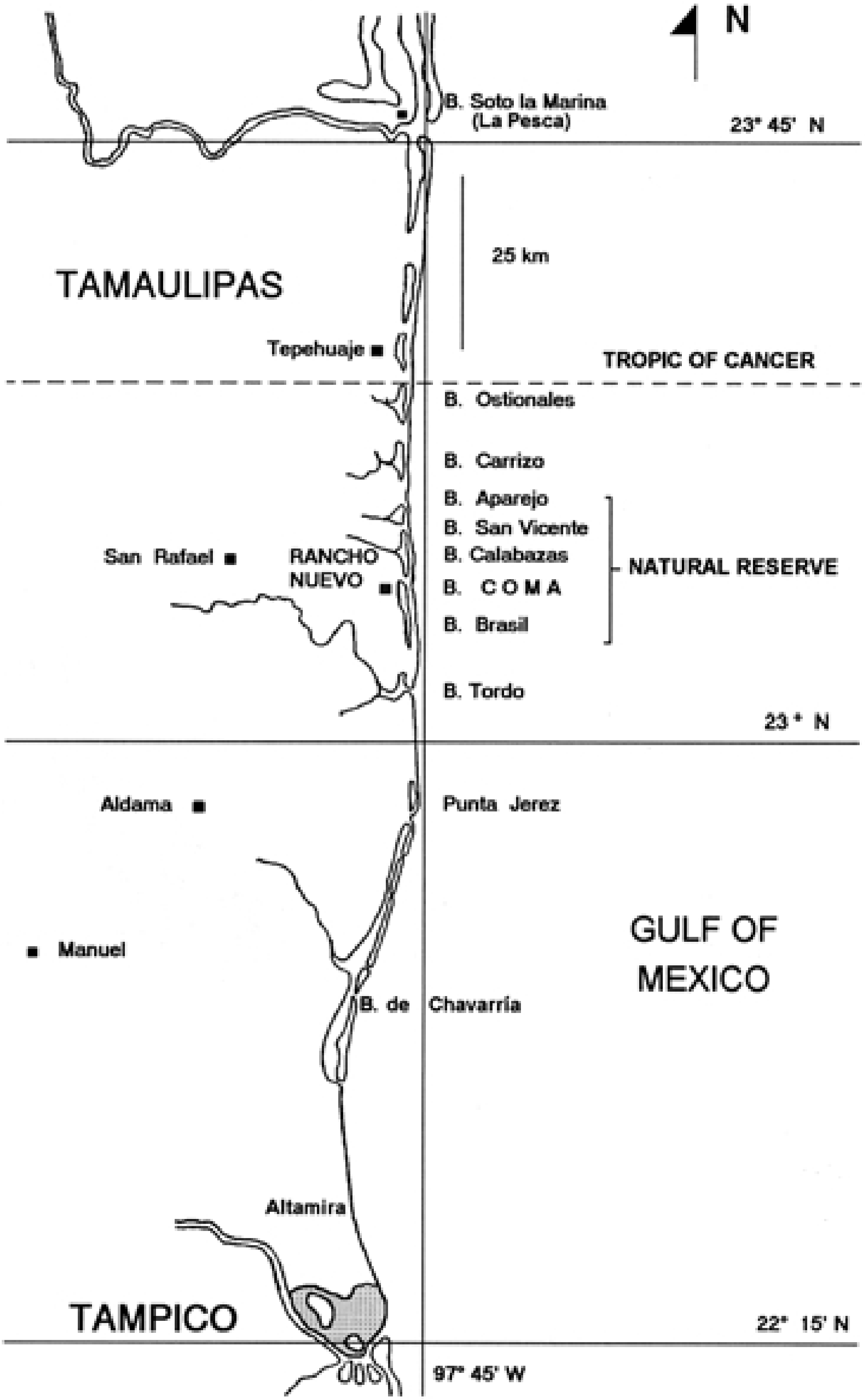

Figure 2. Main nesting area for the Kemp's ridley sea turtle in Tamaulipas, México (Márquez, 1994).

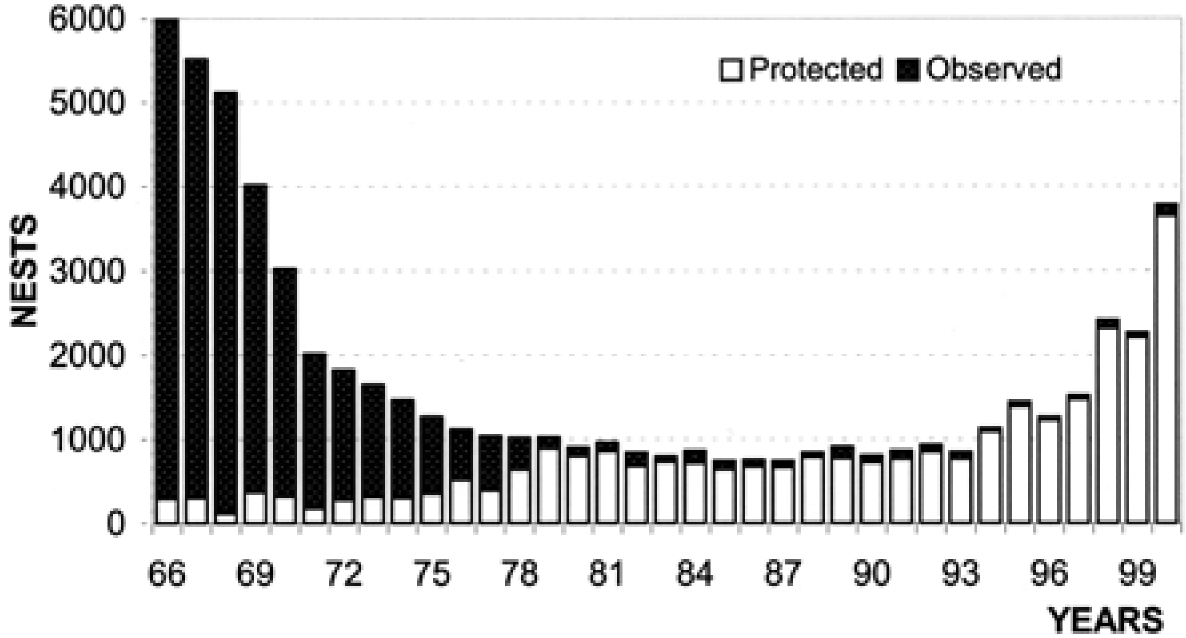

Figure 3. Progress of Kemp's ridley nestings in the beach at Rancho Nuevo, Tamaulipas, México.

countries wishing to export their shrimp harvest into the USA.

Acknowledgements

I am especially grateful to my collaborators: Juan Díaz F., Miguel A. Carrasco, M. Carmen Jiménez, Rafael Bravo, Manuel Garduño D., Manuel Sánchez P. and Alma Leo P. from INP/CRIP-Manzanillo, as well as Patrick Burchfield and Jaime Peña from the Gladys Porter Zoo in Texas.

Since 1966, many researchers, students and volunteers have contributed their invaluable support to this unique program. In México, the National Institute of Ecology, universities, NGOs, state agencies, the Department of the Navy, Federal Office of Environmental Protection, PEMEX, Federation of Fishing Cooperatives of Tamaulipas and Texas, and others have contributed to these activities. The community of Rancho Nuevo was paramount in the achievements of this endeavor. Recognition must also be given to institutions in the USA, including the Fish and Wildlife Service, National Marine Fisheries Service, National Park Service, and the Gladys Porter Zoo (Brownsville, Texas) for their continuous support. A special mention goes out to our fellow workers in the campsites. Finally, we thank the Organizing Committee of this meeting for their support, as well as WIDECAST, IUCN, and the Government of the Dominican Republic for their help in the presentation of these updates.

Literature Cited

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Byles, R. 1993. Head-Start experiment no longer rearing Kemp's ridleys. Marine Turtle Newsletter 63:1-3.

Caillouet, C. W. and A. M. Landry (Editors). 1989. Proceedings of the First International Symposium on Kemp's Ridley Sea Turtle Biology, Conservation and Management. TAMU-SG-89-105. Texas A&M University Sea Grant College Program, Galveston, Texas. 260 pp.

Chávez, H., M. Contreras G. and T. P. E. Hernández D. 1990. Aspectos biologicos y proteccion de la Tortuga Lora, *Lepidochelys kempi* (Garman), en la costa de

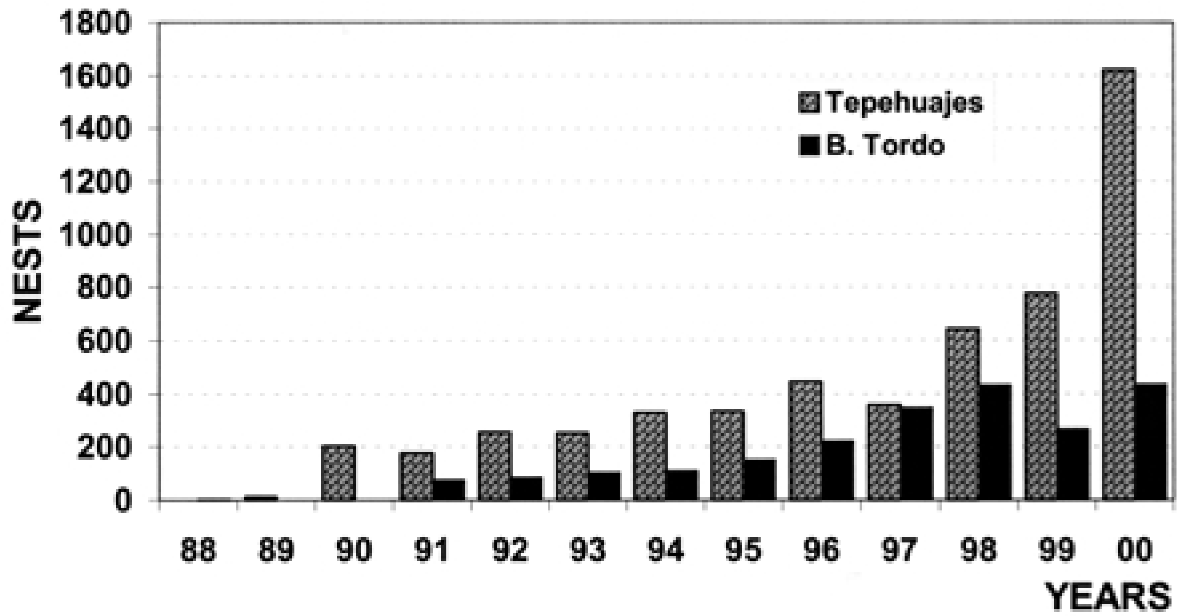

Figure 4. Increases in Kemp's ridley nestings in the beaches of Tepehuajes and Barra del Tordo, Tamaulipas, México.

Tamaulipas, México. 1990. Inst. Nacional de la Pesca Serie: Documentos de Trabajo Año 11, No. 19. 40 pp.

Eckert, S. A., D. Crouse, L. A. Crowder, M. Maceina and A. Shah. 1994. Review of the Kemp's Ridley Sea Turtle Headstart Program. NOAA Tech. Memo. NMFS-OPR-3. U.S. Dept. Commerce. 11 pp.

Hildebrand, H. H. 1963. Hallazgo del área de anidación de la tortuga "lora" *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de México (Rept., Chel.). Ciencia*,* México 22(4):105-112.

Johnson, S. A., A. L. Bass, B. Libert, M. Marshall and D. Fulk. 1999. Kemp´s Ridley (*Lepidochelys kempi*) nesting in Florida. Florida Scientist 62(3-4):194-204.

Márquez M., R. 1989. Status Report of the Kemp's Ridley Turtle, *Lepidochelys kempi*, p.159-168. *In*: L. Ogren (Editor-in-Chief), Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. U.S. Dept. Commerce.

Márquez M., R. 1990. FAO SPECIES CATALOGUE. Vol. 11. Sea Turtles of the World. An Annotated and Illustrated Catalogue of Sea Turtles Species Known to Date. FAO Fisheries Synopsis No. 125, Vol. 11: 81pp.

Márquez M., R. 1994. Sinopsis de datos biológicos sobre la tortuga lora, *Lepidochelys kempi* (Garman, 1880). Instituto Nacional de la Pesca. México FAO. SAST-Tortuga Lora. 5.31(07)016.02, INP/S152:141pp.

Márquez M., R., J. Díaz, M. Sánchez, P. Burchfield, A. Leo, M. Carrasco, J. Peña, C. Jimenez and R. Bravo. 1999. Results of the Kemp's ridley Nesting Beach Conservation Efforts in México. Marine Turtle Newsletter 85:2-4.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In:* Karen L. Eckert, Karen A. Bjorndal, F. Alberto Abreu-Grobois and Marydele Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Ross, J. P., S. Beavers, D. Mundell and M. Airth-Kindree. 1989. The Status of Kemp's Ridley. Center for Marine Conservation, Washington. D.C. 51 pp.

Shaver, D. J. and C. W. Caillouet. 1998. More Kemp's ridley turtles return to south Texas to nest. Marine Turtle Newsletter 82:1-5.

Wibbels, T. A. 1984. Orientation characteristics of immature Kemp's ridley sea turtles, *Lepidochelys kempi*. NOAA Tech. Memo. NMFS-SEFC-131. U.S. Dept. Commerce. 67 pp.

Karen L. Eckert and F. Alberto Abreu Grobois, Editors (2001)
Sponsored by WIDECAST, IUCN/SSC/MTSG, WWF,
and the UNEP Caribbean Environment Programme

Status and Distribution of the Olive Ridley Turtle, *Lepidochelys olivacea*, in the Western Atlantic Ocean

Maria Ângela Marcovaldi
Fundação Pró-TAMAR
Brazil

Identity and Description

The generic name *Lepidochelys* was introduced by Fitzinger (1843). The specific name *olivacea* was first used by Eschscholtz (1829), but in conjunction with the genus *Chelonia*. Soon thereafter the binomial *Caretta olivacea* was published (Rüppell 1835), and there were subsequent modifications as well (summarized by Márquez, 1990). Today two species are recognized, *L. olivacea* and *L. kempii*. *L. olivacea* is rare in the Western Atlantic, but large populations inhabit the Indo-Pacific; hence, the common literature misnomer 'Pacific ridley' (see Eckert, 1995). The preferred English name is olive ridley. In Spanish it is known as golfina; in French, tortue olivâtre; in Portuguese, tartaruga oliva.

The olive ridley is one of the smallest of the marine turtles, rarely exceeding 45 kg, with average weights around 35 kg (Schulz, 1975). The basic morphological differences between *L. olivacea* and *L. kempii* include a smaller head in the olive ridley and differences in jaw structure. The carapace of the olive ridley is distinctive in having a variable and often uneven number of lateral scutes, between 6 and 10 pairs. The genus is unique in having four pairs of pores in the inframarginal scutes of the plastron (Pritchard and Mortimer, 1999). The function of these pores is unknown.

Adults are generally olive colored; hatchlings are uniformly dark brown. Hatchlings average 42 mm in carapace length and typically weigh 16-19 g. The costal and vertebral scutes are keeled in hatchlings. Carapace scutes are slightly imbricate (overlapping) in hatchlings and young juveniles, but non-overlapping in adults. For a more in-depth review of the description and/or ecology of this species, the reader is referred to Pritchard (1969), Schulz (1975), Reichart (1989, 1993), Eckert (1995), Pritchard and Plotkin (1995), and Pritchard and Mortimer (1999).

Ecology and Reproduction

Olive ridley turtles are distributed in all tropical and subtropical ocean basins. On a global scale, the olive ridley is probably the most abundant species of marine turtle, with some nesting beaches receiving more than half a million turtles during a nesting season (up to 800,000 on Gahirmatha beach, in Orissa, India — Anonymous, 1994; more than 700,000 on Playa Escobilla on the Pacific coast of Mexico - Márquez et al., 1996). Ironically, it is also the least abundant marine turtle in the Western Atlantic region.

Olive ridleys exist in distinct populations in primarily coastal habitats, but captures far offshore indicate that at least some individuals may be pelagic. The species is carnivorous, generally eating crustaceans and invertebrates, and prefers foraging areas that are near biologically rich bays and estuaries (Reichart, 1993). Migrations and movements are known to exist (based on tag returns) along the coasts of Venezuela, the Guianas, and Brazil, but very little is known about the behavior of the species at sea, including migratory paths. There are no reliable data on age to sexual reproduction or maximal longevity (Reichart, 1993).

Olive ridleys lay 2-3 nests per year, and often nest in consecutive years. In Suriname, clutch size ranges from 30-168 eggs (average: 116) (Schulz, 1975). Some populations in the Indo-Pacific nest *en masse*, a phenomenon which used to occur in Suriname but has not be witnessed for over 20 years in the Western Atlantic. During these events, known as "arribadas", from tens to hundreds of thousands of turtles emerge from the ocean to nest on the same beach over a period of a few days. The stimuli which precipitate the beginning of an arribada may include environmental factors such as wind speed and direction and phases of the tide and moon, and gravid females apparently can delay nesting for several weeks, despite the presence of fully shelled eggs. Arribada nesting continues during daylight hours also, in contrast to most other marine turtle species that prefer to lay their eggs under the cover of darkness.

The arribada behavior is not fully understood. It has been suggested that this is a form of predator saturation which may increase the likelihood of survival of the hatchlings produced (Pritchard, 1969). Evidence from Pacific Costa Rica suggests that, on average, a nest laid during an arribada is less likely to suffer predation than a nest laid by a solitary female (Eckrich and Owens, 1995). However, gains made in terms of predation rates may be negated by losses in hatching rates: typically, the hatching success of nests laid during arribadas is terribly small; for example, only around 5% of the eggs laid on Nancite beach, in Costa Rica actually produce viable hatchling (Cornelius, 1986). This is thought to be due largely to turtles digging into previously laid nests, and the high levels of bacteria and other microorganisms present in the sand.

After the arribada, individual turtles migrate to other areas independently, rather than in flotillas or groups. This is based on data collected while tracking individual turtles with satellite transmitters, following nesting during an arribada in Costa Rica (Plotkin et al., 1995).

Distribution and Trends

In the western Atlantic there are only three countries in which significant numbers of olive ridley nests (totaling about 1,400-1,600 nests) are made each year:

- Suriname: Principally Eilanti beach, and secondarily Matapica beach
- French Guiana: Ya:lima:po beach and others, both east and west of Cayenne
- Brazil: the beaches of Pirambu, Abaís, and Ponta dos Mangues in the state of Sergipe, in northern Brazil

There are few, if any, records of olive ridley nests outside these areas in the western Atlantic. Incidental capture of olive ridley turtles has been recorded mostly near the Guianas and in northern Brazil, although there are records of animals caught in the waters of Venezuela, Trinidad and Tobago, and Brazil (Schulz, 1975; Marcovaldi et al., in press).

Suriname: In Suriname, the local name for olive ridley is *warana*. The yearly total of *warana* nests laid each year in Suriname has been declining (see "Threats") for the past 30 years from a high of 3300 in 1968 to fewer than 200 in 1999 (Figure 1). The principal nesting beach for olive ridleys in Suriname is Eilanti beach, close to the border with French Guiana. Small-scale arribadas were seen in the late 1960s and 1970s on Eilanti beach, but have not occurred since.

French Guiana: The local name for olive ridley in French Guiana is *tortue olivâtre*. Until recently the focus of monitoring in French Guiana was Ya:lima:po beach, which is frequented by enormous numbers of leatherback turtles each year (Girondot and Fretey, 1996). There are numerous beaches in the western half of the country, from the border with Suriname to Cayenne, and some with as many as 25 olive ridley nests laid per night; an estimated 500 nests were laid in 1999 (Johan Chevalier, pers. comm.). East of Cayenne to the border with Brazil, the beaches were regularly monitored for the first time in 1999; an estimated 500 nests were encountered in this region (Jean-Christophe Vié, pers. comm.).

Due to the lack of consistent data, it is not known if these relatively large numbers of nests are the result of (i) true population increases, (ii) displacement of females from Suriname, or (iii) the increased monitoring and reporting effort. Indeed, all these factors may be at play in this situation. Certainly regular monitoring is needed in French Guiana in order to better characterize the status of the population.

Brazil: In Sergipe, on the northern coast of Brazil, regular monitoring was begun in 1982 at Pirambu beach, the principal nesting site of olive ridleys in Brazil. Since 1989, nests have been protected in three areas in Sergipe: Abaís, Pirambu, and Ponta dos Mangues. Despite fluctuations in the annual numbers of nests, the overall pattern seems to be steady, with a yearly mean of 200-400 nests (Figure 2). There is no evidence that arribadas previously existed in Sergipe. Indeed, the lack of a common name for this species in Brazil suggests that its relative scarcity has been long-term.

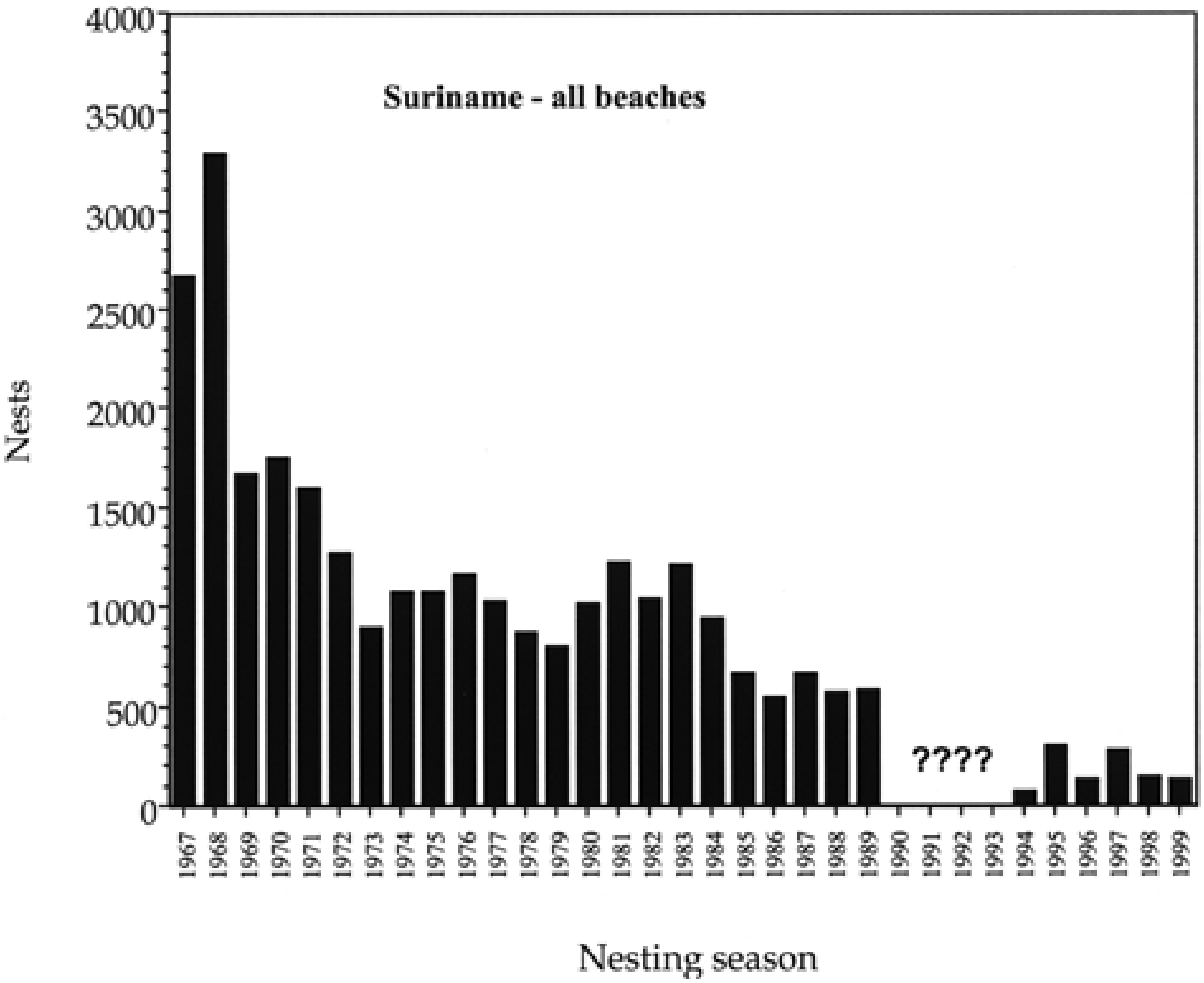

Figure 1. Annual number of olive ridley nests laid per nesting season, in all of Suriname. Data are not available for 1990-1993. Source: Reichart (1993) and Kris Mohadin, STINASU/ LBB, Suriname (pers. comm.).

Threats

The principle threat to olive ridleys is incidental capture by both artisanal and industrial fisheries, with the largest number of incidental captures occurring off the coast of the Guianas. Indeed, Reichart and Fretey (1993) wrote that incidental capture is the "largest unaddressed problem in turtle conservation" in these countries. Other threats include natural erosion cycles, habitat destruction, predation by jaguars, and poaching.

Conservation Status

Olive ridleys are classified as Endangered by the World Conservation Union (IUCN) (Baillie and Groombridge, 1996). They are included in Annex II of the SPAW Protocol [Protocol concerning Specially Protected Areas and Wildlife] to the Cartagena Convention, Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and Appendices I and II of the Convention on the Conservation of Migratory Species (the Bonn Convention). Since Japan ratified CITES with a reservation on *Lepidochelys olivacea,* the import of olive ridley products (mostly skins, and all of them originating from Pacific populations) into that country continued until 1992 when the reservation was withdrawn. No nation currently holds a CITES exemption for this species (Eckert, 1995).

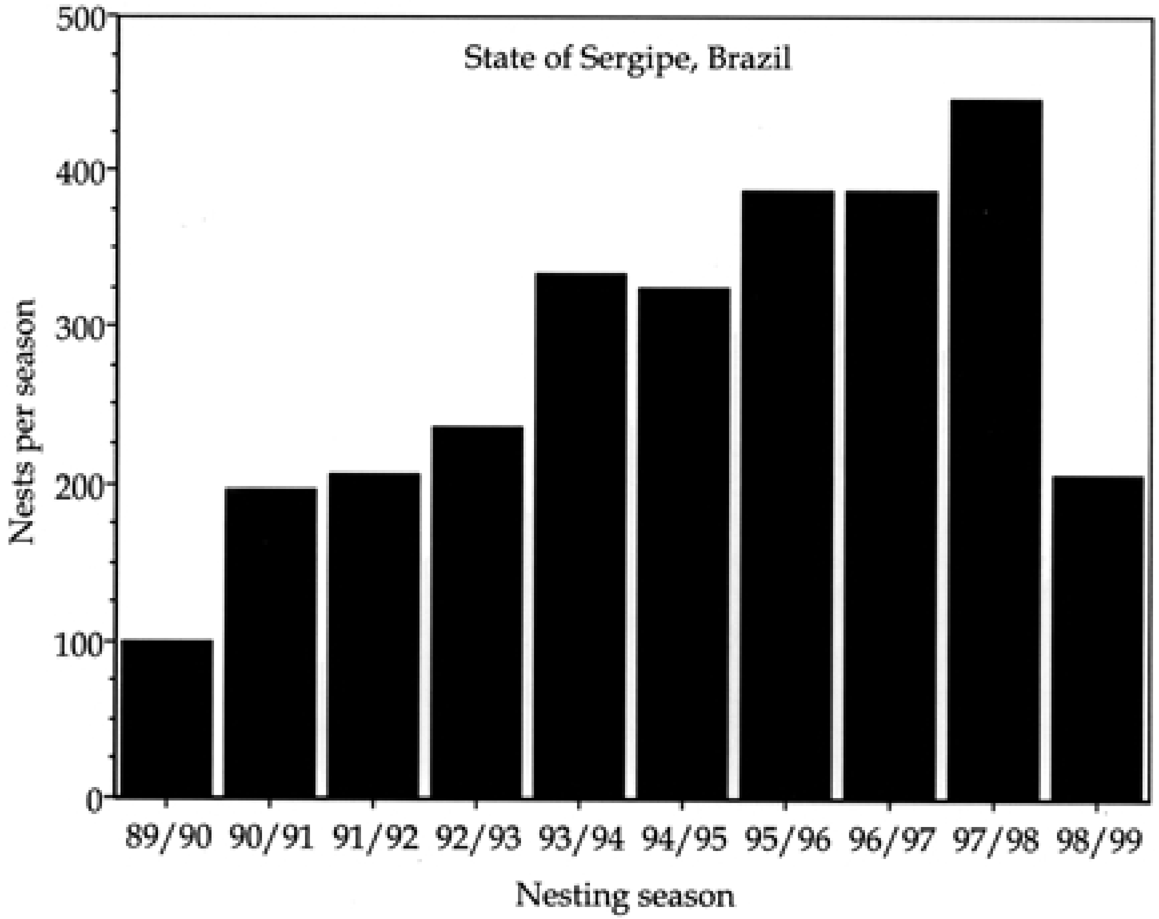

Figure 2. Annual numbers of olive ridley nests laid per nesting season in the state of Sergipe, in Brazil. The monitoring effort was reduced in the 1998/99 nesting season. Scattered nesting of this species also occurs in the states of Bahia and Espirito Santo, but in low numbers (<50 per year). Source: Projeto TAMAR-IBAMA.

Conclusions

The overall situation of olive ridleys in the western Atlantic is mixed. In Suriname, historically the primary nesting ground for the Western Atlantic population, the numbers of nests laid per year have declined more than 90% in the last three decades. The good news is that increased attention to monitoring in French Guiana and Brazil has resulted in a surprising number of reported nests, perhaps 1000 or more in French Guiana alone. Whether these females represent displaced members of the Suriname population or an indigenous but previously unknown population in French Guiana is unknown. In Brazil, the population is small but apparently stable.

Reasons for the dramatic decline of the Surinam population are unknown. All nests laid by olive ridleys are excluded from the legal egg harvest program in Suriname (Reichart, 1993). The natural erosion cycle of Eilanti Beach is probably one cause of the decline, and in recent years it is likely that at-sea mortality due to incidental capture has undermined all other conservation initiatives aimed at this depleted population. Incidental catch and associated mortality is a serious problem that must be addressed if we hope to stabilize populations of *L. olivacea* in the Western Atlantic Region.

Acknowledgements

I would like to thank several people for providing unpublished information on short notice, particularly Kris Mohadin of STINASU in Suriname, Jeroen Swinkels of BIOTOPIC, Johan Chevalier of ONC, Laurent Kelle of WWF-France, and Jean-Christophe Vie of the Kwata Project in French Guiana. Thanks to Jaqueline C. de Castilho and Augusto César C. Dias da Silva of the Projeto TAMAR-IBAMA bases in Sergipe for their dedication over the years in conserving the olive ridleys in Brazil, and thanks to Matthew Godfrey for help with organizing the data.

Literature Cited

Anonymous. 1994. Concern rises over threat to Indian turtles. Marine Turtle Newsletter 64: 1-3.

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Cornelius, S. 1986. The Sea Turtles of Santa Rosa National Park. Fundación de Parques Nacionales, Costa Rica. 64 pp.

Eckert, K. L. 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Eckrich, C. E. and D. Wm. Owens. 1995. Solitary versus arribada nesting in the olive ridley sea turtles (*Lepidochelys olivacea*): a test of the predator-satiation hypothesis. Herpetologica 51: 349-354.

Girondot, M. and Fretey, J. 1996. Leatherback turtles, *Dermochelys coriacea*, nesting in French Guiana, 1978-1995. Chelonian Conservation and Biology 2(2): 204-208.

Marcovaldi, M. Â., B. G. Gallo, E. H. S. M. Lima and M. H. Godfrey. In press. *Nem tudo que cai na rede é peixe*: an environmental education initiative to reduce mortality of marine turtles caught in artisanal fishing nets in Brazil. Ocean Yearbook.

Márquez M., R. 1990. Sea Turtles of the World. FAO Species Catalogue Vol. 11. Food and Agricultural Organization of the United Nations, Rome. 81 pp.

Márquez M., R., Peñaflores, C., and Vasconcelos, J. 1996. Olive ridley turtles (*Lepidochelys olivacea*) show signs of recovery at Escobilla, Oaxaca. Marine Turtle Newsletter 73: 5-7.

Plotkin, P. T., R. A. Byles, D. C. Rostal and D. Wm. Owens. 1995. Independent versus socially facilitated oceanic migrations of the olive ridley, *Lepidochelys olivacea.* Marine Biology 122: 137-143.

Pritchard, P. C. H. 1969. Sea Turtles of the Guianas. Bulletin of the Florida State Museum, Biological Series 13: 85-140.

Pritchard, P. C. H. and J. A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification, p.21-38. *In*: Karen L. Eckert, Karen A. Bjorndal, F. Alberto Abreu G. and Marydele Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Pritchard, P. C. H. and P. T. Plotkin. 1995. Olive ridley sea turtle, *Lepidochelys olivacea*, p.123-139. *In*: P. T. Plotkin (ed.), National Marine Fisheries Service and U. S. Fish and Wildlife Service Status Reviews for Sea Turtles Listed under the Endangered Species Act of 1973. National Marine Fisheries Service, Silver Spring, Maryland.

Reichart, H. A. 1989. Status report on the olive ridley sea turtle, p.175-188. *In*: L. Ogren (Editor-in-Chief), Proceedings of the Second Western Atlantic Turtle Symposium. NOAA Tech. Memo. NMFS-SEFC-226. U. S. Department of Commerce. 401 pp.

Reichart, H. A. 1993. Synopsis of Biological Data on the Olive Ridley Sea Turtle *Lepidochelys olivacea* (Eschscholtz 1829) in the western Atlantic. NOAA Tech. Memo. NMFS-SEFSC-336. U.S. Dept. of Commerce. 78 pp.

Reichart, H. A. and J. Fretey. 1993. WIDECAST Sea Turtle Recovery Action Plan for Suriname (K. L. Eckert, ed.). CEP Technical Report No. 24. UNEP Caribbean Environment Programme, Kingston, Jamaica. 65 pp.

Schulz, J. P. 1975. Sea turtles nesting in Surinam. Zoologische Verhandelingen 143:1-143.

Session II

Marine Turtle Management Goals and Criteria

Management Planning for Long-Lived Species
John A. Musick, Presenter

Management and Conservation Goals for Marine Turtles
Nat B. Frazer, Presenter

Open Forum
Miguel Jorge, Moderator

Management Planning for Long-Lived Species

John A. Musick[1]
Department of Fisheries Science
Virginia Institute of Marine Science
College of William and Mary
USA

Presented by:
Nat B. Frazer
Department of Wildlife Ecology and Conservation
Institute of Food and Agricultural Sciences
University of Florida
USA

Abstract

Long-lived marine animals generally grow slowly and mature at a late age. In addition, many long-lived species have low fecundity or variable and infrequent recruitment. Long-lived marine animals are particularly vulnerable to excessive mortalities and rapid population collapse after which recovery may take decades. The von Bertalanffy growth coefficient (k) is a useful index in addressing the potential vulnerability of populations to excessive mortality. Groups that have k coefficients $\leq$ .0.10 are particularly vulnerable and include most elasmobranchs (for example, sharks), all sturgeons, many large teleosts (bony fish), and all the cheloniid sea turtles (among others).

Another useful index in assessing the vulnerability of populations to excessive mortality is the intrinsic rate of increase (r). Vulnerability is inversely proportional to r, with groups that have annual increase rates $\leq$ 10% being particularly at risk. These include most elasmobranchs, all sturgeons, many teleosts, all sea turtles, many sea birds, and large cetaceans.

Traditional surplus production models may be inappropriate for most long-lived marine animals because of the long lag-time in population response to harvesting. Rather, demographic models based on life-history parameters have provided useful recently in assessing impacts of mortality on long-lived species such as sharks and sea turtles. The greatest threats to long-lived marine animals come from mixed species fisheries in which long-lived species are taken ancillary to more abundant, productive species. Such fisheries may drive long-lived species to extirpation while the more productive species sustain catches.

Resource managers need to be aware of the critical management requirements of long-lived species. In most instances such species can sustain only limited excess harvesting. To ignore the special nature of the population dynamics of long-lived species leads inevitably to population collapse or even extirpation.

