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Female olive ridley sea turtles (*Lepidochelys olivacea*) come ashore at sunset to nest during an "arribada" at Ostional, Costa Rica. © Doug Perrine/seapics.com

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Marine Turtle Newsletter 100: A Celebration

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A Celebration in Words and Pictures

It is a part of being human to feel the need to celebrate milestones. Welcome to the 100th issue of what has affectionately become simply the *MTN*. In the first issue of the *Marine Turtle Newsletter* in 1976, Nicholas Mrosovsky outlined the main aims of the publication:

1) to provide a forum for exchange of information about all aspects of marine turtle biology and conservation.

2) to alert interested people to particular threats to marine turtles, as they arise.

We are happy that it has served these goals admirably under the direction of its founding editor and those who carried on the editorship in turn: Nat Frazer (1984-1987) and Karen and Scott Eckert (1988-1997). We took over the helm in 1998 and are proud to have been involved with such an important publication.

To mark the first "century" of the *MTN* we have assembled an extra special issue of editorial articles by past editors, members of our editorial advisory board and other internationally respected colleagues concerned with the study and conservation of marine turtles, their habitats and their relationships with man.

The main body of this issue is made up by six opinion editorials designed to stimulate thought and debate within the community served by the *MTN*. Following on from these, we welcome letters of comment for publication in future issues. Founding Editor, Nicholas Mrosovsky starts off this section by elaborating the story of why the *MTN* became an independent entity from the IUCN-SSC organisation now known as the Marine Turtle Specialist Group and how important he sees the continued independent role of the publication. Nat Frazer and, in turn, Jack Frazier then ask us to reflect on what we should be doing in the future. Karen Bjorndal and Alan Bolten give their argument as to why we should set our sights on restoring sea turtle populations to levels at which they perform their ecological function. Charles Caillouet focuses on the relationship between US shrimp fishing, its assessment and the future of shrimp, shrimp fisheries and of course, the marine turtles. Finally, Lisa Campbell outlines some of the challenges we face before we can reach the goal of carrying out truly interdisciplinary research.

The final three editorials are excellent reviews of sea turtle conservation by authors deeply involved at a regional level on the Atlantic coast of Africa, in Latin America/the Caribbean and in South and Southeast Asia. We would hope to follow-up these regional perspectives with others in future issues. The 100th issue is rounded off by the most up-to-date News and Legal Briefs and Recent Publications sections.

However, many of us are enthralled simply by the look of marine turtles and, to add to the celebration, we are privileged to include the wonderful photos of ace photographer and marine turtle enthusiast, Doug Perrine (seapics.com). We thank him for his generosity. In choosing the pictures we have used one of each extant species and a number of life-cycle stages.

An Online Milestone

April 2003 does not just see the publication of *MTN* 100 but it also marks the passing of a key stage in the evolution of the *MTN Online*. Since 1998, Online Co-ordinator Michael Coyne has been working incrementally to ensure the ambitious goal of getting the *MTN* on the web. This was a difficult task which was given a boost by the involvement of IT consultant and sea turtle enthusiast Anton Holland of NIVA. At time of publication we fully expect to have all 100 issues of the *MTN* on the web as HTML and fully searchable. Adobe .pdf files in the archive will gradually be augmented until all are present and correct. The utility of the online version is demonstrated by the increasing number of our readers who are forgoing the hardcopy and subscribing online to receive updates as to when the new issue is available for downloading or browsing. Additionally, the documented online usage tells a story. In the first two months of 2003, there were over 150,000 pages of the *MTN Online* requested; a staggering rate, taking the total number of requests to more than 1.5 million. Adobe .pdf files of all but the most recent issues of the *MTN* have been downloaded more than 15,000 times, with each issue of the *NTM* downloaded over 5,000 times. It appears that with all past issues online, the only way is up! Please consider using the online version yourself.

Editorial Advisory Board

When we took over the editorship in 1998, we selected a six-strong Board of Editorial Advisors including the Founding Editor and Editor Emeritus. The board was augmented by four additional members in 2001. We are most grateful to all our Board members for the dedication and hard work they have put in over the years. This is especially true of Anders Rhodin who since our tenure began as editors has managed the finances under the auspices of the Chelonian Research Foundation, carried out the lion's share of the fundraising and maintained subscription database. This help has been invaluable, allowing us to grow into the roles of editors whilst he did much of the more mundane work. Unfortunately, additional commitments mean that Anders will soon have to step down from his multiple roles with the *MTN* and we will see him leave the Board after one more year in April 2004 once he has helped oversee the financial transition to our new home at SEATURTLE.ORG. *MTN* 100 sees us say farewell to Board Members Jack Frazer, Peter Lutz and Jeff Miller. We no doubt join with the readership in thanking them for their efforts. We will appoint a new group of board members to join the team in the near future.

A New Financial Home and a New Appeal

The *MTN/NTM* has now moved from under the financial umbrella of the Chelonian Research Foundation and financial matters will now be handled by SEATURTLE.ORG. This independent NGO has been home to the *MTN*-online since its inception and has full non-profit status, which means that donations will be fully tax deductible under US laws governing 501(c)(3) non-profit organisations. Thank-you to Michael Coyne for taking on this additional task.

It is remarkable that the *MTN* has survived so long without compulsory subscription. This is due to a massive volunteer effort and the profound generosity of our individual and institutional donors. We would very much like this to continue the subscription-free tradition and so ask you to show your appreciation for this key resource by completing the Annual Donations Appeal on the inserted coupon. Remember, although the *MTN* is accessible online, the relatively expensive hardcopy will still be needed for distribution to researchers, educators and managers throughout the developing world. Please give generously!

Thank you!

Over the past 5 years many people have helped us produce the *MTN*. Not only do we have all our past and present editorial board, and Online and *NTM* coordinators to thank, but a host of referees, reviewers and contributors. Please continue to send us your results and thoughts and encourage those that you work with to do the same. There are many people out there who wish to share your knowledge to fully understand and conserve marine turtles. Thank you!

Mating green turtles (*Chelonia mydas*) off Sipadan Island, Malaysia. © Doug Perrine/seapics.com

MTN 100: Looking Back, Looking Forward

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The hundredth issue of the *MTN*! — well, strictly speaking only the 87th because the first 13 issues were the *Marine Turtle Newsletter IUCN/SSC*. It was only in the 14th issue (1980) that this publication became the plain *Marine Turtle Newsletter* (Fig 1). Therein lies a story whose retelling defines one of the roles for the *MTN*.

The Newsletter started in 1976 when the IUCN/SSC Sea Turtle Group (now called the MTSG) realized the need for better communication between conservationists and turtle biologists scattered in different parts of the world. For example, in 1975 those in charge of leatherbacks in Terengganu, Malaysia, were unaware of various important papers on this species published by Pritchard and others in N. America; and many in N. America were uninformed about the situation of turtles in other parts of the world. In this context, I offered to produce a newsletter, an idea enthusiastically promoted by Tom Harrisson, co-chair of the MTSG. On his untimely death, fund raising initiatives for the *MTN* devolved on me also. Most of the articles in the early issues were uncontroversial, as is still the case, but there were occasional potentially contentious pieces such as those exploring what might now be called sustainable use (e.g., Hughes 1979).

As an academic editor, I had naively assumed that those wanting to disagree with anything would send in rebuttals and counter opinions, just as there had been discussion in the early issues on technical matters such as tag loss and head-starting. Instead, there were attempts at the World Conference on Sea Turtle Conservation, held in Washington, D.C., 26-30 November 1979, to set up some screening committee that would in effect determine what was to be published. Without that change, it was hinted, support for the *MTN* from the IUCN was in jeopardy (in fact, most of the support for early issues came from WWF Canada).

These events led to the *MTN* becoming independent in early 1980. The newsletter then went through some turbulent passages but at a critical juncture was kept financially airborne by the Mittag family, at that time owners of the Cayman Turtle Farm. There were those who felt that support from such a source would compromise the freedom of the *MTN*. The irony in this was that it was people from academia and conservation organizations who had tried to impose controls on content as a condition for sponsorship, whereas the industry support came with no strings attached.

Attempts to marginalise the *MTN* were exemplified by what happened to resolutions passed at the World Conference on Sea Turtle Conservation (1979) in Washington. Action project 11, which was adopted at a plenary session of this conference, read:

> *The IUCN/SSC Marine Turtle Newsletter should make biologists and government conservation officials aware of the latest information on sea turtle conservation, management, and research and the status of implementation of the Sea Turtle Conservation Strategy.*

In a rewritten version of this resolution, sent out about March 1980 to those who had participated in the conference, the wording was altered from that voted on to:

> *Governmental and nongovernmental conservation agencies and organizations should make biologists and governmental conservation officials aware of the latest information on sea turtle conservation, management, and research, and the status of implementation of the Sea Turtle Conservation Strategy through newsletters and other media (e.g., IUCN/SSC Marine Turtle Newsletter).*

In the final version published in the proceedings as part of a Sea Turtle Conservation Strategy (Bjorndal 1981), all reference to the *MTN* had been purged, the

Figure 1. Top: heading on first issue of the *MTN*. Bottom: heading after the *MTN* became independent.

words in parentheses above being dropped, despite the March 1980 MTN (#14) having stated that it stood ready to help with dissemination of such information.