Introduction

Life history traits have proven valuable in predicting the responses of populations to various perturbations (Begon et al., 1986; Gadgil and Bossert, 1970; Southwood, et al., 1974). Adams (1980) pointed out that fishes which grow fast and mature at an early age, and have short life spans, have higher maximum sustainable yields and recover relatively rapidly from over-fishing, whereas slower growing, later maturing, long-lived species provide low maximum sustainable yields and recover slowly from over-fishing. Jennings et al. (1998) showed that in 18 intensively exploited fish stocks, those fishes that had the highest declines, mature later, are larger, and had lower potential rates of population increase compared with their nearest taxonomic relatives. Parent and Schrimi (1995) evaluated a matrix of 51 variables that could contribute to increased risk of extinction in 117 species of freshwater fishes in the Great Lakes of the U.S. They found age at maturity to be one of the most important predictors of extinction risk, and that long-lived species were the most vulnerable. Crouse et al. (1987) showed that the loggerhead sea turtle (*Caretta caretta*), a slow growing, long-lived species, had a very low potential for recovery after severe population reduction. In a paper dealing with demographics and management of long-lived turtles, Congdon et al. (1993) stated "The concept of sustainable harvest of already-reduced populations of long-lived organisms appears to be an oxymoron." Landa (1997) examined the relevance of life history theory to harvest and conservation and noted that certain life history traits such as low intrinsic rate of increase and large body weight were interrelated in a predictive way. He also noted that these and other life history traits, such as low fecundity, could be used to predict the potential effects of harvest on populations.

Thus, life history traits have been used by workers to better understand the effects of excessive anthropogenic mortalities on specific groups of long-lived animals and to predict population recovery trajectories. Until recently, very little work has been done to compare life history parameters across major taxonomic boundaries. Musick (1999a) introduced the notion that several higher taxa of long-lived marine vertebrates share quantitative life history parameters that are useful in predicting vulnerability and in formulating conservation strategies across taxonomic boundaries. The present paper will explore that notion further.

Growth Rates

The relative rate of growth is a critical component of every species' life history strategy. Growth rate of a species may define size or age at maturity, maximum size or age, and potential production (Chaloupka and Musick, 1997). Growth may be defined in quantitative terms in many ways (Hilborn and Walters, 1992), but among the most useful are the von Bertalanffy, Logistic, and Gompertz mathematical models (Beverton and Holt, 1957; Ricker, 1958). The von Bertalanffy model has had most widespread application, although statistical computer programs are available that easily produce all three models from the same input parameters (Parham and Zug, 1997). In its simplest form (von Bertalanffy, 1938), the model may be expressed thusly:

$$L_t = L_\infty (1 - e^{-k\ (t - t_0)})$$

where: L_t = length at age t; L_∞ = asymptotic length; k = growth coefficient; t_0 = age when length is theoretically zero.

Among the parameters provided by the model, the growth coefficient k is especially useful in comparing life history strategies and limitations among species. Among the fishes (where much research on growth has been done), values of k may vary from 0.80 to 1.40 in a rapidly growing anchovy (*Thryssa hamiltoni*) (Hoedt, 1992); 0.17 to 0.25 in a spanish mackeral (*Scomberomorus commersoni*), a species with moderate growth (McPherson, 1992); 0.09-0.19 for swordfish (*Xiphias gladius*) (Berkeley and Houde, 1983); and 0.04 to 0.07 in some of the slowest growing galeoid sharks (Branstetter, 1990) (Table 1).

Slow growth is associated with late maturity and long life span (Hoenig and Gruber, 1990; Smith et al., 1998). Within the carcharhiniform sharks, small species such as *Mustelus henlei* and *Rhizoprionodon terraenovae* tend to have much faster growth, earlier maturity and shorter life spans than large species such as *Carcharhinus plumbeus* and *Carcharhinus obscurus* (Camhi et al., 1998; Yudin and Cailliet, 1990; Cortés, 1995; Sminkey and Musick, 1996; Natanson et al., 1995). Most shark species are at extreme risk of over-harvesting because of their conservative life history traits (Musick et al., 2000a). Beverton and Holt (1959) compared 69 stocks of fish and showed a general inverse relationship between k (growth rate) and L_∞ (asymptotic size); i.e., large fishes grow relatively slowly compared to small fishes. However, caution is advised in making generalizations about size-growth rate relationships outside of limited taxonomic boundaries. For instance, another small shark, *Squalus acanthias*, comparable in size to *Mustelus* and *Rhizoprionodon* but in a different Order (Squaliformes), has very slow growth which is comparable to that of large Carcharhinformes (Jones and Geen, 1977; Ketchen, 1975; Nammack et al., 1985). Stevens (1999) compared the history of the fisheries of two small triakid sharks, *Galeorhinus galeus* and *Mustelus antarcticus*, off

Table 1. Von Bertalanffy Growth Coefficient (k) **(after Musick 1999b)**

Species	k coefficient	Source
Thryssa hamiltoni anchovy (IndoPacific)	0.80-1.40	Hoedt, 1992
Thunnus albacares yellowfin tuna	0.45	Moore, 1951
Paralichthys dentatus summer flounder	0.32-0.40	Desfosse, 1995
Dermochelys coriacea leatherback sea turtle	0.27	Parham and Zug, 1996
Scomberomorus commerson Spanish mackerel	0.17-0.25	McPherson, 1992
Mycteroperca sp. groupers	0.06-0.17	Ault et al., 1998
Epinephelus sp. groupers	0.05-0.18	Ault et al., 1998
Xiphias gladius swordfish	0.09-0.19	Berkley and Houde, 1983
Acipenser oxyrinchus Atlantic sturgeon	0.03-0.16	Kahnle et al., 1998
Galeoid sharks (Carcharhindae)	0.04-0.07	Branstetter, 1990
Cheloniid sea turtles (all sea turtles, excluding *Dermochelys*)	~ 0.08	Chaloupka and Musick, 1997

Australia. The slow growing *G. galeus* had become overfished, whereas the more productive *M. antarcticus* was being harvested sustainably even though both had been under management for several years.

Among the osteichthyans the Chondrostei (sturgeons) are large anadromous or fresh water species. Most sturgeon species in the world have become severely depleted, or extirpated (Birstein, 1993). All sturgeons have relatively slow growth and, in addition, they are particularly vulnerable to spawning and nursery habitat destruction because of their anadromous behavior. Atlantic sturgeon (*Acipenser oxyrinchus*) stocks in Delaware Bay (USA) were virtually extirpated by over-fishing in the late 19th century in little more than a decade, and have shown little recovery since (Secor and Waldman, 1999). This species has very slow growth (Table 1) and has undergone similar declines in the Chesapeake Bay and in New England (Musick et al., 1994; Musick, in press).

Myers et al. (1997) related growth rate to age at maturity and intrinsic rate of increase (r) in Atlantic cod (*Gadus morhua*). They noted that northern stocks of cod off Canada had slower growth, later maturity, and lower r values, than southern stocks. Consequently, it was the northern stocks that were most severely depleted (some to the point of extirpation) by gross over-fishing. Likewise, Casey and Myers (1998) showed that the northern-most Newfoundland stocks of the barndoor skate (*Raja laevis*) had been extirpated by severe over-fishing, whereas the southern stocks off New England still persisted although at a severely depleted level.

Groupers (*Mycteroperca sp.* and *Epinephelus sp.*) are a group of tropical percomorph reef fishes, many of which are large and slow growing. Ault et al. (1998) recorded k coefficients for this group of 0.05-0.18, with the larger species having the lower growth rates. It is these larger, slower growing species such as Nassau grouper (*E. striatus*) and jewfish (*E. itajara*) that have been severely depleted or locally extirpated by a multi-species line fishery off the southeastern United States (Coleman et al., 1999; Huntsman et al., 1999). Some of these species form large local seasonal spawning aggregations that are particularly vulnerable to fisheries. In addition, groupers and several other groups of reef-dwelling percomorphs are protogynous. Individuals mature first as females, then switch both morphologically and behaviorally into males when they are larger and older (larger territorial males have a strong advantage over smaller males in breeding). Overfishing may cull out the larger males at a faster rate than the rate of sex reversal, and severely skew the sex ratio toward an even larger proportion of females than is natural (Vincent and Sadovy, 1998). There is evidence that, for some heavily-fished protogynous reef fishes off the southeastern U.S., the number of males has been so reduced as to severely compromise the reproductive capacity of the populations (Coleman et al., 2000; Huntsman et al., 1999). This is an example of population depensation, where the recruitment drops suddenly below that predicted from the normal stock-recruitment relationship, and where the population suddenly crashes (Musick, 1999b).

A comparison of k coefficient values from fishes with those estimated for different sea turtle species may provide insights into the ecology and vulnerability of both groups. Among the sea turtles, the growth coefficient (k) for the Kemp's ridley (*Lepidochelys kempii*) (Zug et al., 1997), the western Atlantic loggerhead (Klinger and Musick, 1995), and the Atlantic green turtle (*Chelonia mydas*) (Bjorndal et al, 1995; Frazer and Ladner, 1986) is 0.08. This value is similar to that found in the slowest growing osteichthyans and in large sharks. Comparisons of growth coefficients among chondrosteans, teleosts, elasmobranchs and sea turtles are enlightening because they suggest that the slower growing members of these groups have similar growth patterns, and thus share similar life history limitations and extreme vulnerability to anthropogenic mortality. Animals with k coefficients $\leq$ 0.10 seem to be particularly at risk (Musick, 1999a).

Demographic Analyses

Stage-based population models have been used to study terrestrial animal populations for many years (Krebs, 1978). These models utilize population data on age specific fecundity, survivorship, age at maturity, life span, and growth rates to estimate the net reproductive rate per generation (R_o), generation time (G), and intrinsic rate of population increase (r) (Caswell, 1989) (Table 2). The method has not been used much by workers studying marine animals. Rather, in the study of marine fishes, an extensive population modeling methodology has evolved based on sampling the catches of fisheries (Hilborn and Walters, 1992) and related techniques. One widely applied group of models are stock production or biomass dynamic models. These provide estimates of surplus production which approximate the intrinsic rates of increase of the population under study. Stock production models have proven valuable in managing many groups of teleosts (Hilborn and Walters, 1992), but are inappropriate for long-lived species because of their long lag period in the reaction of surplus production to stock density (Ricker, 1958). Unfortunately, such models have been used in fishery management plans (FMPs) for long-lived sharks, and have failed because they grossly overestimated r (Musick, 1999a). Hoff (1990) had cautioned that traditional fisheries population models were inappropriate for long-lived species such as sharks, and suggested that demographic models would provide more accurate estimates of the population responses under differing levels of fishery mortality.

Agardy (1989) emphasized the importance of having information about the intrinsic rate of increase (r) before a comprehensive management plan could be developed for sea turtles. Crouse et al. (1987) used a stage-based matrix model to study the demographics of the loggerhead sea turtle in the western Atlantic. This species has been listed as Threatened by the U.S. Fish and Wildlife Service under the U.S. Endangered Species Act. Data presented in Crouse et al. (1987) and from Frazer (1983) suggest that the loggerhead has a low intrinsic rate of increase (r=0.06). Sensitivity analysis to simulate different levels of mortality at various stages in the species' life history determined that survivorship of large juveniles was critical to population maintenance or recovery (Crouse et al., 1987). Crowder et al. (1994) further refined this model to predict the impact of trawl Turtle Excluder Devices (TEDs) on loggerhead population recovery. Bonfil (1990) used a similar stage based matrix model and sensitivity analysis to study the demographics of the long-lived silky shark (*Carcharhinus falciformes*) off Campeche, Mexico. His conclusions were similar to those of Crouse et al. (1987), survivorship of larger juveniles was critical for population maintenance. Cortés (1999) came to similar conclusions regarding the sandbar shark (*C. plumbeus*), and Heppell et al., (1999) using elasticity analysis came to similar conclusions for two species of sharks in other Families (Triakidae, Squatinidae), for the Kemp's ridley sea turtle (*Lepidochelys kempii*), and for the wandering albatross (*Diomedea exulans*). Many sea birds, particularly the diomedid albatrosses and procellarid petrels and shearwaters, are late-maturing (6-10 years) and virtually all seabirds have very low fecundity (clutches of 1-2 eggs) (Russell, 1999). Most cetaceans, particularly the balaenopterid whales, have very low intrinsic rates of increase (Best, 1993). Table 3 compares life history parameters and increase rates for several cetaceans and sharks, the loggerhead turtle, the royal albatross, and, for perspective, the African elephant. Species that have annual intrinsic increase rates $\leq$ 10% seem to be particularly vulnerable to excessive mortalities (Musick, 1999a).

Table 2. Demographic Parameter
(after Musick 1999b)

s_i = survivorship at age or stage i

t_{mat} = age-at-maturity

t_{max} = longevity

m_x = fecundity

G = generation time = mean period between birth of parents and birth of all offspring

R_o = net reproductive rate = $\frac{\text{no. females born in generation } t+1}{\text{no. females born in generation } t}$

r = intrinsic rate of population increase

$r = \frac{\log_e(R_o)}{G}$

Management

Some long-lived species, such as the African elephant, sea turtles and balaenopterid whales, have been protected from international trade by the Convention on International Trade in Endangered Species (CITES), and some species of seabirds and sharks have been listed on the IUCN Red List of Threatened Animals (Baillie and Groombridge, 1996). The precarious conservation status and intrinsic vulnerability of elephants, whales, and sea turtles has been recognized for many years, yet the vulnerability of seabirds and sharks has only recently been recognized by conservationists and resource managers. Recent consultations sponsored by the United Nations Food and Agricultural Organization are focused on assessing and reducing the high mortalities of seabirds in pelagic long-line and drift-net fisheries and on assessing the global status of shark populations. This effort is better late than never, but many seabird and shark populations have already been severely impacted (Russell, 1999; Camhi et al., 1998).

Table 3. Demographics of Selected Vertebrates (after Musick 1999b)

	Age to Maturity (yrs)	Life Span (yrs)	Litter Size	Reproductive Periodicity (yrs)	Annual Rate of Population Increase (%)	Source
Loxodonta africana african elephant	8-13	55-60	1	2.5-9	4.0-7.0 (favorable conditions)	(Larsen and Bekoff, 1978)
Orcinus orca killer whale	5-9	57-61	1	3-4	2.5	(Brault and Caswell, 1993)
Megapetera novaeangliae humpback whale	9	60	1	2+	3.9-11.8	(Anon., 1991)
Balaenopteridae baleen whales (maximum rates after severe depeltion)					3.0-14.4	(Best, 1993)
Diomedea epomorpha Royal albatross	6-11	58-80	1	2	“very low”	(Gales, 1993)
Caretta caretta loggerhead sea turtle	20-25	50+	~ 300	~ 3	~ 2.0-6.0	(Estimated from Crouse et al., 1987)
Carcharhinus plumbeus sandbar shark	13-16	35+	8-10	2	2.5-11.9	(Sminkey and Musick, 1996)
Squalus ancanthias spiny dogfish (North Atlantic population)	6-12	35-40	2-15	2	2.3%	(Jones and Geen, 1997)
Selachei (Hexanchidae, Squalidae, Squatinidae, Lamnidae, Alopiidae, Carcharhinidae), sharks (rate calculated when population at MSY)					1.7-6.9	(Smith et al., 1998)

Managers continue to be ignorant of, or choose to ignore the vulnerable nature of long-lived animals. Lessons learned by the conservation community from past histories of long-lived species seem to be lost on those who manage the world’s fisheries which remain the single greatest source of mortality for long-lived marine animal populations (Musick, 1999a; Musick et al., 2000b). Sharks continue to be killed in large numbers worldwide for the Asian fin market with no management. Only a few countries have implemented management plans for their shark populations (Camhi et al., 1998). Even in shark fisheries that are managed, more common species with greater rebound potentials continue to support the fisheries while less resilient species taken in the same fisheries may continue to decline (Musick, 1995, 1999b). Sea turtle mortalities remain high because of by-catch in fisheries and egg harvesting in many areas. Precipitous declines have been recorded recently in some of the largest remaining leatherback (*Dermochelys coriacea*) nesting populations in the world, including the Pacific coast of Mexico where mortality to adults in distant long-line and gillnet fisheries is the major threat (Sarti et al., 1996; Eckert and Sarti, 1997; Crouse, 1999). Nassau grouper (*E. striatus*) and jewfish (*E. itajara*) continue to be taken in a mixed species line fishery off the southeastern United States, even though both species are depleted and locally extirpated in places. Both species have been afforded protection from harvest by the regional Fisheries Management Council, but to no avail as these groupers are captured as by-catch in the fishery which operates in deep-water where most of the fish caught are dead or moribund when they come on board (Huntsman et al., 1999). Two principal management solutions appear to be available for this problem. Close the fishery or establish large marine refugia where no harvest is allowed (Huntsman et al., 1999; Coleman et al., 2000).

Reserve systems are being considered to conserve Pacific rockfishes (Sebastinae) off the west coast of the U.S. (Yoklavich, 1998). Rockfishes are another group of slow growing, long-lived teleosts with ages to maturity of 6-12 years and life spans of 50-140 years (Archibald et al., 1981; Wyllie, 1987). Some of these rockfishes, such as boccaccio (*Sebastes paucispinis*), have undergone $\geq$90% population declines with little sign of recruitment for decades (Ralston, 1998; Parker et al., 2000).

Long life span in the boccaccio and most other long-lived marine animals may be an evolutionary adaptation to promote iteroparity (Parker et al., 2000; Musick, 1999a). Spawning or breeding in multiple years may be necessary to maintain stable populations for groups like the rockfishes or groupers or even sea turtles with relatively high fecundity, but very low egg and/or larval or hatchling survivorship. Likewise, iteroparity may be necessary to maintain stable populations for animals with very low fecundity such as seabirds, whales and sharks. Heavily exploited fisheries whether directed or bycatch not only reduce the biomass of marine populations, but constrict the age structure (Hillborn and Walters, 1992) while severely reducing iteroparity in long-lived species. The result must be lowered fitness (Musick, 1999a). Therefore, where several species or stocks are harvested together (i.e., on feeding grounds) management must be based on protecting the most vulnerable stocks. To do otherwise risks the extirpation of these stocks (Musick, 1999a).

Conclusions

Long-lived marine species usually have slow-growth and late maturity and are much more vulnerable to over-harvesting or even extirpation than more resilient species.

Because long-lived species have low intrinsic rates of increase, population recovery after depletion may take decades and may not occur even under strict regulation.

Many population models appropriate for more highly productive species are inappropriate for long-lived species that have low population response times.

The greatest threats to long-lived species are from mixed-species fisheries where long-lived species are taken as directed catch or by-catch. Such fisheries can continue to operate and be economically viable, driven by more productive species, while long-lived populations become depleted or extirpated.

Where several stocks or species are harvested together (i.e., on feeding grounds) management should be aimed to protect the most vulnerable stock. In mixed stock harvesting regimes where some stocks have been depleted and others are healthy, harvesting at rates that are sustainable for healthy stocks will prevent recovery of depleted stocks or may even lead to extirpation.

[1] Virginia Institute of Marine Science Contribution Number 2353.

Literature Cited

Adams, P. B. 1980. Life history patterns and their consequences for fisheries management. Fish. Bull. 78(1):1-12.

Agardy, M. J. 1989. What scientific information is critical for management and why? p.3. *In*: S. A. Eckert, K. L. Eckert and T. H. Richardson (eds.), Proceedings of the Ninth Annual Workshop on Sea Turtle Conservation and Biology. NOAA Tech. Memo. NMFS-SEFC-232. U. S.

Department of Commerce.

Archibald, C. P., W. Shaw, and B. M. Leaman. 1981. Growth and mortality estimates of rockfishes (Scorpaenidae) from B. C. coastal waters, 1977-1979. Can. Tech. Rep. Fish. Aquat. Sci. 1048:1-57.

Ault, J. S., B. A. Bohnsack, and G. A. Meester. 1998. A retrospective (1979-1996) multispecies assessment of coral reef fish stocks in the Florida Keys. Fish. Bull. 96(3): 395-414.

Baillie, J. and B. Groombridge. 1996. IUCN Red List of Threatened Animals. IUCN, Gland, Switzerland: 368 pp.

Begon, M., J. L. Harper, and C. R. Townsend. 1986. Ecology, individuals, populations and communities. Sinauer Assoc., Sunderland, Massachusetts. 876 pp.

Berkeley, S. A. and E. D. Houde. 1983. Age determination of broadbill swordfish, *Xiphias gladius* from the Straits of Florida using anal fin spine sections, p.137-144. *In*: E. D. Prince and L. M. Pulos (eds.), Proceedings of the International Workshop on Age Determination of Oceanic Pelagic Fishes: Tunas, Billfishes, and Sharks. NOAA Technical Report, NMFS 8. U.S. Dept. Commerce.

Best, P. B. 1993. Increase rates in severely depleted stocks of baleen whales. ICES J. Mar. Sci. 50:169-186.

Beverton, R. J. H. and S. J. Holt. 1957. The dynamics of exploited fish populations. U.K. Min. Agr. and Fish., Fish. Invest., Ser. 2(19):533.

Beverton, R. J. H. and S. J. Holt. 1959. A review of the lifespan and mortality rates of fish in nature, and their relation to growth and other physiological characteristics. CIBA Foundation Colloquia on Ageing, 5: 142-180.

Birstein, V. J. 1993. Sturgeons and paddlefishes: Threatened fishes in need of conservation. Conservation Biology 7(4): 773-787.

Bjorndal, K. A., A. B. Bolten, A. L. Coan, and P. Kleiber. 1995. Estimation of green turtles (*Chelonia mydas*) growth rates from length-frequency analysis. Copeia (1):71-77.

Bonfil-Saunders, R. 1990. Contributions to the fisheries biology of the silky shark, *Carcharhinus falciformis*, from Yucatan, Mexico. Thesis, Univ. of Wales, Bangor. 77 pp.

Branstetter, S. 1990. Early life-history implications of selected carcharhinoid and lamnoid sharks of the northwestern Atlantic. NOAA Technical Report, NMFS 90:17-28.

Camhi, M. S. Fowler, J. Musick, A. Bräutigam, and S. Fordham. 1998. Sharks and their relatives: Ecology and Conservation. IUCN/SSC Occasional Papers No. 20: 1-39.

Casey, J. M. and R. A. Myers. 1998. Near extinction of a large, widely distributed fish. Science 281: 690-692.

Caswell, H. 1989. Matrix population models: Construction, analysis and interpretation. Sinauer, Sunderland, Massachusetts.

Chaloupka, M. and Musick, J. A. 1997. Age, growth and population dynamics of sea turtles, p.233-276. *In*: P. Lutz and J. A. Musick (eds), Biology of Sea Turtles. CRC Press, Florida.

Coleman, F. C., C. C. Koenig, A. L. Eklund, and C. B. Grimes. 1999. Management and conservation of temperate reef fishes in the grouper-snapper complex of the southeastern United States, p.233-242. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Coleman, F. C., C. C. Koenig, G. R. Huntsman, J. A. Musick, A. M. Eklund, J. C. McGovern, R. W. Chapman, G. R. Sedberry and C. B. Grimes. 2000. Long-lived Reef Fishes: The Grouper-Snapper Complex. Fisheries 25(3): 14-21.

Congdon, J. P., A. E. Dunham and R. C. Van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): Implications for conservation and management of long-lived organisms. Conservation Biology 7(4):826-833.

Cortés, E. 1995. Demographic analysis of the Atlantic sharpnose shark, *Rhizoprionodon terranovae*, in the Gulf of Mexico. Fish. Bull. 93(1): 57-66.

Cortés, E. 1999. A stochastic stage-based population model of the sandbar shark in the western North Atlantic, p.115-136. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Crouse, D. T. 1999. The Consequences of Delayed Maturity in a Human-Dominated World, p.195-202. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Crouse, D. T., L. B. Crowder, and H. Caswell. 1987. A stage-based population model for loggerhead sea turtles and implications for conservation. Ecology. 68:1412-1423.

Crowder, L. B., D. T. Crouse, S. S. Heppell and T. H. Martin. 1994. Predicting the effect of excluder devices on loggerhead sea turtle populations. Ecol. Applications 4:437-445.

Desfosse, J. C. 1995. Movements and ecology of summer flounder (*Paralichthys dentatus*) tagged in the southern mid-Atlantic Bight. Doctoral dissertation College of William and Mary, Williamsburg, VA.

Eckert, S. A. and L. Sarti M. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Frazer, N. B. 1983. Demography and life history evaluation of the Atlantic loggerhead sea turtle, *Caretta caretta*. Ph.D. dissertation, University of Georgia, Athens.

Frazer, N. B. and R. C. Ladner. 1986. A growth curve for green sea turtles (*Chelonia mydas*) in the U.S. Virgin Islands, 1913-14. Copeia (1986):798-802.

Gadgil, M. and W. H. Bossert. 1970. Life historical consequences of natural selection. American Naturalist 104:1-24.

Heppell, S., L. B. Crowder, and T. R. Menzel. 1999. Life table analysis of long-lived marine species with implications for conservation and management, p.137-148. *In*: J. A. Musick (ed), Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Hillborn, R. and C. J. Walters. 1992. Quantitative fisheries stock assessment: Choice, dynamics and uncertainity. Chapman and Hall, New York. 570 pp.

Hoedt, F. E. 1992. Age and growth of a large tropical anchovy, *Thryssa hamiltoni* (Gray): a comparision of ageing techniques, p.81-100. *In*: D. C. Smith (ed.), Age Determination and Growth in Fish and Other Aquatic Animals. CSIRO, Australia.

Hoenig, J. M. and S. H. Gruber. 1990. Life history patterns in the elasmobranchs, p.1-16. *In*: H. L. Pratt, Jr., S. H. Gruber and T. Taniuchi (eds.), Elasmobranchs as living resources: advances in the biology, ecology, systematics, and the status of the fisheries. NOAA Technical Report NMFS 90.

Hoff, T. B. 1990. Conservation and Management of the western North Atlantic Shark Resource based on the Life History Strategy Limitations of Sandbar Sharks. Ph.D. dissertation. University of Delaware, Newark. 282 pp.

Huntsman, G. R., S. Huntsman, J. Potts, R. W. Mays and D. Vaughn. 1999. Groupers (Serranidae, Epinephalinae): endangered apex predators of reef communities, p.217-231. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Jennings, S., J. D. Reynolds, and S. C. Mills. 1998. Life history correlates of responses to fisheries exploitation. Proc. R. Soc. Lond. B, 265: 333-337.

Jones, B. C. and G. H. Geen. 1977. Age and growth of spiny dogfish (*Squalus acanthias L.*) in the Strait of Georgia. British Columbia. Fish. Mar. Serv. Res. Dev. Tech. Rep. 669:1-16.

Kahnle, A. W. et al. 1998. Stock status of Atlantic sturgeon of Atlantic coast estuaries. Atlantic States Marine Fisheries Commission.

Ketchen, K.S. 1975. Age and growth of the dogfish *Squalus acanthias* in British Columbia waters. J. Fish. Res. Bd. Canada 32: 43-59.

Klinger, R. C. and J. A. Musick. 1995. Age and growth of loggerhead turtles from Chesapeake Bay. Copeia (1): 204-209.

Krebs, C. J. 1978. Ecology: The experimental analysis of distribution and abundance. Second Edition. Harper and Row, New York. 678 pp.

Landa, A. 1997. The relevance of life history theory to harvest and conservation. Fauna Norvegica. Ser. A. 18: 43-55.

McPherson, G. R. 1992. Age and growth of narrow-barred spanish mackeral (*Scomberomorus commerson:* Lacepede, 1800) in northeastern Queensland waters, p.397-410. *In*: D. C. Smith (ed.), Age Determination and Growth in Fish and Other Aquatic Animals. CSIRO, Australia.

Moore, 1951. Estimation of age and growth of yellowfin tuna (*Neothunnus macropterus*) in Hawaiian waters by size frequencies. Fishery Bulletin 52:131-149.

Musick, J. A. In Press. The Sturgeons. (Acipensenidae). *In*: B. B. Collette (ed.), Fishes of the Gulf of Maine. Smithsonian Press, Washington, DC.

Musick, J. 1995. Critically endangered large coastal sharks, a case study: the sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827). *Shark News* (Newsletter of the IUCN Shark Specialist Group) 5: 6-7.

Musick, J. A. 1999a. Criteria to Define Extinction Risk in Marine Fishes. Fisheries 24(12): 6-14.

Musick, J. A. 1999b. Ecology and Conservation of Long-Lived Marine Animals, p.1-10. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Musick, J. A., R. Jenkins and N. Burkhead. 1994. The Sturgeons (Acipenseridae), p.183-190. *In*: R. E. Jenkins and N. Burkhead (eds.), The Freshwater Fishes of Virginia. American Fisheries Society. Washington, D. C. 1079 pp.

Musick, J. A., S.A. Berkeley, G. M. Cailliet, M. Camhi, G. Huntsman, M. Nammack and M. L. Warren, Jr.

2000b. Protection of Marine Fish Stocks at Risk of Extinction. Fisheries 25 (3): 6-8.

Musick, J. A., G. Burgess, G. Cailliet, M. Camhi and S. Fordham. 2000a. Management of Sharks and Their Relatives (Elasmobranchii). Fisheries 25 (3): 9-13.

Myers, R. A., G. Mertz, and R. S. Farlow. 1997. Maximum population growth rates and recovery times for Atlantic cod, *Gadus morhua*. Fish. Bull. 95: 762-772.

Nammack, M. F., J. A. Musick and J. A. Colvocoresses. 1985. Life history of spiny dogfish off the Northeastern United States. Trans. Amer. Fish. Soc. 114: 367-396.

Natanson, L. J., J. G. Casey and N. E. Kohler. 1995. Age and growth estimates for the dusky shark, *Carcharhinus obscurus*, in the western North Atlantic Ocean. Fish. Bull. 93:116-126.

Parent, S. and L. M. Schrimi. 1995. A model for the determination of fish species at risk based upon life-history traits and ecological data. Can. J. Fish. Aquat. Sci. 52: 1768-1781.

Parker, S. J., S. A. Berkeley, J. T. Golden, D. R. Gunderson, J. Heifetz, M. A. Hixon, R. Larson, B. M. Leaman, M. S. Love, J. A. Musick, V. M. O'Connell, S. Ralston, H. J. Weeks and M. M. Yoklavich. 2000. Management of Pacific Rockfish. Fisheries 25 (3): 22-30.

Ralston, S. 1998. The status of federally managed rockfish in the U.S. West Coast, p.6-16. *In*: M. Yoklavich (ed.), Marine harvest refugia for west coast rockfish: a workshop. NOAA Tech. Memo. NMFS-SWFSC-255. U.S. Dept. Commerce. 255 pp.

Ricker, W. E. 1958. Handbook of Computations for Biological Statistics of Fish Populations. Fish. Res. Bd. Canada Bull. 119:1-300.

Russell, R. W. 1999. Comparative demography and life-history tactics of seabirds: implications for conservation and marine monitoring, p.51-76. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-Lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Sarti M., S. A. Eckert, N. T. Garcia and A. R. Barragan. 1996. Decline of the world's largest nesting assemblage of leatherback turtles. Marine Turtle Newsletter 74:2-5.

Secor, D. H. and J. R. Waldman. 1999. Historical abundance of Delaware Bay Atlantic sturgeon and potential rate of recovery, p.203-215. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Sminkey, T. R. and J. A. Musick. 1996. Demographic analysis of sandbar sharks in the western North Atlantic. Fishery Bulletin 94:341-347.

Smith, S. E., D. W. Au and C. Show. 1998. Intrinsic rebound potentials of 26 species of Pacific sharks. Marine and Freshwater Research 41: 663-678.

Southwood, T. R. E., R. M. May, M. P. Hassell and G. R. Conway. 1974. Ecological strategies and population parameters. Am. Nat. 108:791-804.

Stevens, J. D. 1999. Variable resilience to fishing pressure in two sharks: the significance of different ecological and life history parameters, p.11-15. *In*: J. A. Musick (ed.), Life in the Slow Lane: Ecology and Conservation of Long-lived Marine Animals. American Fisheries Society Symposium 23. Bethesda, Maryland.

Vincent, A. and Y. Sadovy. 1998. Reproductive ecology in the conservation and management of fishes, p.209-245. *In*: J. Caro (ed.), Behavioral Ecology and Conservation Biology. Oxford University Press. Oxford.

von Bertalanffy, L. 1938. A quantitative theory of organic growth. Human Biology. 19(2): 181-213.

Wyllie, E. T. 1987. Thirty-four species of California rockfishes: maturity and seasonality of reproduction. Fish. Bull. 85: 229-250.

Yoklavich, M. M. 1998. Marine harvest refugia for west coast rockfish: a workshop. NOAA Tech. Memo. NMFS-SWFSC-255. U. S. Dept. Commerce. 159 pp.

Yudin, K. G. and G. M. Cailliet. 1990. Age and growth of the gray smoothhound, *Mustelus californicus*, and the brown smoothhound, *M. henlei*, sharks from central California. Copeia: 191-204.

Zug, G. R., H. J. Kalb and S. J. Luzar. 1997. Age and growth in wild Kemp's ridley sea turtles (*Lepidochelys kempii*) from skeletochronological data. Biol. Conserv. 80: 261-268.

Zug, G. R. and J. F. Parham. 1996. Age and growth in leatherback turtles, *Dermochelys coriacea* (Testudines: Dermochelyidae): a skeletochronological analysis. Chelonian Conversation and Biology 2(2): 244-249.

Management and Conservation Goals for Marine Turtles

Nat B. Frazer
Department of Wildlife Ecology and Conservation
Institute of Food and Agricultural Sciences
University of Florida
USA

I agree with Karen Eckert's (1999) statement that: "Whether one defines conservation as 'preservation' or as 'management for sustained utilization,' there can be little doubt that sea turtles are in need of stringent conservation measures." What is also clear to most of us is that sea turtles have developed this need only very recently in their history on the planet. As Jack Frazier (1999) has pointed out, "Marine turtles have persisted for eons, prospering without protected areas, conservation laws, action plans, research manuals, and other accouterments of conservation programs." In fact, sea turtles have been on this planet at least 25 times longer than we have. We know that sea turtles have been around for over 100 million years in one form or another (Meylan and Meylan 1999), and humans have been here only about 4 million years in one form or another. So for well over 90 million years, sea turtles certainly did not need any help from us at all. It was not until they encountered modern humans in the last two or three hundred years that sea turtles developed this stringent need for conservation measures.

But even if turtles did not need us for millions of years, *we* certainly do need them now. Let us make no mistake about why we have decided to hold this regional meeting. We are not really here to help sea turtles; we are here to help ourselves. We are not here to meet the needs of sea turtles; we are here to meet the needs of people. Sea turtles do not need stringent conservation measures for sea turtles; it is *we* who need stringent conservation measures for sea turtles. Whether we want to consume them, trade in them, or just watch them . . . we need to ensure their survival.

Jack Frazier (1999) wrote, "Wildlife management and conservation are as much managing people as managing wildlife: in the end, they are politics – not biology." We are not trying to solve a sea turtle problem; rather, we are trying to solve a human problem, a problem that begins as an economic problem. A problem in the valuation of sea turtles.

As Issacs (1998) has said, "Efforts to place an economic value on a natural resource...involve an intellectual concession to anthropomorphism..." And so I will begin by discussing the total value of sea turtles in human economic terms.

As pointed out by Isaacs (1998) for other natural resources, the total value of sea turtles includes both *use* value and *non-use* value (Figure 1). First, let us consider use value. We exploit sea turtles for many purposes, both consumptive (e.g., meat, eggs, tortoiseshell, oil) and non-consumptive (e.g., ecotourism). Both use categories contribute importantly to the total economic value of sea turtles. Sea turtles also have "option value"; that is, we may have uses for turtles in the future that we do not yet know about. For example, there may be medicinal uses discovered at some future date. So it might not be wise to exploit the resource to extinction, but to keep our options open.

As an aside, let me say that it is possible for economists to conduct analyses that lead to the conclusion that it *is* logical to exploit a potentially renewable resource to extinction. If it can be demonstrated that turtle meat will never bring a higher price that it does today, it could be logical – in a strictly economic sense – to harvest them all, sell the meat, and invest the money in some more lucrative venture with a higher rate of return. However, such analyses are based on two faulty assumptions. One is that there will always be some future resource to exploit – when we have eaten all the turtles, we can eat iguanas, until they're gone, then we can eat rats, then cockroaches, and then . . . well, you get the idea. The other assumption is that we already know all the things that can be done with turtles or all the products they have to offer. In other words, such analyses are based only on presently known consumptive uses. The concept of option value is that we recognize the possibility of future uses for turtles that are unknown to us now.