Why go over these old battles? The reason is these issues are still with us today. There are still groups today that fail to listen to or incorporate in their discussions the diversity of existing views. In 1996, without either seeking input from its membership or informing them afterwards of its action, the MTSG endorsed a pamphlet (Species Survival Network 1996) with guidelines for sustainable use of wild fauna and flora. This is not the only case of documents being inappropriately distributed in this way with the name of the MTSG on them (see Mrosovsky 1997). In taking this approach to controversial issues the MTSG forced expression of other views to take place outside of the ambit of its influence, and cut themselves and others off from potentially productive and energizing debate:

> *A strong case can be made that progress has been most rapid when debate has been the most vigorous and a "creative tension" has forced the evaluation of alternative strategies in the field, with resolution of conflicts based on data rather than on authority or impassioned argument.*

These words come from Noel and Helen Snyder's (2000 p. 372) riveting book about their experiences with conservation of California condor, a subject even more searingly intense — can you imagine that? — than sea turtle conservation. The Snyders note the tendency of organizations or individuals to seek victory by "silencing opposition by the exclusion of opponents from the debate".

It is in this kind of climate that the MTN's role of publishing a variety of viewpoints has been, and for the moment still is needed. Although the vast majority of material in the MTN is uncontroversial, this newsletter fills an important niche simply by being there as a place where contentious matters can be aired. We are much concerned about biodiversity, but what about diversity of the mind and of ideas, ideodiversity? As Nat Frazer wrote in a letter about the time he took over editorship, "the sea turtles themselves will not be served if any voice is stilled .... as a scientist, I can learn most from those who disagree with me most forcefully".

In 1979/1980, as well as loosing an opportunity for dialogue and dialectic, the MTSG lost a vehicle of communication which has not been since adequately replaced. A MTSG Bulletin of limited scope appeared sporadically in the mid to late 1990s but was mostly so anodyne as to exclude discussion of controversial issues. Communication has continued to be an openly acknowledged problem within the MTSG. For example, had the MTSG had a proper system of communication, and had they used it to consult with their membership, the red listings in 1996 might not have caused so much fracas, including calls for documentation and appeals against the listings.

I hope the MTSG will take up the offer, repeatedly made, for a page or two in the MTN, to make announcements, help keep in touch with their members, and publicize their activities.

Of course, apart from being a publication independent from governments or NGOs, a home for ideodiversity, probably the most important function of the MTN is the exchange of information. Its survival for 26 years attests to its value. Will the MTN see another 100 issues in that role? Although personally attached to this publication-I find it useful and like its familiar humanized logo-I see no ineluctable mission to sustain it. The MTN is simply a vessel for carrying thoughts and information. The recent publications section is arguably the most useful feature of the MTN, giving, as it should, the addresses of authors who can then be contacted for details. If a vessel of other shapes, sizes and colours proves superior, so be it. Increased use of electronic communication seems likely.

However, some things may never change. It has been a continual struggle to maintain the MTN without subscriptions, to make sure that it can go to places and people who most need it and might least be able to afford it, and to cover editorial and publication costs as well as those for translation of the Spanish edition. The MTN is like a leatherback with the financial flippers of a ridley. So please, if you find this publication of any use, and have not done so recently, send a contribution by way of saying thank you and happy birthday, MTN!

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Concerning Those Things Which We Ought to Have Done: Reflections on the Future of Sea Turtle Research

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Since beginning my study of comparative world religion at 12 years of age, I occasionally seek new insights by returning to my native sect, closely akin to the Church of England. A passage in the General Confession has haunted me since childhood: "We have left *undone* those things which we *ought* to have done" (Church of England 1992, emphasis mine). And so I found myself contemplating those things which we ought to have done concerning sea turtle research.

We have met annually to present research findings since 1980 at the Symposium on Sea Turtle Biology and Conservation and have shared our results in the *Marine Turtle Newsletter* since 1976. These interactions center on reporting what we *have done*; there's little discussion of research we *ought to be doing* that we are *not* doing.

Important regional meetings addressing sea turtle management and conservation (e.g., in the Mediterranean, the Wider Caribbean, the Indian Ocean and Southeast Asia, the Western Pacific, Latin America, the Californias and elsewhere) typically identify research needs. Some specify research necessary to provide a basis for sound management (e.g., Eckert & Abreu Grobois 2001). However, it is rare for us to gather for the sole purpose of identifying and prioritizing research needs.

In 1989 invited participants to a three-day workshop in New Orleans, Louisiana (USA) reached a consensus on research priorities to enable the US Department of Commerce to ameliorate the impacts of offshore gas and oil drilling platforms on sea turtles in the Gulf of Mexico (Tucker & Associates Inc. 1990). Concurrent sessions resulted in the identification of over 30 specific research priorities. Unfortunately, the list received little circulation beyond those who attended the workshop. No attempt was made to determine who should address each priority, or to produce a list of individuals and agencies currently addressing any of the 30 topics. There was no entity charged with seeing that the projects would be initiated.

Although it is important to list research topics that we think are important regionally or globally, such lists do not typically result in the planning of new research efforts in any coordinated way. Thus, some very important areas of potential research receive little or no attention at all.

The Global Strategy (MTSG 1995) and various marine turtle action plans notwithstanding, there is little or no strategic planning of the type I envision. We must organize ongoing and future research into meaningful categories specifically to foster interaction among investigators and enable new investigators to identify more experienced practitioners for advice and counsel. The same structure should be mirrored in our symposia and workshops so that the same clusters of researchers continue to interact – not just hearing papers on what each has done, but also planning future work in concert. This would help to ensure a sufficient, but not wasteful, level of redundancy. It would be instructive to spend an entire meeting discussing only those topics about which too little or no research is being conducted.

Thus, there are two things we must do. First, we must organize our existing research efforts in a way that makes us easily aware of who is doing what. This effort also would enable each of us to ensure that our research methodology complements the efforts of others. It also should identify gaps in which research has been left undone. The second thing we must do is to begin immediately promoting and conducting research in important neglected areas, both topical and geographical.

I propose one possible framework, parts of which were suggested by another group seeking to coordinate their work (US Department of Energy 1994). Sea turtle research, symposia, and workshops might be organized in the following five major categories:

- Assessment and Monitoring
- Prediction and Modeling
- Technical Development
- Socio-Economic Analysis
- Demonstration and Evaluation

Assessment and Monitoring

Obviously, we must continue studying sea turtles, their habitats, and the impacts of human activities on their individual and collective health. This should include assessing and monitoring the effects of disease,

contaminants, and human activities on the key demographic components of survivorship, fecundity, age at maturity and longevity. We should expand our assessment of behavior and physiology. We must assess conservation activities and monitor the human and turtle populations subjected to them. And we must keep track of who is doing what and where, and identify research topics and geographical areas receiving too little assessment and monitoring.

Prediction and Modeling

We must develop methods to predict the turtles' responses to human activities, including responses to our conservation activities. Models allow us to put together all of what we know (or *think* we know) about a population, to identify areas of missing information, to assess the consequences of assuming alternative values for missing information, and to determine which information is critical to furthering our understanding. Models also allow us to assess the sensitivity of our predictions to errors in assumed or unknown values. Most of the advances in our population models will result from acquiring better data and some measure of the variance of key life history components. We must continue to update previous models as more recent data become available (Heppell *et al.* 2003).

We should work with ecological toxicologists to create models predicting the movement and ultimate fate of specific contaminants, both in sea turtles' habitats and in their bodies. Such efforts require us to gather information on the interactions of pollutants and environmental conditions, and to determine the pathways, sinks, and effects of contaminants. We also must work with epidemiologists and oceanographers to produce predictive models of the vectors and spreading of known diseases between and among sea turtle populations.

We must improve our understanding of how sea turtles have dealt with the vagaries of weather and climate change through tens of millions of years in order to create models predicting their response to climate change. We also need better models of sea turtle behavior. Again, we must know who is modeling what and identify important processes for which models have not yet been developed.

Technical Development

We must develop better technology for following turtles at sea (e.g., tags and transmitters) and for ameliorating the effect of human activities (e.g., new TEDs and long-line hooks). We must work with biochemists and physiologists to improve methods of identifying gender and assessing health. We must improve methodologies for epidemiological and toxicological studies, and for diagnosing and identifying diseases. It is necessary to develop new population modeling software to overcome the continuing difficulty of obtaining information on sea turtles. The "partial life cycle models" developed by Oli and Zinner (2001) might be adaptable to allow us to deal with vagaries of sea turtle life histories. And we should pay particular attention to technologies that can be adapted from other fields (e.g., laparoscopy from the medical field). We also must determine the technological needs not being addressed.

Socio-Economic Analysis

All aspects of the social and cultural attitudes towards sea turtles require much more attention, but I shall mention only one – the determination of the economic value of sea turtles. As one who has given much thought to the spiritual and ecological value of sea turtles, I confess discomfort at assigning a monetary value to turtles or any of their parts. But we must learn to do this if we are to communicate effectively with some sectors of the public to convince them that they, too, have sound reasons for conserving turtles. The economic valuation of sea turtles is a complicated process (Witherington & Frazer 2003) and I shall mention only certain aspects here.

One reason that we pay so little attention to economic aspects of sea turtles may be that the goals of neoclassic economic models often are in direct conflict with our goals as conservationists (Hall *et al.* 2000). A second may be that many of us lack formal training in economics and therefore find economic analyses difficult to understand. But some economic studies are neither draconian or nor unintelligible. Indeed, some economic analyses are building cases that justify the protection of sea turtles.

Most notable among those assessing the consumptive value of sea turtle products and the conditions necessary for sustainable harvest are Campbell (1998) and Hope (2000), both of whom studied the egg harvest at Ostional, Costa Rica. Both of these investigators understand that it is necessary to consider conditions necessary to support both the economic and biological sustainability of the harvest. And both recognize that consumptive use may play an important role in species conservation under carefully controlled scenarios. We need many more such studies to address the socio-economic and biological impacts of consumptive use of

eggs for species that do not nest in *arribadas*, as well as for harvesting of meat and tortoiseshell.

Few studies have addressed the value of sea turtles in the USA. Whitehead (1993) found that residents of North Carolina were willing to pay approximately $11 annually per person to keep loggerheads in existence for the next 25 years. In a study about public attitudes toward the coastal environment and marine resources in Florida (Milon *et al.* 1998), most respondents indicated that funding for environmental protection should be increased, and there was evidence linking their attitudes about sea turtles with attitudes favoring increased funding for environmental protection in general. People surveyed on Florida beaches were willing to pay higher parking fees in support of beach renourishment if it resulted in improving sea turtle nesting habitat (Shivlani *et al.* in press). I find it embarrassing that we in the USA have so little understanding of the non-consumptive economic value of sea turtles.

No one has provided a better assessment of the non-consumptive value of sea turtles for ecotourism in a developed country than have Tisdell and Wilson (2001a, 2001b; Wilson & Tisdell 2001) for the nesting beach at Mon Repos in Australia. They estimated that the effect of turtle-watching visitors on the local economy was approximately $450,000 US per year (Tisdell & Wilson 2001a). They also found that tourists who had seen nesting or hatchling sea turtles on their visits were more willing to pay to conserve them (Tisdell & Wilson 2001b), and shed light on the numbers or densities of nesting turtles necessary to sustain a viable sea turtle ecotourism project (Tisdell & Wilson in press). Similar studies should be conducted on other beaches that support ecotourism. We also need studies to determine if other sites have the potential to support sustainable ecotourism.

This general type of study (e.g. contingent valuation) is not without criticism within the economic community because: (1) respondents may be asked to consider issues for which they previously might have had no opinions (Hannemann 1994), and (2) respondents' stated willingness to pay additional costs does not usually result in their actually having to pay those costs (L. Campbell pers. comm.).

But with the proper design and care, I am convinced that meaningful results can be obtained, as is the case with Tisdell and Wilson's efforts (2001a,b, in press; Wilson & Tisdell 2001). And I am intrigued by the potential insights we might gain from additional studies conducted with similar care. Would people be willing to pay more for shrimp or finfish if they knew it had been caught by means that do not endanger sea turtles? If so, how much more? Could the increased cost help to defray the expense of refitting trawl nets with new TEDs or refitting long lines with hooks less lethal to sea turtles? Carefully conducted economic studies might help to answer these and other important questions. The answers may help us to build convincing cases for conservation among non-conservationists and also to find the means to fund it.

Identifying and promoting the needed research will require us to identify willing colleagues among natural resources economists who can help us design and carry out the projects. Perhaps economic modeling and prediction eventually could be subsumed under the Modeling and Prediction category.

Demonstration and Evaluation

For the activities outlined above, we must demonstrate that research projects are effective and evaluate them for their efficacy, continued methodological improvement, and cost-effectiveness. Conservation projects should serve as open demonstrations of applied research. We also should promote meetings among those who are working on similar research projects, encouraging ongoing constructive criticism. Those planning new projects could benefit from consulting those experienced with similar techniques. No project should be initiated or continued without a thorough evaluation of the proposal. The annual Symposium could be organized around the five general topics outlined above. At a special sixth session, a limited number of papers – only those reporting results that offer truly novel insights into sea turtle biology, behavior or conservation – should be allowed ample time for mediated dialogue among attendees. In this scenario we present our research to others mainly so that they can evaluate it through constructive criticism directed towards improved understanding.

What Shall We Do?

If there is no agency to produce a strategic research plan or promote and regulate its implementation, then what shall we do? In the absence of a formal organizational structure, we must self-organize and empower ourselves. This will require at least three years of concerted effort.

Should we elect to begin immediately, I suggest the following general approach. During 2003, the IUCN Marine Turtle Specialist Group could draft an initial

plan by forming subcommittees for the five areas outlined above. During 2004, the *MTN* and CTURTLE (or a special chat-room) could serve as sounding boards for critiquing the draft and ensuring that a diversity of voices is heard. This would allow constructive feedback on the prioritization of research needs. It also would enable respondents to help tabulate existing research. In 2005, the 25th Annual Symposium on Sea Turtle Conservation and Biology could provide the venue for energetic open discussion and debate on the draft strategic research plan, with sessions on each of the five topic areas and a general vote at the final plenary session to endorse the revised draft and the idea of incorporating the sixth session at future meetings.

By doing this, we shall set a new standard for the future of sea turtle research. We also will ensure that our symposia, workshops and regional meetings always acknowledge and address *those things we have left undone which we ought to have done.*

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Why Do We Do This?

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With few exceptions, few of us have horny beaks – we are not marine turtles. Yet, many of us behave as if we were turtles, or at least as if our emotional, intellectual, spiritual, and social bases were sustained firmly upon the keratinous back of a marine turtle. The community of marine 'turtleologists' is renowned for the intensity and dedication that is devoted to its work – as if this were a religion. Why is this? Why do we do this?

In some cases the motivations are relatively clear: it's a job, it provides financial income and some form of social security, it's a tradition, it's a consultant's position, it's a livelihood and source of food and sustenance, it's a source of social recognition and prestige, it's a hobby, it's 'fun', and so on. But often there is another consideration – indeed, for many of us it is most definitely NOT a job, nor a source of social security, nor a significant source of material sustenance – it is almost to the point of being 'a way of life', if not a penance. The amount of devotion, dedication, motivation, and yes, passion, that is commonly part and parcel of marine turtle work is remarkable. This generality is true with youngsters who have just discovered turtles, as well as with mellowed, grey-haired elders who have been at it for half a century.

Doubtless, there is no small amount of romanticism that keeps many of us focused on these 'forerunners of the dinosaurs' (the turtles, not the grey-haired elders). There is something overpoweringly primeval, ancient, 'wild', 'natural', … indefinably fascinating in a marine turtle. Intellectually we may 'know' and even argue that there is no such thing as a 'pristine coastal environment' (Jackson, 2001; Kirch 1988: 247), that 'entire island ecosystems must be understood as the consequences of human actions' (Kirch 1988: 250); and while we may grant that these reptiles have been shaped over past millennia by humans – that they are perhaps even 'semi-domesticated' (Frazier 2003; in press a), our fascination with them is not diminished. There appears to be something so primal and fundamental in associating with these unique creatures that they nurture basic needs and desires 'to be connected with nature'.

Clearly, there is adventure and excitement involved in turtle work, spiced with varying amounts of hardship, risk, and discomfort. How many turtlers have spent countless, long nights trudging through endless kilometres of soft, sandy beach in the hopes of encountering a nesting turtle? How many have camped on nesting beaches for extended periods with only the minimum (or less) of food and water? What of the indescribable – and everlasting – odours left from working up necropsies, or nest contents, of long-dead, putrefied turtle carcasses and eggs? The trials and tribulations of community workers and educators, as they struggle to develop and maintain activities without adequate resources, braving the turbid waters of social-political tempests are harrowing enough, but when intermeshed with an endless array of environmental conundrums, the frustrations and risks seem infinite. (Of course, this is not to ignore those who dwell in laboratories, transfixed long into the night by their computer screens or doubled over lab benches inhabited by jungles of aliquots and equipment; and it would be a travesty to disregard those dedicated administrators who battle endless, omnipotent bureaucracies to bring support to others. But, these latter activities could rarely be described as 'natural excitement'!).

The numbers involved in the turtle community are impressive. Close to a thousand souls attend the annual symposium, with representation from almost half the countries that are members to the United Nations, hundreds of organisations, and virtually all sexes, ages, races, disciplines, and walks of life (*e.g.*, Possardt 2002). A quick perusal of the contents page of the proceedings of this annual meeting, now moving into its 23rd year, can only impress one at both the quantity and diversity of information and activity (*e.g*,. Mosier *et al*. 2002). Additional to this, the mother of all turtle marathons, there are dozens of other marine turtle meetings and events every year, at national and regional levels; a perusal of the 'Meeting Reports' and 'Announcement' sections of the *Marine Turtle Newsletter* clearly shows how many and varied the activities and events can be. The Central American Marine Turtle Network (Anon, 1997; Anon, 1999), the Inter-University Reunion in Mexico (Benabib & Sarti 1992) and the Wider Caribbean Sea Turtle Conservation Network (WIDECAST) have been especially active and consistent, the last-named for nearly two decades (Eckert 2002). Indeed, one could fill the year by going from

turtle event to turtle event. The importance of these various meetings is revealed at many levels. There are intergovernmental events attended by plenipotentiaries to debate and negotiate treaties and other international instruments that are focused exclusively on marine turtles (*e.g.*, Frazier 2002); regional dialogues that work toward developing better understanding, communication, and cooperation between national entities (*e.g.*, Al Ghais & Frazier 2001; Eckert & Abreu 2001); national and regional workshops for capacity building and regional coordination (*e.g.*, Godley *et al*. 2002; Guada *et al*. 2000; SEAFDEC 1997; Try *et al*. 2002); and regional symposia (*e.g*. Pilcher & Ismail 2000). At the other end of the scale, community groups meet and deliberate common problems relevant to their interactions with these reptiles, with no less seriousness, political pressure, or commitment (*e.g.*, Palma *et al*. 2002; Pesenti & Nichols 2002). The amount of scientific research published annually, focused on just these seven species of turtle, is truly daunting, and quite impossible to keep up with. In just one year more than a hundred publications that have direct relevance to marine turtles and their interrelationships with humans may appear in scholarly journals, not to mention entire books focused on these marine reptiles. These writings span disciplines from anthropology, to biology, to climatology, to law and policy, to marine biology, to technology, … to zooarchaeology; and this is not to mention many more articles relevant to the concepts and environments in which the turtles swim, nor to disregard the importance of productions in the popular press and diverse media. Moreover, some of the marine turtle work is at the 'cutting edge' for western science, policy development, and community participation in general, with significant impacts on a wider body of information and a larger corpus of students and concepts. Obviously, a key vehicle of communication and coordination for more than a quarter of a century in the midst of all this is the *Marine Turtle Newsletter (MTN)*, regularly distributed to more than 2000 addresses in more than 100 nations.