It may surprise you that there is also economic value in not using resources (i.e., non-use value). Economists have spent a lot of effort on the concept of contingent valuation for natural resources, including the issues of passive use (Randall, 1993). Contingent valuation has been used to determine the value of resources destroyed or damaged by events such as the *Exxon Valdez* oil spill so that the courts can calculate penalty fines. But many people think that nature has an actual economic value "just because it's there." They are willing to assign monetary value to a mountain range or a clear river even if they never intend to go see them. For these people, natural resources have what is called an "existence value" (Issacs, 1998). And economists are beginning to understand that we should not wait until a resource is destroyed or damaged to recognize this economic value. People are willing to incur real economic costs in order to go on living in a world that has sea turtles in it. Similarly, many people want to leave their children a planet that has sea turtles and other natural wonders; and they're willing to pay an economic price for this privilege. This is known as "bequeath value" (Issacs, 1998).

When we speak purely of the economic value of sea turtles, we must be careful to take into account all aspects of their total value – consumptive value, non-consumptive value, option value, existence value, and bequeath value (Figure 1).

Certainly everyone attending this meeting wants our relationship with sea turtles to be sustainable. We need for sea turtles to be economically sustainable, so we must ensure that our use of them is sustainable both for consumptive use and for non-consumptive use. And we must not reduce our potentially sustainable future options. Furthermore, we must not reduce their populations to the point that we interfere with either their existence value or their bequeath value.

For turtles to be sustainable economically, they also must be sustainable biologically. They must be able to regenerate their populations. But we can choose to sustain large populations or we can choose

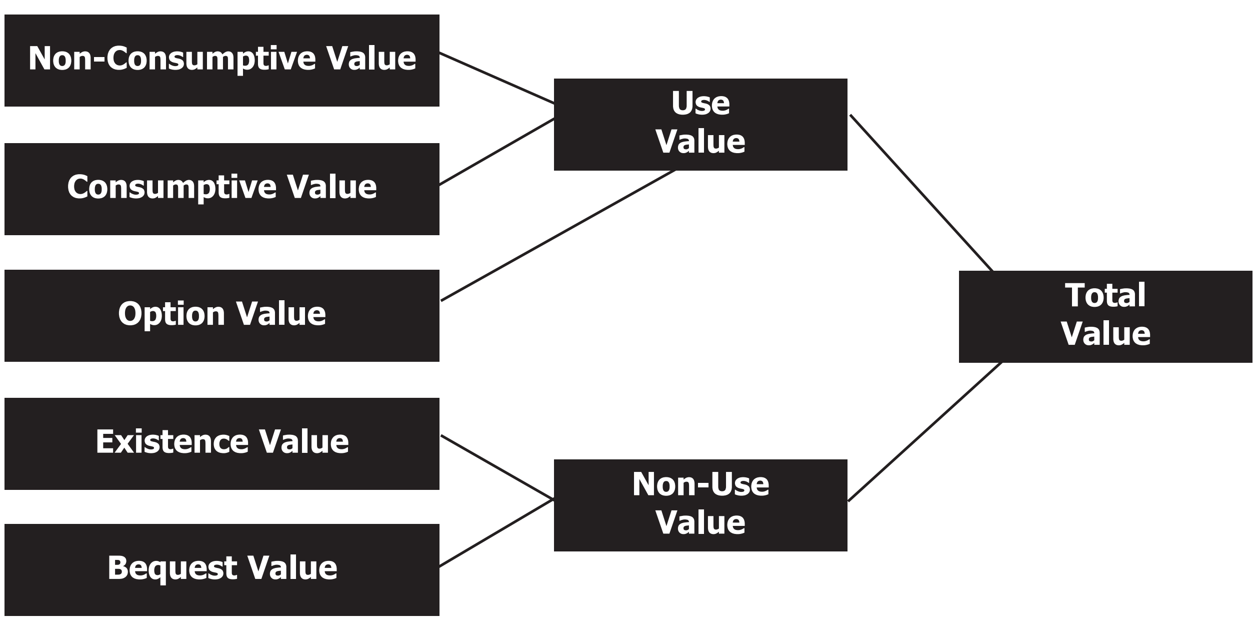

Figure 1. Total Economic Value of Sea Turtles (after Isaacs, 1998).

to sustain smaller ones. However, if we keep populations at too low a level, we may interfere with non-consumptive use – for example, if there are very few turtles, the chances of seeing one on an eco-tour may be so small that the non-consumptive use value is essentially zero. Similarly, bequeathing our children a world with small turtle populations is not as valuable as one with large turtle populations.

We also want sea turtles to be ecologically sustainable. Karen Bjorndal (1999) asked the question, "Are sea turtle species central to and essential for healthy ecosystem processes or are they relict species whose passing would have little effect on ecosystem function?" My honest answer is: "I don't know. And neither do you!" We do not know exactly how many turtles it takes to sustain an ecosystem. No one knows how many Caribbean green turtles (*Chelonia mydas*) there were before Columbus "discovered" the Antilles. Jackson (1997) estimated 33-39 million adults. Bjorndal et al. (2000) estimated something between 38-600 million, including adults and juveniles. Surely that many turtles must have had an important role in ecosystem dynamics.

Bouchard and Bjorndal (2000) recently determined that only between 25-39% of the matter and energy that loggerhead turtles (*Caretta caretta*) deposit on a beach as eggs may actually return to the ocean in the form of hatchlings. Here is what 14,305 loggerhead turtle nests contributed to a 21 km beach in Florida (Bouchard and Bjorndal, 2000): 9,800 kg of organic matter; 2200 kg of lipids; 1030 kg of Nitrogen; 93 kg of Phosphorus; and 268,000,000 kiloJoules of energy.

Now imagine this. If there were 17,000,000 adult female green turtles in the Caribbean Sea, they would lay 23,800,000 nests per year (34 million turtles x 0.5 [assuming a 1:1 ratio of females to males] x 4.2 nests per female / 3yr average remigration interval). Assuming their nest contents are similar to that of loggerhead turtles, they would contribute 1,600,000 kg of organic matter; 365,000 kg of lipids; 170,000 kg of Nitrogen; 15,500 kg of Phosphorus; and 44,500,000,000 kJ of energy to the beach. It may be more than this, because green turtles lay their nests higher up on the beach than do loggerhead turtles (Bouchard and Bjorndal, 2000).

It is clear that sea turtles used to make substantial nutrient and energy contributions to beaches, promoting plant growth that stabilized the beach, enhancing and protecting the nesting environment. They also may have served as ecosystem engineers. Hawksbills (*Eretmochelys imbricata*) may have played a major role in maintaining reef dynamics by eating sponges that otherwise would engulf and smother the reefs. And when green turtles graze on seagrass beds, they actually increase the productivity of those areas, just as large mammals do on land (Thayer et al. 1984; McNaughton 1985). While we cannot know the full extent of their former impact, we can only hope that the ecosystem is sustainable with the smaller number of turtles we have today.

Envision this with me...millions of sea turtles pulsing ashore onto the beaches...fertilizing the rims of thousands of islands and two continents. And after this wave of nutrients enters the rims, it is pulsed on up and into the interior lands in successive waves of biological transport. Year after year — tons of nutrients and billions of kiloJoules of energy in a predictable, regular cycle — for tens of millions of years.

Envision this with me...millions of turtles grazing on seagrass beds, stimulating primary productivity at the base of the ocean's food chain. And this surge of increased productivity works its way up the food chain, nourishing shrimp, mollusks, lobsters, and fish — as well as eventually pulsing onto the shore in the annual ballet of nesting activity.

Envision this with me...millions of sea turtles nibbling on sponges — trimming back the invading poriferans that otherwise would overgrow and shut down the coral reef machine. A constant system of checks and balances that also contributes to the gift of energy that sea turtles offer to the land each year in the form of nests and eggs. Year after year, for tens of million of years, the ecosystem engineers, these hawksbill and green and loggerhead and ridley and leatherback turtles, shape and improve and fine-tune the complex and mysterious and marvelous cybernetic machines of the oceans.

How many turtles does this cosmic dance require for a successful performance? I tell you honestly, I do not know. What are the consequences to long-term functioning of the ocean's food chains if there are too few turtles to subsidize the nutrient and energy requirements of ocean life-support systems? Again, I do not know. Do the services previously provided by millions of turtles have any economic value to us? Of course they do – but in ways that we cannot even begin to imagine, since we assume that they are provided for free by inexplicable means that are too complex for economists to figure out or to measure.

We also want our relationships with sea turtles to be culturally sustainable. Sea turtles hold an important place in the traditions of many societies (Frazier 1999). But do our modern uses allow these traditions to be sustained? In many cases, the answer is "No."

The existence value and bequeath value of sea turtles underscore their importance to us in an ecological and cultural sense, but also in a spiritual sense. The attempt to place a spiritual value on them stems from a deep-seated feeling that their 100 million-year existence has made them far wiser than we are in the fundamental mysteries by which the planet operates. Will our modern consumptive and non-consumptive uses of sea turtles be compatible with their spiritual sustainability? I am not sure.

And so, the task is before us: We must set our goals and develop benchmarks to measure our success at using sea turtles *sustainably*. It seems so simple an idea but, as I hope you can see from my suggestions, it is not!

We must pledge as our first goal not to permit any further decline in the numbers of sea turtles. We must decide how many we need for sustainable consumptive economic use. We also must define the densities we need for ecotourism and other non-consumptive uses. And we must ensure that those numbers allow for unanticipated future uses. Then, if we truly believe that present numbers of turtles are insufficient for economic, biological, ecological, cultural or spiritual sustainability, we must find a way to increase their populations up to sustainable levels. Then, once we decide how many we want and how many we have, we must monitor, monitor, and monitor their numbers to detect any future declines!

As Gerrodette and Taylor have said (1999), "Because of sea turtle life history characteristics, it is nearly impossible to estimate total population size for any sea turtle population." So we must monitor them at the places and times we can reliably encounter them. In this long-term monitoring effort, we must ensure that all users of sea turtles – fishermen, government workers, eco-tour guides, coastal villagers and scientific researchers – become master naturalists who can report numbers of turtles accurately.

On selected benchmark nesting beaches we must monitor the number of adult females, the number of nests and eggs, and the number of hatchlings as indicated in the IUCN/SSC Marine Turtle Specialist Group's recently published "techniques manual" (e.g., Schroeder and Murphy 1999; Valverde and Gates 1999; Miller 1999). We must closely monitor stranding data for any trends that are apparent (Shaver and Teas, 1999). In foraging habitats we must conduct transect surveys and mark-recapture studies to monitor the numbers of juveniles and males (Ehrhart and Ogren, 1999; Henwood and Epperly, 1999; Gerrodette and Taylor, 1999). Careful records must be kept in local marketplaces (Tambiah, 1999) and on board vessels concerning the number of turtles harvested (both directly and incidentally), as well as changes in catch per unit effort.

While we use sea turtles, we must understand that the users have a vested interest in keeping sea turtle populations viable. Since every turtle has value to our users, we probably cannot afford to lose any "extra" turtles. So we must reduce the threats that take them from us outside our intended uses. We must protect the nesting habitats for these valuable commodities (Witherington, 1999). We must also protect the foraging habitat (Gibson and Smith, 1999) and reduce incidental catch (Oravetz, 1999).

We must benchmark and monitor the nesting habitats and quantify any changes in rates of erosion and accretion, beach armoring, artificial beach nourishment, sand mining, and beach lighting as well as changes in the activity levels of vehicles, foot traffic, livestock, obstacles (debris) and oil spills on the beach (Witherington, 1999). We must also benchmark and quantify changes in the foraging habitat with information on water quality, the number of boats anchoring in these areas, the amount of oil pollution and marine debris, dynamiting and chemical fishing, and other threats (Gibson and Smith, 1999).

If we want to catch turtles for consumptive use, we must benchmark and quantify changes in the level of incidental catch from trawling, pelagic longlines, bottom longlines, gill and entanglement nets, seins, purse seins and pound nets, buoy and trap lines, and hook and line gear (Oravetz, 1999). For we cannot allow incidental catch to destroy the sustainability of directed turtle fisheries.

So these are the fundamental questions, assuming that we have the collective will to answer them:

- How many sea turtles do we need?
- How many sea turtles do we want?
- What sacrifices are we willing to make to get and keep that number of turtles?

In closing, I'd like to offer one last consideration. Recalling Jack Frazier's (1999) point of view that, "Wildlife management and conservation are as much managing people as managing wildlife..." Let's remember that it is people's behavior we will be changing, not the behavior of sea turtles. So there must be one final set of benchmarks to consider. As Marcovaldi and Thomé (1999) have reminded us, "In establishing a conservation program, it is essential to evaluate all pertinent socio-cultural issues." We must ascertain how our program affects local people. Does it result in their economic improvement? Does it enhance and enrich their cultural traditions? Does it contribute to spiritual growth? Does it nurture the soul (Moore, 1992)?

Literature Cited

Bjorndal, K. A. 1999. Priorities for research in foraging habitats, p.12-14. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Bjorndal, K. A., A. B. Bolten and M. Y. Chaloupka. 2000. Green turtle somatic growth model: evidence for density dependence. Ecological Applications 10:269-282.

Bouchard, S. S. and K. A. Bjorndal. 2000. Sea turtles as biological transporters of nutrients and energy from marine to terrestrial ecosystems. Ecology 81:2305-2313.

Eckert, K. L. 1999. Designing a conservation program, p.6-8. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Ehrhart, L. M. and L. H. Ogren. 1999. Studies in foraging habitats: capturing and handling turtles, p.61-64. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Frazier, J. G. 1999. Community-based conservation, p. 15-18. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Gerrodette, T. and B. L. Taylor. 1999. Estimating population size, p.67-71. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Gibson, J. and G. Smith. 1999. Reducing threats to foraging habitats, p.184-188. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Henwood, T. A. and S. P. Epperly. 1999. Aerial surveys in foraging habitats, p.65-66. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Isaacs, J. C. 1998. A Conceptual and Empirical Approach for Valuaing Biodiversity: An Estimate of the Benefits of Plant and Wildlife Habitat Preservation in the Tensas River Basin. Doctoral Dissertation, Louisiana State University. Baton Rouge. 239 pp.

Jackson, J. B. C. 1997. Reefs since Columbus. Coral Reefs 16, Supplement: S23-S33.

Marcovaldi, M. A. G. and J. C. A. Thomé. 1999. Reducing threats to turtles, p.165-168. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

McNaughton, S. J. 1985. Ecology of a grazing ecosystem: the Serengeti. Ecological Monographs 55:259-294.

Meylan, A. B. and P. A. Meylan. 1999. Introduction to the evolution, life history, and biology of sea turtles, p.3-5. *In:*

K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Miller, J. D. 1999. Determining clutch size and hatching success, p.124-129. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Moore, T. 1992. Care of the Soul: A Guide for Cultivating Depth and Sacredness in Everyday Life. Harper-Collins, New York. 312 pp.

Oravetz, C. 1999. Reducing incidental catch, p.189-193. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Randall. 1993. Passive use values and contingent valuation. Choices (Second Quarter): 12-15.

Shaver, D. J. and W G. Teas. 1999. Stranding and salvage networks, p.152-155. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Schroeder, B. and S. Murphy. 1999. Population surveys (ground and aerial) on nesting beaches, p.45-55. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Tambiah, C. 1999. Interviews and market surveys, p.156-161. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Thayer, G. W., K. A. Bjorndal, J. C. Ogden, S. L. Williams and J. C. Aieman. 1984. Role of larger herbivores in seagrass communities. Estuaries 7:351-376.

Valverde, R. A. and C. E. Gates. 1999. Population surveys on mass nesting beaches, p.56-60. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Witherington, B. E. 1999. Reducing threats to nesting habitat, p.179-183. *In:* K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4., Washington, D.C. 235 pp.

Open Forum: Criteria and Benchmarks for Sustainable Management of Caribbean Marine Turtles

Miguel Jorge – Moderator
Latin America and Caribbean Program
World Wildlife Fund

M. Jorge (WWF) opened the discussion by asking the participants why they have come to this meeting. He reminded participants to remember Dr. Frazer's suggestion that the "value" of sea turtles should be the basis of conservation planning and the framework for management. He asked, "What do sea turtles mean to us and the people we represent?"[1]

R. Márquez (México) responded that in México there are five species of sea turtles that inhabit the Gulf and Caribbean coasts. Some populations are recovering, some are declining, some are stable. Economic needs are different in each area of the country: in the North the economy is booming, while in the South (Chiapas) the economic needs are so high that people have few resources. Each country has its own problems, and we have to solve them within our own countries.

M. E. Herrera (Costa Rica) explained that, with regard to the Caribbean coast of Costa Rica, efforts similar to those suggested by Dr. Frazer should be undertaken. Specifically, there must be a commitment to offering alternatives [to sea turtles] in order to provide income. At present, eco-tourism brings tourists and this provides alternative income. Recently Costa Rica abolished the law that allowed for a legal harvest of sea turtles. Illegal harvest continues, but there is an interest by others to learn about eco-tourism activities in Tortuguero and elsewhere and to emphasize non-consumptive values and uses for sea turtles.

E. Carillo (Cuba) stated that use exists in the region, and the important issue is how to manage this use – preferably with joint planning and management – in order to achieve sustainable utilization. She noted that her purpose in attending the meeting was to learn more about management. She said that improvements had been made in Cuba in the area of national management planning, as well as research of nesting and migration patterns. She suggested that the nations of the Caribbean "do something together" in order to protect sea turtles in domestic and international waters. She also shared information about a program in Cuba that involves training personnel (including fishermen and students) to participate in data collection.

S. Poon (Trinidad) described a co-management program in Trinidad where Government works in partnership with local NGOs to protect nesting leatherback turtles at some of the most important nesting beaches (for that species) in the Wider Caribbean Region. The challenge is to expand these programs to include mitigation for threats at sea (mainly incidental catch) and to eliminate contradictions in the national regulatory framework (specifically between fisheries and wildlife legislation).

M. Jorge (Moderator) asked why leatherbacks have declined in [Pacific] Mexico. Are these high-profile population collapses the result of mismanagement at the local level, or do we all need to look beyond our own waters and forge partnerships to protect shared stocks?

R. Márquez (México) responded that each species has its own peculiarities. México has had conservation and management programs in place for leatherbacks for 20 years... but leatherbacks tagged on Méxican nesting beaches are routinely killed in Chile by pelagic fisheries. We have to reach international agreements on conservation of these species.

M. Jorge (Moderator) asked whether there are any additional remarks on the domestic capture of turtles.

R. Kerr (Hope Zoo) stated that more resources are needed for local communities. In Jamaica, it is not possible to enforce existing laws without support from local communities. Therefore, we must get local people more involved. A national network of community members, land owners, divers, students, fishermen and interested citizens was formed in Jamaica with assistance from WIDECAST several years ago, and this has provided a model for involving communities in population monitoring and record-keeping.

N. Frazer (UFL) noted that México had been successful in increasing the numbers of Kemp's ridleys in recent years, and he wondered what would happen if the government were to pull out of that long-term conservation program.

R. Márquez (México) explained that 30 years ago sea turtle biologists had to defend themselves from the community in Rancho Nuevo. But today the community supports the conservation efforts. Even if the government pulled out, the activities would continue. Poachers are captured with the help of the local people.

M. Jorge (Moderator) concluded that there had been a change of attitude and perspective because of local "buy in."

R. Ryan (St. Vincent & the Grenadines) described the situation in St. Vincent where the government has adopted a policy of sustainable use for all marine resources. He explained that his country was willing to cooperate with nations in the region in the management and/or conservation of sea turtles, given the limited financial and technical resources. To this end, a number of states recently formed a group called the "Caribbean Turtle Management and Research Group" (CTMRG), whose purpose is facilitate collaboration on research and management issues.

M. Jorge (Moderator) asked for additional information on the program in St. Vincent. Why had the policy of sustainable use been implemented?

R. Ryan (St. Vincent & the Grenadines) responded that the policy was based partly on a tradition of consumptive use and the revenues that come from it.

R. Connor (Anguilla) informed the meeting that, prior to 1995, Anguilla had open and closed seasons for sea turtles. Now a five-year (1996-2000) moratorium is in place in order to give local biologists and policy-makers a chance to evaluate the status of sea turtles and make recommendations to government about their long-term management. With assistance from WIDECAST, a national management plan is under development. Some fishermen would like to see the moratorium lifted, as they feel that turtle stocks have increased. He noted that his purpose in attending the meeting was to learn more about how to monitor local sea turtle stocks.

J. Horrocks (UWI) asked whether anyone knew the countries that had joined the CTMRG.

R. Ryan (St. Vincent & the Grenadines) responded that the CTMRG countries are St. Vincent and the Grenadines, St. Lucia, Dominica, Antigua and Barbuda, St. Kitts and Nevis, Colombia, Venezuela, Trinidad and Tobago, and Cuba. Fisheries institutions within each country are the participants [B. Mora from Venezuela later clarified that Venezuela was still evaluating the CTMRG and hadn't made any decision on whether or not to join].

N. Frazer (UFL) asked, "What happens to fishing livelihoods when moratoria are repeatedly instituted and then lifted? Who can benefit from that kind of cycle?"

R. Márquez (México) explained that prior to 1973, México had a moratorium. His country's experience with lifting moratoria was quite negative. After 1973, turtle fisheries were opened again only for cooperative organizations, but the industrial organizations got involved and over-exploitation began. The moratorium was re-instated in 1990. Now there is pressure to open the market once again for olive ridleys in the Pacific. He noted that the government will do it differently this time (if the moratorium is lifted once again), and will provide for better protection. He also noted that the conditions are not the same today as in the past. He agreed that cycling on and off moratoria does not allow fishermen to survive.

S. George (St. Lucia) said that in islands like St. Lucia fishermen have come a long way in the last 6-

8 years with regard to management decisions. St. Lucia imposed a moratorium (on sea turtle capture) in 1995 without the collaboration of the fishermen, and they resented it. St. Lucia has limited enforcement capacity and a limited ability to conduct research. Collaboration on subregional and regional levels would provide valuable information that the government could not afford to compile alone.

M. Hastings (BVI) stated that the BVI also has had experience with a moratorium, as well as with open and closed seasons. The situation is complicated, but is eased somewhat by the reality that younger fishermen are not attracted to the turtle hunt. Many of them, in fact, have been incorporated into monitoring programs. He asked R. Maáquez whether egg poaching had contributed to the leatherback collapse in México.

E. Delevaux (Bahamas) followed-up on the discussion of alternatives for fishermen and described how local fishermen and NGOs had requested the government to designate certain areas as conservation parks. About 20% of these areas are Marine Parks. The Bahamas has benefited by being an ecotourism destination. At present there is a total ban on the harvest of hawksbills, and seasonal and size limits on greens and loggerheads. The total annual catch is unknown.

R. Márquez (México) responded to M. Hastings by saying that the poaching problem is a complex one, and its effects really depend on the species. If a population is stable, low levels of poaching may not constitute a serious management issue. On the Caribbean coast of México the majority of the populations are depressed; thus, there is a need to protect 100% of the nests. Mexico has seen the results of over-exploitation; for example, in the loss of whole populations of olive ridleys on the Pacific coast.

C. Parker (Barbados) indicated that the turtle fishery had been managed in Barbados since about 1880. He suggested that there were four basic components to be considered in a successful fisheries management program: enforceability, education, alternatives (such as tourism and/or offshore fisheries), and co-management. The history of turtle management in Barbados provides examples of these factors. The legislation used to regulate turtle harvesting from 1880 to 1998 was almost impossible to enforce. As populations continued to decline, a complete ban was adopted in 1998. Fortunately, the rapid development of offshore fisheries since the 1940's and a boom in the tourist industry have offered economic alternatives to turtle fishing. In addition, an intensive education and public awareness program led by Bellairs Research Institute, the University of the West Indies, and the Fisheries Division sensitized the public to the conservation needs of sea turtles. Finally, the Fisheries Division has recently promoted co-management policies (including stakeholders in the process) for the management of fisheries resources, with the rationale that persons are more likely to abide by the regulations that they have helped to formulate.

M. L. Felix (St. Lucia) asked C. Parker how Barabdos has dealt with incidental catch.

C. Parker (Barbados) responded that gill nets are set for flying fishes in certain areas but, on the whole, sea turtle bycatch is not a large problem. Nets that are most likely to catch and kill turtles have been prohibited since 1998.

G. Allport (Dominica) stated that Dominica is currently the Chair for the CTMRG, which in part takes its mandate from harmonized OECS (Organization of Eastern Caribbean States) seasons and regulations. Most of the Eastern Caribbean islands face similar situations and thus a collaborative approach among fisheries offices is advantageous. The CTMRG provides a venue for sharing data and training personnel. For example, a two-week training program was held in Cuba in 1999. Members of the CTMRG have pledged to support each other, and the Group is promoting the sustainable use of sea turtles. Fisheries Departments are considered an essential link between fishermen and experts.

K. Eckert (WIDECAST) agreed that sustainable use, whether consumptive or non-consumptive, was the ideal goal. To this end many governments have committed themselves to management initiatives, including open and closed seasons and other regulations. The question is, "How are the effects of these management interventions evaluated? How do we know that a course of action is, in fact, sustainable?" She asked G. Allport how sustainability was evaluated in Dominica, and whether or not the monitoring of index nesting beaches and foraging grounds provided information useful to evaluation.

M. Jorge (Moderator) suggested that the meeting take note of the example of the Galapagos, where fishing for depleted sea cucumbers was re-opened for three months as a result of intense public pressure following an economic crisis in Ecuador. The fishery was re-opened for purely economic and political (as opposed to biological) reasons. The result was disastrous for the resource.

G. Allport (Dominica) described the turtle fishery in Dominica as "small". She noted that the Fisheries Department was intensifying its research and developing a management plan. In the meantime, management efforts were continuing. She emphasized the value of a regional management plan, especially for small countries with limited domestic resources.

M. L. Felix (St. Lucia) discussed the fact that the Eastern Caribbean islands are geographically very close, and that the turtles move between the islands. She agreed that sharing information on best practices and participating in regional collaboration were advantageous to small island states.

R. Ryan (St. Vincent & the Grenadines) noted that in St. Vincent, public education programs have been instituted and that this is also a valuable component of management. Local sea turtle stocks seem to be stable. The government's objective is to monitor the turtle populations and to acquire relevant training for personnel.

N. Frazer (UFL) commended members of the CTMRG for working together toward shared goals. He agreed that the road is difficult, but reminded the meeting of the Chinese philosopher who said that a journey of 1,000 miles begins with the first step.

M. Hastings (BVI) said that this was the first time he had heard of the CTMRG and, being an OECS country, he inquired how the BVI might participate. He asked for information from CTMRG countries on their standard methodology for monitoring.

M. L. Felix (St. Lucia) responded that the Group does not as yet have much data or many resources at its disposal. The Group is "still working the monitoring program out."

R. Kerr (Hope Zoo) expressed her concern that Jamaica did not have a comprehensive assessment of the status of its local [sea turtle] populations. From what data are available, it seems clear that hawksbills have been extirpated in many areas of Jamaica. Evaluating the precise status of hawksbills is not easy. The peak nesting period is between May and October, but nesting occurs throughout the year and often in remote areas. Comparatively faint nesting signs make it difficult to determine when a hawksbill has successfully nested. Each country has to do the best it can, taking both its own needs into account and those of the region. Regional cooperation is commendable. She asked, "Whose turtles are they?" All of ours? None of ours?

M. Hastings (BVI) agreed and said that the BVI faces similar challenges with its hawksbills. Volunteers walk the beaches to count hawksbill nests, but additional training is needed.

M. G. Pineda (Honduras) explained that isolated research has been conducted in Caribbean Honduras since the 1980s. In the North, a marine reserve has been in place for three years with university student volunteers. Local volunteers and NGOs have also given their support to leatherback and loggerhead turtle protection efforts. In the Miskito Cays area there is a high consumptive use of turtle products. Education is just starting in many areas. There is a need for much more research, and to involve communities at local and regional levels. Fisheries legislation in Honduras is outdated; open and closed seasons are in place.

R. O. Sanchez (Dominican Republic) observed that sea turtle management is complex, and characterized by two peculiarities among species: long-life and migratory habits. There is a permanent moratorium in the Dominican Republic, but enforcement is inadequate. He said that the experience of the Dominican Republic with regard to natural resources was that restrictions alone do not work. The local people must be involved in management. Fishermen often have very poor living conditions, and we must take this into account. Education of fishermen and the general population is certainly needed. Turtle fishing is not only for consumption, but also to make souvenirs for tourists. We are discussing this in an air-conditioned room, but the issue is how to reach these fishermen. Regional collaboration is commendable. The pressure to use natural resources is growing as human populations increase. We have to reflect on this. Restriction for sake of restriction will require an army of law enforcement.

E. Carillo (Cuba) recommended that nesting beaches be monitored in order to evaluate management success. With regard to R. Kerr's earlier remarks, she agreed that it is difficult to monitor nesting beaches, and especially for hawksbill turtles, but it is not impossible. There is a need to train local people to participate, and to find the money to do this. Since we cannot modify the behavior of the sea turtles, we must modify our own behavior. In Cuba we did this, with the support of students and fishermen, and we have had very positive results.

R. Kerr (Hope Zoo) responded that Jamaica, being a relatively small country, is not in a position to implement a monitoring system like Cuba's, which has put great effort into its programs. Other countries may not be able to do this either. There must be a strong commitment, with resources behind it, to obtain accurate and consistent data that are useful to managers. More emphasis should perhaps be placed on models that will help managers make thoughtful decisions in the absence of complete data.

J. Jeffers (Montserrat) said that Montserrat is still rebuilding following the volcanic explosions in 1998, and that the country has lost 2/3 of its fishing areas. Due to economic problems, some fishermen have returned to harvesting 8-10 turtles per year. This year a leatherback was found nesting on the island. Efforts are being made to support conservation by upgrading legislation and restricting beach sand mining. The British government is asking Montserrat to do more to protect sea turtles.

S. Tijerino (Nicaragua) said that Nicaragua also has legislation that conserves sea turtles. The green turtle and olive ridley are partially protected. However, some 60% of the population is unemployed and consumption of sea turtles has increased as a result of these economic circumstances. Nicaragua is seeking credible alternatives for coastal communities. The government is trying to determine how to establish sustainable alternatives, such as were described by N. Frazer in his presentation. A control program is very difficult to implement. Poverty in coastal areas is often due to poor fisheries management. A commitment to communities and to people, as well as to sea turtles, is needed.

E. Possardt (USA) explained that there has been an intense investment and commitment in the USA for sea turtle conservation for many years. This has included mandatory use of Turtle Excluder Devices (TEDs) in the shrimp industry, for example, and buying expensive beachfront nesting habitat in order to preserve nesting grounds. These efforts have shown positive results for our nesting populations, but no matter what is done in one country, others can undermine these programs. For example, fisheries in the eastern Atlantic may be undermining our long-term efforts to protect loggerhead turtles. No matter what we do, we are all in the same boat. As neighbors sharing an important resource, we need to agree on shared goals. I am looking forward to working in partnership with all of you who are here.

K. Eckert (WIDECAST) noted that there is a great deal of information available in the region (e.g., growth rates, diet, nest frequency, remigration intervals), and agreed with many of the delegates that information-sharing should be a priority. Some types of information (such as from satellite telemetry) can be quite expensive to gather and results can be very useful to managers over a wide area, whether or not they participated directly in the research. Local emphasis should focus on gathering information specific to local management needs. She asked, "Do you need to monitor every beach?"... and answered, "Probably not." She recommended that efforts focus instead on selected Index Beaches – relatively accessible beaches where nesting is predictable and comparatively high. She recommended that managers stick to the basics and emphasize data-gathering with a direct bearing on management questions, especially monitoring trends in local breeding and foraging assemblages.

She noted that it takes dedication to gather baseline data, but agreed with E. Carillo that remaining optimistic is important and duplicative effort should be avoided.

M. L. Felix (St. Lucia) expressed her desire that the meeting make time to discuss sustainable management.

M. Isaacs (Bahamas) explained that, in the Bahamas, turtle fishing is opportunistic. There is a refugee problem on isolated islands, and an enormous problem with poaching in the southern Bahamas. Enforcement is very difficult and regulation alone is pointless; sustainable management requires community collaboration.

M. Jorge (Moderator) concluded the session by noting the long tradition of sea turtle use in the region, and the broad-based interest in finding ways of accommodating resource use, especially at the community level, while at the same time ensuring a future for the resource. He said that he hoped the meeting would have time to address non-consumptive use also, including eco-tourism, and that meeting participants would think about regional mechanisms as they continued to build regional consensus. Referring to N. Frazer's presentation, he asked participants to think about how to achieve the goal of stable population levels.

[1] The interventions documented by the Minutes of this Plenary Session (Open Forum) were filtered through translators, rapporteurs, and editors before being finalized in these Proceedings. Every effort was made to ensure a fair representation of the views presented. Any misinterpretations or errors are the sole responsibility of the editors.

Session III

Strengthening International Cooperation

Caribbean Marine Turtles and International Law
Nelson Andrade Colmenares, Presenter

Open Forum
Nelson Andrade Colmenares, Moderator

Conclusions and Recommendations

Caribbean Marine Turtles and International Law

*Nelson Andrade Colmenares
Regional Coordinating Unit
UNEP Caribbean Environment Programme
Jamaica*

Several international treaties and conventions are of relevance to Caribbean marine turtles (Table 1). At the global level, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) entered into force in 1975. The treaty was developed in response to concerns about the potential detrimental effects on species' survival of high levels of international trade in wild animals and plants. It established an international legal framework for the prevention of trade in endangered species and for an effective regulation of trade in certain other species. The treaty's fundamental principles govern the species to be listed in the various Appendices on the basis of different levels of threat posed by international trade, and detail appropriate levels of trade regulation. The three Appendices to the Convention form the basis for implementation of the treaty (see Rosser and Haywood, 1996). All species of marine turtles are included in CITES Appendix I which prohibits international trade, although specific exemptions are held by Suriname (for the green turtle, *Chelonia mydas* and leatherback turtle, *Dermochelys coriacea*), by Cuba (for the green turtle and hawksbill turtle, *Eretmochelys imbricata*), and by St. Vincent and the Grenadines (for the hawksbill turtle).

The Convention on the Conservation of Migratory Species of Wild Animals (CMS, or Bonn Convention) came into force in 1983. It was established to protect species of wild animals migrating across and outside national borders, including marine animals. Parties agree to restrict harvesting, conserve habitats, and control other adverse factors. Above all, Parties are obliged to prohibit the taking of animals listed in Appendix I, with few exceptions (Hykle, 1999). All six species of Caribbean-occurring marine turtles are included in Appendices I and II, but few Caribbean states are members (Table 1). The Convention on Biological Diversity (CBD) requires Parties to develop national plans, programs, and strategies for conservation and sustainable use of biodiversity, which directly benefits high priority resources such as marine turtles. The UN Convention on the Law of the Sea (UNCLOS, which came into force in 1994) includes environmental provisions for pollution control and management, and provides for an Annex for highly migratory species, which could include marine turtles. The 1973 International Convention for the Prevention of Pollution from Ships (MARPOL Treaty), has as its objective "to preserve the marine environment by achieving the complete elimination of international pollution by oil and other harmful substances and the minimization of accidental discharge of such substances" (UNEP, 1989). Under the provisions of Annex V, Caribbean states have proposed to the International Maritime Organization (IMO) that the Caribbean Sea be declared a "Special Area", a designation which will be formalized when various pollution protection measures have been implemented by Caribbean states.