At one level marine turtle work shows clear deification of 'science' and its most glorious practitioners, with the not-so-hidden addiction to advanced technology. Yet, there are also powerful humanistic, social, and policy components; and of late specialists from outside the conventional portals of the biological sciences have been appearing more frequently, more numerously, and with greater integration and impact into the main mass: for example, Bache's (e.g., 2002) evaluations of international policy and marine turtle conservation, Campbell's (2003a) recent chapter 'Contemporary culture, use, and conservation of sea turtles' in *The Biology of Sea Turtles*, vol. 2, and her contribution to this issue of the MTN (Campbell 2003b). 'Interdisciplinary' approaches and research are very much in fashion, and the term is bandied around with other contemporary jingoisms like 'sustainable development' and 'sustainable use' (Frazier 1997; Jackson 2001). But, in fact the marine turtle community has been involved in this approach for decades; many of its members have a deep dedication to exploring – and understanding – outside their respective 'disciplinary boxes'. Take the composition, structure, and function of the annual symposium: the founders made certain decades ago that there would be a diversity of opinions and representation at the event, with the freedom and dignity to air diverse views (*e.g.*, Richardson & Richardson 1995). In addition, The Global Strategy of the Marine Turtle Specialist Group very explicitly articulates the need to integrate diverse actions, disciplines, and initiatives (IUCN 1995). This is not to suggest that the lofty goals of truly ***inter***disciplinary work have been reached (see Campbell 2003b), but there is a widely held conviction that we ***must*** work toward interdisciplinary actions.

Perhaps it is the nature of the beast that attracts humans of like mind: resilient to hardship, or at least not seriously addicted to creature comforts; dedicated (i.e., close to impossible to deviate from a course once it has been chosen); at home in a variety of environments; and perhaps most important, of broad (international) vision. Because an individual marine turtle may disperse and migrate over thousands of kilometres of ocean, living in the territorial waters of various nations, as well as on the open seas – the 'global commons', to understand these animals one must be able to appreciate the complexity of the world as they experience it.

With these introductory accolades one might – nay, ***must*** – ask: are we successful? At first the question seems obvious enough, but how to measure success? Who sets the standards for success? And who makes the evaluation? There can be no doubt that as a result of all this activity, information is more abundant, more available, more sophisticated, and even more integrated in many aspects. No doubt either, that far more people than ever before are informed about these fascinating, complex animals, their value to diverse societies, and the plight that many turtle populations have met in the past few decades. But here, at what might seem to be a common point of agreement, we reach a note of discord. Various intergovernmental organisations, governments, non-governmental organisations, and other interested

groups have categorised marine turtles as requiring special conservation attention. Information from numerous and diverse sources shows that there are many reasons for concern about the status of these reptiles; reviews done more than two decades ago on declines and disappearances of nesting populations around the world (King, 1982; Ross, 1982) are no less worrying than are more recent, thorough, specialised reviews on single species (Bolten & Witherington 2003; Meylan & Donnelly 1999; Pritchard & Plotkin 1995; Seminoff 2002; Spotila *et al.* 2000; TEWG 1998). In a word, these animals have been subject to intense (over)exploitation, around the world, and going back no less than seven millennia (Frazier 2003). Environmental archaeologists working in the Arabian Gulf, Caribbean, and Pacific have argued that populations of marine turtles were decimated, often with the first wave of 'indigenous colonists' (Frazier in press a). Nowadays, in addition to direct exploitation, other human activities have also resulted in significant threats to marine turtles, such as habitat perturbation and degradation, pollution, and more recently, incidental capture by mechanised fisheries (Lutcavage *et al*. 1997).

Indeed, the World Conservation Union (IUCN), reputed to be a world authority on the matter of conservation status of species, recently listed six of the seven species of marine turtle as either 'endangered' or 'critically endangered' (Hilton-Taylor 2000; S&PS 2001). The seventh, the Australian flatback (*Natator depressus*), is listed by the IUCN as 'data deficient' (S&PS 2001). These listings are done on the basis of a series of numeric calculations regarding population sizes, trends (*e.g*., declines), and generation times (IUCN, 2001a; 2001b).

One might marvel at the wisdom that professes to compress into a few numbers the biological, evolutionary, economic, and political status of globally distributed species, with highly complex life cycles, delayed maturity, overlapping generations, discrete breeding populations, and other biological attributes that leave ***any*** such species on this planet highly susceptible to human activities, particularly exploitation and habitat disturbances (Crouse 1999; Musick 2001). These reductions of complex biological, ecological, economic, and political relationships into a handful of numbers, show the power of western science – or at least the power that many practitioners firmly believe that they have, as bearers of 'the truth' (Caldwell 1990; Dermitt 2001).

But we need to step back from the illusion. With the tremendous increase in scientific activity and information since the end of World War II, we must ask if we are clearly living in a better world, and central to this article – are populations of marine turtles now more secure than they were before? With the aid of this 'new found knowledge', are conservation, environmental, and social problems necessarily being solved more effectively, more readily, more justly? Me thinks not (Frazier in press b). 'Science is a human invention and a cultural artefact' (Caldwell 1990: 5). Leaving aside that in many post-modern societies there is an active, even purposeful, confusion between science (ideally, the gathering and organising of information) and technology (pragmatically, the application of information toward fulfilling certain human goals and desires, and more and more requiring access to considerable capital), we need to be much, much more cautious about assumptions regarding the power of science, the hidden agendas wrapped within a noble mantle of dedication to 'truth', and the limits to even the least politicised of scientific endeavours (Caldwell 1990; Dermitt 2001; Nader 1996).

When writing about marine fisheries (marine turtles have been, and continue to be, subjects of marine fisheries), Johannes (1998) explained that we will never have adequate scientific information (not to mention political will, see Ludwig *et al*. 1993) to be able to manage marine fisheries for optimal yields: there is simply too much to know, and the systems – both human-dominated and otherwise – are far too complex, dynamic and unpredictable. Yet, sub-optimal management, as deficient as it may be, is still better (or '***less-worse***') than no management at all. Hence, Johannes explains the fundamental need for data-less management: 'that is, management carried out in the absence of the data required for the parameterization and verification of models that predict effects of various management actions with useful statistical confidence limits.' And while '[m]anagement not preceded by conventional research or followed by scientific monitoring may verge, to some people, on heresy', there are no realistic options: 'science' for all the revered, sanctified qualities attributed to it, will never have enough information. As he explains, the need for the precautionary approach could not be clearer: 'Data-less and data-poor management are, under the circumstances, not just valid alternatives. They are an imperative.' (Johannes 1998).

Even accepting that science has distinct limitations, it is far from clear what constitutes a precautionary approach. Certain attempts at restricting human activities and impacts may cause unacceptable grief to some people, as the measures will not be accepted as cautious enough; yet, others will resist the same restrictions as not only unneeded but also antisocial and

disruptive to development. For example, an entrepreneur bent on trading parts and products of marine turtles, to increase profits, capital holdings, and investments, might find acceptable standards set by an 'expert consultant' whose rate of remuneration is based on volume of sales, but a deep ecologist, adamant on animal rights, would never countenance their criteria, and would instead see the same situation as an unbearable failure. And those of us who try to listen to the various views, extreme and otherwise, and then adopt moderate positions, are still going to end up as targets in an argumentative crossfire.

Frazer (2001) and Witherington and Frazer (2003) have explored the roots of this dilemma, showing that the quandary lies in basic questions such as: 'What are sea turtles worth?' 'How does one measure these values?' and 'How many turtles are needed?' Even although they strove to separate their inquiry from dogma and fads, it was not easy to avoid the contemporary belief that monetary-based economy provides the ultimate scale for human existence and relations, nor was it easy for them to avoid the canon that science provides the ultimate answers to the basic questions. And there are yet other, profound levels of complexity; intimately intertwined within considerations of value is the issue of culture, or the 'cultures of conservation' as Campbell (2003a) explains.

Hence, before we can meaningfully answer the 'simple question' about how successful we have been, we urgently need to explore these seemingly existential questions about values, social perceptions and goals. An understanding of success and its measures will be deeply imbedded within a complex cultural matrix. In other words, after posing what I consider to be a fundamental question, I have to beg off on it!

While there is no denying the fundamental importance of culture and the need to understand basic questions of values, there is also the profound concern that *Homo sapiens sapiens* has not given itself the most accurate name. Just perhaps, our species may not be all-knowing and wise – sapient – as we might like to think. Putting aside the 'pristine myth' and romanticisms about prehistoric societies 'in balance with nature' (e.g., Kay & Simmons 2002), the archaeological record left by our ancestors – around the world – does not bode well for our abilities to manage our relationships with the environment and our resource base, particularly when it comes to marine turtles (Frazier in press b). The evidence, although often not unequivocal, indicates again and again that shortly after *Homo sapiens sapiens*, that all-knowing primate, arrived on the scene, resources (including marine turtles) were diminished, if not devastated.

And here we can see a clear breach in *Homo sapiens sapiens'* knowledge and wisdom. The opening to Ganter's (1994:1) account of the development and then decline of the pearl shell fishery in the Torres Strait provides a vivid image of the paradigm: 'At the faded margin of Australian historical consciousness are the shadows of a once vibrant industry which provided the pulse of bustling little townships on the northern extremities of the continent.' The same could be said of many marine turtle fisheries, around the world. Hence, not only has our species precipitated the decline (or devastation) of marine turtles and other marine resources, but we have no 'historical consciousness' about what we have done. This phenomenon, particularly in regard to depleted fisheries resources, has been aptly called the 'sliding baseline syndrome' (Pauly 1995), a theme of central importance to humanity, which is discussed by Bjorndal and Bolten (2003).