At the regional level, the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (Cartagena Convention) is the only legally binding environmental treaty for the Wider Caribbean Region. It is an umbrella treaty with far reaching provisions for regional cooperation including pollution control, habitat and ecosystems and species conservation. Its Protocol Concerning Specially Protected Areas and Wildlife (SPAW), which will enter into force in 2000, provides a mechanism whereby species of wild fauna and flora can be protected on a regional scale. The SPAW Protocol is an innovative legal agreement to facilitate international cooperation and guide national actions to protect important ecosystems and threatened or endangered species of wildlife of national and regional concern. As such, it is one of a few comprehensive regional biodiversity conservation agreements throughout the world that provides guidance and assistance toward meeting the comprehensive

Table 1. Some Key Multilateral Environmental Agreements to the Wider Caribbean Region (updated October 1, 2000)

	Cartagena Convention	Oil Spills Protocol	SPAW Protocol	LBS	CMS	MARPOL	CBD	UMCLOS	W. Hemisphere	IAC	CITES
Wider Caribbean Region											
Antigua & Barbuda	CP	CP	S			AN 5	CP	CP			CP
Bahamas						AN 4	CP	CP			CP
Barbados	CP	CP				AN 4	CP	CP			CP
Belize	CP	CP				AN 5	CP	CP		S	CP
Colombia	CP	CP	CP			AN 5	CP	S	S		CP
Costa Rica	CP	CP		S			CP	CP	CP	S	CP
Cuba	CP	CP	CP			AN 2	CP	CP	S		CP
Dominica	CP	CP					CP	CP			CP
Dominican Republic	CP	CP	CP	S		AN 5	CP	S	CP		CP
France	CP	CP	S	S	CP	AN 5	CP	CP			CP
Grenada	CP	CP					CP	CP			CP
Guatemala	CP	CP	S			AN 5		CP	CP	S	CP
Guyana						AN 5	CP	CP			CP
Haiti							CP	CP	CP		
Honduras	S	S					CP	CP		S	CP
Jamaica	CP	CP	S			AN 5	CP	CP			CP
Mexico	CP	CP	S			AN 3	CP	CP	CP	S	CP
Netherlands	CP	CP	CP	S	CP	AN 4	CP	CP		S	CP
Nicaragua	S	S					CP	S	CP	S	CP
Panama	CP	CP	CP		CP	AN 5	CP	CP	CP		CP
St. Kitts & Nevis						AN 5	CP	CP			CP
Saint Lucia	CP	CP	CP				CP	CP			CP
St. Vincent & Grenadines	CP	CP	CP			AN 5	CP	CP			CP
Suriname						AN 5	CP	CP	CP		CP
Trinidad & Tobago	CP	CP	CP				CP	CP	CP		CP
U.K.	CP	CP	S		CP	AN 5	CP	CP			CP
USA	CP	CP	S	S		AN 4			CP	S	CP
Venezuela	CP	CP	CP	CP		AN 5	CP		CP	R	CP

CP = Contracting Party
R = Ratification
S = Signature
A = Accession
AN= Annex Number accepted by the State

The only implication which stems from signing an international agreement after the signature period has expired, but before the Protocol itself has entered into force, is related to the nature of the instrument required in order to become a Party to the Protocol: the issue becomes one of accession to the agreement and no longer one of ratification. Only those States which have signed the agreement during the signature period are able to deposit instrument of ratification. Stakes which sign the agreement after the expiry of the signature period, becomes parties to the agreement through accession by sibmitting an instrument of accession or approval. In either these two hypotheses (i.e., if signature took place either during or after the signature period), signatory states are not legally bound by the provisions of the agreement until the agreement enters into force. The signature demonstrates a State's willingness to start its ratification process (by approval by its parliament, etc.). Nonetheless, according to Article 18 of the Vienna Convention on the Law of Treaties (1969), signatory States have an obligation not to defeat the object and purpose of the treaty after signature of the treaty but prior to its entry into force. When the agreement enters into force, it will be binding on all States having ratified or acceded to.

obligations of the Convention on Biological Diversity. The SPAW Protocol also integrates well with other global conventions; for example, it encourages the use of CITES administrative mechanisms in implementing SPAW's requirements for control of trade in threatened and endangered species (see UNEP, 1995).

All species of marine turtles in the Region are protected under Annex II of the SPAW Protocol, which relates to endangered and threatened fauna. Although the SPAW Protocol is not yet in force as we speak here today, numerous activities have been implemented to support Caribbean governments in their desire to safeguard our native biodiversity, including marine turtles. These activities include species conservation through national recovery plans, such as the "Sea Turtle Recovery Action Plans" published during the last decade in collaboration with the Wider Caribbean Sea Turtle Conservation Network (WIDECAST). Article 10 of the SPAW Protocol specifies that Parties "carry out recovery, management, planning and other measures to effect the survival of [endangered or threatened] species" and regulate or prohibit activities having "adverse effects on such species or their habitats". UNEP also recognizes the need for a regional strategic plan to protect marine turtles, and for that reason we are very pleased to have the opportunity to participate in this meeting. In 1995, the Third Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol adopted draft "General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region" (Eckert, 1995).

Other relevant instruments operating at the regional level include the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere (known as the Western Hemisphere Convention), which came into force in 1942. This treaty protects all native American species from extinction and preserves areas of wild and human value; five species of marine turtles are included in its annexes. The Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) was concluded after four rounds of negotiations in the Region in 1996. It has yet to be ratified. It has at its objective, "to promote the protection, conservation and recovery of sea turtle populations and of the habitats on which they depend, based on the best available scientific evidence, taking into account the environmental, socio-economic and cultural characteristics of the Parties." It is the only international treaty dedicated exclusively to marine turtles, and demonstrates the progressive nature of conservation in our region.

There is much more that could be said, but suffice to say that in this region there are a great variety of international legal agreements to assist us in the process of shared management, and UNEP looks forward to working together with you to ensure that Caribbean marine turtles survive for many years to come.

Literature Cited

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Hykle, D. 1999. International Conservation Treaties, p.228-231. *In*: Karen L. Eckert, Karen A. Bjorndal, F. Alberto Abreu G. and Marydele Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Rosser, A. and M. Haywood. 1996. CITES: A Conservation Tool. A Guide to Amending the Appendices to the Convention on International Trade in Endangered Species of Wild Fauna and Flora, Fifth Ed. IUCN, Gland. 136 pp.

UNEP. 1989. Register of International Treaties and Other Agreements in the Field of the Environment. UNEP/GC.15/Inf.2. United Nations Environment Programme, Nairobi. 250 pp.

UNEP. 1995. Relationship between the Convention on Biological Diversity (CBD), the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region. UNEP(OCA)/CAR WG. 19/4. Prepared for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. United Nations Environment Programme Kingston, 11-13 October 1995. 55 pp.

Open Forum: Strengthening International Cooperation

Nelson Andrade Colmenares — Moderator
Regional Coordinating Unit
UNEP Caribbean Environment Programme
Jamaica

J. Sybesma (UNA) began the Plenary discussion by expressing his strong support of International and Regional mechanisms. He offered the following explanatory and cautionary comments. First, Conventions work between parties and are not for the citizens of a party. Second, there are basically two different legal systems within nations, dualistic and monastic, when it comes to implementation. Either the international norm must be transformed into national law (dualistic) or it is directly applicable to citizens (monastic); the former is typical. Third, because international/ regional conventions are constructed on the basis of consensus, norms in international/regional conventions are mostly vague, "open", and lack time constraints. Fourth, at the moment there are at least four international/ regional conventions with legal mechanisms to protect sea turtles. They overlap considerably, which begs the question, "Why do we need so many international/ regional tools?" Lastly, most conventions require regular reports to be submitted, sometimes every year. In doing so, governments spend more time writing reports and less time implementing conventions. That is a problem. [1]

G. Allport (Dominica) asked for feedback on the progress of UNEP Action Plans for sea turtles.

K. Eckert (WIDECAST) explained that the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) had been formed as a result of a recommendation coming from a regional IUCN/CCA meeting in Santo Domingo in 1981. A natural relationship soon emerged between the network of experts and the UNEP office, which was seeking partnerships to assist governments in the discharge of their responsibilities under the Cartagena Convention, and later the SPAW Protocol. National management and recovery planning are explicit in the Convention, and an early focus of the relationship between WIDECAST and UNEP was to assist Governments and local stakeholders in development national "Sea Turtle Recovery Action Plans" (STRAPs) that followed a standard format. The first STRAP was published in 1992; there have been 10 published to date and a dozen more are in draft form. The documents are very comprehensive and represent a great effort by WIDECAST participants. Before WIDECAST, there was no mechanism for the broad exchange of information, but in the last ten years there has been incredible progress at the grassroots level in the areas of networking, data management, and training. Some of the Action Plans have been better implemented then others. She asked if perhaps some of WIDECAST's national coordinators, present at the meeting, would like to comment on implementation.

J. Horrocks (UWI) emphasized that in Barbados there was input into the "Sea Turtle Recovery Action Plan [STRAP] for Barbados" by all levels of society. Through the process of developing the STRAP, stressors and priority conservation actions were identified. UWI, Bellairs Research Institute, and the Fisheries Department are currently implementing the Action Plan. Programs have also been initiated in collaboration with dive operators and fishermen that focus on in-water work with green turtles and hawksbills. Currently partnerships are emerging that capitalize on the ecotourism market; e.g., making arrangements for visitors and volunteers to participate directly in our beach surveys and in-water census work.

P. Hoetjes (N.A.) noted that the Netherlands Antilles was the first country to produce an Action Plan ["Sea Turtle Recovery Action Plan for the Netherlands Antilles"]. It was authored by Jeff Sybesma, then Manager of the Underwater Park in Curaçao. Although there are not many turtles in the N.A., the government put legislation in place to fully protect the sea turtles. Now there is specific legislation on each island of the NA. There are no extractive commercial activities on sea turtles. There are plans to survey Saba Bank, part of the NA Economic Fisheries Zone (EFZ), where turtles and other important marine resources can be found. A good deal of work has been done on Bonaire (which adopted an extensive Marine Park in 1979), especially after the STRAP was published and a local sea turtle group ("Sea Turtle Conservation Bonaire") was formed. Curaçao has low density nesting beaches and does not monitor them consistently. Turtles in the Windward Islands of the N.A. are protected in the marine parks but, again, there is no formal monitoring of key nesting beaches or foraging sites.

C. d'Auvergne (St Lucia [2]) noted that the STRAP ["Sea Turtle Recovery Action Plan for St. Lucia"], published in 1993, was the first time that all relevant information about sea turtles in St. Lucia was gathered into one place. It represented a lot of work by NGOs and Government experts, as well. It had not been closely followed in recent years, but the Fisheries Department was now showing an increased interest in sea turtle activities, and in revisiting the STRAP.

K. Eckert (WIDECAST) stated that one of the big challenges to STRAP implementation was funding. Since 1995 WIDECAST contributed (through fund-raising) about US$ 700,000 to local sea turtle research and conservation in the region, but that is only a fragment of what is needed. She noted that, until a few years ago, the network had been focused mainly on training and capacity building, activities that are not capital intensive, but now the real need is to finance priority actions identified by stakeholders. WIDECAST itself is only a technical network, a mechanism to facilitate action, but not a donor *per se*. Local groups must become more successful at obtaining funding from national corporate or philanthropic sources. Trinidad, Bonaire, Costa Rica, Jamaica, Barbados, Belize and others have already been quite successful at local fund-raising.

N. Andrade C. (UNEP/Moderator) encouraged stakeholders to consider submitting joint proposals to Global Environment Facilities (GEF), either through the Convention on Biological Diversity (CBD) or the UNEP Regional Coordinating Unit (RCU) in Kingston. Small grants are accessible in the region through local UNDP offices; these grants have supported sea turtle projects in Anguilla, Trinidad, and perhaps elsewhere.

M. Donnelly (IUCN MTSG) commented that five countries had ratified the Inter-American Convention [for the Protection and Conservation of Sea Turtles, or IAC]: Venezuela, Mexico, Costa Rica, Peru and, most recently, Brazil, and that the treaty was expected to enter into force within the year. Following up on Nelson's presentation of the various international instruments in the region, and noting that the Conventions often appear to overlap in specific details, she asked for input from participants on whether this situation was considered to be problematic or useful in fulfilling the objective of coordinated, international conservation action.

P. Hoetjes (N.A.) expressed his concern that when treaties cover the same ground, it just means that "double work" is required for the reporting process. This costs more money and resources.

D. Salabarria Fernández (Cuba) offered her view that what really matters is implementation. When a treaty costs resources (including money) that are not available within the country, then it is just paper on a desk, and this is a common problem for the countries of the Wider Caribbean. All treaties have progressive and useful provisions, and most have aspects that are not relevant. A government must choose what agreements to support. A government must set its priorities.

M. Jorge (WWF) agreed, and noted that treaties are negotiated because countries desire to reach agreements that benefit them and that support their national priorities. The basis of a successful treaty is that countries agree by consensus. The recovery, management and/ or conservation of a resource or resources is often the shared motivation. The motivation must be clear before governments enter into agreements.

R. O. Sanchez (Dominican Republic) further clarified the issue by characterizing it as an ongoing debate between those who believe that signing more treaties strengthens conservation by obligating a nation to specific responsibilities, and those who believe that these responsibilities might be achieved with less (or perhaps more selective) international participation. He agreed that what is important is not just signing but implementation, even despite limited resources. It has been the experience of the Dominican Republic that a minimum or sufficient number of agreements is needed in order to effectively conserve resources, but he recognized that there were differences of opinion on this topic.

M. E. Herrera (Costa Rica) said that Panama and Costa Rica have an agreement on sea turtles ["Agreement for the Conservation of Sea Turtles on the Caribbean Coast of Panama, Costa Rica and Nicaragua", or Tripartite Agreement] and that they would like to include Nicaragua as a signatory, as well. In addition, Costa Rica has ratified the IAC and has introduced domestic legislation for the protection of sea turtles in order to improve implementation. The government is working on a management plan with NGOs and other entities with an aim to achieve sustained conservation results into the future. She emphasized the importance of range states working together.

M. Isaacs (Bahamas) expressed his view that the benefits of some Conventions are obvious, as evidenced by a global participation in CITES ("Convention on International Trade in Endangered Species of Wild Fauna and Flora") and other broadly applicable instruments. Most agreements do have administrative and other costs, but it is all to the end of achieving and supporting conservation on the ground. He agreed with Dalia (Cuba) that there may be a need to focus more on needs within individual countries, however, and not create so much bureaucracy as to divert limited resources away from real progress on the issues.

D. Chacón (ANAI) agreed with Maria Elena (Costa Rica) in that Costa Rica is working on many issues, both national and regional, and that to some extent the number of treaties and conventions offers a positive aspect in that a nation can chose to participate in the treaties that best meet its needs as a nation. In the case of Costa Rica there was a feeling that the various international agreements did not, in fact, meet a priority national need to work collaboratively with Nicaragua and Panama to jointly manage shared sea turtle populations. For this reason the "Tripartite Agreement" was born. He talked about an ongoing need for updated domestic legislation, and the "enormous gap" between legislation and work being done in the field. To overcome this gap, local legislation is required in some cases because national legislation is too broad. He agreed that with conventions there is often good intention but insufficient attention to the work in the field. Therefore, local laws are also very important.

N. Andrade C. (UNEP/Moderator) indicated his support for the comments made by Didiher (ANAI) and Maurice (Bahamas) and observed that while it is easy for a country to sign an agreement, a balance must be struck between good intentions and resources that must be made available to assist institutions in implementation. Necessarily, national financial resources must be available in order to fulfill treaty obligations. In many cases governments have asked UNEP to provide these resources. WTO and other global entities are also now speaking of the "economic values" of the environment. There is interest in the idea of coordination among global and regional conventions. Secondly, treaties are based on consensus among nations, so it is at the level of the individual governments that there must be a willingness to implement. At the national level, countries have a difficult but necessary task to evaluate what benefit a convention is likely to provide, and then also think carefully about the availability of resources before the convention is signed.

R. Márquez (Mexico) agreed that the effects and benefits of a treaty must be examined and then balanced with the available budgets. Treaties require a sufficient budget. He noted that budgets for research projects often remain the same year after year, but because of inflation (which increases each year), these budgets are really shrinking.

N. Andrade C. (UNEP/Moderator) read a statement from the delegate from France informing the meeting that France had not yet ratified the SPAW Protocol, but considers it a priority. France does not support ratification of the IAC.

S. Tejerino (Nicaragua) revisited the "Tripartite Agreement", which also includes Costa Rica and Panama, and expressed interest in the agreement. She noted that Nicaragua has revised the text of the agreement, which was originally developed and launched by two NGOs. Since international treaties are signed by governments and not NGOs, NGOs are not responsible. At the present time Nicaragua is emphasizing the need for local groups to participate, but such groups are not in full agreement. She asked whether the avenue to consensus would be best achieved by education or diplomacy? And she indicated that Nicaragua is ready to sign several of the agreements talked about during the Plenary session, but that Nicaragua is a country that uses a lot of natural resources, and that some annexes work against current practices. The country must take into account not only conservation, but also sustainable use. "Conservation" must have a more realistic approach in some cases, especially when economies are heavily resource-dependent.

N. Andrade C. (UNEP/Moderator) noted some contradictions among conventions, such as between WTO and CBD and between SPAW and CITES, but concluded that these conventions should not lose their importance. He suggested that we identify the contradictions and adjust the treaties when practicable, but that we not forget the essential meanings of these conventions. He agreed that governments need and should expect clarity in interpreting the various conventions, and that there must be a will to work together. As an example, as a result of the last SPAW meeting in Havana UNEP is working on making global conventions more complementary.

M. Isaacs (Bahamas) agreed that this topic had been discussed in Havana. He suggested that the problem is not a contradiction between conventions, but a problem within some countries regarding compliance with the SPAW Protocol. Once again, countries must take the time to examine the documents carefully before entering into a convention.

M. Donnelly (IUCN MTSG) asked whether or not it would be useful to draft model national legislation, or to harmonize national legislation in the region as the OECS nations have attempted to do?

P. Hoetjes (N.A.) responded that harmonization of legislation may work well when countries are close together and have the same background, as is the case for many countries in the Eastern Caribbean. But it is probably very difficult, if not impossible, when this is not the case.

D. Salabarria Fernández (Cuba) noted that legislation is the responsibility of the governments, as is policy.

S. George (St. Lucia) agreed with Paul (N.A.) that harmonization in the Eastern Caribbean was relatively easy because of a common legal background. Management guidelines coming from this meeting would be more useful than specific legislative wording. All countries of the Wider Caribbean region have legislation, but it is incomplete in various ways. Guidelines that could be used to evaluate national legislation, especially to assist Government in filling existing gaps, would be useful.

M. Jorge (WWF) stated that the term "harmonizing legislation" is subject to differences of opinion. For example, Honduras, Guatemala and Belize are harmonizing policy for fishery resources. They are sharing natural resources and they do not want to "undercut" each other's efforts. For this reason, they are designing a joint management scheme for these resources. As an another example, several countries in the Caribbean are working diligently to manage their conch fisheries, and they are harmonizing policies. We may want to go in this direction.

C. D'Auvergne (St. Lucia [2]) agreed with Sarah (St. Lucia) in that whether or not countries decide to harmonize legislation or policy depends on their particular situation. The OECS, for example, has seen significant success in managing access by foreign fleets. When countries are managing geographically contiguous resources, then there is more likely to be a justification for harmonizing.

P. Hoetjes (N.A.) said that treaties are about harmonizing policy, and that this was an important point for the meeting to discuss because it can be a very difficult thing to achieve. He noted that even within the N.A. harmonization is difficult to achieve because of a complex layering of local (island), national, and kingdom legislative frameworks. He also noted that in some treaties (e.g., CITES, SPAW), sea turtles are classified as endangered species, … yet in some countries sea turtles are used commercially. This is often because of poverty. Countries sign the treaties, but on a national level they let this consumption continue. He asked, "How do we deal with this?"

S. Tijerino (Nicaragua) responded that in the case where a country signs a treaty and lets national consumption continue in ways that contravene the intent of the treaty, it does not mean that the country lacks a willingness to regulate consumption. The situation is complicated. There is an effort to harmonize legislation within Latin America, for example, but procedures with commerce and internal management are very complex. Countries will have to focus on the similarities in this matter.

M. Isaacs (Bahamas) agreed that no country has 100% compliance. When a country decides to sign or ratify a treaty, it agrees to try its best to comply with the principles of that treaty.

J. Frazier (Smithsonian) observed that the world is complex, political processes are not transparent, and conventions are difficult to implement. Since the meeting had been called to discuss sea turtles, and it was the first such forum to convene in many years, he invited the participants to consider whether or not sea turtles could be managed on an individual country level and, if so, what was the role of the regional dialogue?

N. Andrade C. (UNEP / Moderator) asked the group to provide some concrete recommendations and suggestions on the subject of "Strengthening International Cooperation."

R.O. Sanchez (Dominican Republic) stated his view that when one considers the migratory nature of sea turtles, it is obvious that we must always think at regional and international levels. Therefore, a regional dialogue has great value. We cannot solve problems as individual nations — we must continue to work on a regional and international level.

M. Isaacs (Bahamas) recommended that copies of national legislation be made available in English and Spanish because "it would be useful for us to see the legislation of other countries when drafting our own legislation."

R. Kerr (Hope Zoo) asked whether or not "model" implementing legislation could be made available to governments of the region regarding IAC and SPAW, since there was hope for these treaties coming into force soon.

K. Eckert (WIDECAST) recalled participating in a SPAW legislation meeting in Ocho Rios (Jamaica) in 1993, and asked whether UNEP had developed model legislation for the SPAW Protocol. [ref: "Workshop to Assist with the Formulation of National Legislation to Implement the SPAW Protocol in the Common Law Countries of the Wider Caribbean Region," 6-9 December 1993]

J. Sybesma (UNA) reminded the meeting that the Jamaica meeting was only for common law countries, and it was his recollection that nothing had become available as a result of the meeting.

N. Andrade C. (UNEP / Moderator) answered that he was unaware of any model SPAW legislation available from UNEP.

S. George (St. Lucia) agreed with previous speakers that the region is committed to moving to a new approach with regards to sea turtle management. She noted that countries recognize that they need to work with others, and that no country can accomplish its management goals in isolation.

K. Eckert (WIDECAST) inquired whether this would be a good opportunity to put forward a recommendation of the meeting in support of the SPAW Protocol, noting that no treaty lends clarity and focus to the issues facing sea turtles in the way that SPAW does. She asked whether there was a copy of the Protocol present for the purposes of a more detailed discussion.

N. Andrade C. (UNEP/Moderator) responded that the meeting could take a decision with regard to SPAW, but it would be non-binding since this is a technical meeting and not an intergovernmental meeting.

A. Abreu (IUCN MTSG) asked the meeting to consider the points of consensus. He suggested that if, for example, there was universal acceptance, based on the migratory characteristics of sea turtles, that sea turtles should be managed regionally, then the recommendations of the meeting should support that point. Perhaps more specific recommendations could come at a later time.

S. Tijerino (Nicaragua) expressed concern that the meeting did not have the authority to support a recommendation on SPAW (or any other treaty). In her case, she works for Environmental Affairs and not Foreign Affairs. She came to discuss this matter with hopes of presenting an initiative, not to make commitments. She noted that Nicaragua had signed the SPAW Protocol years ago, but had not ratified it. This was a matter for Foreign Affairs.

N. Andrade C. (UNEP/Moderator) clarified the point that this is not an inter-governmental meeting; nothing that comes out of this meeting should be construed as mandatory or binding. This is a meeting of technical experts and an indication of the commitment of Caribbean governments to participate in this important discussion. The recommendations of the meeting should be of a technical nature.

E. Carillo (Cuba) agreed with Alberto (IUCN MTSG) that the management of marine turtles must be regional, but that implementation must logically occur at the national level. There might be a mosaic of national plans, each supporting the regional consensus but crafted to meet national priorities as well.

J. Aiken (Cayman Islands) stated his support for the meeting as a forum to discuss regional management of marine turtles in the Caribbean, and offered his view that the ecology of marine turtles should be viewed first from a regional perspective and then from a national perspective. A "mosaic of national plans" may neglect important aspects of marine turtle life history, especially when developing a "Regional Management Plan for the Conservation of Marine Turtles in the Caribbean."

C. Parker (Barbados) suggested that recommendations must be based on biological realities, but also on the needs of the different countries. Sea turtle harvest is prohibited in Barbados, but to what level should turtles be harvested in other countries? He suggested that information be made available indicating the extent to which exploitation is important to various countries.

R. O. Sanchez (Dominican Republic) agreed that resource use within countries should be taken into account, including the traditional use of turtles. There is a wide range of current practices.

C. Parker (Barbados) described the purpose of the meeting as a forum to share information, with the intent of trying to move from a national level of management to an international level where responsibilities are shared. He suggested that what governments really need to know is whether or not their efforts are useful or in vain; for example, are turtles protected in one country, but overexploited in other areas so that we may never see them again? What are our shared values in this regard? Can we agree that if we do not conserve them internationally, they will be lost? Countries will be less likely to increase their national conservation activities if they do not understand why others do not do the same.

M. Isaacs (Bahamas) agreed that we must move away from a parochial mentality. In talking of highly migratory species which are a shared resource, we are obligated to remember that turtles in the waters or on the beaches of any particular country are only there for a period of time, but during that time they are wholly dependent on that country for their survival. Feeling the importance of this view, the Bahamas does not have a problem with regard to compliance with either SPAW and CITES.

A. Abreu (IUCN MTSG) asked for volunteers to comprise a Drafting Committee to make recommendations to the meeting, based on the discussion.

M. Jorge (WWF) noted it would be prudent to ensure that a range of viewpoints be represented on the Drafting Committee. It was agreed that the Drafting Committee would include S. George, M. Isaacs, E. Carillo, S. Tijerino, N. Andrade C. and J. Sybesma. V. Sybesma and M. Donnelly agreed to type the minutes of the session.

[1] The interventions documented by the Minutes of this Plenary Session (Open Forum) were filtered through translators, rapporteurs, and editors before being finalized in these Proceedings. Every effort was made to ensure a fair representation of the views presented. Any misinterpretations or errors are the sole responsibility of the editors.

[2]Mr. C. d'Auvergne participated in the meeting as an Invited Expert, and not as a delegate from St. Lucia

Conclusions and Recommendations: Strengthening International Cooperation

NOTING the efforts of all countries of the Wider Caribbean in conserving marine turtles and their habitats on a national level;

RECOGNIZING the constraints that all countries continue to face in implementing the conservation of marine turtles and their habitats;

WE RECOMMEND:

- Supporting the establishment of a regional data center, including legislation, biological and technical information to be located, for example, at the SPAW Regional Activity Center to be established in Guadeloupe;
- Encouraging and supporting the countries of the Wider Caribbean in becoming more involved in international, regional and sub-regional agreements for the conservation of sea turtles;
- Encouraging countries of the Wider Caribbean that have a "Sea Turtle Recovery Action Plan" (STRAP) in place to implement it, and encouraging those who do not have such a plan in place to develop and implement one, with the final goal being to achieve regional consensus on the guidelines and criteria for cooperative conservation and management of Caribbean marine turtles;
- Continuing to use cooperative mechanisms to make the implementation and reporting requirements of the various international and regional conventions more effective and efficient; and
- Encouraging and supporting those countries with jurisdiction over outstanding critical marine turtle habitat in increasing their efforts to conserve those populations and habitats, with the support of the regional and international community.

Sessions IV and V

Meeting Management Goals

Determining Population Distribution and Status
F. Alberto Abreu G., Presenter

Monitoring Population Trends
Rhema H. Kerr Bjorkland, Presenter

Promoting Public Awareness and Community Involvement
Crispin d'Auvergne, Presenter

Reducing Threats at Nesting Beaches
Barbara A. Schroeder, Presenter

Reducing Threats on Foraging Grounds
Julia A. Horrocks, Presenter

Strengthening the Regulatory Framework
Jeffrey Sybesma, Presenter

Determining Population Distribution and Status

F. Alberto Abreu G.
IUCN/SSC Marine Turtle Specialist Group
Instituto de Ciencias del Mar y Limnologia
Universidad Nacional Autónoma de México
México

Introduction

To implement biodiversity conservation programs, necessary input to establish priorities includes information on the distribution of the species, its structure (how is it organized internally?), and its conservation status, both for the species as a whole and for the populations or stocks that comprise it. This information enables the development of an effective and direct strategy linking priority goals with local and regional actions. This chapter outlines the methods used in determining the distribution of marine turtles species and emphasizes the issues related to the study of population structure and the assessment of conservation status.

Determining Distribution

A species' distribution describes the entire geographic region with all known or inferred sites in which a species occurs (vagrants are excluded). For migratory species such as marine turtles, which utilize numerous habitats during their lifetimes, distribution encompasses vast areas, including all sites essential for the survival of every life stage. Marine turtles are present in many of the world's oceans and seas. They have complex life histories, and over a period of many years use continental shelves, bays, estuaries, and lagoons in temperate, subtropical and tropical waters. Determining the extent of their distribution has been difficult. Fortunately, once the major aspects of each species' life cycle became known, direct and indirect methods to identify the presence of individual species have permitted the collection of a great deal of information about their distribution.

The simplest direct method relies on the identification of species during the nesting season at *breeding sites.* The global nesting distribution is the sum of all sites found. In most cases, many sites are already known from recent and historical surveys (see individual species chapters in this volume). Aerial and boat surveys (Schroeder and Murphy, 1999) are useful to increase the coverage of large expanses of territory and extend scrutiny into regions less well studied or with difficult access. Identification of species using these survey methods can rely on direct observations of nesting turtles or on deductions from characteristic tracks.

Basic data derived from nesting beach surveys are essential to construct the inventory of the species' nesting sites and should include: (a) geographic coordinates and references to landmarks and/or the political entities where each nesting beach is located; (b) nesting period for each of the species using the beach; and (c) the relative importance (in terms of numbers of nests per season) of the nesting beach within the country or the region (Briseño-Dueñas and Abreu-Grobois, 1999).

Other essential habitats and areas include those used as *migratory* corridors, *developmental* sites and *foraging* areas. Identification of the location of these sites is much more difficult due to the fact that they are found at sea and they exist at localities often separated by many hundreds or thousands of kilometers from the nesting sites where the majority of research efforts take place. Species have distinct developmental and foraging sites that correspond to their ecological requirements. When more than one species of marine turtles utilizes an area, each species generally has different ecological requirements. For example, hawksbills forage on sponges in reef areas while green turtles utilize grass flats. However, at some sites, particularly in the coastal areas, a combination of species may be found during a portion of their life cycle even though the seasonality and locality of breeding may not coincide. In other cases, turtles of the same species but of different ages may be found at individual habitats.

The locations of migratory routes initially were derived from opportunistic sightings in the open sea by biologists or fishermen familiar with these species. Tagging programs for marine turtles in many regions have provided useful insights into the extent of the species' ranges. With time, the accumulated information gathered has allowed biologists to construct a more complete picture of nesting sites, migratory routes and developmental areas. The use of traditional mark-recapture techniques (Balazs, 1999) together with more sophisticated biotelemetry (Eckert, 1999) or genetic methods (FitzSimmons *et al.*, 1999) in conjunction with an understanding of oceanic currents has refined our knowledge of dispersal routes as well as the location of developmental and feeding sites of juvenile and mature organisms. The emerging picture now includes details of long distance movements, and the realization that turtles originating in many breeding colonies converge in developmental and feeding sites. This research has also confirmed the extensive migratory behavior of all marine turtles, crossing through and into territorial waters of more than one country during their lifetimes.

Indirect methods are also useful to detect the presence of marine turtles in coastal habitats that are less well studied or difficult to reach. Relevant data often can be derived from historical and anecdotal information from individuals acquainted with sea turtles, such as villagers, marketplace shoppers, or fishermen (Tambiah, 1999). Published accounts of the general biology of the species are very useful as general guides to potential locations. Surveys of potential nesting or feeding sites can be undertaken in areas which have the ecological, physical or biological characteristics known to correlate with sea turtle presence (e.g., coral and sponge reefs, seagrass beds for hawksbill and green turtle foraging grounds, respectively; Diez and Ottenwalder, 1999). On some beaches during the reproductive season, nesting can be confirmed through the presence of crawls, nesting pits, or egg shells and the species' identity can be deduced from characteristic markings left by nesting females (Pritchard and Mortimer, 1999).

Importance of identifying the basic demographic units

As in many other species with broad geographic distributions, marine turtle species are made up of discrete demographic subunits and these can, for the most part, be differentiated with modern genetic techniques. Isolation between these subunits (also known as "stocks", "populations" or "management units"), originates from relatively low levels of gene flow between breeding assemblages. In the case of marine turtles, a tendency for organisms to return to breed at or near the site of birth ("natal homing" or "philopatry"; see Frazier, this volume) promotes this kind of isolation between breeding assemblages, even though they still remain part of the same species. A practical consequence of this degree of isolation is that the populations will exhibit independent population dynamics that correlate with the degree of genetic differentiation. Thus, as individual populations may react independently to management actions, management practice can and should be tailored specifically to the conservation status of each individual population. In practice this means that each individual population will need to be identified, tracked and evaluated throughout the geographic range where it is distributed. This requirement imposed upon marine turtle management on a regional scale is not unlike fisheries management of species composed of multiple stocks (see Musick, this volume).

Identification of populations of marine turtles can rely on a combination of techniques, including mark-recapture with flipper tags and various forms of telemetry and molecular methodologies for the most precise results. However, because differences between breeding assemblages have a genetic basis, the most useful and time-efficient method takes advantage of assayable differences between the populations, either in the form of frequency shifts or presence or absence of distinct segments of the DNA, that serve as "markers" that can be used to track and identify populations or individuals.

In many cases, the use of DNA analysis allows for the unambiguous characterization of discrete breeding assemblages at their nesting grounds and their discrimination in distant feeding ground assemblages, in migratory corridors, or in harvests, where the actual composition of a mixture of stocks would be impossible without this technique

(Bowen, 1995; FitzSimmons *et al.*, 1999).

Although these studies are preliminary until more populations are researched, these types of genetic studies have been successfully applied to hawksbill populations in the Caribbean region. The significant differences in characteristics of the mitochondrial DNA among rookeries (Bass *et al.*, 1996; Díaz-Fernández *et al.*, 1999), besides demonstrating the existence of independent stocks, were employed to distinguish populations in sites where more than one stock would be present. At foraging sites located in Puerto Rico, Cuba and Mexico the presence of a mixture of populations was thus proven and the contribution by each stock at that time and season was derived by statistical analyses (Bowen *et al.*, 1996: Díaz-Fernández *et al.*, 1999). Further analysis of the genetic data also allows estimates of gene flow between rookeries, providing for a much clearer picture of the dynamics among populations.

Determining Status

The term "status" or "conservation status" refers to the condition or health of a species or population. Assessments of a species' status follow analogous procedures to those used by a physician when diagnosing a patient, requiring a comparison of his current condition against a standard of "health". Similarly, the status of a species can be derived by scrutinizing for "symptoms" that reflect its condition. These are based on an assessment of a species' population trends, distribution, and the state of critical habitat. On one end of the spectrum, threatened and stressed species exhibit marked declines in population size over time. This may be associated with direct threats to the organisms themselves or to loss or degradation of habitat. On the other end of the spectrum, if population stability or growth is observed over an acceptable period of time, the conclusion would be that the species is "healthy". When the latter is observable subsequent to a period of decline, the species could, at least, be considered "recovering". Condition of full recovery will require the elimination or control of external threatening factors, a measure of the species' health, as well as assuring that the species can perform its full ecological role.

Status in terms of risk of extinction

Rigorous methods for the evaluation of status of endangered species have been developed to focus attention on identification and measurements of extinction risk. Resulting evaluations have the additional value of providing means by which species can be compared across taxa on the basis of extinction risk. This information can be used in turn to prioritize conservation programs.

Extinction results from complex and not completely understood interactions between external threat factors and the species' intrinsic characteristics that, under extreme circumstances, lead to an ever increasing decline and, eventually, to an inability to survive altogether. In modern times, the major forces driving extinction are anthropogenic, such as a) habitat loss or degradation, b) overexploitation, c) introduction of exotic species or diseases, or d) a combination of all these factors. When these circumstances are present, they are symptoms that a species it at risk. Some natural history traits, because of the additional constraints they impose on population growth and general resilience, augment a species' vulnerability to extinction. Among these: a) narrow geographic range, b) only one or a few populations, c) population size is small, d) characteristic low population density, e) requirement for a large home range, f) low intrinsic rates of population increase, g) migratory behavior, h) scarce genetic variability, or i) highly specialized niche requirements. The more of these traits that a species exhibits, the more vulnerable it is to extinction.

Because of the biological complexities of species and their interactions with their environment, a thorough and objective analysis to gauge the precise risk of extinction for any species is extremely difficult. It requires in-depth knowledge of all factors involved and their effects on the survival capability of the species. In practice, however, identification of species at risk <u>can</u> be derived by employing measures of the symptoms that species under stress provide (habitat loss or degradation, population decline or highly reduced population sizes) and these can be used to classify species into threat categories. This can be seen as the initial decision a doctor takes when dealing with ill patients and will identify the cases that require most urgent action.