But the dilemma goes beyond the status of the turtles. If the ecological roles played by these lowly marine reptiles (Bjorndal & Jackson 2003) are in fact critical to the quality and accessibility of environmental services needed by our species (e.g., Baskin 1997; Daily 1997), then there are likely to be other more profound considerations that transcend human values and human culture. Beyond the questions of human values, perceptions, and desires, there is a profound question about the condition, or vitality, of the environment shared by humans and turtles.

Once again, the relevance of this issue transcends marine turtles. It is imperative to bear in mind that because marine turtles are 'flagship species', whatever is accomplished with them will have much greater ramifications on other species and environments (Miller *et al*. 1999).

So, back to the question: have we been successful? It seems not only that the jury is still out, but that we will need to carefully consider a number of other questions, for which there are no simple answers.

And, the question before that: why do we do this? Each person will have to answer that one for them self. Many of us, I suspect, are deeply concerned about what the jury will find in the end, and somehow there is a hope to be more than just a witness to this complex drama.

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Loggerhead turtle hatchling, (*Caretta caretta*) hiding in clump of floating sargassum in the pelagic Atlantic. © Doug Perrine/seapics.com

From Ghosts to Key Species: Restoring Sea Turtle Populations to Fulfill their Ecological Roles

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"*What they all overlook is the fact that they came to know Chelonia long after it had been cut down to a mere trace of its primitive abundance. They either hunt it today in the few places where schools hold out, or they take the trickle of waifs and stragglers that still faintly outline the old great feeding range of the species. The young men of today catch about as many turtles in a season as their fathers did, and so see no cause for alarm. What they do not know, though, is that the scattering of schooners and canoes that hunt Chelonia in the 1900s is picking about among the ruins of the great turtle fishery of the centuries before. But that is what it is doing. The documentation is voluminous and clear."*
Archie Carr (1955: 241-242).

When Archie Carr (1955) wrote of the "passing of the fleet" in *The Windward Road*, he recognized the phenomenon of the "shifting baseline syndrome" four decades before Pauly (1995) introduced the phrase and before the concept was emphasized in the ecological and conservation literature (Dayton *et al.* 1998; Jackson 2001; Pauly 1995; Sheppard 1995). Referring to fisheries management, Pauly (1995) described the "shifting baseline syndrome" as the tendency of scientists to use population levels at the beginning of their careers as the baseline against which to measure population change. He stressed the importance of incorporating historical anecdotes of abundance into population models. Identifying the proper perspective, or a reliable baseline, against which to assess trends in sea turtle populations is a challenge because populations were already greatly reduced or extirpated before they were recorded or quantified. Many sea turtle populations of today are ghosts (sensu Dayton *et al*. 1998) of past populations. For sea turtle conservation to succeed, the shifting baseline syndrome must be avoided when population trends are evaluated and recovery goals are set. In this essay, we discuss a framework for assessing sea turtle population trends and setting recovery goals based on sea turtles fulfilling their ecological roles (Figure 1).

Upward trends in some sea turtle populations, such as Kemp's ridleys (Márquez *et al.* 1999) and green turtles nesting at Tortuguero, Costa Rica (Bjorndal *et al.* 1999), have been celebrated, and rightly so. But these increases must be viewed in perspective—they must be evaluated with the proper baselines. For Kemp's ridleys, the 40,000 nesting females estimated from a film made on 18 June 1947 at Rancho Nuevo, México, has been used as a baseline. We should all be grateful to the persistence of Andrés Herrera in making the film and to Henry Hildebrand for rediscovering it (Hildebrand 1963). But Hildebrand (1963) reported intense commercial exploitation of eggs from the colony in 1961. What was the extent of this egg exploitation before the 1947 film, and what were the population levels of Kemp's ridleys before exploitation by humans began? These pre-exploitation population levels might have been even higher than the 1947 population, requiring a higher baseline, and further influencing how the current upward population trend is perceived.

What baseline should we use for the Tortuguero population? We know that the Tortuguero rookery has been heavily exploited since at least the 1500's (Parsons 1962). In the 1830's Cayman turtlers went to Miskito Cays (the major foraging grounds for the Tortuguero rookery), having destroyed the green turtle populations in the Cayman Islands by 1790 and in the waters of south Cuba by 1830 (Lewis 1940; Smith 2000; Williams 1970). By 1890, concerns were expressed over growing scarcity of turtles in the Miskito Cays (Hirst 1910). Duerden, in his 1901 review of the marine resources of the British West Indies, called for artificial hatching and rearing of green turtles and hawksbills under the supervision of the Government of Jamaica (the Caymans were part of the territory of Jamaica) because of "the diminution in the supply which is now being felt" in the Miskito Cays (Duerden 1901). In 1889, a formal complaint from the Governor of Jamaica was forwarded to the Government of Costa Rica protesting the indiscriminate slaughter (for calipee) of green turtles nesting at Tortuguero because of its effect on the turtle populations in the Miskito Cays (Hirst 1910). The

current green turtle population in the Caribbean is estimated to represent 3-7% of the pre-human green turtle populations (Jackson *et al.* 2001). Of course, not all of those green turtles nested at Tortuguero, but undoubtedly the Tortuguero population was affected by the massive decline over the past centuries. Could Tortuguero Beach support a nesting population 20 times greater than that of today? Research now underway on density-dependent effects and carrying capacity of Tortuguero Beach for green turtles may provide an answer (Tiwari, Bjorndal & Bolten, unpubl. data) and may put the recent upward population trend in a different perspective. Both the Kemp's ridley and green turtle examples illustrate the importance of establishing appropriate baselines for evaluation of population trends.

The World Conservation Union (IUCN) has set 10 years or three generations before present (whichever is longer) as the baseline against which to assess population trends in evaluating the status of species for their Red List (Hilton-Taylor 2000; IUCN 2001). This arbitrary assignment of three generations for sea turtles exemplifies the trap of the shifting baseline syndrome. In the recent status assessment of green turtles conducted by the Marine Turtle Specialist Group at the request of IUCN (Seminoff 2002), the range of generation times for green turtles in the Atlantic was estimated as 35.5 to 45.5 years. Three generations would range from 106.5 to 136.5 years. Atlantic green turtle populations in 1865 to 1895 would therefore be the assigned baseline under IUCN guidelines. Clearly, by 1865-1895, Atlantic green turtle populations had already suffered catastrophic declines. In addition to the over-exploitation of the Tortuguero green turtle rookery (documented in the previous paragraph), green turtle nesting populations had disappeared from a number of sites including

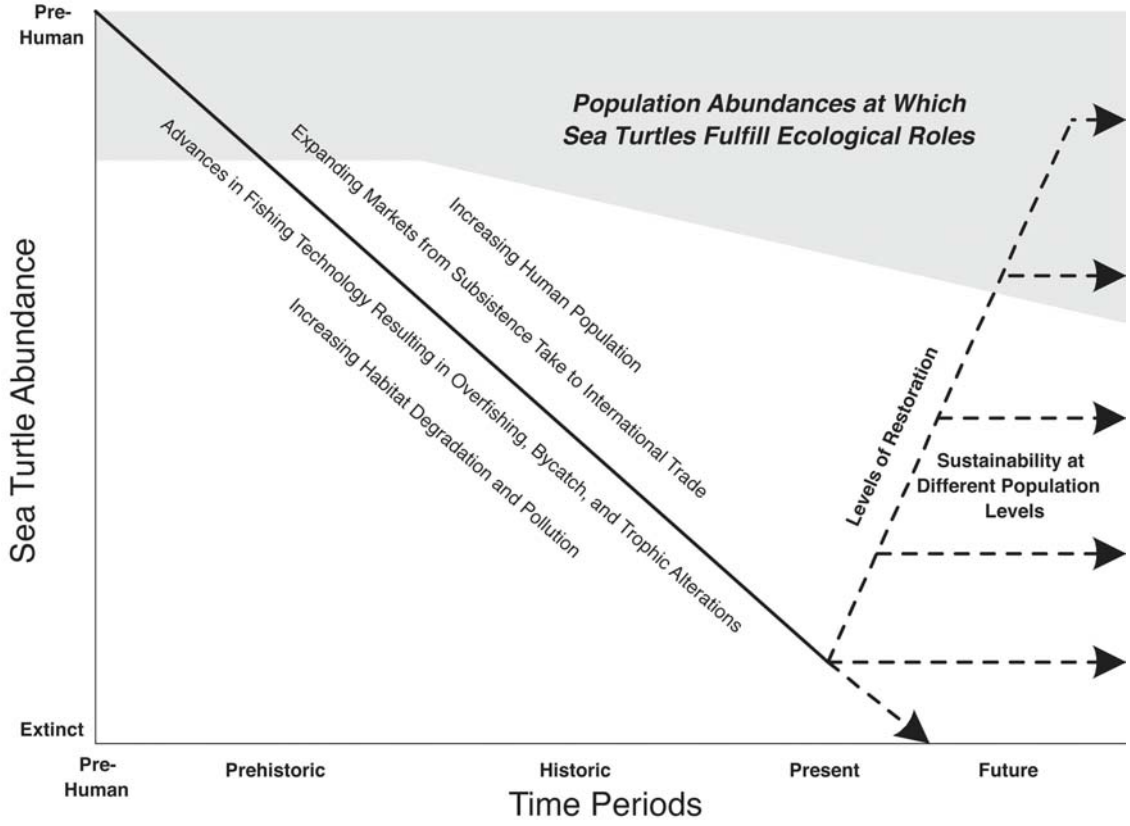

Figure 1. Diagram of the decline in sea turtle abundance from pre-human times to the present with potential trajectories for the future. Some of the causes for sea turtle declines are presented along the downward slope. The population declines are represented by a straight line although the declines for different species certainly followed different trajectories. This schematic illustrates 3 scenarios for the future: (1) if nothing is done to sustain the present levels of abundance, the populations will go extinct; (2) populations can be sustained at their present state (for many, ghosts of past populations); and (3) populations can be restored and sustained at various population levels. We propose that the goal should be to restore sea turtle populations to levels at which they fulfill their ecological roles (shaded area), a goal that would promote ecosystem recovery as well. The shaded area increases with time because, with habitat degradation, the number of sea turtles required to fulfill ecological roles may decrease. This schematic was inspired by those of Pitcher & Pauly (1998) and Pitcher (2001).