For example, if a population is characterized as having a small size and/or has a slow rate of population growth *and* is known to be drastically reduced in size, it is logical to deduce it is threatened. Likewise, if a significant proportion of a population's habitat has been lost or degraded, *and* the population has declined in size, this population is also vulnerable.

Measuring the extinction risk of species should ideally be objective and rely on the best available scientific data and incorporate measurements of indicators that correlate with extinction risk. Thus, the results of the assessment should be the same when performed by different assessors. Developing a single procedure for all organisms is a daunting task, particularly as species vary considerably in their life-histories and other ecological attributes that affect their vulnerability to extinction. Faced with devising dependable and rigorous guidelines for species status assessments, national and international authorities have developed procedures based on the ideas presented above. For example, for legislative and management policy purposes, some countries specify general guidelines defining endangered species as those showing some or a combination of the symptoms associated with extinction. In these cases, scientific or technical advisory committees review available information and the biological characteristics of species on a case-by-case basis to produce national lists of endangered species (e.g., Mexico's Diario Oficial de la Federación, 1994; The US Endangered Species Act 1973). Several international conservation treaties consider endangered species using general definitions (e.g., UNEP's SPAW Protocol, and the Convention on the Conservation of Migratory Species of Wild Animals-CMS).

Two major international organizations have specific pre-defined procedures to be applicable to all species under their respective evaluation processes: the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and, through its Red List Program, the World Conservation Union (IUCN).

CITES utilizes a suite of "Biological Criteria" to assess species that are, or are likely to be involved, in international trade in order to detect if they can be considered endangered species (Table I). These criteria detect endangerment on the basis of observations or inferences that reflect small population size and decline in the number of individuals or in the quality of their habitat; populations having a restricted area of distribution and exhibit declining population sizes, or fluctuations in size or are fragmented; or populations whose size has declined significantly over generations. Species meeting these criteria are listed in CITES Appendices I and II (see left column, Table I for CITES criteria; for further details, the interested reader should consult CITES Conf. 9.24 available in http://www.cites.org/CITES/eng/ index.shtml).

The IUCN has developed a more complex system (the Red List Categories) that relies on specific quantitative thresholds to assign one of eight categories of extinction risk. Of these categories, the three applicable to threatened species are relevant to marine turtles: *Vulnerable*, *Endangered* and *Critically Endangered* since each of the seven species of marine turtles are currently listed under one of them. The goal of the Red List Categories is to provide an explicit, objective framework (criteria) to classify species according to their risk of extinction. These have been developed to be applicable across all taxa and life histories, although some difficulties remain. The 1994 IUCN Red List categories and the corresponding thresholds are presented in a simplified form in Table I (right column). While species initially should be evaluated against all criteria, some of the criteria are not applicable to particular taxa. If a species meets one criterion, it is listed as threatened at that level (category) of risk. The Red List Categories employ quantitative criteria to distinguish amongst three categories of extinction risk, thus providing for greater resolution in the evaluation. Since a thorough description of the assessment procedure is beyond the scope of this chapter, the interested reader is encouraged to consult the complete documentation for further details and application guidelines (IUCN, 1994).

A number of important elements in the assessment procedure should be stressed. First, for adequate assessments, the time frame of the observations needs to be biologically relevant to the processes involved. Since population dynamics are scaled by generation lengths (see Congdon *et al.*, 1993), assessments need to be made over a period spanning several generations. Secondly, generation is defined as "the average age of parents". This value is greater than the age at which first reproduction is observable and less than the age of the oldest breeding individual. One problem with this definition is that this number will be lower than would occur naturally in a heavily exploited species because breeders will not have natural lifetimes. Third, although the assessments are usually applied to species at a global scale, they are also effective in evaluating the status of individual populations or stocks, particularly when they are isolated from other conspecific populations (as occurs for most marine turtle stocks). Fourth, since the results of either procedure rely on evaluating parameters such as "decline" or "reductions" in aspects of a species' habitat or its population size, the cut-off points need to be clearly defined for objective application. CITES, for example, provides a guideline (not a threshold) for defining a "decline" to be sufficiently large to warrant classifying a species in trade as "endangered": $\geq$50% reduction in number of individuals or in its area of distribution over a period of 5 years or 2 generations whichever is longer ($\geq$20% in 10 yrs or 3 generations for small populations). The IUCN Red List Categories, on the other hand, specify that the observed or inferred changes occur over 3 generations or 10 years, whichever is the longer period (see Table I).

Using the IUCN Red List Categories to assess extinction risk of marine turtles

IUCN's procedures have been widely accepted by governmental agencies, academic and non-governmental organizations as a universal reference point for listing endangered species. All species of marine turtles have been assayed with these criteria and are provided in the IUCN Red List of Threatened Animals (Baillie and Groombridge, 1996; see species chapters in this volume).

Marine turtles are commonly analyzed for global assessments under Criterion A ("Declining population size", right column in Table I) which is the criterion most applicable to the taxon. For these species, assessments are generally based on direct observations (subcriterion a), an index of abundance appropriate to the taxon (subcriterion b), or actual or potential levels of exploitation (subcriterion d).

In most surveys, marine turtle population sizes are gauged on the basis of numbers of nests constructed annually as this information is the most accessible and abundant information which is amenable to analysis (Meylan, 1995). There is a very significant advantage in that these data are directly related to the true number of breeding females during each nesting season. To estimate population abundance, estimates of annual number of nests are commonly preferred over estimates of the number of individual nesting turtles as the index of abundance because (a) many (if not most) projects do not tag turtles, so it is not possible to distinguish between individual nesters leaving multiple clutches in the season and (b) there is no need to monitor individual tagged turtles between subsequent nestings (remigrations) to detect and account for variations amongst individuals and between geographic populations for frequency and length of remigration intervals (Alvarado and Murphy, 1999). Thus, information gathered by most surveys can be compiled and compared. If desired, numbers of nests can be converted to the number of females nesting annually by dividing the average number of nests per female (Alvarado and Murphy, 1999) when this information is available.

As mentioned above, evaluation of changes in population size for status assessment needs to be analyzed over a period of time compatible with the dynamics of population turnover. This scale would extend beyond the time frames required solely to achieve statistical robustness in trend estimates from demographic data (roughly in the region of 5-10 years; see Kerr, this volume) into a 2-3 generation period that is required by international procedures. Furthermore, employing multi-generation time series also facilitates the detection of true long-term trends.

Age at maturity for long-lived species, such as marine turtles, extends into decades (see Frazier, this volume). For the fastest developing species, such as Kemp's ridley (*Lepidochelys kempii*), maturity may be first reached in the range of 10-16 years (Márquez, 1994; Márquez, this volume; Zug et al. 1997). At the other end of the spectrum, green turtles may take as long as 50 years to reach maturity (Bjorndal and Zug, 1995). Although regional

Table 1. Simplified CITES and IUCN criteria and categories for assessing species threatened with extinction.

CITES Biological Criteria for inclusion in Appendix I

Species that meet, or are likely to meet, at least one of the following criteria (simplified)

A) A wild population is **small** *and* there is **decline** in the **population size or habitat size or quality**; *or* each sub-population is very small; *or* most of the individuals are concentrated in a single sub-population; *or* there are large fluctuations in population size; *or* there is high vulnerability due to the species' biology or behavior (e.g. migration), *OR*

B) A wild population has a **restricted area of distribution** *and* the distribution is fragmented; *or* there are large fluctuations in the area or number of sub-populations; *or* there is a decline in the population size or distribution or quality of habitat, *OR*

C) The **number of individuals** in the wild has declined, which has been observed or inferred as having occurred in the past; *or* inferred or projected on the basis of: decreased area or quality of habitat; *or* levels or patterns of exploitation; *or* threats from extrinsic factors (e.g., pathogens, parasites, introduced species, etc.); *or* there is a decreased reproductive potential, *OR*

D) The status of the species is such that if it isn't protected by inclusion in Appendix I, it is likely to satisfy one or more of the criteria within the following 5 years.

Definitions in CITES Criteria:
Decline — a guideline of 50% decrease in 5 years or 2 generations, whatever is longer; for small populations, a guideline of 20% in 10 years or 3 generations
Generation — average age of parents
Restricted area of distribution — guideline of 10,000 km^2 for smallest area essential for any life stage of the species

Criteria for the 1994 IUCN Red List Categories (simplified)
CR = critically endangered; EN = endangered; VU = vulnerable

A) Declining Population Size (past and/or projected), measured as changes in the numbers of mature individuals only
An observed, estimated, inferred or suspected reduction of at least X% over the last 10 years or three generations, whichever is the longer, based on either:
1) (a) direct observation; *or* (b) an index of abundance appropriate for the taxon; *or* (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat; *or* (d) actual or potential levels of exploitation; *or* (e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites *OR*
2) A reduction of at least X%, projected or suspected to be met within the next ten years or three generations, whichever is the longer, based on any of (b), (c), (d) *or* (e) above.
[values for: **X%- CR=80; EN=50; VU=20**]

B) **Small Geographic Distribution** *and* Decline, Fragmentation or Fluctuation. Population occurring in <X km^2 or occupying < Y km^2, *and* indications of any two of the following:
1) Severely fragmented or known to exist at only Z location(s).
Continuing decline, observed, inferred or projected, in any of the following: (a) extent of occurrence, or (b) area of occupancy, or (c) area, extent and/or quality of habitat, or (d) number of locations or subpopulations, or (e) number of mature individuals.
2) Extreme fluctuations in any of the following: (a) extent of occurrence, or (b) area of occupancy, or (c) number of locations or subpopulations, or (d) number of mature individuals.
[values for: **X km^2- CR=100; EN=5,000; VU=20,000 / Y km^2- CR=10; EN=500; VU=2,000 / Z loc.- CR=1; EN= ≤5; VU= ≤ 10**]

C) **Small Population Size** *and* Decline. Population estimated at < V mature individuals *and* either:
1) An estimated continuing decline of at least W% within X years or Y generation, whichever is longer *or*
2) A continuing decline in numbers of mature individuals and population structure in the form of either:
(a) severely fragmented (i.e. no subpopulation estimated to contain more than Z mature individuals), or (b) all individuals are in a single subpopulation.
[values for: **V** individuals - **CR=250; EN=2,500; VU=10,000** / values for: **W**% - **CR=25; EN=20; VU=10** / values for: **X** years - **CR=3; EN=5; VU=10** / values for: **Y** generations – **CR=1; EN=2 ; VU=3** / values for: **Z** individuals - **CR=50; EN=250; VU= 1,000**]

D) **Very Small Population** or **Very Restricted Distribution**. Population estimated to number < X mature individuals.
[values for: **X** ind.- **CR=50; EN=250; VU=1,000 or with acutely restricted area of occupancy**]

E) **Quantitative Analysis** (e.g., Population Viability Analysis). Quantitative analysis showing the probability of extinction in the wild is at least **X**% within **Y** years or **Z** generations whichever is the longer
[values for: **X%- CR=50; EN=20; VU=10** / values for: **Y** years and **Z** generations- **CR= 10 years or 3 generations; EN= 20 years or 5 generations VU= 100 years**]

Species are assessed against all possible criteria considered applicable for the available quantity and quality of data as well as the species' life history characteristics that best fit Criteria A - D. However, it is only sufficient for one category to be applicable for listing under one of the three "threatened" categories. Identification of category of risk (level of extinction risk) will depend on which threshold values for parameters in bold text best corresponds to the available information on the species.

Note: At the time of writing, the 1994 Categories are under revision by IUCN. However, since marine turtles are normally assessed under Criteria A and there the only major change is in the threshold for VU (to 30%) , the information is adequate for the purposes of this chapter assessments of age at maturity have not yet been undertaken, differences in growth rates among populations of the same species found in different ocean basins may also need to be taken into account when making assessments.

An assessment of the extinction risk for *Lepidochelys kempii* using the IUCN Red List Categories can best illustrate their application since this is a case where a time series spanning many decades is available. The species is the most seriously endangered of the sea turtles, having declined precipitously from the 1940s to the 1980s (Figure 1) and it has a distribution concentrated in the Gulf of Mexico (in contrast to global distributions for five of the other six species). For this species, the assessment can be performed using Criterion A (decline criteria) for data on the number nests laid annually.

The remaining parameter required for the assessment is the generation length for the species. When undertaking assessments, the MTSG has concluded that the most appropriate measure of generation length in marine turtles is age at sexual maturity plus half of reproductive longevity (Pianka, 1974). Using approximations for maturity of 11-16 years for this species and an estimate of reproductive longevity of about 11-15 years (observed in conservation programs for olive ridleys, *L. olivacea* [D. Rios-Olmeda, pers. comm.] and which is probably equally applicable to Kemp’s ridleys), 20 years is a reasonable estimate for one generation.

Observed trends in the estimated size of the annual breeding female population (Figure 1) can be compared to the Red List threshold decline rates. In spite of a dramatic 3-fold increase in nestings from 1986 to the present, the species has not yet recovered sufficiently to remove it from the Critically Endangered category.

Methodical monitoring of marine turtle nesting beaches did not begin until the 1950s in some areas, and not until the mid 1960s or even later is this information obtainable. In order to overcome limitations in the available scientific literature, historical accounts, trade data, and qualitative information need be considered to complement existing reports from modern nesting beach monitoring programs. This approach has been used for status assessments of hawksbills, green turtles, olive ridleys, and leatherbacks at a global level. In the case of the hawksbill, a species which has been scrutinized in recent years within the Wider Caribbean region, Meylan (1999) inferred the status of Caribbean hawksbill populations from a compilation of reports and various accounts, showing the species to be declining or depleted in the majority of areas for which some status and trend information was available (22 of the 26 countries or territories).

Measures of recovery

Though it is understandable that efforts at developing universally acceptable criteria have concentrated on extinction risk, it is no less important to have practical means with which to measure the success of conservation programs and ultimately “recovery”. In general, population recovery has been defined in terms of: reversing, stabilizing and increasing a formerly declining population; abatement, control or elimination of known threats; and stabilizing and guaranteeing the long-term protection of critical habitats.

Nonetheless, as with measurements of extinction risk, there is great utility in being able to gauge the recovery process to provide wildlife management authorities with benchmarks against which to measure advances made in their management and conservation programs. In the absence of adequate, clearly stated criteria, conservation actions can remain open-ended, with no clear objectives. To date, few national conservation programs for any species have included a formal analysis to identify recovery criteria and goals. The need to define these will become more urgent in the not so distant future as marine turtle conservation programs start to bear fruit, at least for some populations (e.g., as probably is the case for both Kemp´s ridleys and hawksbills in the Gulf of Mexico, see Márquez *et al.*, 1999 and Garduño *et al.*, 1999, respectively).

While an analysis of the mechanisms and processes underlying recovery is beyond the scope of this paper, a listing of criteria comparable in scope to those utilized for measuring risk of extinction is presented (Table II), derived largely from the Recovery Plans that the US National Marine Fisheries Service (NMFS) and the Fish and Wildlife Service (USFWS) have devised for marine turtle conservation programs in that country. Including

Determining distribution and status in marine turtles

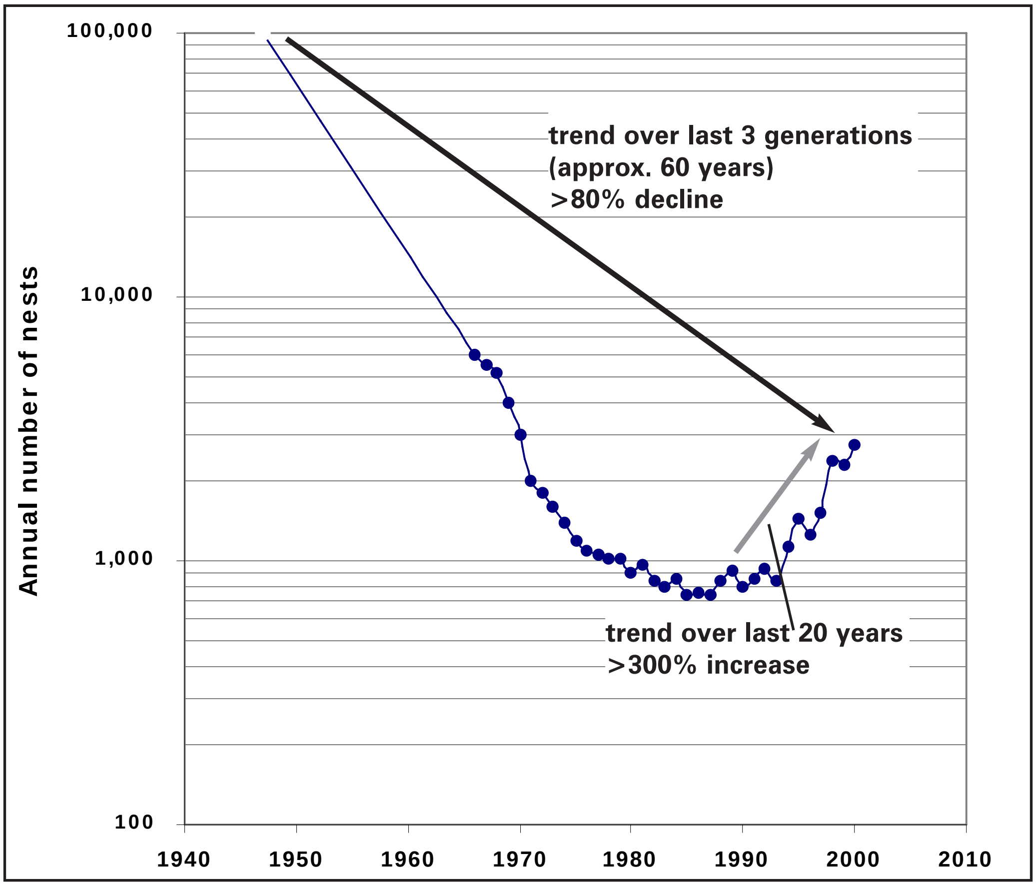

Figure 1. Long-term trends in the annual number of nests laid by *Lepidochelys kempii* 1947-2000. These records include information from 1947 of observed females (derived by Hildebrand (1963) from a 1947 film) and records from modern monitoring of annual numbers of nests (data from Márquez *et al.*, 1999). The 1947 record was converted to numbers of nests by multiplying the estimated number of nesting females by nesting frequency of 2.5 nests/female/season for the species (Turtle Expert Working Group, 1998). A three generation decline of >80% (equivalent to the IUCN *critically endangered* status) is not yet reversed by the very significant increases over the last 10 years.

this draft list should stimulate further discussions among sea turtle specialists, national and international resource managers, as well as NGO's, with the aim of developing them into a universally accepted set of criteria to define recovery, under a similar scheme to what is available for species' extinction risk assessments. It should be noted that besides including criteria for demographic parameters (population sizes, trends, etc.), considerations are also necessary that gauge improvements in management capabilities such as threat control and presence of national and international management schemes.

While goals for desirable population size should figure prominently in any recovery criteria, questions stemming from current debates on this issue need to be addressed. What level of recovery should be aimed for and can it be known which levels are necessary to restore full ecological functioning to depleted marine turtle populations? Is it desirable or practical to aim at recovering historical population sizes of marine turtles? Alternatively, if

Table 2. Some criteria useful in determining population recovery in marine turtles

(largely based on US Recovery Plans for marine turtles, e.g., NMFS and USFWS, 1998)

A species or population could be considered "recovered" if it meets the following criteria:

A) Knowledge

- Individual stocks and migratory routes of populations are known and the natal origin of each stock has been identified
- Natal origin of each stock has been identified
- Most important foraging sites have been identified

B) Habitat integrity and stock productivity

- Adequate protection is in place at key foraging areas
- Protection of size and quality of nesting habitat for at least **50%** of the known sites is guaranteed in perpetuity
- Hatching recruitment into the marine environment is stabilized at above **75%** of eggs laid in key nesting beaches

C) Size of Populations

- Numbers of annually nesting females at key source beaches for the identified stocks are either stable or increasing for at least **1 generation**
- Each stock reaches and maintains a sufficiently large average annual nesting female population size that it will be biologically reasonable that it can remain a stable population in perpetuity [e.g., **10,000** (*Lepidochelys kempii*)] over a period of at least **six** years
- Foraging populations show statistically significant increases (or stability) at key foraging grounds within each stock region for at least 5-10 years (time scale necessary to derive a robust estimate of trends; see Kerr, this volume)

D) Management capabilities

- A management plan based on mechanisms that guarantee sustained populations for turtles is in effect
- All sources of threat (including bycatch) have been identified, and their impacts controlled to levels not affecting the intrinsic rate of increase of the species
- International agreements are in place for adequate conservation and management of shared stocks

Author's note: terms in bold are guidelines for possible values, based on usage by NMFS/USFWS marine turtle recovery plans which would need to be adjusted to characteristics of specific marine turtle stocks, or will require further clarification. Periods of time for key parameters (e.g., for foraging populations) that have not been analyzed have been left as tentative values.

declines in populations can be arrested or stabilized, should population sizes below historical levels be acceptable, given the probably diminished carrying capacity of the present-day environments and/or the existence of limited harvests of marine turtles?

Answers to these questions by scientists and resource managers are becoming more urgent as demands upon the natural resources increase. These issues need to be debated widely to reach consensus before decisions on alternative conservation or management schemes can become accepted, particularly if these are to occur at a regional scale. Yet, whichever management policy is selected, adequate benchmarks and monitoring over time scales appropriate to the biological characteristics of marine turtles are also needed to obtain universally acceptable status assessments of individual populations that are shared among the countries in a region.

Conclusions

Since marine turtle populations form discrete demographic entities, genetically isolated from other populations, major research efforts on the species in the Wider Caribbean region should focus on identifying individual stocks, and determining their distribution and migratory behavior.

Once individual stocks are identified, extinction and recovery status assessments of each stock should be promoted, taking into account that because of migratory patterns, information and analysis will need to involve collaboration among many countries within the Wider Caribbean region.

Until long-term monitoring data accumulate for periods beyond a single generation, status assessments will continue to rely on direct and indirect evidence of past abundance of marine turtles.

Universally accepted criteria for assessing population recovery need to be developed, based on the best available knowledge of the recovery process in marine turtles. These criteria should become an essential guideline for national and international resource management policy-making with which to monitor improvements in the status of individual stocks, particularly those that are shared among many range states.

Although providing essential information, extinction risk and recovery assessments will not by themselves be sufficient to define conservation and management priorities. Other factors that will need to be incorporated into the resource management decision process include cultural and economic values, as well as international commitments.

Literature Cited

Alvarado, J. and T.M. Murphy. 1999. Nesting Periodicity and Internesting Behavior. Pp. 115-118. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, M. Donnelly (Eds.) Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Baillie, J. and B. Groombridge. 1996. 1996 IUCN Red List of Threatened Animals. World Conservation Union (IUCN), Gland, Switzerland. 368 pp. + annexes.

Bass, A. L., D. A. Good, K. A. Bjorndal, J. I. Richardson, Z.-M. Hillis, J. Horrocks, and B. W. Bowen. 1996. Testing models of female migratory behavior and population structure in the Caribbean hawksbill turtle, *Eretmochelys imbricata*, with mtDNA control region sequences. Mol. Ecol. 5:321-328.

Bjorndal, K.A. and G. Zug. 1995. Growth and age of sea turtles. Pp. 599-600. *In*: K.A. Bjorndal (Ed.) The Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press, Washington, D.C. 619 pp.

Boulon, R., Jr. 1994. Growth rates of wild juvenile hawksbill turtles, *Eretmochelys imbricata*, in St. Thomas. U.S. Virgin Islands. Copeia 1994(3): 811-814.

Bowen, B. W. 1995. Tracking marine turtles with genetic markers. BioScience 45:528-534.

Bowen, B.W., A.L. Bass, A. García-Rodríguez, C.E. Diez, R. van Dam, A. Bolten, K.A. Bjorndal, M.M. Miyamoto and R.J. Ferl. 1996. Origin of hawksbill turtles (*Eretmochelys imbricata*) in a Caribbean feeding area as indicated by mitochondrial DNA sequence analysis. Ecol. Appl. (6) 566.

Briseño-Dueñas, R. and F.A. Abreu-Grobois, 1999. Databases. Pp. 94-100 *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, M. Donnelly (Eds.) Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Congdon, J.D, Dunham, A.E., and van Loben Sels, R.C. 1993. Delayed sexual maturity and demographics of Blanding's turtles (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. Conserv. Biol. 7:826-833

Diario Oficial de la Federación. 1994. Norma Oficial Mexicana NOM-ECOL-059-1994 que determina las especies y subespecies de flora y fauna silvestres terrestres y acuáticas en peligro de extinción, amenazadas, raras y las sujetas a protección especial, y que establece especificaciones para su protección. DOF Tomo CDLXXXVIII No. 10. 16 de mayo de 1994. (can be found at http://www.ine.gob.mx/ dgra/normas/rec_nat/no_059.htm)

Diez, C. E. and J. A. Ottenwalder. 1999. Habitat Surveys. Pp. 41-44. *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Diaz-Fernández, R., T. Okayama, T. Uchiyama, E. Carrillo, G. Espinosa, R. Márquez, C. Diez, and H. Koike. Genetic sourcing for the hawksbill turtle, *Eretmochelys* *imbricata*, in the Northern Caribbean Region. Chelonian Conservation and Biology 3(2): 296-300.

Eckert, S. A. 1999. Data Acquisition Systems for Monitoring Sea Turtle Behavior and Physiology. Pp. 88-93. *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Encalada, S.E., P.N. Lahanas, K.A. Bjorndal, A.B. Bolten, M.M. Miyamoto and B.W. Bowen. 1996. Phylogeography and population structure of the Atlantic and Mediterranean green turtle *Chelonia mydas*: a mitochondrial DNA control region sequence assessment. Molecular Ecology 5: 473-483.

Endangered Species Act USA. 1973. (http://www.nmfs.noaa.gov/prot_res/laws/ESA/esatext/ sacont.html)

FitzSimmons, N., C. Moritz and B. W. Bowen. 1999. Population Identification. Pp. 72-79. *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Gärdenfors, U., J. P. Rodríguez, C. Hilton-Taylor, C. Hyslop, G. Mace, S. Molur, and S. Poss. 1999. Draft Guidelines for the Application of IUCN Red List Criteria at National and Regional Levels. IUCN Species Survival Commission. (http://www.iucn.org/themes/ssc/RAguidelinesfinal.htm)

Garduño, M., V. Guzmán, E. Miranda, R. Briseño-Dueñas, and F. A. Abreu-Grobois. 1999. Increases in hawksbill turtle (*Eretmochelys imbricata*) nestings in the Yucatan Peninsula, Mexico 1977-1996: Data in support of successful conservation? Chelonian Conservation andBiology 1999 (3)2:286-295.

Groombridge, B. and R. Luxmoore. 1989. The green turtle and hawksbill (Reptilia: Cheloniidae): World status, exploitation and trade. Lausanne, Switzerland. CITES Secretariat. 601 pp.

Hildebrand, H. H. 1963. Hallazgo del área de anidación de la tortuga marina "lora" *Lepidochelys kempi* (Garman), en la costa occidental del Golfo de México. Sobretiro de Ciencia, México 22:105-112.

IUCN. 1994. IUCN Red List Categories. Prepared by the IUCN Species Survival Commission. IUCN, Gland, Switzerland. (iucn.org/themes/ssc/redlists/ssc-rl-c.htm)

Limpus, C.J. 1992. The hawksbill turtle, *Eretmochelys imbricata*, in Queensland: population structure within a southern Great Barrier Reef feeding ground. Wildl. Res. 19:489-506.

Márquez, R.M., 1994. Sinopsis de datos biológicos sobre la tortuga lora, *Lepidochelys kempii* (Garman, 1880). Instituto Nacional de la Pesca. México FAO. SAST-Tortuga Lora. 5.31(07)016.02, INP/S152:141pp.

Márquez M., R., J. Díaz, M. Sánchez, P. Burchfield, A. Leo, M. Carrasco, J. Peña, C. Jimenez and R. Bravo. 1999. Results of the Kemp's ridley Nesting Beach Conservation Efforts in México. Marine Turtle Newsletter 85:2-4.

Meylan, A.B. 1995. Estimation of population size in sea turtles. Pp. 135-138. *In*: K.A. Bjorndal (Ed.) The Biology and Conservation of Sea Turtles, Revised Edition. Smithsonian Institution Press, Washington, D.C.

Meylan, A.B. 1999. Status of the hawksbill turtle (*Eretmochelys imbricata*) in the Caribbean region. Chelonian Conservation and Biology 3(2): 177-184.

Meylan, A.B. and M. Donnelly. 1999. Status justification for listing the hawksbill turtle (*Eretmochelys imbricata*) as Critically Endangered on the 1996 *IUCN Red List of Threatened Animals.* Chelonian Conservation and Biology 3(2): 200-224.

Mortimer, J.A. and R. Bresson. 1999. Temporal distribution and periodicity in hawksbill turtles (*Eretmochelys imbricata*) nesting at Cousin Island, Republic of Seychelles, 1971-1997. Chelonian Conservation and Biology 3(2): 318-325.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the Loggerhead Turtle (*Caretta caretta*). National Marine Fisheries Service, Silver Spring, MD.

Pianka, E.R. 1974. Evolutionary Ecology. Harper and Row, New York. 356 pp.

Pritchard, P. C. H. and J.A. Mortimer. 1999. Taxonomy, External Morphology, and Species Identification. Pp 21-38 *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Schroeder, B. and S. Murphy. 1999. Population Surveys (Ground and Aerial) on Nesting Beaches. Pp. 45-55. *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group

Publication No. 4.

Tambiah, C. 1999. Interviews and Market Surveys. Pp. 156-163. *In:* Eckert, K. L., K. A. Bjorndal, F. A. Abreu-Grobois, and M. Donnelly (Editors). Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Turtle Expert Working Group. 1998. An assessment of the Kemp's ridley (*Lepidochelys kempii*) and loggerhead (*Caretta caretta*) sea turtle populations in the Western North Atlantic. NOAA Technical Memorandum NMFS-SEFSC-409. 96 pp.

Zug, G. R., H.J. Kalb, and S.J. Luzar. 1997. Age and growth in wild Kemp's ridley sea turtles *Lepidochelys kempii* from skeletochronological data. Biological Conservation 80(3): 261-268

Monitoring Population Trends

Rhema Kerr Bjorkland
Wider Caribbean Sea Turtle Conservation Network (WIDECAST)
Jamaica

As resource managers, scientists and conservationists, a considerable portion of our professional effort relates to population monitoring and assessment. The reasons for population monitoring are readily obvious and include the need to increase general knowledge, provide baseline data for management intervention, evaluate the success of management action, and inform general decision-making. This presentation will suggest a framework for developing a successful marine turtle population monitoring program.

One fundamental aspect of the assessment and monitoring of wildlife populations is an assessment of population trends. It is useful to begin discussing this topic by revisiting a definition. The Oxford Dictionary defines "trend" as "a general direction and tendency, to bend or turn away in a specified direction, or to be chiefly directed." We are therefore seeking to determine directions and tendencies in the population of interest.

To be informed as to whether a population is "in recovery" or is "recovered" is a desired landmark for managers and policy-makers**.** In order to reach this landmark, it is necessary to establish recovery criteria. There is some relativity to this. We could, for example, define "recovery" in terms of restoration to pre-Colombian population sizes. That would be a valid benchmark, but not a realistic one from an ecological or socio-political standpoint.

Sea Turtle Recovery Plans developed by federal agencies in the USA provide examples of recovery criteria; for example, "The U.S. populations of hawksbill turtles can be considered for delisting if, over a period of 25 years, the following conditions are met: (i) the adult female population is increasing, as evidenced by a statistically significant trend in the annual number of nests on at least five Index Beaches, including Mona Island and the Buck Island Reef National Monument; (ii) habitat for at least 50% of the nesting activity that occurs in the USVI and Puerto Rico is protected in perpetuity; (iii) numbers of adults, subadults, and juveniles are increasing, as evidenced by a statistically significant trend on at least five key foraging areas within Puerto Rico, USVI, and Florida; and (iv) all Priority I tasks have been successfully implemented." (NMFS-FWS, 1993).

Other examples of recovery criteria are provided by the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) in its Caribbean recovery action plan series. For example, our draft *WIDECAST Sea Turtle Recovery Action Plan for Jamaica* recommends a "…. statistically significant rising trend in nesting populations over one generation, for all three [locally occurring] species" (Sutton et al., in prep.). As we heard in the species assessments yesterday, maturation requires one to several decades, depending on the species.

We [in Jamaica] have not yet developed target criteria for our foraging assemblages, nor have we moved beyond measuring "population recovery" by a single demographic parameter, typically annual estimates of the number of nesting females. This is an important point, because criteria based solely on the abundance of reproductively active females inevitably results in less available information for adaptive management than if other life stages (e.g., foraging juveniles) had been included in the assessment.

If a population is to be manipulated, either for conservation purposes or for sustainable harvest, additional criteria must be met. Indeed, most population models require age or size-specific growth rates, age (size) structure for all life stages, and other complex inputs.

Given the challenges posed to researchers by the marine, migratory and long-lived nature of marine turtle life history, there is a corresponding lack of real-world data to feed into population models. For example, long-term monitoring of adult populations on their foraging grounds (for the purpose of estimating demographic parameters) is not feasible for most marine turtle programs. As a consequence, we recognize that many if not most management

Table 1.
Comparison of accessibility (for purposes of research and monitoring) of population segment or life history stage, by species. 1 = practically inaccessible to 5 = readily accessible. Cc = loggerhead turtle; Cm = green turtle; Dc = leatherback turtle; Ei = hawksbill turtle; Lk = Kemp's ridley turtle; and Lo = olive ridley turtle.

Population Segment	***Species***					
	Cc	*Cm*	*Dc*	*Ei*	*Lk*	*Lo*
Nesting females (terrestrial) at sea	5	5	5	4	5	5
Large juveniles and adults at sea	3	3	1	2	4	4
Small juveniles	5	5	1	5	5	5
Pelagic neonates	1	1	1	1	1	1
Eggs and/or hatchlings	5	5	5	5	5	5

decisions will continue to be made using less-than-complete-data and will mostly likely focus on estimating changes in population parameters.

In the design and implementation of surveys and monitoring programs, conservationists and managers are constrained by human and monetary resources, as well as by the need for timely results. Monitoring programs reflect a trade-off between the accessibility of the target species and the timeline required to determine a significant trend in the various demographic parameters (abundance, recruitment, and survival/mortality). Because of their accessibility, gravid females on nesting beaches have been the mainstay of research and monitoring programs worldwide. However, slow growth and delayed maturation combine with stochastic variation in the annual number of females coming ashore to create time frames for trend analysis (annual survival, recruitment) that extend into decades. The time frame for parameter estimation and trend analysis is, by definition, much shorter for earlier life stages. Table 1 compares life stage

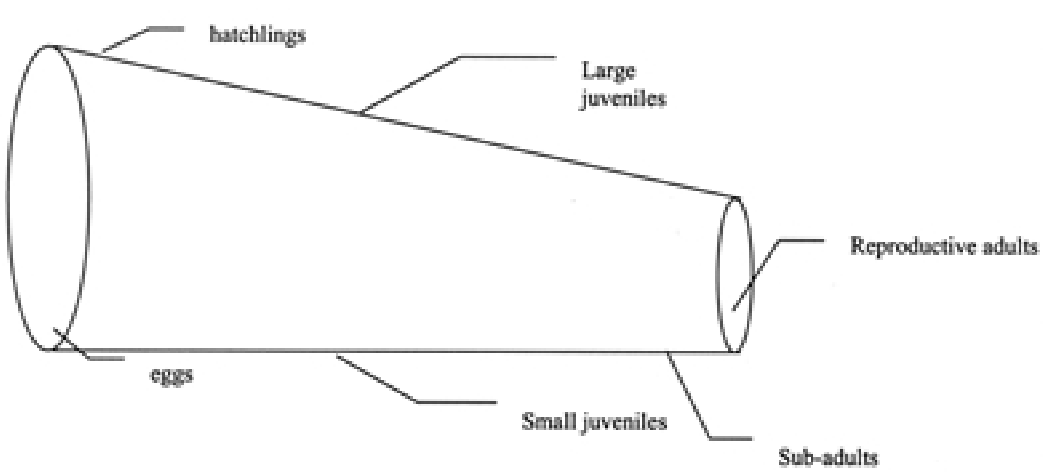

Figure 1. The Pipeline Concet

Table 2. For each "readily-accessible" life history stage (see Table 1), the minimum time frame required for parameter estimation is followed by the minimum time frame required for trend analysis in parentheses. These time frames are "floating" targets, as detecting a trend depends on abundance and the number of points (i.e., length of time), as well as the precision of the estimates. The time frames suggested here are loosely based on data from intense monitoring efforts emphasizing saturation tagging. An asterisk indicates that the "trend" for that parameter is at least 2 point-estimates that each cover the minimum suggested time frame or longer; i.e., an estimate based on 8-10 years of data will be one point in a linear regression. With fewer than five points, the power associated with any statistical tests may be low (see Gerrodette, 1987, 1993).