Bermuda and Cayman Islands (Parsons 1962), the Isle of Savona off the coast of Hispaniola, as well as on the west coast of mainland Hispaniola (Esquemeling 1684), and St. Helena (Ashmole & Ashmole 1997). In a recent review of coastal marine ecosystems in seven countries in the western Atlantic (Bahamas, Belize, Bermuda, Cayman Islands, Jamaica, Panama [Caribbean coast], and Virgin Islands), green turtles were described as depleted, rare, or ecologically extinct at all seven areas by 1865-1895 (Pandolfi *et al.*, in review). The 3-generation baseline of IUCN is equally inappropriate for green turtles in other geographic regions and for other sea turtle species.

The appropriate baselines against which to assess population trends are the earliest estimates of past sea turtle populations that can be derived with a reasonable degree of confidence. In many cases these estimates would significantly predate the 3-generation limit set by IUCN. Prehistoric and historic evidence can help reconstruct the abundances of pre-exploitation sea turtle populations. Prehistoric evidence-such as evaluation of middens left by prehistoric peoples (Frazier 2003; Steadman & Stokes 2002; Wing 2001)-has demonstrated that sea turtle populations came under substantial levels of exploitation and some rookeries may have been lost as a result (Carlson 1999; O'Day 2001). Thus, when Columbus first arrived in the Caribbean in 1492, sea turtle populations had already been depleted to an extent often not realized by sea turtle biologists today. Historic accounts even more clearly record the over-exploitation and rapid decline of sea turtle populations (King 1982; Parsons 1962, 1972; Ross 1982) as human populations grew and technological advances increased the efficiency of exploitation of marine resources and degradation of marine habitats. Traditional environmental knowledge and local environmental knowledge may also contribute valuable information for the reconstruction of historic sea turtle populations. In addition to reconstructions based on prehistoric and historic evidence, models of ecosystem function and estimates of carrying capacity can be used to generate baseline estimates of past abundance.

The population levels set as baselines for assessing population trends, however, may be inappropriate recovery goals. The degraded marine habitats and altered food webs of today may be unable to sustain sea turtle populations at pre-human levels. For example, the reduction in area of healthy coral reef habitats (Hughes 1994; Jackson 2001; Jackson *et al.* 2001) unfortunately means that fewer hawksbills are now needed to fulfill their roles as major predators and arbitrators in the competition for space on coral reefs (León & Bjorndal 2002). This decrease in the number of sea turtles required to fulfill their ecological roles is illustrated by the decline over time of the lower boundary of the shaded area in Fig. 1. So, if the natural, pre-human-exploitation levels of sea turtle populations cannot be sustained today, how should recovery goals be selected?

We believe that all individuals concerned with the status of sea turtles would agree that sustainable sea turtle populations are the goal of conservation and management efforts, with sustainability defined as "a characteristic of a process or state that can be maintained indefinitely" (IUCN/UNEP/WWF 1991). The debate over management of sea turtles centers on the level at which sea turtle populations should be sustained-or the recovery goal-and the probability that populations can be sustained "indefinitely" at those various levels of abundance. Recovery goals may range from attempting to sustain the current levels of depleted sea turtle populations, which in some cases would be sustaining ghosts of past populations, to restoring and then sustaining sea turtle populations at some earlier level of abundance (Fig. 1).

Recovery goals should be set to population abundances at which sea turtles can *fulfill ecological roles* unless the remaining habitat is so reduced or degraded that this population level would not be large enough to ensure sufficient genetic diversity to respond to changing selective pressures. An approach for identifying population levels that fulfill ecological roles is reconstruction of past marine ecosystems and quantification of the roles that sea turtles played in those ecosystems. These reconstructions would allow estimation of the abundance of sea turtles necessary to fulfill their ecological roles in the marine ecosystems of today. As stated above, these population levels may be below pre-human levels because of the loss of habitat. (Under certain conditions, such as dramatic trophic shifts to jellyfish-dominated food webs, sea turtle abundance required to fulfill ecological roles could be above pre-human levels.) However, the estimates of pre-human sea turtle population levels generated from prehistoric and historic evidence are essential to provide the proper perspective for evaluating the ecological roles of sea turtles. Because the declines in sea turtle populations were so massive and occurred so long ago, it would be nearly impossible for modern biologists to imagine, and thus assess, the influence of past sea turtle populations on the structure and function of marine ecosystems without the historical perspective. For example, without knowledge of the massive reduction of green turtles in the Caribbean, how could marine biologists realize that the Caribbean *Thalassia* pastures of today, characterized

by long blades, extensive epibionts, and detrital-based nutrient cycles, represent a drastically altered state from the short-bladed, low-epibiont pastures of the past, in which grazing by green turtles dominated nutrient cycling?

A great advantage of using *fulfilling ecological roles* as recovery goals is that the focus of management efforts are shifted away from single-species recovery strategies to strategies that recognize the need to restore ecosystem function. Recent collapses of marine ecosystems, resulting in unstable and altered ecosystem states characterized by dramatic shifts in food webs and trophic cascades (Jackson 2001; Pauly *et al.* 1998), are not only the result of recent events, but were initiated hundreds to thousands of years ago, soon after humans began to exploit marine resources (Jackson 1997, 2001; Jackson *et al.* 2001; Pitcher 2001; Pitcher & Pauly 1998). Sea turtles (both carnivores and herbivores) were once key species in marine ecosystems. We use the concept of "key species" in the sense of "species that are important to ecosystem structure and function in whatever form (e.g., biomass, abundance, productivity, or functional role), driving ecosystem process or energy flows" (Piraino *et al.* 2002). The decline in abundance of sea turtles and other megavertebrates initiated the collapse of marine ecosystems in which they lived (Jackson *et al.* 2001; Pandolfi *et al*., in review). Today, the degradation of marine ecosystems has accelerated as a result of continued overfishing, pollution, habitat destruction, and climate change with the result that higher trophic levels have been lost and microbial processes dominate an increasing array of marine habitats (Jackson 2001; Jackson *et al.* 2001; Pauly *et al.* 1998; Pitcher 2001). Just as healthy sea turtle populations require healthy ecosystems, the reverse is also true. Only when ecosystems are restored, can the ecological services and economic benefits that marine ecosystems provide to humans be fully realized (Costanza *et al.* 1997).

Establishing recovery goals on the basis of *fulfilling ecological roles* is achievable. The Marine Turtle Specialist Group has adopted this approach as reflected in its mission statement: "The IUCN/SSC Marine Turtle Specialist Group exists to develop, support, and implement programs which promote the restoration and survival of healthy marine turtle populations that fulfill their ecological roles" (Marine Turtle Specialist Group 1995). Of course, much research is needed before the ecological roles of sea turtles can be defined (Bjorndal in press; Bjorndal & Jackson 2003), but much has already been accomplished and with focused research, much can be accomplished in the near future. We suggest an approach for building models of ecological roles (Bjorndal in press). The basic model is organized on three scales: individual, population, and ecosystem. The interactions among and within these scales may take many forms, but the most common currencies are energy and nutrients. Interactions may be quantified-and the ecological roles of sea turtles defined-by tracing flow of energy and cycling of nutrients within and among the three scales. The model can be expanded to illustrate the major processes occurring at each scale. At the individual level, digestive processing (intake of food, passage of digesta, digestion, and gut morphology) and individual productivity (somatic growth and reproduction) must be quantified. At the population level, population growth is the process of greatest interest, requiring a knowledge of the associated parameters of birth rate and probabilities of survival, immigration and emigration, as well as the effects of density-dependence and intraspecific competition. The complexity of the model increases greatly at the ecosystem level. Here, all interspecific interactions (e.g., predator-prey, competition, parasitism) come into play as well as interactions with the environment. This model is discussed in greater detail and applied to loggerheads in Bjorndal (in press).

Defining the ecological roles of sea turtles would be greatly facilitated by collaborating with programs now underway to reconstruct marine ecosystems. These programs (e.g., see Pitcher 2001) employ a diversity of tools including archaeological and historical data, traditional environmental knowledge, local environmental knowledge, and ecosystem models such as balance-mass models (Ecopath, Ecosim and Ecospace) which are compatible with our modeling approach described above.

We endorse the goal of the Marine Turtle Specialist Group to restore sea turtle populations to levels at which they fulfill their ecological roles (shaded area in Fig. 1) and then to sustain those levels. We believe that these recovery levels have the greatest probability, if not the only chance, of being sustained "indefinitely."

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Hawksbill sea turtle (*Eretmochelys imbricata*) at Layang Layang Atoll, Sabah, Malaysia. © Doug Perrine/seapics.com

Improved Assessments and Management of Shrimp Stocks Could Benefit Sea Turtle Populations, Shrimp Stocks and Shrimp Fisheries

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This paper proposes that improved assessments and management of Penaeid shrimp stocks in State and Federal waters of the Gulf of Mexico could lead to reductions in shrimp fishing effort that would reduce sea turtle mortality while enhancing shrimp stocks and fisheries dependent upon them. Despite use of turtle excluder devices (TEDs) by shrimp trawlers, sea turtle strandings show positive correlations with shrimp fishing effort (Caillouet *et al*. 1996). Indications of growth overfishing in shrimp stocks are strong, and have been developing for decades, so it would be prudent for federal and state marine fisheries management agencies to reduce fishing pressure on the shrimp stocks, thereby preventing overfishing, avoiding recruitment overfishing, and protecting sea turtles and other bycatch species.