Parameter	*Nesting females*	*Juveniles*	*Eggs and Hatchlings*
Abundance	3-5 yr (1 generation)	1-3 yr (5 yr)	3-5 yr (3 yr)
Recruitment	4-5 yr (8-10 yr)*	3-5 yr (5-10 yr)	N/a (no prior stage to recruit from)
Annual survival	8-10 yr (8-10 yr)*	3-5 yr (5-10 yr)	N/a (hatchlings disperse to pelagic zones)

accessibility for the six Wider Caribbean species. Table 2 compares the time frame for parameter estimation and trend analysis for the various life stages. We can see from these tables that monitoring juveniles should receive increased priority from a management and policy-making standpoint.

If we visualize marine turtle life history as a pipeline (Figure 1) which "begins" with eggs laid on a nesting beach and "ends" with gravid females coming ashore to nest, the "lag" time in seeing credible results from nesting beach-based population monitoring programs is better appreciated. To expand on the pipeline concept, which is a modification of a concept first introduced by Mortimer (1995), consider the scenario of a newly protected nesting beach. Very soon we would expect to see a rising trend in successful hatchling production. Barring serious threats to neonates and small juveniles in early developmental habitats, increased hatchling production would lead, in a few years, to an increase in the number of juveniles recruited into coastal developmental habitats. Years and decades later we would anticipate an increase in larger juveniles and sub-adults. Finally, after as many as "10 to 50 or more years" (see Frazier, this volume), we might document an increase in gravid females emerging on to the nesting beach. To use nesting females as our recovery criteria is to use the life stage with the longest "turn-around time."

To improve (that is, to shorten) the timeline for obtaining quantifiable indices of recovery, we must place more emphasis on surveys and monitoring programs that extend beyond a single parameter (e.g., annual estimates of abundance) and a single life stage (e.g., mature females). In many Caribbean countries, monitoring small juveniles in neritic environments represents a positive trade-off between accessibility and a reasonable monitoring time frame (Table 3).

In summary, an *ideal* action plan for marine turtle population monitoring should logically include the following:

- estimate abundance (absolute or relative) of accessible life stages;
- estimate recruitment and survival rates for nesting females and small juveniles;

Table 3. Estimating key demographic parameters**.** An asterisk indicates that with populations of fewer than several hundred nesting females per year, saturation tagging may be required for accurate parameter estimations

	Nesting Females	*Small Juveniles*
Annual Survival	Tagging program 8 – 10 yr (*)	Tagging program 3-5 yr
Recruitment	Tagging program 4-5 yr (*)	Mark-recapture 3-5 yr
Reproductive Output	Nest counts 3-5 yr	X
Abundance	Tagging program with nest counts 3-5 yr	Tagging program 1-3yr

• estimate recruitment and survival rates for other accessible life stages, as practicable;

• estimate reproductive output (i.e., number of hatchlings per female per year);

• identify and quantify sources of mortality;

• identify the foraging grounds associated with local nesting stocks (such as by the use of satellite telemetry, tagging, genetic evaluation); and

• identify source beaches (natal beaches) for local foraging stocks.

The most successful monitoring programs will be those that are tailored to local circumstances and operate within local constraints of trained personnel, funding, infrastructure, and record-keeping capacity. Working to implement an action plan such as that described above will assist managers in the transition between the ideal and the real.

For additional information on this topic, please see Eckert et al. (1999), in particular the "Population and Habitat Assessment" chapters. In addition, Mortimer (1995), Conroy and Smith (1994) and Skalski (1990) are useful. Tim Gerrodette and John Brandon have made their software for power analysis of trends, TREND, available at http://mmdshare.ucsd.edu/trends/html

Literature Cited

Conroy, M. J. and D. R. Smith. 1994. Designing large scale surveys of wildlife abundance and diversity using statisitical sampling procedures. Trans. 59th North American Wildlife and Natural Resources Conference.

Eckert, K. L., K. A. Bjorndal, F. Alberto Abreu G. and M. Donnelly (eds.). 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Gerodette, T. 1987. A power analysis for detecting trends. Ecology 68(5):1364-1372.

Gerrodette, T. 1993. Trends: software for a power analysis of linear regression. Wildlife Society Bulletin 21:516-516.

Mortimer, J. 1995. Teaching critical concepts for the conservation of sea turtles. Marine Turtle Newsletter 71:1-4

NMFS-FWS [National Marine Fisheries Service - Fish and Wildlife Service]. 1993. Recovery Plan for Hawksbill Turtles in the U. S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service, U. S. Department of Commerce. St. Petersburg, Florida.

Skalski, J. R. 1990. A design for long-term status and trend monitoring. Journal of Environmental Management 30:139-144.

Sutton, A. H., R. Bjorkland, A. Donaldson and M. Hamilton. In prep: WIDECAST Sea Turtle Recovery Action Plan for Jamaica (K. L. Eckert, ed.). CEP Technical Report. UNEP Caribbean Environment Programme, Kingston, Jamaica.

Promoting Public Awareness and Community Involvement

Crispin d'Auvergne
Ministry of Finance and Planning
St. Lucia

Marine turtles have been around for a very long time, much longer than we have. Given the rate at which we seem to be perpetrating the demise of our planet, and ultimately ourselves, one wonders how much longer these graceful creatures will survive. I do not wish to linger on this sobering thought, but rather I wish to deal with the issues of public awareness and participation. All of these aspects are connected because, while we seem so able to jeopardize the survival of marine turtles, we still have so much to learn about their biology and ecology. Many stakeholders remain ignorant of current information that, if they had it at their disposal, might encourage them to make a positive difference.

Many youngsters growing up in St. Lucia today have never seen a turtle, living or dead. They may have seen posters and videos and have read about marine turtles, but that is about all. As recently as the early 1980's, marine turtles were a fairly common sight at St. Lucia's fish landing sites and in the Central Market. This situation has since changed. Today marine turtle meat, eggs, and other products are illegal commodities in St. Lucia due to a moratorium on the capture of all species.

Recent reports, unconfirmed by empirical studies, indicate that St. Lucia's marine turtle stocks are on the rise. Whether or not this is indeed the case, it cannot be concluded that the environment for the survival of marine turtles is ideal or improving. There is still illegal and accidental capture of marine turtles, and managers have no idea what our standing stocks are. Thus our efforts to establish sustainable levels of take are fruitless. Moreover, many nesting beaches have been degraded or destroyed by sand mining and foraging grounds have also been affected by human activity. Further, the fact that marine turtles are migratory means that they may be prone to capture in other countries.

The St. Lucia scenario is not unique in the Caribbean context. Despite cultural and other situational differences, we all grapple with many of the same problems. Where the status of marine turtles is concerned, all of us here today have some grasp of the problems as well as some ideas on how such problems should be resolved. If I identify one of the fundamental problems as a lack of awareness, I suspect, and hope, that most of you will agree with me. If my assertion is correct, then how can we address the issue?

I believe that we need to recognise first of all that people do not always feel compelled to learn about things which do not seem to affect their day-to-day existence. The young farmer in the hills, for example, who has never seen a turtle and has no expectation of eating turtle meat in her lifetime, will not necessarily be concerned about the status of marine turtles even though soil from her farm is destroying their foraging grounds. The turtle fisher, on the other hand, might be concerned as his livelihood is directly related to the sustained existence of the resource.

One of the primary objectives of any public awareness exercise, therefore, must be to create or to reinforce in the minds of people, the link between their existence and the issue(s) at hand. While this might appear to be obvious, many public awareness campaigns fail because they do not find the right means of creating the "link".

Another fundamental point to be remembered is that the target of the public awareness campaign is not necessarily a homogenous mass of people; indeed, there may be a number of target groups including policy-makers, resource users, management officials, educators (and pupils), and civic groups. Accordingly, the message and the mechanism(s) for delivery may both have to be fine-tuned to suit the respective groups. Booklets with useful biological information will not work for fishers who cannot read. Television will reach only those with access to television. Sometimes meetings with resource user groups or one-on-one interface with influential persons will succeed where other means fail. In some situations, popular theatre or the involvement of Church has been used to great effect.

We could embark on a lengthy discourse about the ins and outs of public awareness, but that is not the objective of this presentation. I will note, however, that while public awareness in and of itself is fine, ideally it should serve as a component of an education process which will result, where possible and necessary, in action or change in behaviour which will, in turn, help to address a specific problem. On the other hand, access to proper information in a timely manner is essential for effective participation. Therefore it can be concluded that public participation is dependent upon and reinforced by the availability of and access to adequate and appropriate information.

Who then, in our context, provides information? Who receives it? What systems exist for transmission? How can it be used to generate public participation? What are the opportunities for and constraints to public participation?

In many Caribbean territories, Government, through the Department of Fisheries or other agencies, is assigned the responsibility for marine turtle research and management. Consequently, much of the information on marine turtles, as well as relevant expertise, resides within these agencies. Over the years, however, many Caribbean territories have seen the growth of non-governmental organisations (NGOs); these bring additional expertise and resources to the issues. Many NGOs, whether working independently or in collaboration with Government, have been able to collect useful information. In St. Lucia, for example, the St. Lucia Naturalists' Society and the Department of Fisheries have collaborated on leatherback turtle research at Grande Anse Beach for many years.

Based on the above, the various government and non-government organisations are usually best placed to undertake public awareness activities due to the information and, hopefully, the resources at their disposal. In some instances, community-based organisations (CBOs) are also involved in a meaningful way in research and information gathering and they, too, can participate in public awareness activities. Further, the traditional knowledge of respective user groups must not be ignored but put to the best possible use when designing and implementing public awareness campaigns. Turtle fishermen, as an example, can be very influential in a classroom, or in sensitising their peers.

In the ideal situation, information flows dialectically between entities at all levels; that is, within and among Government, NGOs and CBOs. There should be a willingness to accept new information and not to become dogmatic, particularly at the Government level. If, as stated earlier, we seek to sensitise people in order to bring about change(s) in behaviour, we must endeavour to find out where change is most needed or feasible and focus on the agents most able to effect that change. Many argue that children should be the focus of environmental awareness efforts, as they will be tomorrow's resource custodians. This is a logical conclusion in most instances. Yet in a situation where an endangered species is being over-exploited, children may not have the chance to become custodians. Does one focus then, on the children, the hunters, the policy-makers, or all?

With respect to conservation issues in general and to marine turtles in particular, I can, using the St. Lucian context, provide some insight into the target audiences for public awareness, sensitisation and education.

1. **Policy-makers** at various levels decide, *inter alia*, what position the country takes on marine turtle conservation issues;
2. **Fishers** capture turtles and play a direct role in affecting the status of the resource;
3. The **media** plays a vital role, but in many cases needs to be further sensitised to environmental issues; to inform, they first must be informed;
4. **Teachers** teach others, especially children, and therefore they have an ongoing need for accurate information;
5. **NGOs** can often take on conservation issues which governments cannot or will not address. They are often a powerful force for advocacy, and their actions must, therefore, be guided by accurate information.
6. **CBOs** are usually more active at a local (community) level. They may have significant influence on community behaviour, but can

also stimulate action at the national level.

7. **Students** are the custodians of our future … and they also have a stake in the present!
8. The **general public** as a whole should be addressed, as well, and this calls for time and effort devoted to relatively generic public awareness strategies.

How do we reach our target audiences? There are a number of approaches that can be adopted, depending on the particular community or society.

While the mass media will continue to play a role in creating and maintaining awareness, nothing equals the effect of direct contact with the resource. For example, while slick videos and slide presentations can help to sensitise the general public about the status of marine turtles, participating in a successful turtle watch and seeing one's first leatherback turtle lays its eggs will have a more enduring impact. The same applies when one re-visits an important nesting beach and witnesses first hand the destructive efficiency of sand miners in reducing the beach to a pathetic shadow of its former magnificence.

The potential impact of direct contact is heightened if the experience is presented as part of a comprehensive and ongoing process of awareness building and education. In this regard, I wish to list just a few approaches that could prove useful in many Caribbean countries where marine turtle conservation is concerned.

Training of teachers to impart relevant information through the school curriculum. Anyone who has had any teaching experience knows how difficult it is to introduce a new subject into the already packed school curriculum, whether it be Family Life Education, Drug Awareness, or Environmental Education. The most realistic option, then, is to infuse issues into existing subjects such as Math, Social Studies and so on. Teachers should be formally trained and provided with relevant background information. In this way they become equipped to pass on knowledge to a continuous stream of students. This has been tried in St. Lucia through the Learning for Environmental Action Project (LEAP). There has been some success, but there is need for continued support and follow-up.

Training of relevant Government and NGO personnel in public awareness and environmental education. This approach will assist those in our community who have the technical expertise (for natural resource management) in selecting the right "tools" for reaching their target audiences.

Collaboration and co-ordination on public awareness and education between agencies and organizations. Many organizations may be involved in such activities, but may be working independently and even duplicating effort. Wherever feasible, avenues for effective collaboration should be explored. In St. Lucia, a number of agencies are discussing the possibility of forming a national environmental education network. A coalition approach suggests a more efficient use of human and monetary resources, and the opportunity to reach a larger audience.

Establishment of accessible information databases. Consideration can be given to establishing "Sea Turtle Information" sections in school and public libraries, as well as in the offices of relevant government and non-governmental organizations. The public availability of such information should be widely advertised.

Utilising the Internet for information gathering and networking. The Internet is becoming available to more and more schools, agencies and private individuals every day and it can serve as a useful tool for information gathering and for networking at the local, regional and international levels.

I must stress, again, that the foregoing list is by no means exhaustive and a little thought and imagination can generate many more useful approaches.

Now let us assume for a moment that our public awareness and education strategies are beginning to bear fruit. People want to make a change. What can they do? Who are the agents of action?

Many of the entities and audiences mentioned above can become directly involved in conservation and resource management. Throughout the Caribbean, NGOs, CBOs, school clubs and similar bodies participate in (and often instigate and organise) turtle watches, beach patrols and related activities.

Increasingly, we hear tell of former poachers turned wardens and stewards.

In some instances, community-based monitoring is the only feasible option because the resources of the "official" state entities are unable to service these areas. In other instances there is a healthy collaboration between Government and NGO or CBO partners. In St. Lucia, the St. Lucia Naturalists' Society (SLNS), the Department of Fisheries, and the Forest and Lands Department work together to monitor leatherback turtle nesting at Grande Anse Beach. Fisheries and Forestry offices provide transportation and logistical support, while the SLNS provides manpower and equipment. The effort is presently expanding in an attempt to involve neighbouring communities, and more work needs to be done in this regard. This is especially important as the poaching which takes place at Grande Anse is mainly the work of illegal sand miners residing in the wider area.

In terms of getting wider public support, one approach that worked well in St. Lucia in the 1980s was to ask members of the public to report turtle sightings at sea or onshore. Persons from all walks of life called the Department of Fisheries, and the data compiled eventually contributed substantively to what is now the Sea Turtle Recovery Action Plan for St. Lucia (d'Auvergne and Eckert, 1993).

In closing, I believe that meaningful public participation depends on the following:

1. Interest groups have to be made to feel some sense of stewardship and responsibility for the resource;
2. Government agencies, where feasible, must encourage involvement by soliciting the participation of user and other interest groups; and
3. Relevant information must be exchanged freely among collaborating entities.

Of course, in all of this, it is helpful if there is some agreement on how the resource should be managed … or at least some degree of consensus that it should be managed at all. I am sure that we all would be happy to live in a world where we were managing our resources perfectly. However, we live in a complex world and we know that life is not that simple. We need all the help we can get to manage our marine turtles, indeed our planet. Awareness building will continue to be an essential tool in our effort.

Literature Cited

Byers, Bruce A. 1996. Understanding and Influencing Behaviours in Conservation and Natural Resources Management. African Biodiversity Series, No. 4. Biodiversity Support Program, Washington D.C. xv +125 pp.

d'Auvergne, C. and K. L. Eckert. 1993. WIDECAST Sea Turtle Recovery Action Plan for St. Lucia. CEP Technical Report No. 26. UNEP Caribbean Environment Programme, Kingston, Jamaica. xiv + 70 pp.

Williams, D, C. d'Auvergne and V. Charles. 1996 Perceptions of and attitudes towards the environment in Soufriere. USAID / OECS / GOSL / WWF ENCORE Project Report. Castries, St. Lucia.

Larsen, P., J. Cumberbatch, M. Fontaine and M. Nolan. 1998. The ENCORE Experience: Lessons Learned to Date. USAID/OECS/GOSL/WWF ENCORE Project Report. Washington, D.C.

Reducing Threats at Nesting Beaches

Barbara A. Schroeder
Office of Protected Resources
NOAA National Marine Fisheries Service
USA

Introduction

Despite the comparatively brief periods of time that marine turtles spend on land, these periods constitute critical stages of their life history. The threats that marine turtles face on their nesting beaches are many and varied. Given the enormous challenges in the marine environment that face scientists and managers, why should we be concerned about threats on nesting beaches? There are several reasons, such as (i) the vulnerability of marine turtles (nesting females, eggs, hatchlings) is extremely high on nesting beaches, (ii) human actions on nesting beaches, whether direct or indirect, can have catastrophic implications for marine turtle populations, and (iii) the long-term reproductive survival of marine turtles hinges on a thin strand of sandy beach. Without suitable, sufficient and "safe" nesting habitat, marine turtle populations are destined for collapse. A key ingredient in any program to recover and conserve marine turtles must include a strong nesting beach component of protection. In addition, conservation efforts on nesting beaches must go hand-in-hand with protection efforts in the marine environment.

Concern for protecting and conserving nesting beach habitat is not new. More than forty years ago, Dr. Archie Carr (1956), in his eloquent book "The Windward Road", wrote: "*There were hundreds of islands and keys and mainland beaches where nobody lived and where you could comfortably imagine thousands of safe nests erupting yearly multitudes of little turtles. But... the wild beaches are shrinking. The drain on nesting grounds is increasing by jumps. It is this drain that is hard to control, and it is this that will finish Chelonia*."

While Dr. Carr was speaking specifically about the green turtle, his words and concerns are all the more applicable today, to all species of marine turtles that inhabit the Wider Caribbean Region and to all nations that have the good fortune to harbor nesting sites. This paper will provide a review of the principal threats that face marine turtles at Caribbean nesting grounds. For additional information on this topic, interested readers should consult Witherington (1999) and Lutcavage et al. (1996). The recently published "Research and Management Techniques for the Conservation of Sea Turtles" (Eckert et al., 1999) explains standard protocols for beach assessment and monitoring and is a "must-have" for the development of assessment, monitoring, and management programs for marine turtles.

The key to solving problems on nesting beaches is to identify the threat(s) facing a particular population, assess the magnitude of these threat(s), and prioritize actions to ensure that effort and resources are focused in the most effective manner. Expending inordinate amounts of time, personnel, and/or funds addressing threats that have low impact on a population, while more serious threats go unchecked, hinders population recovery, depletes program funds, and frustrates personnel. Understanding the threats operating on nesting beaches requires careful survey and monitoring efforts during the nesting and hatching seasons; thus, an assessment of threats is the first step. Follow-up monitoring efforts are equally important in that they are required to evaluate the success of management action taken to reduce priority threats.

Witherington (1999) suggested four general approaches to minimizing threats on nesting beaches: (i) eliminate the threat, (ii) manage the threat, (iii) relocate eggs, or (iv) do nothing (some threats, such as chronic erosion, either cannot be eliminated or threaten too few nests to justify costly intervention). The preferred approach will vary depending on the specific situation and local conditions, but in general the least manipulative approach is preferred. Management actions that allow the nesting cycle (from egg-laying to hatchling emergence) to occur without direct human intervention should be the goal. Measures that require some level of manipulation (e.g., beach hatcheries) should be considered interim measures while efforts continue to solve underlying threats. Manipulative management measures are often costly, time consuming, and require high effort; thus, eliminating the source of the threat can be the most cost- and labor-effective in the long run.

Threats to marine turtles on their nesting beaches may generally be divided into two sources: natural and anthropogenic (human-induced). Anthropogenic threats may be direct (e.g., egg poaching) or indirect (e.g., artificial beachfront lighting). The following discussion will review the principal threats.

Managing Natural Threats

Depredation: Depredation of nesting females, eggs, and/or hatchlings, while generally considered a "natural threat", is often linked indirectly to human activity and the consequences of coastal development. For example, small mammals are a significant egg predator on some nesting beaches, largely because their populations are unnaturally high as a result of the creation of new and favorable habitat, access to human garbage, or the removal of top predators in the ecosystem. In a normally functioning ecosystem, natural predators are an integral part of the system; however, on some nesting beaches, depredation of nests can be so significant that steps must be taken to reduce this source of mortality. Highly successful techniques and programs have been implemented that reduce nest depredation, including the use of nest cages and screens that keep predators out while allowing egg clutches to incubate *in situ* and hatchlings to emerge unimpeded.

Storm Events: Episodic storm events that occur during the incubation period can expose and destroy incubating clutches or cover them with so much additional sand that hatchlings are prevented from emerging successfully. Storms can also alter beach profiles and deposit extensive debris, leaving the beach unsuitable for successful nesting. These naturally occurring events are unpredictable and little can be done to prevent ensuing damage. Some managers have suggested that relocating nests to a safer (more stable) beach site provides assurance that storms will not affect nest success, but manipulative intervention can introduce unacceptable risks (e.g., high cost and maintenance, lowered hatch success), especially when the probability of a catastrophic event is comparatively low.

Beach Erosion and Accretion: Nesting beaches are dynamic and undergo physical changes on a regular basis, irrespective of major storm events. Over time some nesting beaches may naturally erode, while others accrete. Marine turtles have evolved to successfully adjust to these changes, provided the changes are not exacerbated or accelerated as a result of human alterations to the beach dune system (see discussion to follow). When human intervention is deemed necessary, under certain local conditions, to safeguard nests from erosion or accretion, the least manipulative option is generally preferred.

Managing Anthropogenic Threats (Direct)

Poaching: Illegal poaching of nesting females and/or eggs can devastate a local marine turtle population and contribute to range-wide depletion. Important strides have been made in addressing this threat in some range states, but poaching remains a serious problem in many places throughout the Wider Caribbean Region. Public outreach and education, community participation in management and recovery programs, and effective law enforcement all contribute to a successful strategy to reduce and eliminate this serious and ubiquitous threat.

Managing Anthropogenic Threats (Indirect)

Virtually all indirect, human-induced threats to turtles on their nesting beaches are intricately related to coastal development. Not only do the vast majority of Caribbean people live on or near the coast, but tourism especially targets coastal areas. The potentially negative impacts to marine turtles of coastal development must be taken seriously and should be addressed in any comprehensive plan for species conservation and recovery.

Beach Erosion: As discussed above, beach erosion is a natural process and part of the dynamic coastal system. As part of a naturally functioning system, beach erosion does not pose significant long-term negative effects to turtles. However, human alterations of the landscape can alter the coastline such that beach erosion is exacerbated and nesting beach habitat is degraded or destroyed. The dredging of natural inlets and the creation and maintenance of man-made inlets to allow deep water vessel access, for example, can significantly alter normal littoral sand transport processes and result in serious erosion at nesting beaches (Kaufman and Pilkey, 1983; Pilkey and Dixon, 1996). Placement of structures on, or in close proximity to, beach frontage can destroy the ability of the beach to respond to normal erosion/accretion cycles and storm events, and ultimately degrades and destroys nesting habitat as well as sandy beach habitat enjoyed by humans.

Coastal zoning that carefully considers the full range of impacts resulting from coastal development is urgently needed throughout the Wider Caribbean Region (and the world). Important lessons can be learned from poorly planned coastal development, and a policy of retreat from the shoreline (often referred to as construction setbacks) should be among those options most seriously considered to repair damage to coastal areas.

Beach Armoring: Armoring consists of a wide variety of hard or semi-hard structures (e.g., concrete or wood seawalls, rock revetments, steel sheet pile walls, sandbags) that are designed to protect upland property from wave force and water damage. In many areas, especially heavily developed areas, armoring is proliferating unchecked and the results are devastating for nesting turtles. Armoring structures block access to suitable nesting habitat, prevent the beach system from functioning properly and, under the most serious conditions, destroy all dry sandy beach. The impacts of coastal armoring structures on marine turtle nesting behavior are serious and include decreased nesting attempts and decreased nesting success (e.g., Mosier, 1999). From a long-term perspective, coastal armoring may be the most grave indirect threat facing marine turtles on nesting beaches. More thoughtful coastal planning that takes into account all users of the beach system, not simply those who own beachfront property, is urgently needed.

Artificial Beach Nourishment: A common practice in highly developed areas, beach nourishment consists of the placement of sand, through mechanical means, on eroded beaches. Sand sources may be from upland sites, dredged inlet material, or offshore "borrow" sites. Sand characteristics are critically important to successful marine turtle nesting, and subtle alterations of the natural nest environment can result in decreased nesting success (i.e., a decline in the number of nests laid), decreased nest success (i.e., a decline in the number of successfully emerging hatchlings), skewed hatchling sex ratios, and decreased hatchling fitness (see Ackerman, 1996; Foley, 1998). In addition to the environmental costs, beach nourishment projects are expensive and must be repeated regularly to maintain the artificially created shoreline. Conducting beach nourishment projects during nesting and hatching seasons is especially harmful to local populations. Despite nest relocation efforts in advance of nourishment projects, some nests are invariably missed and the risks (e.g., decreased hatch success) associated with egg relocation must be taken into consideration.

It should also be noted that the removal of nearshore and/or upland sand is not without broader ecological consequences. As more readily accessible sand sources are depleted, the search for sand widens, making projects more costly and widening the sphere of ecological concerns. Thoughtful, long-term coastal planning that obviates the need for perpetual beach nourishment should be among the goals of an integrated plan for species conservation and recovery.

Sand Mining: Sand mining is the opposite of beach nourishment and involves the deliberate mining of beach sand for use in construction (e.g., concrete production). According to UNEP (1989), "Sand mining is a predominant cause of beach and dune destruction throughout much of the insular Caribbean." The removal of beach sand destroys the functioning beach-dune ecosystem, exacerbates erosion, and can directly destroy incubating egg clutches. Sand mining can alter beach profiles which may lead to the intrusion of saltwater into incubating nests and result in escarpments that prevent nesting turtles from accessing suitable nesting sites. Sand mining on marine turtle nesting beaches is a chronic problem at many sites in the Wider

Caribbean Region and has degraded or destroyed once valuable nesting areas (see Eckert, 1995). Beach sand mining is incompatible with successful marine turtle nesting.

Artificial Beachfront Lighting: As coastal areas are developed, structures are lighted. Once remote areas now have ready access to electrical power. The negative effects of artificial lighting on nesting females and their emergent hatchlings have been well documented to include reduced nesting success and, most seriously, modifications to the sea-finding behavior of hatchlings (Witherington, 1992; Witherington and Bjorndal, 1991). Lighted beaches have catastrophic consequences for tens of thousands of hatchlings each year, and can significantly reduce hatchling productivity across large stretches of suitable nesting habitat. Fortunately, among anthropogenic threats, artificial lighting is one of the most easily solved. Witherington and Martin (2000) provide a comprehensive review of the problem and provide a wide-range of solutions. These solutions have been used with excellent success at many nesting beaches. Sky-glow caused by the cumulative effects of thousands of inland light sources not directly visible from the nesting beach is a more complex problem and one that has yet to be adequately addressed.

Beach Cleaning and Vehicle Use on Beaches: Beach cleaning often involves the use of mechanized machinery to remove both human garbage and natural materials from the beach. The use of mechanized beach cleaning vehicles, as well as driving on beaches for other purposes, can directly damage incubating egg clutches or pre-emergent hatchlings, create tire ruts that impede the movement of hatchlings from nest to ocean, and/or directly kill emergent hatchlings traversing the beach (Hosier et al., 1981; Cox et al., 1994). The removal of human-generated garbage from nesting beaches should be done by hand whenever practicable. Removal of natural materials from the beach (e.g., seaweed) should not be a matter of routine practice, as these materials serve important roles in the beach ecosystem and provide food and cover for other species that share the beach, such as shorebirds and invertebrates. Driving on nesting beaches should be limited to emergency situations only, and should be confined to the lowest portions of the beach, away from incubating nests.

Increased Human Presence: The development of coastal areas brings human activity to the beach and can both negatively and positively affect marine turtles. Uncontrolled human activity can deter nesting females, cause aborted nesting attempts, and the use of lights can lead hatchlings astray. Recreational beach equipment (e.g., beach chairs) can block access to nesting sites, impede hatchlings, and trap nesting females. On the other hand, increased human presence may deter poaching and may provide for more accurate monitoring and protection. Organized, ecotourism-oriented “turtle watches” can bring heightened awareness of marine turtles to coastal communities and serve as a source of income, underscoring the value of live turtles and the value of protecting nesting beaches. It is important that this aspect of ecotourism be carefully planned to ensure that it does not interfere with nesting activity. Local communities should strive to develop measures that protect turtles while at the same time educate, inform, and galvanize public support for their long-term conservation.

Oil Spills: Nesting females, incubating eggs, and emergent hatchlings can all be exposed to oil that reaches nesting beaches. Lutcavage et al. (1995) provide a review of the effects of oil on loggerhead turtles (*Caretta caretta*). While some nations have developed oil spill response plans, an integrated response plan is needed throughout the Wider Caribbean Region. The catastrophic effects of a large-scale oil spill may be unthinkable, yet the probability that such an event may occur cannot be ruled out. We must be prepared to rapidly mobilize, act, and provide whatever assistance is necessary when the time comes. Most Wider Caribbean governments are Contracting Parties to UNEP’s “Protocol Concerning Co-operation in Combating Oil Spills” to the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region (‘Cartagena Convention’) (see Andrade, this volume).

Summary

It should be clear from this overview, as well as that provided by Horrocks (this volume), that the challenges facing managers concerned with marine turtle recovery and conservation are numerous and complex. Ensuring the survival of marine turtles in the Wider Caribbean Region will require genuine cooperation within and among nations. I would like to suggest the following reasons why it is important to have a shared vision and a plan of action for protecting marine turtle nesting beaches:

- Nesting females exhibit strong nest site fidelity; a short-term ability on the part of nesting females to shift nesting sites as their natal beaches are degraded or destroyed should not be assumed.
- Each nesting beach produces turtles that are eventually shared (in non-breeding habitats) by many other nations. Hatchlings produced in one nation become immature and adult turtles that inhabit the waters of one or more other nations, and they form an integral part of the regional ecosystem.
- Nesting habitat, once destroyed, can oftentimes be impossible to restore, and with its destruction may come dire consequences to the human economy.
- Catastrophic events on a subregional scale may affect nesting habitat and reduce nesting success for one or many years, thus emphasizing the value of a mosaic of healthy, intact nesting habitats.

While significant progress has been made in addressing some of the identified threats on nesting beaches, more work is clearly ahead of us to ensure the recovery and long-term survival of marine turtles in areas where they have been seriously depleted. We must work both regionally and domestically to ensure that sufficient nesting habitat remains intact and protected for the long-term future. A unified strategy and range-wide attention to reducing nesting beach threats must occur in order to recover the depleted populations of marine turtles in the Wider Caribbean Region.

Literature Cited

Ackerman, R. A. 1996. The nest environment and the embryonic development of sea turtles, p.83-106. *In:* P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Carr, A. 1956. The Windward Road. Alfred Knopf, Inc., New York, New York. 258 pp.

Cox, J. H., H. F. Percival and S. V. Colwell. 1994. Impact of vehicular traffic on beach habitat and wildlife at Cape San Blas, Florida. Florida Cooperative Fish and Wildlife Research Unit, U.S. Biological Survey Tech. Rept. 50. 44pp.

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP(OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST for the 3rd Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Eckert, K. L., K. A. Bjorndal, F. Alberto Abreu G. and M. A. Donnelly (eds.). 1999. Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publ. No. 4. Washington, D.C.

Foley, A. M. 1998. The nesting ecology of the loggerhead turtle (*Caretta caretta*) in the Ten Thousand Islands, Florida. Doctoral Dissertation, University of South Florida, Tampa, Florida.

Hosier, P. E., M. Kochhar and V. Thayer. 1981. Off-road vehicle and pedestrian track effects on the sea-approach of hatchling loggerhead turtles. Environmental Conservation 8(2):158-161.

Kaufman, W. and O. H. Pilkey, Jr. 1983. The Beaches are Moving: The Drowning of America's Shoreline. Duke University Press, Durham, North Carolina. 336 pp.

Lutcavage, M. E., P. Plotkin, B. Witherington and P. L. Lutz. 1996. Human impacts on sea turtle survival, p.387-409. *In:* P. L. Lutz and J. A. Musick (eds.), The Biology of Sea Turtles. CRC Press, New York.

Lutcavage, M..E., P. L. Lutz, G. D. Bossart and D. M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology 28(4):417-422.

Mosier, A. E. 1999. The impact of coastal armoring structures on sea turtle nesting behavior at three beaches on the east coast of Florida. Master's Thesis, University of South Florida, Tampa, Florida.

Pilkey, O. H. and K. L. Dixon. 1996. The Corps and the Shore. Island Press, Washington, D.C. 272 pp.

UNEP. 1989. Regional Overview of Environmental Problems and Priorities Affecting the Coastal and Marine Resources of the Wider Caribbean. CEP Technical Report No. 2. UNEP Caribbean Environment Programme, Kingston.

Witherington, B. E. 1992. Behavioral responses of nesting sea turtles to artificial lighting. Herpetologica 48:31-39.

Witherington, B. E. 1999. Reducing threats to nesting habitat, p.179-183. *In:* K. L. Eckert, K. A. Bjorndal, F. A.

Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Witherington, B. E. and K. A. Bjorndal. 1991. Influences of artificial lighting on the seaward orientation of hatchling loggerhead turtles (*Caretta caretta*). Biological Conservation 55:139-149.

Witherington, B.E. and R.E. Martin. 2000. Understanding, assessing, and resolving light-pollution problems on sea turtle nesting beaches. FMRI Technical Report TR-2 (revised edition). Florida Marine Research Institute. St. Petersburg, Florida. 73 pp.

Reducing Threats on Foraging Grounds

Julia A. Horrocks
Department of Biological and Chemical Sciences
University of the West Indies
Barbados

Introduction

Reducing threats to marine turtles, eggs and hatchlings at nesting beaches and protecting beach habitat is only part of the process required to ensure the long-term survival of threatened and endangered marine turtle populations. Threats to marine turtles on their foraging grounds, as well as threats to foraging habitat, must also be identified and addressed.

Following an epipelagic post-hatchling dispersal phase, most Caribbean marine turtles (with the exception of the leatherback) settle into relatively shallow nearshore foraging habitats where they will spend the vast majority of their lives (Meylan and Meylan, 1999). Two particularly important foraging and refuge habitats for marine turtles in the Caribbean region are coral reefs and seagrass beds. Coral reef-associated algae, sponges and other invertebrates are grazed and preyed upon by hawksbills (Meylan, 1988), and coral reefs are widely used as refuge areas by hawksbill and green turtles. seagrasses are grazed by herbivorous green turtles, while olive ridleys and loggerheads prey on crustaceans and other invertebrates within the beds (Bjorndal, 1997).

As juveniles, turtles may reside for relatively short periods on a particular reef or in a particular seagrass bed; individuals may move extensively among nations during the decades prior to sexual maturity. Upon reaching adulthood, turtles apparently engage in more predictable movements between established breeding and foraging grounds. Studies of the migratory behaviour of post-nesting hawksbills in Barbados, for example, suggest that these animals may only be in Barbadian waters for a few months every few years, and that immediately following their last nest they leave Barbados and return to resident foraging grounds in other countries, taking advantage of prevailing currents and moving quickly over areas of deep water (Horrocks et al., submitted). Minimising threats to turtles on foraging grounds, particularly threats to adults, and minimising threats to the foraging grounds themselves are clearly critical to the effective management of marine turtle populations (Eckert, 1995; IUCN, 1995).

The Importance of the Coastal Zone

Most marine turtles spend the majority of their lives in nearshore marine habitats within 2 km of the coast, and 40% of the human population of the Wider Caribbean Region resides within 2 km of the coast. Many threats to the marine environment emanate from the land ... and the nearshore coastal zone is disproportionately affected.

Coral reefs and seagrass beds are among the most important coastal resources in the Wider Caribbean Region. Reefs are formed by the secretion of calcium carbonate skeletons by tiny colonial animals (Cnidaria). seagrasses are submerged flowering plants. Both ecosystems are slow to develop and slow to recover from disturbance. The fastest growing corals (e.g., finger corals, staghorn corals) grow at rates of 2.5-26.6 cm/yr, while the massive brain corals only 0.81-2.5 cm/yr (Davies, 1983). Similarly, mature seagrass beds (defined as 95% substratum cover) dominated by the climax species *Thalassia,* (commonly known as turtle grass) require some 15-50 years to develop (Patriquin, 1975, Duarte, 1995).

Coral reefs and seagrass beds are both highly productive ecosystems, and aside from their value to marine turtles, they provide substrate, food, shelter and nursery areas for many commercially important fish and crustaceans. Coral reefs are the basic habitat for all of the reef-associated fish that support trap fisheries throughout the Caribbean. seagrass beds serve as juvenile and adult habitat for many commercially harvested species (e.g., shrimp, lobsters, conch, sea urchins, mullets) in addition to be used as nursery habitat by commercially important reef fish (e.g., groupers, parrotfish, surgeonfish) and as foraging habitat to which adult reef fish routinely migrate (e.g., grunts, snappers, parrotfish, squirrelfish). Studies have shown that coral reefs near to seagrass beds have larger and more diverse reef fish populations than reefs without nearby beds (e.g., Ogden, 1972; Salm and Clark, 1984).

Much of the sand on Caribbean beaches is produced as a result of the erosion of reef structure and reef-associated calcareous algae, and reefs physically protect the coastal zone during storm and hurricane events. seagrass beds are also important in physically stabilising the coastal zone. Their dense leaf canopy reduces current velocity near the sediment surface and promotes settling, and the roots and rhizomes bind sediments and limit erosion (Ogden, 1983). seagrass meadows often develop in the protected waters landward of reefs, and they play an important role in reducing sedimentation of reefs from land-based sources. Coral reefs and seagrass beds therefore have a high level of ecological interdependence and a change in one ecosystem as a result of man's activities often has repercussions in the adjacent ecosystem, emphasizing the need for a holistic approach to their management and conservation.

Managing Threats to Foraging Habitat

Declining Water Quality: Declining water quality is perhaps the most important factor affecting shallow marine habitats. Fringing reefs are in the immediate vicinity of the land, and this results in them being maximally exposed to land-based sediments, high levels of nutrients such as nitrates and phosphates from sewage and fertilisers, and of industrial and agricultural pollutants. Between the years 1982 and 1992, percent substrate cover by living coral on the fringing reefs of Barbados declined by between 30-50% and species numbers by between 25-45% (Hunte et al., 1998). The principal cause was algal overgrowth resulting from reduced grazing pressure and eutrophication.

Increased sediment loads reduce the amount the light needed by seagrasses and the algal symbionts of corals for photosynthesis. Turbidity is increased by sediment runoff from land-based sources as a result of poor land clearing practices for agriculture, deforestation of watersheds, reclamation of mangroves, mining, road construction, and development activities for tourism such as marina construction and golf courses (Gibson and Smith, 1999). Similarly, dredging for navigational purposes or shoreline reclamation can significantly increase nearshore turbidity in localized areas. Upon settling, sediments reduce available substrate for larval settlement by corals and other reef-associated organisms, reduce oxygen levels, or in severe cases physically smother corals and seagrasses. Pesticides and herbicides that are toxic to marine organisms can also be bound to sediment particles.

Nutrient enrichment of nearshore waters is of increasing concern in the Wider Caribbean Region. On Barbados' south coast, for example, there was a 3-10 fold increase in nitrate contamination of ground water discharging into the coastal zone between 1977 and 1994 (Delcan International Ltd., 1995). A primary source of the nitrate contamination is sewage, reflecting increased tourist and resident densities in the coastal zone over this 15-year period. Nutrient enrichment of the water promotes the growth of microscopic phytoplankton, benthic or bottom-living macro-algae and of epiphytic algae.

Microscopic algae suspended in the water column contribute to turbidity and further reduce light penetration to seagrass beds and reefs. The increased BOD (biological oxygen demand) caused by algal respiration can reduce oxygen levels sufficiently to contribute to fish kills. Increased abundance of benthic turf and macroalgae can result in overgrowth of the slower growing corals leading to increased mortality, particularly among juveniles (Wittenberg and Hunte, 1992). Dense cover by turf algae also decreases successful coral larval settlement on reefs. The problem of increased turf algal abundance on reefs has been aggravated by reduced herbivory on reefs. Over-fishing of herbivorous reef fish, and the 1983 mass mortality of the black spiny sea urchin (*Diadema antillarum*) throughout the Caribbean, have both contributed to reduced herbivory on Caribbean reefs (Hunte et al., 1996). Epiphytes growing over seagrass blades may reduce light availability and hence the growth rates of seagrasses.

With respect to the use of seagrass beds as foraging habitat by green turtles, it is important to note that nutrient enrichment of nearshore sediments may increase the abundance of narrow-bladed seagrass species, such as *Syringodium*, relative to the broad-bladed *Thalassia* (Vermeer, in prep). *Thalassia* is the seagrass species most often seen in gut analyses of Caribbean green turtles (Mortimer, 1981) and may be preferred over other species because it can be grazed more efficiently. *Thalassia* can fix nitrogen in its roots (Patriquin and Knowles, 1972) and therefore in more pristine, nutrient-poor waters, it has a competitive edge over *Syringodium*.

Anchor Damage: As tourism and pleasure boating intensifies in the Caribbean, indiscriminate anchoring can result in significant physical damage to both coral reefs and seagrass. Anchors uproot seagrasses and break the rhizome system; once the roots are disturbed, recovery is slow. Repetitive anchoring in many coastal bays of the U.S. Virgin Islands has so reduced seagrass cover that pastures once extending to 18.5 m depths now rarely persist below 4 m. With disturbance rates higher than recovery rates in many areas, the capacity of seagrass beds to support foraging green turtles is declining (Williams, 1988). Local physical damage to coral colonies through indiscriminate anchoring can be extreme and in addition to the direct mortality caused, holes and channels in the reef can alter current patterns and result in atypical sediment movement, thus causing further damage.

Oil Pollution and Marine Debris: The Wider Caribbean Region is one of the largest oil producing areas in the world. Most of the oil produced in the region is shipped to destinations within the region, and on an average day, more than 700,000 tons of oil are being transported by sea (Gibson and Smith, 1999). The result is an intricate network of distribution routes, some of which run through restricted channels close to islands, and which increase the vulnerability of the region to accidents. In spite of regulations established in Annex I of MARPOL 73/78 (Convention for the Prevention of Pollution from Ships), tankers do not always use port facilities for the disposal of bilge and tank washings. The deliberate release of washings at sea far exceeds the amount of oil entering the sea from accidental spills. Offshore oil and gas exploitation are also potential sources of pollution, either in the form of accidental oil spills or from the release of "produced water" from the oil-bearing strata during drilling operations.

Oil pollution and tar fouling are hazardous to coral reefs and seagrass beds, as well as to marine turtles and their young (Lutcavage et al., 1995). Aside from the toxic effects of oil constituents, an oil slick decreases gas exchange between the water and the atmosphere, and can cause oxygen depletion in enclosed bays. Following a spill on the Caribbean coast of Panama in 1986, seagrasses declined in biomass and infauna was severely affected, intertidal reefs declined, and sub-tidal reefs suffered significant mortality and sub-lethal effects (Keller and Jackson, 1993).

Marine debris (i.e., garbage disposed at sea, or finding its way to the sea from land-based sources) is a serious global threat to the coastal zone. Death to marine turtles as a result of ingestion or entanglement in marine debris is widespread and well publicized (e.g., Balazs, 1985), but perhaps less widely known is the threat that debris poses to the environment. For example, plastic bags can wrap around corals and suffocate underlying tissues. Debris also smothers seagrass, and can leak noxious elements and pose other threats to important foraging habitats.

Damaging Fishing Techniques: The use of dynamite, chemicals and coral smashing techniques to capture fish causes irreparable harm to the sea bed, and especially to coral reefs. Bottom trawling, and the dropping of fish traps or anchoring blocks indiscriminately on living reef is similarly destructive. In the case of dynamite, many non-target fish are killed. Many of the target fish do not float to the surface and therefore are not collected. The physical damage effected by methods such as these destroys the very foundation of the reef, reducing or eliminating its capacity to support commercial fishes and invertebrates, as well as marine turtles (Gibson and Smith, 1999). Chlorine and a wide variety of other chemicals are extremely toxic to corals.

The application of chlorine bleach or other noxious substances to a reef for the purpose of catching lobsters or obtaining fish (including tropical specimens for the pet trade) kills corals, poisons important nursery areas for commercial fishes, and degrades marine turtle foraging habitat.

Tourism Impacts: These stressors are particularly serious in countries where there is significant tourism development. Negative impacts include careless snorkeling and diving, collection of corals and reef-associated organisms for sale to tourists, and physical removal of reef rubble and seagrass to improve areas for sea-bathing.

Global Warming: The impacts discussed above are, in a sense, local but widespread stressors of reef and seagrass systems. However, there are other more global factors that contribute significantly to seagrass and coral reef disease and deterioration. These are increases in sea temperature, severe storm events, and sea level rise, all of which have been exacerbated by human-induced global warming resulting largely from excessive CO_2 emissions in the developed world. These stressors cannot easily be mitigated by individual countries in the region and require mitigation at a regional or global level.

Managing Threats to Marine Turtles on Foraging Grounds

The major threats to marine turtles on their foraging habitats arise as a consequence of directed catch, whether legal or illegal, and incidental catch. This becomes particularly problematic when turtles are protected on the nesting beaches in one country but exploited on the foraging grounds of another. For example, adult female hawksbills nesting in Barbados where they are legally protected, spend the majority of their lives in the waters of countries that have legal turtle fisheries. These countries may have closed seasons, but their closed seasons generally coincide with the breeding season in order to protect their own breeding populations. The "Barbados females" return to their foraging habitats in these countries as the closed seasons end there, and they are, therefore, fully exposed to the harvest.

Incidental catch can sometimes be more damaging to marine turtle populations than directed catch (Oravetz, 1999). The annual mortality of loggerheads and Kemp's ridley turtles due to drowning in shrimp trawls in U.S. waters, for example, was estimated at 5,500-55,000 per year in 1990 and has been a significant factor constraining the recovery of the "Critically Endangered" Kemp's ridley turtle. Likewise, incidental capture of leatherback turtles in the swordfish gill net fisheries of Chile and Peru has been implicated in the recent collapse of the largest nesting assemblage of leatherbacks in the world (in Pacific Mexico: Eckert and Sarti, 1997).

Aside from catch, turtle mortality on the foraging grounds due to oil ingestion and smothering, ingestion of and entanglement in debris, and as a result of boat strikes is widespread. We have all seen examples of this in our own countries.

Summary

All of the factors discussed above (see "Managing Threats to Foraging Habitat") are known to pose threats to coral reefs and seagrass beds, critically important foraging habitats for the long-term survival of marine turtles. But the diversity and vitality of these ecosystems may also have been adversely affected by the demise of the turtle populations themselves (Bjorndal, 1999). Both hawksbills and green turtles fill unusual marine feeding niches. Green turtles have specially modified guts that can digest the cellulose found in seagrasses, and the hawksbill gut is modified to subsist on a diet consisting almost entirely of sponges. We do not know what the impacts of historically high levels of turtle harvest have been on these ecosystems. Currently, only about 10-20% of seagrass biomass in the Caribbean is grazed by herbivores, the remainder either decays *in situ* and forms the base of detrital food chains, or floats out to sea to form the base of pelagic food chains (Thayer et al., 1984).

Before European colonisation and increased levels of turtle harvesting, a much larger percentage of the primary production in these beds would have been grazed by green turtles, and nutrients moved from the seagrass beds to contribute to the energy budgets of adjacent reefs. Furthermore, green turtles are known to maintain grazing plots, i.e. to consistently re-graze specific areas (Bjorndal, 1980). The re-growth provides a higher quality diet for the turtles because the new blades are higher in nitrogen and lower in indigestible lignin. It is very likely that this conditioning of the environment by green turtles was also to the benefit of other formerly important grass bed herbivores. In short, the absence of green turtle grazing has probably significantly altered the productivity and nutrient content of seagrasses, and through this, the biodiversity and community structure of the grass bed ecosystem. It has also been recently suggested that spongivorous hawksbills play a critical role in controlling overgrowth of corals by sponges on coral reefs (Hill, 1998). Consideration needs to be given to what the repercussions have been for the health of coral reefs from the widespread decline in numbers of hawksbills over the last few decades.

Literature Cited

Balazs, G. H. 1985. Impact of ocean debris on marine turtles: entanglement and ingestion, p. 387-429. *In*: R. S. Shomura and H. O. Yoshida (eds.), Proceedings of the Workshop on the Fate and Impact of Marine Debris. NOAA Tech. Memo. NMFS-SWFC-54. U.S. Dept. Commerce.

Bjorndal. K. A. 1980. Nutrition and grazing behavior of the green turtle, *Chelonia mydas*. Marine Biology 56:147-154.

Bjorndal, K. A. 1997. Foraging ecology and nutrition of sea tutles, p.199-231. *In*: P. L. Lutz and J. A. Musick (eds.) The Biology of Sea Turtles. CRC Press, New York.

Bjorndal, K. A. 1999. Priorities for research in foraging habitats, p.12-14. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Davies, P. J. 1983. Reef growth, p.69-106. *In*: D. J. Barnes (ed.), Perspectives on coral reefs. AIMS Contribution No. 200.

Delcan International Ltd. 1995. Terrestrial water quality report: Feasibility studies on coastal conservation. Technical Report to the Ministry of Tourism, International Transport and the Environment, and the Coastal Conservation Project Unit of the Government of Barbados.

Duarte, C. M. 1995. Submerged aquatic vegetation in relation to different nutrient regimes. Ophelia 41:87-112.

Eckert, K. L 1995. Draft General Guidelines and Criteria for Management of Threatened and Endangered Marine Turtles in the Wider Caribbean Region. UNEP (OCA)/CAR WG.19/ INF.7. Prepared by WIDECAST and adopted by the Third Meeting of the Interim Scientific and Technical Advisory Committee to the SPAW Protocol. Kingston, 11-13 October 1995. United Nations Environment Programme, Kingston. 95 pp.

Eckert, S. A. and L. Sarti M. 1997. Distant fisheries implicated in the loss of the world's largest leatherback nesting population. Marine Turtle Newsletter 78:2-7.

Gibson, J. and G. Smith. 1999. Reducing threats to foraging habitats, p.184-188. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Hill, M. S.1998. Spongivory on Caribbean reefs releases corals from competition with sponges. Oecologia 117:143-150.

Horrocks, J. A., L. A. Vermeer, B. Krueger, M. Coyne, B. A. Schroeder and G. H. Balazs. Submitted. Migration routes and destination characteristics of post-nesting hawksbill turtles satellite-tracked from Barbados, West Indies. Chelonian Conservation and Biology: xxx.

Hunte, W., H. Wiltshire and L. A. Vermeer. 1996. Environmental deterioration and water quality at fringing reefs on the west coast of Barbados. Technical Report to Stanley International and the Government of Barbados. 27 pp.

Hunte, W., L. A. Vermeer and R. Goodridge. 1998. Temporal changes in coral reef communities on the west and south coasts of Barbados: 1987-1997. Technical Report to the Coastal Zone Management Unit of the Government of Barbados. 142 pp.

IUCN. 1995. A Global Strategy for the Conservation of Marine Turtles. IUCN/SSC Marine Turtle Specialist Group, Washington D.C. 24 pp.

Keller, B. D. and J. B. C. Jackson (eds.). 1993. Long-term assessment of the oil spill at Bahia Las Minas, Panama. Synthesis Report, Vol. II: Technical Report. OCS Study MMS 93-0048. Minerals Management Service, U.S. Department of Interior. 1017 pp.

Lutcavage, M..E., P. L. Lutz, G. D. Bossart and D. M. Hudson. 1995. Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles. Archives of Environmental Contamination and Toxicology 28(4):417-422.

Meylan, A. (1988) Spongivory in hawksbill turtles: a diet of glass. Science 239: 393-395.

Meylan, A. B. and P.A. Meylan. 1999. Introduction to the evolution, life history and biology of sea turtles, p.3-5. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine

Turtle Specialist Group Publication No. 4.

Mortimer, J. A. 1981. The feeding ecology of the green turtle, *Chelonia mydas*, in Nicaragua. Biotropica 13:49-58.

Ogden, J. C. 1972. An ecological study of Tague Bay reef, St. Croix, U.S. Virgin Islands. Special Publications in Marine Biology 1:1-57. West Indies Laboratory, St. Croix.

Ogden, J. C. (ed.). 1983. Coral reefs, seagrass beds and mangroves: their interaction in the coastal zone of the Caribbean. Report of a Workshop held at the West Indies Laboratory, St. Croix, U.S. Virgin Islands, May 1982. UNESCO Reports in Marine Science 23: 1-16.

Oravetz, C. A. 1999. Reducing incidental catch in fisheries, p.189-193. *In*: K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois and M. Donnelly (eds.), Research and Management Techniques for the Conservation of Sea Turtles. IUCN/SSC Marine Turtle Specialist Group Publication No. 4.

Patriquin, D. G. 1975. "Migration" of blowouts in seagrass beds at Barbados and Carriacou, West Indies, and its ecological and geological implications. Aquatic Botany 1: 163-189.

Patriquin, D. and R. Knowles. 1972. Nitrogen fixation in the rhizosphere of marine angiosperms. Marine Biology 16: 49-58.

Salm, R.V. and J. R. Clark. 1984. Marine and coastal protected areas: a guide for planners and managers. IUCN, Gland, Switzerland. 302 pp.

Thayer, G.W., K. Bjorndal, J. C. Ogden, S. L. Williams and J. C. Zieman. 1984. Role of larger herbivores in seagrass communities. Estuaries 7: 351-376.

Williams, S. L. 1988. *Thalassia testudinum* productivity and grazing by green turtles in a highly disturbed seagrass bed. Marine Biology 98: 447-455.

Wittenberg, M. and W. Hunte. 1992. Effects of eutrophication on juvenile scleractinian corals I. Abundance, mortality and community structure. Marine Biology 112: 131-138.

Strengthening the Regulatory Framework

*Jeffrey Sybesma
Faculty of Law
University of the Netherlands Antilles
Curaçao*

Introduction

This paper is about the regulatory framework for the protection and management of the natural environment and, in particular, the marine turtles of the Wider Caribbean Region. The words 'regulatory framework' imply a body of rules and regulations that constitute a national framework for environmental protection, including marine turtles. Before exploring these rules and regulations it is necessary to put the framework in its proper setting, and that is the national level. Earlier today, Mr. Andrade (UNEP) provided an excellent review of international treaties and conventions applicable to the protection and management of marine turtles. These (international) legal instruments are, in principle, only binding between parties; that is, between countries. To be effective at the national level, treaties need either to be transformed into national law or at least must be directly applicable to nationals in their local legal setting.

We must keep in mind the structure of the political, economic and socio-cultural system of a country. If we consider the Caribbean Region, for example, there are big and small states and island nations. There are four major language groups (English, Spanish, French, Dutch) and hundreds of dialects. Caribbean states have different historical backgrounds, and this heritage is reflected in the national regulatory framework. Within this context we find the basis for the existing structure of legislation, organization, implementation, control and enforcement of rules and regulations in every Caribbean state necessary to protect and manage the environment and, in this case, marine turtles.

Despite the differences, there is a common logic among regulatory mechanisms, and it is this logic which forms the basis of my presentation.

Legislation and Legal Structures

The first area to consider is the legal structure of the state. One needs to examine the body of environmental laws and derivatives, including decrees, ordinances, rules, regulations, legal guidelines, and rulings, to have an impression about the type of regulatory framework that exists to protect the environment. In general, there are two types. The first category is comprised of laws that protect and manage marine turtles directly. These laws protect specific species (flora and fauna) and their habitat. Fisheries legislation can be placed in this category, although fisheries rules tend to have a strong economic tendency and value. The second category is comprised of laws that protect and manage marine turtles indirectly by prohibiting activities that are harmful to the environment, and are generally considered harmful to people as well. Examples include laws against pollution of the marine environment, or spatial planning legislation on land.

It is important to understand the different kinds of regulations in place at the national level. Very often there are strict norms, such as rules that prohibit or rules that are mandatory, and these are referred to as "hard laws". There are also rules that demand installing various types of policy and management plans, which are referred to as "soft laws". Regulations of all types can be constrained by insufficient and/or outdated legislation, and this is certainly true of marine turtles where, for example, many fisheries laws protect young turtles but allow the seasonal harvest of breeding-age adults. We also find conflicting regulations, which makes it even more difficult to know what is applicable and what is not. Moreover, we find that countries are party to international or regional treaties, such as CITES, SPAW or CMS, but have failed to implement treaty commitments by adopting the necessary implementing legislation at the national level. As a result, multilateral agreements are significantly weakened.

Organizational Structures

Part of the regulatory framework is the legal organization of the Government, be it on a national level and/or vested in local municipalities. Most Governments are divided into departments or (sub)departments that operate independently of one another and all have their specific legal tasks to perform. Some of them protect or manage nature, including marine turtles (e.g., National Park Service, Department of Environment), or have related tasks (e.g., Fisheries Department) or combined tasks (e.g., Department of Public Health and Environment).

Besides governmental offices or departments we sometimes find subsidized private organizations that are given a mandate by the government to protect and manage nature. As private corporations or foundations, these organizations perform governmental tasks. Nowadays there is a trend to increasingly "privatize" former government offices and make them semi-governmental or independent private organizations with governmental tasks. In these cases, the government withdraws from an executive role and focuses more on policy development and control. These private organizations are then subsidized for their task of managing the environment.

In the organizational field we find also the non-government organizations (NGO's), which are a strong force nowadays in the environmental framework. The first and oldest role they play is that of a "watchdog organization", observing and often criticizing bureaucratic and inefficient action by government in environmental protection and management. They form an effective advocacy for all kinds of specific environmental topics, including the protection of biodiversity. More recently we see the role of NGO's changing, becoming partners of government. By acknowledging that governing structures can be ill-equipped to perform specialized executive tasks, resource agencies form alliances with NGO's with the intent of allowing the NGO to perform a task originally done by the government. The government may subsidize the NGO, and in return the NGO uses these funds more efficiently (than could government) and with maximal output.

Even in countries where there is no strong NGO presence, individual non-organized activities can make a difference. For example, public outcry as a result of media coverage of the pointless slaughter of a giant leatherback turtle may result in changes in public attitudes and public policy.

As a final note on organizational structure, we find that, as a general rule, there is institutional overlap and redundancy within the governmental organizational structure in Caribbean countries. There are also gaps in jurisdiction among departments which lead to non-productive competition and duplicative programming or, alternatively, inaction as one department is confident that "the other will do it". We see similar patterns among NGOs. In countries with energetic and enthusiastic NGO's, we sometimes find several groups working with almost the same statutory goals . . . and in this case there is redundancy and wasted effort. On the other hand, other critical areas with the same need for input and energy are neglected.

Implementation

With regard to the implementation of plans and programs within a legal framework for environmental protection, we see within the Government organization the following constraints. First, there is a pervasive lack of sufficient funds for all the necessary tasks required to protect and manage the environment properly. Government income from taxes is decreasing, while the scope of tasks is increasing. Environment is an area that was some years ago a primary sector for fund allocation. Today we see interests changing to combating crime, poverty, health and drug abuse, and other social issues. What funds are given to the environmental departments are often and necessarily allocated to wages and infrastructure, such as vehicles, offices and utilities. For every dollar budgeted, the major part is not used for direct environmental projects in the field. Second, we face a lack of technical personnel trained to oversee all the necessary tasks required to protect and manage the environment properly. A related problem is that what government lacks in quality, it makes up in quantity; that is, more people are employed than reasonably necessary. Finally, with respect to plans and programs on which budgets are appointed, many such plans lack realistic goals and time-frames; for this reason, progress is difficult to evaluate. Bureaucratic rules and regulations make the project "input-oriented" rather than "output-oriented". It is critical that information is shared among departments (indeed, among countries) to ensure that the lessons of the past are learned and that best practices are strongly integrated into policy making and planning.

NGOs have fewer bureaucratic problems, but often struggle mightily to acquire the necessary funds for their scheduled environmental programs and goals. It seems that the government subsidy is always given to the other NGO, and not yours! Competition amongst NGOs, especially for limited funding, is common. Too often the subsidy is insufficient to ensure a proper job, or funds are specifically earmarked for relatively low priority projects. A lot of energy is put into fund-raising, and thus diverted from the real work of environmental protection. On the other hand, strong competition (in biological terms, the struggle for life) makes the surviving NGOs strong, efficient, and not to be underestimated players in the national environmental framework.

Control and Enforcement

Despite common shortcomings, there is, of course, always some legal structure and most governments have a more-or-less functional organizational structure when it comes to the environment. Government also has the obligation to use its power to enforce the laws protecting the environment, including public health, land use, biodiversity, etc., and to ensure the continuation of necessary projects and action plans. When violations or breaches of the law are identified, action must be taken. Control and enforcement are usually seen as a governmental, especially police, task and area of responsibility.

Typically there are three areas in which we can think of control and enforcement. The first is the use of administrative powers. Many departments of government have special supervisory powers to control and inspect people's, and especially corporation's, activities. If these activities are not done in agreement with the relevant laws or regulations, actions can be taken that include withdrawal of subsidy or permits, or prohibiting the person or corporation to continue the task. Government can take many actions without the use of judicial steps. The second area is the judicial route, or what I call the use of penal powers. Many laws have penal articles as methods for enforcement. Police and special enforcement agencies (generally answering to the office of a public prosecutor) have the power to perform investigations into activities that are suspected of being illegal. With enough evidence, offenders or wrongdoers are prosecuted by a judge or court of justice and allotted a fine or even imprisonment. The third area which can be used to combat environment unfriendly behavior is the use of civil law powers. Individuals, NGOs, and even government can use torts or unlawful behavior lawsuits against offenders and claim damages. Nowadays a trend is visible where NGOs are suing the government in civil court for non-compliance or negligence with regard to laws they (government) made themselves. This is surely a part of the watchdog role of NGOs.

Once again, constraints in the area of law enforcement include funding shortages and a lack of basic tools (e.g., patrol boats, vehicles, radios). Enforcement and other skills training for rangers are, too often, minimal. And penalties, if given, are not commensurate with product value or the ethical standards of the community. The majority of environmental fines, and this includes marine turtle violations, are far too low to act as effective deterrents. Public prosecutors tend to focus on common criminality, rather than environmental offences. Support from government for its enforcement agencies is typically low and sometimes internal corruption ensures that the enforcement effort is not made.

Conclusions

To summarize and to conclude, there are four areas to consider when talking about the regulatory framework for environmental protection and management. These are: (i) legislation, (ii) organization, (iii) implementation, and (iv) control and enforcement.

Every one of these areas has its own specifics to recognize. After recognition, it is necessary to identify the setbacks and constraints of each area. Only then will it be possible to find solutions and to make recommendations for improvement in each area. I have almost not touched on this last aspect; that is, how can we improve and strengthen the regulatory framework so that the environment, including our marine turtles, will meaningfully benefit from it? I did this intentionally, because I want the Working Group, using this presentation as a starting point, to discuss means and mechanisms for strengthening the regulatory framework. By doing so, the outcome of that Working Group will be the final section of this presentation.

May I suggest that the Working Group focus on the following aspects? First, legislation – is there direct or indirect environmental legislation, is it sufficient, and is it outdated? Second, organization — is there an adequate governmental and non-governmental environmental organization, is there overlap (or are there gaps) in tasks, what role do NGO's play, and are NGOs partners or watchdogs? Third, implementation — are there enough funds available (both for government and NGOs), are the available tools adequate, is there enough quality available for high standard performance, and are there enough (or too many) people involved? And, finally, control and enforcement — what kinds of control and enforcement are in place, are all legal possibilities used, what problems contribute to a poor performance in the areas of control and enforcement, and how can these problems be resolved?

Open Forum: Meeting Management Goals

*F. Alberto Abreu G. – Moderator
IUCN/SSC Marine Turtle Specialist Group (MTSG)
Univ. Nacional Autónoma de México
México*

A. Abreu (Moderator) suggested that the discussion focus on questions asked by participants, as well as on the identification of elements for the Working Groups.

S. Tijerino (Nicaragua) asked how the Presenters would consider the threat of climatic change on nesting beaches, and how might it affect populations over time?

B. Schroeder (USA) responded that this was an excellent question, and that climatic change will result in rising sea levels that will influence coastal geography in the future. She felt that the complexity of the topic was beyond our capacity to discuss in this forum, but that one influence on sea turtle populations may be skewed sex ratios in hatchlings as incubation temperature regimes shift.

S. Tijerino (Nicaragua) emphasized the need to take anthropogenic effects on these species into account in the policy and management process. She asked for feedback from the Presenters regarding the vulnerability of seagrasses and coral reefs, which serve as important sea turtle foraging habitats.

J. Horrocks (UWI) responded that coral reefs and seagrasses are indeed critical foraging habitats for sea turtles throughout the Caribbean. Global warming and sea level rise threaten shorelines, but also coastal marine ecosystems such as coral and seagrass. Perhaps of more immediate concern, however, are threats to these important ecosystems that result from coastal development. These threats include erosion, sedimentation, beach armoring, and destruction of the seabed. These threats have a direct effect on sea turtle populations, as well.

N. Frazer (UFL) added that we need to protect habitat in order to protect sea turtles, and he noted that sea turtles themselves often act in ways that "engineer" the habitat to their advantage.

M. Donnelly (IUCN MTSG) agreed, adding that we cannot take habitat for granted or allow good habitat to be degraded. We should be diligent in safeguarding habitats, especially unspoiled habitats, that are successfully exploited by sea turtles for nesting or foraging. Habitat monitoring programs are critical to the success of any long-term conservation or management program.

J. Frazier (Smithsonian) agreed with S. Tijerino and recommended that we protect habitat because without it, we have no sea turtles.

C. d'Auvergne (St. Lucia [1]) expressed the view that climate change would surely have a profound effect on sea turtles, and that we must also take into account the reactions of people to climate change...reactions that include building sea walls, for instance. He expressed his concern, as well, about the transport of hazardous nuclear waste through the Caribbean Sea, and the fact that oil spills are always a possibility. He reminded the meeting that one of every eight barrels of the world's oil passes through the Caribbean. In St. Lucia there has been a loss of seagrass and living coral as a result of dredging, as well as some fishing practices.

C. Parker (Barbados) observed that "everything we have discussed in this session is part of integrated coastal management", and that integrated coastal management should be a priority for every nation in the region. He noted that the threats we and our environment face are complex, and the answers will not be found in fragmentary and isolated programs. We must strive to assimilate best practices in the management of marine turtles and their habitats.

A. Abreu (Moderator) closed the session with instructions about convening the Working Groups after the lunch break. He thanked the translators for their diligent and professional assistance.

[1] Mr. C. d'Auvergne participated as an Invited Expert, and not as a delegate from St. Lucia.

Session VI

Working Group Results and Recommendations

Determining Population Distribution and Status
F. Alberto Abreu G., *Chair*

Monitoring Population Trends
Rhema H. Kerr Bjorkland, *Chair*

Promoting Public Awareness and Community Involvement
Crispin d'Auvergne, *Chair*

Reducing Threats at Nesting Beaches
Barbara A. Schroeder, *Chair*

Reducing Threats on Foraging Grounds
Julia A. Horrocks, *Chair*

Strengthening the Regulatory Framework
Jeffrey Sybesma, *Chair*

Determining Population Distribution and Status

F. Alberto Abreu G., Working Group Chair
Instituto de Ciencias del Mar y Limnología
Universidad Nacional Autónoma de México
México

Goal 1: To achieve sound management of the sea turtle resource by determining the distribution of sea turtle populations

Objective 1: Locate all sea turtle nesting sites:

Identify all breeding units (also known as "stocks" or "populations") for each species and record geographic coordinates for nesting sites, past and present. Register causes of population collapse if known.

Characterize nesting habitats by:

- Physical characteristics
- Human use and degree of human presence
- Major habitat type (according to the ecology of each species)

Determine nesting intensity at all nesting sites so that it becomes possible to:

- Classify nesting sites as Primary, Secondary, or Tertiary [High, Medium, Low], according to nest density
- Classify nesting sites according to human accessibility to sites
- Select "Index Beaches." Criteria for selection of Index Beaches may vary. One favored method is to select Primary beaches with adequate accessibility that will allow or has allowed long term monitoring.

Objective 2: Locate all marine turtle foraging sites

Locate major feeding sites for each species, recording geographic coordinates for each site.

Identify source populations contributing to each foraging assemblage

Determine marine turtle abundance at feeding sites for each species/population

Classify sites as Primary, Secondary, or Tertiary for each species, based on the size of the foraging aggregation with respect to the known total abundance of the species in the nation and region

Characterize feeding habitats by:

- Food type and abundance
- Quality of the environment
- Level of threats
- Size (e.g., square meters, hectares)
- Identify formerly utilized feeding sites for each species, if information is available.

Identify level of human impact

Objective 3: Locate marine turtle migratory routes

Using remote sensing techniques (e.g., satellite tracking) to evaluate whether marine turtles utilize specific oceanic corridors during juvenile or adult (e.g. pre- or post-nesting) life stages

Identify species/populations that utilize specific routes or corridors

Assess any threats (e.g., commercial fishing, shipping) affecting these routes

Objective 4: Locate mating sites

Locate major mating sites for each marine turtle species

Identify source populations at each mating site

Determine seasonality and abundance at mating sites for each species/population

Classify sites as Primary, Secondary, or Tertiary for each species

Characterize mating sites by:

- Quality
- Level of threats
- Size (e.g., square meters, hectares)

Identify historically utilized mating sites for each species

Identify level of human impact

Objective 5: Locate developmental habitats

Locate major developmental sites/habitats for marine turtles

Identify source populations at each developmental site

Determine seasonality and abundance at feeding sites for each species/population

Classify sites as Primary, Secondary, or Tertiary for each species

Characterize developmental habitats by:

- Food type and abundance
- Quality
- Level of threats
- Size (e.g., square meters, hectares)

Identify historically utilized developmental sites for each species, if possible

Identify level of human impact

Goal 2: To achieve sound management of the marine turtle resource by determining the current status of marine turtle populations

Objective 1: Determine the current status of all populations with a procedure that is congruent with the biological characteristics of the species, and which includes measures of trends in both nesting and foraging habitats

Determine demographic trends for each population using statistically robust procedures over biologically relevant time frames (typically 5-10 year time-series; see "Monitoring Population Trends" Working Group recommendations, this volume)

Take regional and global species-specific trends into consideration

Consider the amount of variability in the demographic trends of the various populations

Using statistically robust procedures, determine population trends as a function of changes in:

- Number of nests/year at Index Beaches, standardized for monitoring effort
- Number of turtles at foraging sites, standardized for monitoring effort

Quality and size of nesting and foraging habitats

Register the magnitude and persistence of known threats; identify gaps in knowledge

Deduce changes in abundance from historical records (changes in relative abundance can be inferred from some historical records, such as national fisheries or trade statistics)

Realize that an accurate assessment of a population trend must consider trend measurements from the full area of the population's distribution (i.e., complete range). If variation in trends is observable within the region, the more common or prevalent trend can be used as a measure for the overall (regional-level) trend

Derive population "status" (as distinct from a "trend," which can be evaluated over a shorter time frame) from trend measurements (whether observed, estimated or inferred) taken from the population's full range for a period of at least 2 generations. Thus "status" becomes a biologically meaningful classification congruent with criteria used internationally (i.e., IUCN)

Chairman's comments: The Working Group voiced an interest in measuring and achieving the "recovery" of marine turtle populations. Unfortunately, there was insufficient time to explore this interest. The Group also noted the difficulty in defining "recovery" in terms and parameters that would be meaningful to resource managers.