Why should sea turtle conservationists be concerned about shrimp stock assessments and management? Simply put, prior shrimp stock assessments have been flawed and have encouraged overfishing. Exposure to shrimp fishing effort levels higher than are necessary to maximize shrimp yield per recruit is not a good thing for sea turtle populations. Therefore, the focus of this paper is on overfishing and the apparent flaws in shrimp stock assessments that have contributed to it.

OVERFISHING

Ludwig *et al*. (1993) noted that there is remarkable consistency in the history of resource exploitation in that resources are inevitably overexploited, often to the point of collapse or extinction. They suggested such consistency is due to the following common features:

1. Wealth or the prospect of wealth generates political and social power that is used to promote unlimited exploitation of resources.

2. Scientific understanding and consensus is hampered by the lack of controls and replicates, so that each new problem involves learning about a new system.

3. The complexity of the underlying biological and physical systems precludes a reductionist approach to management. Optimum levels of exploitation must be determined by trial and error.

4. Large levels of natural variability mask the effects of overexploitation. Initial overexploitation is not detectable until it is severe and often irreversible.

The Committee on Ecosystem Management for Sustainable Marine Fisheries (CEMSMF, 1999) defined overfishing as fishing at an intensity great enough to reduce fish populations below the size at which they could provide the maximum long-term potential (sustainable) yield, or at an intensity great enough to prevent their recovery to that size. From the point of view of fishery stock dynamics, there are two recognized types of overfishing. Growth overfishing occurs when the level of fishing mortality (determined by the amount of fishing effort and factors affecting the fishing power of fishing units) exceeds that which produces maximum sustainable yield or maximum yield per recruit. Trends of reduction in size of individuals in the annual catch coupled with trends of reduction in annual catch per unit effort or total catch are symptoms of growth overfishing. Recruitment overfishing can occur when fishing mortality continues to increase beyond levels that produce growth overfishing until the stock collapses, because the remaining spawners are too few to produce enough offspring to restore the stock. Some shrimp stocks can withstand extended periods of high fishing mortality without producing major concern about recruitment overfishing, but growth overfishing can be a significant economic problem under such conditions (Neal & Maris 1985).

While growth overfishing produces negative socio-economic impacts, the negative impacts of recruitment overfishing, both ecological and socio-economic, are much more severe and either prolonged or permanent. Recruitment overfished stocks either do not recover or they take a very long time to recover. Not only can an important fishery be lost, but also marine ecosystems can be irreparably altered by paucity or loss of important species. Therefore, the CEMSMF (1999) concluded that management agencies should adopt regulations and policies that strongly favor conservative and precautionary management and that penalize overfishing. Unfortunately this has not been the case with shrimp management.

The National Marine Fisheries Service (NMFS) defined shrimp overfishing only in terms of recruitment overfishing (Klima *et al*. 1990, Nance 1993b, NMFS 1999). Then NMFS (1999) concluded that stocks of brown shrimp (*Penaeus aztecus*) and white shrimp (*P. setiferus*) were not overfished under the pre-SFA

(Sustainable Fisheries Act of 1996; see CEMSMF 1999) definition of overfishing, and that neither stock was approaching an overfished condition [as so defined]. This was a dangerous course to take, since growth overfishing exacerbates socio-economic hardships experienced by those in the fishery, and the exact timing of recruitment overfishing is difficult if not impossible to predict. The Gulf of Mexico Fishery Management Council's (GOMFMC) *Management Plan for the Shrimp Fishery of the Gulf of Mexico* contained definitions of overfishing for brown shrimp and white shrimp that were disapproved under SFA guidelines (NMFS 1999).

Some participants in the shrimp industry believe that recruitment overfishing of shrimp stocks is either impossible or highly unlikely. The "conventional wisdom" has been that annual production of shrimp is determined wholly by environmental variables outside the control of management agencies, that the fishery should harvest every shrimp it can each year, and that the stock is not jeopardized in any way by such harvest. However, the CEMSMF (1999) pointed out that environmental changes can produce effects similar to those of fishing, and that it is often difficult to distinguish them from the effects of fishing. Recognizing that environmental fluctuations exert a fundamental influence on the behavior of marine ecosystems and that they cannot be controlled directly, the committee (CEMSMF 1999) nevertheless stated that uncertainties about effects of environmental variability should not be used as an excuse to continue overfishing.

EVIDENCE OF SHRIMP OVERFISHING

Almost two decades ago, Gulland and Rothschild (1984) stated that a reduction of shrimping effort in the Gulf of Mexico would most certainly lead to economic benefits. They stated further that an increase in effort would be of limited economic value to the fishermen, and could result in increased risk of population collapse or a sustained reduction in production of the population. They suggested that a conservative view must be taken on the potential for biological danger to the stocks. Yet, shrimp fishing effort in the Gulf of Mexico was allowed by management agencies to continue to increase.

Signs of shrimp growth overfishing in the Gulf of Mexico and along the U.S. Atlantic coast have been developing for decades. Size composition has long been recognized as a simple criterion for assessing status of a fishery (Henderson 1972; Ricker 1975). Declining average size of individuals can indicate increasing mortality (usually equated with increased fishing effort) or decreasing growth (usually attributed to overcrowding in overabundant populations, but overcrowding is not likely in heavily fished shrimp stocks). Caillouet *et al*. (1980) detected trends of reduction in size of brown shrimp and white shrimp in reported annual catches from Texas and Louisiana during 1959-1976. Downward trends in size of these two species in reported annual catches have also been detected in the Gulf of Mexico and on the U.S. Atlantic coast by Caillouet and Koi (1980, 1981, 1983), Nichols (1984), Nance and Nichols (1988), Nance (1989), and Nance *et al*. (1989). Caillouet and Koi (1980) conducted simulations showing that the ex-vessel value of a given weight of landings could be greatly increased, if the trends toward decreasing size of shrimp in the landings could be reversed. This was true for brown shrimp, white shrimp and pink shrimp (*P. duorarum*). Although foreign imports of shrimp most certainly played a large role in reducing the real price (price adjusted for inflation) of domestic shrimp through competition (Keithly & Roberts 2000), reduction in size of shrimp in the catch also took its toll on value of the catch (Caillouet & Koi 1980; 1981; 1983).

Declines in catch per unit effort, beginning as early as 1960, have been evident for Gulf of Mexico brown shrimp and white shrimp and have accompanied continued increases in fishing effort (Klima *et al*. 1990; Nance 1993a; Nance 1999; Neal 1975; Nichols 1984). In addition, the total annual catch of brown shrimp (as well as that of pink shrimp) seems to have declined over the past decade or so. Catch per unit effort for brown shrimp, white shrimp and pink shrimp has been declining for almost four decades (Nance 1999).

Some have argued that shrimp fishing effort has decreased rather than increased over recent years. But, changes in fishing mortality are not always directly proportional to observed changes in fishing effort. Technological improvements in boats, vessels, gear, equipment, and fishing strategies as well as increasing knowledge and skill of fishermen can increase fishing power of the fishing units. Griffin *et al*. (1997) examined historical trends in standardized fishing effort (nominal fishing effort adjusted for fishing power) for the Gulf of Mexico shrimp fleet. They showed that relative fishing power of the fleet increased from 1965 through 1993. Trends in standardized effort in the inshore and offshore fisheries were generally upward over the same years, but appeared to level off in the offshore fishery in the last seven of those years, and to decline in the inshore fishery in those same seven years. Obviously, it would be important to update this time series analysis to the present.

In its *Texas Shrimp Fishery Briefing Book April 2000*, TPWD (2000) stated that "A recent 18-month

comprehensive review of the shrimp fishery by TPWD once again documented serious overfishing including a continuing long-term downward trend in the population of adult spawning shrimp in the Gulf." The briefing book also stated that *"Failure to reverse these trends could lead to an economic and biological collapse of the shrimp stocks."* TPWD accepted such trends as warning signs of growth overfishing and proactively recommended reductions in fishing mortality in hopes of forestalling a collapse of these stocks due to recruitment overfishing. Although some doubters suggested that TPWD's evidence was insufficient to justify additional shrimping regulations, the Texas Parks and Wildlife Commission ruled in favor of the additional regulations after hearing and reviewing published testimony.

POTENTIAL FLAWS IN SHRIMP STOCK ASSESSMENTS

The status of penaeid shrimp stocks in the Gulf of Mexico (as well as on the U.S. Atlantic coast) could be worse than indicated by past stock assessments. There are potentially serious, unresolved flaws in the stock assessments conducted by NMFS. Virtual population analyses (VPA), spawner-recruit relationships, recruitment indices, and recruitment overfishing indices are all based on number of shrimp estimated from the weight of catch within size class intervals, using methods that may be statistically biased. Not only may these methods yield biased estimates of the number of shrimp, but also the magnitude of this bias may be size related; i.e., the bias may increase with decrease in size of shrimp. Such biases could have affected prior estimations of spawner-recruit relationships (Gulland & Rothschild 1984; Klima *et al*. 1990; Nance 1989; Nance & Nichols 1988; Nance *et al*. 1989), recruitment overfishing indices (Klima *et al*. 1990; Nance 1993b; Nance 1998), and VPA results (Nance 1989; Nance 1999; Nance & Nichols 1988; Nance *et al*. 1989; Nance *et al*. 1994) upon which NMFS' shrimp management recommendations to the GOMFMC have been based. Keep in mind that the annual total catches of shrimp measure in the millions of pounds, so discrepancies resulting from biases in estimating number of shrimp could have dramatic effects on stock assessment results.

NMFS' time series database includes observations derived from both "box-graded" and "machine-graded" shrimp catches. Box grading provides a single average count (number of shrimp per pound) applied to the landed portion of the catch of a shrimp vessel or boat. Machine grading separates the landed portion of the catch into segments sorted into count class intervals set by shrimp processors and influenced by marketing strategies.