Monitoring Population Trends

*Rhema Kerr Bjorkland, Working Group Chair
Wider Caribbean Sea Turtle Conservation Network (WIDECAST)
Jamaica*

Goal 1: To achieve sound management of the marine turtle resource by monitoring population trends, and incorporating that information into decision-making

The Group laid a foundation for their discussion by defining "trend" as "a change in abundance over time," and then agreed that trends could be deduced from three primary sources: nesting beaches, foraging grounds, and markets. The Group agreed to limit its recommendations to monitoring nesting beaches and foraging grounds, but noted that useful information could be obtained from market data as long as Catch Per Unit Effort (CPUE) was quantified (i.e., if fewer and fewer and/or smaller and smaller turtles are landed *with the same effort*, then a decline in the fished population could be inferred).

The balance of the Group's time was spent discussing monitoring trends in nesting populations and foraging assemblages. The Group recognized that:

• For practical purposes the management unit at the national level should be the assemblage of turtles occurring in a nation's waters and/or on its beaches, but, due to the migratory nature of marine turtles, local trends may be the result of adequate or inadequate management practices on the part of several range state nations.

• Nesting beaches and foraging grounds should be monitored independently. A statistically significant trend at an Index Beach relates to that segment of the adult population utilizing the monitored habitat but may not, for example, relate to mixed-stock foraging assemblages offshore.

• Information-sharing should be a priority. A mechanism to collate and link information pertinent to a particular population would be very useful and would require long-term collaboration between Nation A (where gravid females nest), Nations B, C, and D (where adults forage during off-breeding years), and Nations E, F, G, and H (where the juveniles spend their developmental years).

Objective 1: Monitor trends on nesting beaches

Select Index Beaches for intensive monitoring, realizing that monitoring every nesting beach is neither possible nor necessary. Index Beaches should:

• include beaches with the highest nest density, if possible

• encompass a majority of known nesting for each species of management concern

• be predictably accessible by researchers

Collect baseline data by measuring:

• Absolute Abundance — determine absolute abundance by counting every animal, year after year, by making use of saturation tagging protocols; or

• Indices of Abundance - determine an index of abundance by making use of statistically viable sampling protocols (e.g., estimating the annual number of nesting females by counting nests or crawls; inferring national trends by monitoring selected Index Beaches)

Collect baseline data for a minimum of 3 multiples of the average remigration interval (ARI) or at least 5 years, whichever is longer. Based on published remigration intervals determined from long-term tagging programs in the Caribbean basin, the following minimum monitoring intervals were recommended:

• *Lepidochelys:* 5 yr, based ARI of 1.5 yr (Rancho Nuevo, México)

• *Eretmochelys:* 8 yr, based on ARI of 2.7 yr

(Jumby Bay, Antigua)

• *Caretta:* 8 yr, based on ARI of 2.5 yr (Georgia, USA)

• *Dermochelys:* 8 yr, based on ARI 2.5 yr (St. Croix, USVI)

• *Chelonia:* 10 yr, based on ARI of 3.2 yr (Tortuguero, Costa Rica)

Continue monitoring until a *statistically significant* change in abundance is detected or until population stability is demonstrated; for small populations this may be *considerably longer* (for purely mathematical reasons) than the minimum intervals defined above

Recognize that trends are not predictive, rather they simply define with a selected degree of mathematical precision that there has been a "change in abundance over time" and that its direction is negative or positive

Objective 2: Monitor trends in foraging grounds

Sample seasonally during the first year to determine when and where the turtles are present and accessible for long-term monitoring

Select Index Foraging Grounds for intensive monitoring, realizing that monitoring every foraging area is neither possible nor necessary. Index sites should:

• include areas where turtles are found in the highest density (to maximize encounters and facilitate statistical analysis)

• encompass a majority of known foraging turtles for each species of management concern

• be predictably accessible by researchers

Develop a census protocol consistent both in its methodology (e.g., study site, net size and type, capture technique, transect(s), reporting) and timing (e.g., time of day, seasonality, repetition)

Collect baseline data for a minimum period of 5 years, relying on standard protocols (e.g., CPUE, capture-mark-recapture, transect) associated with tracking Indices of Abundance; assume that measuring Absolute Abundance is impossible

Continue monitoring until a *statistically significant* change in abundance is detected (or until population stability is demonstrated with statistical precision); for small sample sizes this may be *considerably longer* than 5 years … a "trend" has to be both measurable and statistically significant

Recognize that trends are not predictive, they simply define with a selected degree of mathematical precision that there has been a "change in abundance over time" and that its direction is negative or positive

Chairman's comments: The Working Group voiced interest in evaluating the extent to which intensive monitoring at 1-5 Index Beaches (or Index Foraging Grounds) - with the exact number of monitored sites depending on the size of the country and the geographic distribution of critical habitat - could sufficiently address management questions at the national level, thereby saving duplicative monitoring effort. There was insufficient time to discuss this topic. A literature search for relevant information was suggested.

Promoting Public Awareness and Participation

*Crispin d'Auvergne, Working Group Chair
Ministry of Finance and Planning
St. Lucia*

Goal 1: To achieve sound management of the marine turtle resource by obtaining stakeholder participation through a process of awareness building, education and changes in behaviour

In order to reach the goal, the Group recognized the need to:

Understand the relationship between awareness, education and participation

Understand the objectives of awareness and participation

Work within existing national legal, institutional and socio-economic contexts

Objective 1: Develop, strengthen, and utilize mechanisms for public participation

Clearly identify target and stakeholder groups, and stakes

Determine the socio-economic importance or value of the resource to the various stakeholders, including communities and nations

Identify economic alternatives (options) in a collaborative manner; such alternatives might include activities totally divorced from the resource, as well as those involving non-consumptive or more sustainable consumptive use of the resource

Develop comprehensive medium- and long-term marine turtle public awareness programmes focused on the respective stakeholder groups

Coordinate and harmonize policies and activities of the relevant sectors, including Governmental and non-governmental

Incorporate marine turtle (and general marine) education into the school curriculum

Identify, strengthen, establish, and maintain mechanisms for the exchange of experiences, information and collaboration (including the Internet and field visits) using various sectors of society

Determine ways in which programme success can be measured and evaluated

Identify funding sources and develop funding strategies consistent with specific program objectives

Chairman's comments: Nelson Andrade noted that UNEP has established a WebSite for the exchange of information on Caribbean Marine Protected Areas. This site, known as CAMPAM Corner (www.cep.unep.org), could serve as a means of exchanging information.

Reducing Threats at Nesting Beaches

Barbara A. Schroeder, Working Group Chair
Office of Protected Resources
NOAA National Marine Fisheries Service
USA

Goal 1: To achieve sound management of the marine turtle resource by improving nesting and hatch success, and maximizing the number of hatchlings that successfully reach the sea

In order to reach the goal, the Group recognized the need to:

Identify threats through assessments, research, and the exchange of information

Consider threats not only to nesting beaches (habitat), but also to nests (eggs), hatchlings, and nesting females

Identify, characterize, and rank threats, giving priority management attention to those with the greatest potential to negatively affect the status of local breeding assemblages

Objective 1: Eliminate illegal poaching of eggs and nesting females

Improve the effectiveness of law enforcement

Promote and facilitate community involvement

Design and implement public education campaigns

Work with stakeholders to develop and encourage economic alternatives

Establish protected units/areas

Objective 2: Control beach sand mining

Assess the extent of beach sand mining and monitor mining activity

Establish areas where no beach sand mining is allowed

Require and enforce permits for mining activities (work with local government)

Strengthen (or adopt) relevant laws and improve the effectiveness of law enforcement

Identify alternative sand sites/sources

Design and implement public education campaigns

Emphasize inter-agency coordination

Objective 3: Minimize egg depredation using the least manipulative strategy

Evaluate the effectiveness of nest cages and/or nest screens, using standard techniques

Evaluate the effectiveness of nest relocation, both *in situ* and hatchery, using standard techniques

Consider predator control, taking care to consider the broader ecological consequences of predator removal

Objective 4: Eliminate (or reduce to non-threatening levels) artificial beach lighting

Using standard techniques, shade or redirect beachfront lights that cannot be turned-off during peak nesting and hatching seasons

Consider beachfront lighting issues during permit and approval stages for new construction at known nesting beaches

Adopt local lighting ordinances obligating landowners to ensure that lighting associated with built structures at known nesting beaches does not interfere with nesting or hatching activity

Design and implement public education campaigns

Organize hatchling rescues (with immediate release) as a temporary measure, while implementing the above actions

Objective 5: Prohibit beach stabilization structures (e.g., seawalls, groynes)

Strengthen (or adopt) relevant laws and improve the effectiveness of law enforcement

Design and implement public education campaigns

Consider alternatives to hard-engineering stabilization options

Objective 6: Manage human activities during the nesting season

Design and implement public education campaigns

Strengthen (or adopt) relevant legislation

Ensure that nesting turtles have access to suitable habitat by removing beach "stuff" (tables, chairs, temporary structures, recreational equipment, etc.) at night during peak nesting and hatching seasons

Develop and implement a beach zonation system to ensure that primary nesting habitat is protected to the maximum extent possible in areas of high human use, especially during peak nesting and hatching seasons

Consider organized and guided public "turtle watches," using standard guidelines concerning the number of people per group, restrictions on lighting, and training for guides

Emphasize the collection or other management of waste generated at beach sites

Strictly regulate the use of vehicles on nesting beaches during peak nesting and hatching seasons

Objective 7: Control (manage) beach rebuilding and renourishment activities

Strengthen (or adopt) relevant legislation and improve the effectiveness of law enforcement

Design and implement public education campaigns

Enact restrictions on rebuilding and renourishment activity during nesting season

- ensure enforcement of restrictions
- ensure sand compatibility (sand characteristics) and other relevant technical requirements

Objective 8: Reduce beach debris

Undertake regular beach clean-ups

Utilize volunteers, NGO partners, and/or government agency programs

Eliminate or reduce the source of the debris problem

Design and implement public education campaigns on proper waste disposal, including the health and ecological consequences of litter

Promote inter-agency collaboration and cooperation

Encourage the media to become involved

Objective 9: Regulate coastal construction of buildings and infrastructure

Establish protected units/areas

Promote inter-agency coordination

Implement building setbacks (minimum distance requirements between buildings and the high water mark)

Strengthen (or adopt) legislation to preserve dunes and protect natural beach vegetation that serves to stabilize the beach

Review current legislation to ensure adequacy (types of structures permitted, size/density, zoning, timing, disposal of construction waste, etc.)

Improve the effectiveness of law enforcement and monitoring for violations

Design and implement public education campaigns

Objective 10: Control chemical/sewage/oil contamination

Strengthen (or adopt) and enforce specific legislation (domestic and international) for point and non-point source pollution (e.g., pesticide/herbicide management; oil use, disposal, exploration, and transport; upland runoff)

Design and implement public education campaigns

Improve the effectiveness of law enforcement

Emphasize adequate (and accessible) sewage treatment

Enact and publicize emergency response plans

Require clean-up/compensation by the responsible (polluting) party

Prohibit activities that are likely to result in contamination from occurring in or near sensitive areas, including known marine turtle nesting beaches

Objective 11: Reduce, to the extent possible, the negative effects of natural disasters/phenomena

Establish protocols for relocating unquestionably "doomed" clutches, such as eggs laid in well documented high-risk erosion zones

Adopt emergency plans for post-disaster responses to devastating episodic events

Recognize that some "natural" phenomena result directly or indirectly from improper water/land management practices

Adopt relevant legislation or other controls to minimize the damage

Chairman's comments: The Working Group voiced concern regarding threats in nearshore marine habitats adjacent to nesting beaches; these might include fishing activities (trawls, nets, seines), recreational activities (boating, jet skis), sources of pollution, and other disturbances. There was insufficient time to explore this concern. The Working Group recommended that actions to be taken within countries (as well as regionally) should be prioritized, and that priority ranking should take "feasibility" into consideration.

Reducing Threats on Foraging Grounds and Inter-Nesting Habitats

*Julia A. Horrocks, Working Group Chair
Department of Biological and Chemical Sciences
University of the West Indies
Barbados*

Goal 1: To achieve sound management of the marine turtle resource by maintaining, improving or restoring foraging and inter-nesting habitats

Objective 1: Map past and present quantitative and qualitative status and extent of foraging habitats

Objective 2: Identify, characterize and rank (as to their impact on local populations) present and potential threats to each foraging area

Objective 3: Develop and incorporate marine turtle habitat management plans as part of national Integrated Coastal Zone Management (ICZM) plans

Objective 4: Promote regional cooperation in managing critical habitats

Actions to be taken:

- Implement relevant portions of ICZMs

Goal 2: To achieve sound management of the marine turtle resource by minimizing threats to marine turtles on foraging grounds and inter-nesting habitats

Objective 1: Identify and rank present and potential threats to marine turtles on foraging grounds

Objective 2: Design and implement management plans to mitigate priority threats

Actions to be taken:

- Assemble and review existing information, nationally and regionally
- Identify information gaps and initiate efforts to acquire the necessary data
- Develop criteria to rank threats on foraging grounds and inter-nesting habitats
- Design and implement monitoring protocols to evaluate the result(s) of management actions

Chairman's comments:

The Group agreed to the following general recommendations:

Review legislation and law enforcement for adequacy and gaps

Incorporate useful program elements from the recommendations of Working Group IV ("Reducting Threats at Nesting Beaches"), since many coastal zone threats affect both sandy beaches and nearshore foraging grounds

The Group recognized the importance of reducing threats along migratory routes. There was insufficient time to discuss recommendations in this regard, but the Group felt the topic should be tackled separately and should include concern about the incidental capture of marine turtles in national waters and on the high seas.

Strengthening the Regulatory Framework

Jeffrey Sybesma, Working Group Chair
Faculty of Law
University of the Netherlands Antilles
Curaçao

Goal 1: To achieve sound management of the marine turtle resource by strengthening the regulatory framework at all levels

Objective 1: Strengthen the regional (international) regulatory framework

Stimulate and promote, on a practical level, cooperation among nations

Harmonize national regulatory frameworks for the protection and management of the natural environment, in particular marine turtles

Ensure that national obligations under international treaties and agreements are met on a timely and ongoing basis

Objective 2: Strengthen the national regulatory framework

Review existing legislation and regulations, identify gaps

Strengthen the national legislative framework by using the best available scientific knowledge and taking into consideration: stakeholders, enforcement capacity, public education, international and regional obligations, financial mechanisms, and existing laws pertaining to the conservation and management of marine turtles

Objective 3: Ensure public participation in the regulatory process

Design and implement public education campaigns

Ensure continuous education to all sectors and stakeholders, relative to the provisions and obligations of environmental legislation

Annex I

Marine Turtle Conservation in the Wider Caribbean Region:

A Dialogue for Effective Regional Management

Santo Domingo
16-18 November 1999

AGENDA

Tuesday, 16 November 1999

08:30	Host Government Opening Remarks
09:30	Welcome and Statement of Purpose
09:50	Meeting Mechanics, Appointment of a Rapporteur

Session I — Biology and Status

10:00	"Ecological Roles of Caribbean Sea Turtles" Dr. John G. Frazier, Smithsonian Institution
10:20	"Cultural and Economic Roles of Caribbean Sea Turtles" Lic. Didiher Chacón C., Asociación ANAI
10:40	*Coffee Break*
11:10	"Status and Distribution of *Dermochelys coriacea* in the Wider Caribbean" Dr. Karen Eckert, WIDECAST
11:22	"Status and Distribution of *Chelonia mydas* in the Wider Caribbean" Dr. Cynthia Lagueux, Wildlife Conservation Society
11:34	"Status and Distribution of *Caretta caretta* in the Wider Caribbean" Félix Moncada Gavilán, Centro de Investigaciones Pesqueras (Cuba)
11:46	"Status and Distribution of *Eretmochelys imbricata* in the Wider Caribbean" Diego F. Amorocho, WIDECAST (Colombia)
11:58	"Status and Distribution of *Lepidochelys kempii* in the Wider Caribbean" Dr. René Márquez M., Inst. Nacional de la Pesca (México)
12:10	"Status and Distribution of *Lepidochelys olivacea* in the Wider Caribbean" Maria Ângela Marcovaldi, Fundação Pro-TAMAR
12:25	Open Forum: Questions and Answers
12:55	Announcements
13:00	*Lunch*

Session II — Goals and Criteria

14:30	"Management Planning for Long-Lived Species" Dr. John A. Musick, Virginia Institute of Marine Science
15:00	"Management Goals and Criteria for Caribbean Sea Turtles" Dr. Nat B. Frazer, University of Florida
15:30	*Coffee Break*
16:00	Open Forum: "Criteria and Benchmarks for Sustainable Management of Caribbean Sea Turtles"
17:30	Session Conclusions and Recommendations of the Meeting
17:50	Appointment of a Drafting Committee
17:55	Announcements and Closing Remarks
18:30	Adjourn

Wednesday, 17 November 1999

08:00	Announcements and Opening Remarks
08:15	Meeting Mechanics, Appointment of a Rapporteur

Session III — International Cooperation

08:30	"Caribbean Sea Turtles and International Law" Dr. Nelson Andrade C., UNEP Caribbean Environment Programme
09:00	Open Forum: "Strengthening International Co-operation"
10:30	Session Conclusions and Recommendations of the Meeting
10:50	*Coffee Break*

Session IV — Meeting Our Goal:

Management Model Components I, II and III

11:20	Introduction of Panel Speakers
11:30	"Determining Population Status and Distribution" Dr. F. Alberto Abreu G., Univ. Nacional Autónoma de México
11:50	"Monitoring Population Trends" Rhema Kerr Bjorkland, Ministry of Agriculture (Jamaica)
12:10	"Promoting Public Awareness and Community Involvement" Crispin d'Auvergne, Ministry of Finance and Planning (St. Lucia)
12:30	Open Forum: Questions and Answers
13:00	*Lunch*

Session IV Working Groups

14:00	Topic I : Determine Population Status and Distribution Topic II: Monitor Population Trends Topic III: Promoting Public Awareness and Community Involvement
15:30	*Coffee Break*

Session V — Meeting Our Goal:

Management Model Components IV, V and VI

16:00	Introduction of Panel Speakers
16:10	"Reducing Threats at Nesting Beaches" Barbara Schroeder, U.S. National Marine Fisheries Service
16:30	"Reducing Threats on Foraging Grounds" Dr. Julia Horrocks, University of the West Indies (Barbados)
16:50	"Strengthening the Regulatory Framework" Dr. Jeffrey Sybesma, University of the Netherlands Antilles
17:10	Open Forum: Questions and Answers
17:30	*Adjournment*

Thursday, 18 November 1999

08:00	Announcements and Opening Remarks
08:15	Meeting Mechanics and Appointment of a Rapporteur

Session V Working Groups

08:30	Topic IV: Reducing Threats at Nesting Beaches Topic V: Reducing Threats on Foraging Grounds Topic V : Strengthening the Regulatory Framework
10:00	*Coffee Break*

Session VI Working Group Results

10:30	Topic I : Determining Population Status and Distribution Presentation of Results Discussion and Recommendations of the Meeting
11:00	Topic II : Monitoring Population Trends Presentation of Results Discussion and Recommendations of the Meeting
11:30	Topic III : Promoting Public Awareness and Community Involvement Presentation of Results Discussion and Recommendations of the Meeting
12:00	Topic IV : Reducing Threats at Nesting Beaches Presentation of Results Discussion and Recommendations of the Meeting
12:30	*Lunch*

14:00	Topic V : Reducing Threats on Foraging Grounds
	Presentation of Results
	Discussion and Recommendations of the Meeting
14:30	Topic VI : Strengthening the Regulatory Framework
	Presentation of Results
	Discussion and Recommendations of the Meeting
15:00	*Coffee Break*
15:30	Resolution: "Santo Domingo Declaration"
16:30	Appoint Drafting Committee for Proceedings
16:40	Statement of Gratitude to Host and Sponsors
17:00	Announcements and Closing Remarks
17:30	Adjourn

Annex II

Marine Turtle Conservation in the Wider Caribbean Region — A Dialogue for Effective Regional Management

***Santo Domingo
16-18 November 1999***

LIST OF PARTICIPANTS

Government Delegates

Anguilla

Rhon Connor
National Sea Turtle Project
Anguilla National Trust
P. O. Box 1234
The Valley
Anguilla BWI
Tel: (264) 497-5297
Fax: (264) 497-5571
Axanat@anguillanet.com
Racjac@hotmail.com

Antigua & Barbuda

Not present

Aruba

Facundo Jean Paulo Franken
Chief
Natural Resources Section
Dept. Agriculture, Husbandry and Fisheries (LVV)
Piedra Plat 114-A, Aruba
Tel: (297) 8-58102
Fax: (297) 8-55639
dirlvvm@setarnet.aw

Bahamas

Dr. Maurice Isaacs
Veterinary Officer
Department of Agriculture
Ministry of Agriculture and Fisheries
P. O. Box N-3028
Nassau, Bahamas
Tel: (242) 325-1173 / 325-3904
Fax: (242) 328-5874 / 325-3960
maurice@grouper.batelnet.bs

Ediston Deleveaux
Deputy Director
Department of Fisheries
Ministry of Agriculture and Fisheries
P. O. Box N-3028
Nassau, Bahamas
Tel: (242) 325-1173 / -3904 / -1978
Fax: (242) 328-5874 / 325-3960
mbraynen@grouper.batelnet.bs

Barbados

Christopher Parker
Fisheries Biologist
Fisheries Division
Princess Alice Highway
Bridgetown, Barbados
Tel: (246) 426-3745
Fax: (246) 436-9068
fishbarbados@caribsurf

Belize

Lic. Alfonso Avilez
Assistant Fisheries Officer
Department of Fisheries
P. O. Box 148
Belize City, Belize
Tel: (501) 2-44552
Fax: (501) 2-32983
species@btl.net

British Virgin Islands

Mervin Hastings
Marine Biologist
Conservation and Fisheries Department

Ministry of Natural Resources and Labour
P. O. Box 3323
Road Town, Tortola
British Virgin Islands
Tel: (284) 494-5681 / -3429
Fax: (284) 494-2670
cfd@bvigovernment.org
boodie@bvigovernment.org

Cayman Islands

Jonathan Aiken
Research Officer
Department of Environment
P. O. Box 486 GT
Grand Cayman, Cayman Islands
British West Indies
Tel: (345) 949-8469
Fax: (345) 949-4020
gina.ebanks-petrie@gov.ky

Colombia

Not present

Costa Rica

María Elena Herrera
Ministerio del Ambiente y Energía
Apartado 338
Guples, Pococi
Limn, Costa Rica
Tel: (506) 710-7542
Fax: (506) 710-7376
Tortuguero Tel: (506) 710-2929
melenahz@ns.minae.go.cr

Cuba

Dra. Elvira Adelaida Carrillo
Jefe del Programa de Tortugas Marinas
Centro de Investigaciones Pesqueras
Playa Barlovento, Santa Fe
5ta. y 2248, La Habana
Cuba
Tel/Fax: (537) 24 5895
cubacip@ceniai.inf.cu

Dalia Salabarria Fernández
Agencia de Medio Ambiente
Min. Ciencia, Tecnologia y Medio
Ambiente de Cuba
Tel: (537) 22 9351
Fax: (537) 24 9031
Dalias@unepnet.inf.cu

Dominica

Giselle Allport
Ministry of Agriculture and
the Environment
Government Headquarters
Roseau, Commonwealth of Dominica
Tel: (767) 448-2401 x3282
Fax: (767) 448-7999
pswillimas@cwdom.dm

Dominican Republic

José Miguel Martinez
Sub-Secretario de Recursos Naturales
Secretaria de Estado de Agricultura
Autopista Duarte Km 61/2
Jardines del Norte
A.P. 1472, Santo Domingo
República Dominicana
Tel: (809) 547-2189
Fax: (809) 227-1281 / -1186 / -532-5312
Surena@codetel.net.do

Ramón Ovidio Sánchez Peña
Director
Departamento de Vida Silvestre
Secretaria de Estado de Agricultura
Autopista Duarte Km 61/2
Jardines del Norte
A.P. 1472, Santo Domingo
República Dominicana
Tel/Fax: (809) 227-6550
Vida.silvestre@codetel.net.do

Gloria Santan Zorrila
Enc. División de Fauna
Departamento de Vida Silvestre
Secretaria de Estado de Agricultura
Autopista Duarte Km 61/2
Jardines del Norte
A.P. 1472, Santo Domingo
Republica Dominicana
Tel/Fax: (809) 227-6550
Vida.slivestre@codetel.net.do

Matilde Mota
Universida Autónoma de Santo Domingo
Facultad de Ciencias
Departamento de Biologia
Ciudad Universitaria
Tel: (809) 686-3346 / [casa] 682-7590
Matilde.Mota@codetel.net.do

France (French Guiana, Guadeloupe, Martinique)

Luc Legendre
Technicien
Direction Regionale de l'Environnement (DIREN)
B.P. 105-97102 Basse-Terre Cdex
Guadeloupe FWI
Tel: (590) 41.04.56
Fax: (590) 41.04.62
nat971@outremer.com

Grenada

Not present

Guatemala

Jorgé Alberto Ruiz Ordoñez
Delegado Regional para el Caribe
Consejo Nacional de Areas Protegidas (CONAP)
Vía 5, 4-50, zona 4
Edificio Maya, 4o.Nivel
Ciudad de Guatemala, Guatemala
Tel: (502) 332-0463
Fax: (502) 332-0464
Conapbarrios@guate.net
jaruizo@c.net.gt

Guyana

Not present

Haiti

Robert Badio
Director, Pesca y Acuacultura
Ministere de l'Agriculture, des Ressources Naturelles et du Developpement Rural
Damien, Route Nationale No. 1
B.P. 1441
Port-au-Prince, Haiti
Tel: (509) 558-0560 / 222-1867 / 249-4005 / 245-8655
(Alt.) Tel: (509) 245-8550 (Home)
Tel/Fax: (509) 245-1371 / 245-1008
Jrobert@haitiworld.com
focusvideo@yahoo.com

Honduras

Maria Gabriela Pineda de Arias
Bióloga
Departamento de Investigación y Tecnología
DIGEPESCA
Apartado 4652
Tegucigalpa, Honduras
Tel/Fax: (504) 232-4054
Tel: Central Office DIGEPESCA (504) 232-8600
Email: *none*

Jamaica

Andrea Donaldson
Director
Wildlife Unit
Natural Resources Conservation Authority (NRCA)
10 Caledonia Avenue
Kingston 5, Jamaica
Tel: (876) 754-7550 / 754-7570
Fax: (876) 754-7595
NRCA@infochan.com
Fmcdonald@agcdot.org

Mexico

Dr. René Marquez M.
Coordinador Nacional
Programa de Investig. y Manejo de Tortugas Marinas
SEMARNAP / INP
Playa Ventanas s/n.
A.P. 591, Manzanillo
Colima 28200
República de México
Tel: (52) (333) 23 750
Fax: (52) (333) 23 751
rmarquez@bay.net.mx

Montserrat

John Jeffers
Fisheries Assistant
Ministry of Agriculture, Trade and Environment
P. O. Box 272
Grove Botanic Station
Montserrat
Tel: (664) 491-2075 / -2546
Fax: (664) 491-9275
minifish@candw.ag

Netherlands Antilles

Paul Hoetjes
Policy Advisor
Nature and Environment Section
Department of Health and Environmental Hygiene
Government of Netherlands Antilles
Heelsumstraat z/n, Curaçao

Netherlands Antilles
Tel: (599-9) 465-5300
Fax: (599-9) 461-2154
paul@mina.vomil.an

Nicaragua

Sandra Varinia Tijerino Mejía
Ministerio del Ambiente y Recursos Naturales
Km. 12 1/2 Carretera Norte
Apartado Postal 5123
Managua, Nicaragua
Tel: (505) 233-1173 / 263-1271 / -1273
Fax: (505) 263-2595 / -1274
mins-mar@adnnic.org.ni

Panama

Not present

St. Kitts & Nevis

Ralph Wilkins
Fisheries Officer
Ministry of Agriculture, Lands, and Housing
Government Headquarters
P. O. Box 186
Basseterre, St. Kitts
Tel: (869) 465-2521
Fax: (869) 465-2635
fmusk@caribsurf.com

St. Lucia

Sarah George
Fisheries Biologist
Min. Agriculture, Fisheries, Forestry and Environment
P. O. Box 709, Castries Waterfront
St. Lucia
Tel: (758) 468-4145
Fax: (758) 542-3853
DeptFish@slumaffe.org

Dr. Marie-Louise Felix
Fisheries Biologist
Min. Agriculture, Fisheries, Forestry and Environment
P. O. Box 709, Castries Waterfront
St. Lucia
Tel: (758) 468-4145
Fax: (758) 542-3853
DeptFish@slumaffe.org

St. Vincent & The Grenadines

Raymond Ryan
Fisheries Officer
Ministry of Agriculture, Industry and Labour
Richmond Hill
Kingstown, St. Vincent
St. Vincent and the Grenadines
Tel: (784) 456-2738
Fax: (784) 457-2121
FishDiv@caribsurf.com

Suriname

Harrold Sijlbing
Director
STINASU
P. O. Box 12252
Paramaribo, Suriname
Tel: (597) 47 6597 / 42 7102 / 42 7101
Fax: (597) 42 1850 / 42 2555 (alt.)
stinasu@sr.net

Trinidad & Tobago

Stephen Poon
Wildlife Section
Min. Agriculture, Land and Marine Resources
Farm Road, St. Joseph, Trinidad
Republic of Trinidad and Tobago
Tel: (868) 662-5114
Fax: (868) 645-1203
Wildlife@trinidad.net

Turks & Caicos Islands

Not Present

United States of America (Puerto Rico, USA, US Virgin Islands)

Earl Possardt
International Sea Turtle Specialist
U.S Fish and Wildlife Service
University of West Georgia
Department of Biology
Carrollton, Georgia
30118-6300 USA
Tel: (770) 214-9293
Fax: (770) 836-6633
Earl_Possardt@hot.fws.gov

Venezuela

Begoña Mora Celis
Bióloga Direccion de Fauna
Ministro del Ambiente y de los Recursos Naturales Renovables (MARNR)

Torre Sur, Piso 26. Centro Simón Bolívar
Caracas 1010, Venezuela
Tel: (582) 482-6279 / 408-1038
Fax: (582) 484-6045
Profauna@marnr.gov.ve

Presenters

Dr. F. Alberto Abreu G.
Presidente
IUCN/SSC Marine Turtle Specialist Group
Estación Mazatlán
Instituto de Ciencias del Mar y Limnologia
Univ. Nacional Autónoma de México (UNAM)
A.P. 811, Mazatlan, Sinaloa 82000
República de México
Tel: 52 (69) 85-28-45 / -46 / -47 / -48
Fax: 52 (69) 82-61-33
abreu@ola.icmyl.unam.mx

Biol. Diego F. Amorocho
Asociación WIDECAST-Colombia
Calle 4B #38A-37
A.A. 44060
Cali, Colombia
Tel: (572) 557-4265
Fax: (572) 680-6711
widecast@widecast-col.org

Nelson Andrade-Colmenares
Coordinator
Regional Coordinating Unit
UNEP Caribbean Environment Programme
14-20 Port Royal Street
Kingston, Jamaica
Tel: (876) 922-9267
Fax: (876) 922-9292
nac.uneprcuja@cwjamaica.com

Lic. Didiher Chacón Chaverri
Coordinator
Proyecto de Conservación de las Tortugas Marinas
Programa Marino y Humedales
Asociación ANAI
Apdo. 170-2070, Sabanilla
San José, Costa Rica
Tel: 506-224-3570
Fax: 506-253-7524
tortugas@sol.racsa.co.cr
anaicr@sol.racsa.co.cr

Crispin d'Auvergne
Sustainable Development, Science and Technology Officer
Ministry of Finance and Planning
P. O. Box 709
Castries, St. Lucia
Tel: (758) 468-4461
Fax: (758) 451-6958
(Alt.) Fax: (758) 452-2506
dcrispin@hotmail.com

Dr. Karen L. Eckert
Executive Director
WIDECAST: Wider Caribbean Sea Turtle Conservation Network
17218 Libertad Drive
San Diego, California 92127 USA
Tel: (858) 451-6894
Fax: (858) 451-6986
widecast@ix.netcom.com

Dr. Nat B. Frazer
Professor and Chairman
Department of Wildlife Ecology and Conservation
Institute of Food and Agricultural Sciences
University of Florida
P. O. Box 110430
Gainesville, Florida 32611 USA
Tel: (352) 846-0552
Fax: (352) 392-6984
FrazerN@wec.ufl.edu

Dr. John ('Jack') Frazier
Research Associate
Conservation Research Center
Smithsonian Institution
1500 Remount Road
Fort Royal, Virginia 22630 USA
Tel: (540) 635-6564
Fax: (540) 635-6551 / -6506
kurma@shentel.net

Dr. Julia Horrocks
Senior Lecturer
Department of Biological and Chemical Sciences
University of the West Indies — Cave Hill Campus
P. O. Box 64
Bridgetown, Barbados
Tel: (246) 417-4320, 422-2087
Fax: (246) 417-4597, 422-0692
horrocks@uwichill.edu.bb

Rhema Bjorkland Kerr, M.Sc.
Curator
Hope Zoological Gardens

Ministry of Agriculture
Kingston 6, Jamaica
Tel: (876) 927-1085
Fax: (876) 977-4853
rhemaker@bellsough.net

Dr. Cynthia Lagueux
Associate Conservation Zoologist
Wildlife Conservation Society
185th Street and Southern Boulevard
Bronx, New York 10460 USA

Correspondence address:
Apartado Postal 59
Bluefields, RAAS, Nicaragua
Tel/Fax: (505) 822-1410 or 822-2344
clagueux@wcs.org

Maria Ângela Marcovaldi
Presidente
Fundação Pró-Tamar
Caixa Postal 2219
Salvador-Bahia
CEP:40210-970, Brazil
Tel: (55 71) 876-1045 / -1020
Fax: (55 71) 876-1067
neca@e-net.com.br

Dr. René Márquez M.
See "Delegate" (México)

Félix Moncada Gavilán, M.Sc.
Biólogo Pesquero
Programa de Tortugas Marinas
Centro de Investigaciones Pesqueras
Barlovento, Santa Fé
5ta. y 2248
La Habana, Cuba
Tel/Fax: (537) 24 5895
cubacip@ceniai.inf.cu

Barbara Schroeder
National Sea Turtle Coordinator
NOAA / National Marine Fisheries Service
Office of Protected Resources F/PR3
(Rm 13657)
1315 East West Hwy
Silver Spring, Maryland 20910 USA
Tel: (301) 713-1401
Fax: (301) 713-0376
Barbara.Schroeder@noaa.gov

Dr. Jeffrey Sybesma
Faculty of Law
University of the Netherlands Antilles
Jan Noorduynweg 111
P. O. Box 3059, Curaçao
Netherlands Antilles
Tel: (599-9) 868-4422 ext. 231
Fax: (599-9) 869-1765
j.sybesma@una.net

Logistical Coordinators

Yvonne Arias
President
Grupo Jaragua
El Vergel No. 33, El Vergel
Santo Domingo
República Dominicana
Tel: (809) 472-1036, 566-2798
jaragua@tricom.net
emys@tricom.net

Marydele Donnelly
Program Officer
IUCN/SSC Marine Turtle Specialist Group
1725 DeSales St. NW #600
Washington, D.C. 20036 USA
Tel: (202) 429-5609 ext. 684
Fax: (202) 872-0619
mdonnelly@dccmc.org

Miguel Jorge
Regional Marine and Freshwater Coordinator
Latin America and Caribbean Program
World Wildlife Fund
1250 24th Street NW
Washington, D.C. 20038
Tel: (202) 778-9624
Fax: (202) 296-5348
Miguel.Jorge@wwfus.org

Rapporteur

Verna G. Sybesma-Garmes
Panoramaweg 19
Curaçao
Netherlands Antilles
Tel: (5999) 4 653-629
jsybesma@curinfo.an