Sampson (1994) examined statistical biases in estimating number of fish landed from sample average weight and the weight of fish landed, using samples of equal size. Sample size (number of shrimp taken per sample) is not constant for samples taken from shrimp landings, so Sampson's (1994) statistical estimation methods are not strictly comparable to those used for shrimp. Nevertheless, his paper elucidates the kinds of statistical considerations that are needed to examine potential biases in the estimation methods used for shrimp. The statistical estimation problem has to do with how well the average count (for box-graded catch), or the midpoint count (for machine-graded catch), represents the true mean of a count class interval.

Nichols (1984) and Parrack (unpublished) each presented a method of estimating number of shrimp from weight of catch, but neither method has been evaluated for statistical biases or received adequate peer review. Nichols' (1984) method is based on pounds of shrimp within size class intervals expressed in count. Parrack's (unpublished) method is based on pounds within size class intervals expressed in pounds per shrimp, the reciprocal of count. Nichols' (1984) method has been the one most used in NMFS' stock assessments. The two estimation methods are as follows:

1. Nichols' (1984) method - The number of shrimp in a count class interval is estimated by multiplying the midpoint count of the interval by the pounds in the count class. The method can be portrayed using a simple example. If the count class is 6-10, the midpoint is 8. For a 100 pound catch in this class interval, the number of shrimp is estimated to be 8x100 = 800. If the count class is 60-120, the midpoint is 90. For a 100 pound catch, the estimated number of shrimp is 90x100 = 9000. It is clear from this example that the larger the count, the greater the distortion in estimated number of shrimp, if the estimation method were biased.

2. Parrack's (unpublished) method - The number of shrimp is estimated by dividing the midpoint between reciprocals of the lower and upper limits of a count class into pounds in the count class. Using the same example as above, the reciprocals of 6 and 10 are 1/6 and 1/10, and their midpoint is 2/15 or 0.133. For a 100 pound catch in this class interval, the number of shrimp is estimated at 100/0.133 = 751.88. If the count class is 60-120, the midpoint of the reciprocals of these count class limits is 1/80 or 0.0125. For a 100 pound catch, the estimated number of shrimp is 100/0.0125 = 8000. Not only does this method give results differing from

those of the Nichols (1984) method, but again any bias in the estimation method would produce a greater distortion when estimating the number of small shrimp than of large shrimp. Parrack's (unpublished) method is akin to that examined by Sampson (1994), but it is not based on samples of equal size.

Another potential problem with Nichols' (1984) method is that the weight of catch in a count class interval was *"assumed to be uniformly distributed by weight between category boundaries"* (i.e., count class limits). Although Nichols' (1984) description is not clear, my interpretation is that he assumed that the weight of the catch within a count class interval was uniformly distributed over the interval (i.e., each fraction of the partitioned weight was equal). This is equivalent to assuming, implicitly, that the number of shrimp in each fraction increases in direct proportion to count, from the lower limit (lowest count) to the higher limit (highest count) of the interval. Under this assumption, when count is converted to weight per shrimp by taking its reciprocal, the number of shrimp in each fraction of the weight (partitioned according to Nichols' method) declines logarithmically with increase in weight per shrimp over the interval. Thus, the reciprocal of the midpoint count of the count class cannot accurately represent the mean weight per shrimp in the count class (see Sampson 1994 for discussion). This probably would not be as serious a problem if the count class intervals in NMFS' database were very narrow and of constant width. However, they are neither. Frequency distributions of count and weight per shrimp are unknown, except perhaps for white shrimp (based on old studies). Nichols (1984) converted white shrimp length-frequency distributions to distributions of weight per shrimp or count and used them in an alternative method for estimating number of white shrimp within count class intervals. However, the resulting frequency distributions of weight per shrimp or count were not presented, nor were details of how they were used to estimate number of shrimp.

So, the degree to which Nichols' (1984) or Parrack's (unpublished) methods may be biased remains to be determined. In any case, the distortion in numbers resulting from estimation biases would be greater for small shrimp than for larger ones, and the errors would be cumulated by aggregating the estimates for total catches, catches of recruits only, or catches of spawners only. This brings into question all past shrimp stock assessments based on Nichols' (1984) or Parrack's (unpublished) methods. If a statistically valid and unbiased estimation procedure were developed and applied, it could lead to different estimates of number of shrimp and different stock assessment results.

A solution to this statistical estimation problem will require theoretical considerations related to sampling theory and size frequency distributions of shrimp. It may require fishery-independent sampling, determination of size distributions within "box-graded" and "machine-graded" catches, use of stochastic methods applied to the available catch and size class data, or a combination of these approaches and perhaps others. Until this is done, all results based on Nichols' (1984) or Parrack's (unpublished) methods are questionable.

Additional problems exist regarding the NMFS database used to estimate shrimp numbers from weight of catch:

1. Methods of grading shrimp have changed over the time series covered by the database. Shrimp discarding practices, which influence sizes of shrimp landed, have changed over time. Limits of count classes in the database overlap, since they were determined by grading methods and marketing factors, not statistical sampling methods.

2. Count class limits may not represent the actual range of shrimp sizes within a class interval.

3. Count classes representing the largest and smallest size extremes of landed shrimp often contain limits 0 or 999 (representing "unknown" or infinity), which are unrealistically low or high, respectively, and make some calculations impossible. For example, one cannot calculate the weight of shrimp weighing 0 count, and shrimp of 999 count would weigh only 1/999 or 0.001 pound. Previous investigators have dealt with this problem by replacing 0 or 999 with assumed numerical values that allow the necessary calculations. Even though such adjustments allowed estimation of shrimp numbers, their validity has not been adequately evaluated.

4. The number of unique count classes in the NMFS database has varied over the time series.

5. A box-graded catch is assigned to a particular count class interval when its average count falls within that interval, whether or not the actual range in size of shrimp in that catch falls within that interval.

I must point out that these seven additional data problems also affected my analyses concerning trends in size of shrimp (see references below).

Because of the socio-economic and other consequences of shrimp management strategies based on stock assessments that might be flawed, I believe there is an urgent need for a thorough statistical examination of data problems, estimation methods, and stock assessment methods used by NMFS.

I would expect that if better estimates of standardized shrimp fishing effort and better estimates of numbers of

shrimp were available, shrimp stock assessments based on them would show the stocks to be more seriously overfished than they now seem to be. If true, this would indicate an even greater need to reduce shrimp fishing mortality.

RECOMMENDATIONS

1. Marine fisheries are common property resources in the United States, and public funds are used to manage and sustain them. Therefore, shrimp fisheries should be managed for the common good. Participants in the shrimp industry and related industries, conservation organizations, taxpayers, and consumers of shrimp all have vested interests in the wise management of these renewable natural resources. Wise management involves sustaining commercial and recreational fisheries and sea turtle populations now and into the future, to perpetuate and optimize the socio-economic benefits these resources provide for the common good.

2. Because of uncertainties surrounding NMFS' estimation of fishing effort, shrimp fishing mortality, and number of shrimp from the weight of catch, NMFS and the GOMFMC should join with Gulf states in an effort to evaluate and improve estimation methods and shrimp stock assessments.

3. NMFS and state marine fisheries management agencies in the Gulf should take whatever steps necessary to place all of their shrimp data files (containing fishery-dependent and fishery-independent observations), adequate documentation of these data files, and detailed explanations of their estimation and stock assessment methods on their web sites, so the data can be downloaded and evaluated by anyone interested in doing so. They should do the same with data files covering other important fisheries species as well as sea turtles. By data files I refer to computer-compatible files containing original observations, and not summary data, although summary data should also be available for downloading. "*Legitimate access to nonsecret government information, information that has been paid for by taxpayers, is the public's right*" (GOVERNMENT INFO, Agencies slow in complying with electronic access bill, Houston Chronicle, August 7, 2000).

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Kemp's ridley sea turtle (*Lepidochelys kempii*) laying at Rancho Nuevo, Mexico. © Doug Perrine/seapics.com

Challenges for Interdisciplinary Sea Turtle Research: Perspectives of a Social Scientist

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Science has been called the modern world's religion, and scientists its high priests (Pepper 1984). But the position enjoyed by natural science has been threatened in contemporary times, challenged in academic circles, and has sometimes lost the public's trust (Wynne 1992). The core assumptions (about objectivity, value neutrality, and independence from social and cultural contexts) are all up for debate, to the extent that we refer to the science wars (Bradshaw & Bekoff 2001; Gould 2000). At the heart of the battle are several issues.

Firstly, using reductionist principles associated with positivism, traditional western science separated humans from nature (a separation with historic and philosophical roots, see Evernden 1992; Pepper 1984), and looked at nature in component parts. In contrast, most modern environmental problems are increasingly characterized as ecosystem wide, with non-linear behaviour, uncertainties, and multi-scalar elements interacting over time and space (Bradshaw & Bekoff 2001), and with humans central to the ecosystem and its problems. Predicting behavior of the "natural" world is recognized as more difficult, and uncertainty is treated as something to be described rather than eliminated (Bradshaw & Bekoff 2001; Redclift 1998). Ecological research in particular is problematic, as the results of lab and field experiments are difficult to extrapolate over time and space (Bradshaw & Bekoff 2001; Hilborn & Ludwig 1993). Thus, the challenge to ecological science is two-fold; the complexity of environmental problems defies reductionist methods, disciplinary organization and thinking, and the role of humans in these problems defies the traditional human versus non-human divide.

Secondly, in spite of dominance of nature science research, contemporary ecological problems are growing and, in many ways, science is implicated in them. While natural science has advanced many human causes, its use for technological development has also provided the means for increased levels of resource exploitation and destruction, and it is linked to a modernist worldview (emphasizing progress, focused on the well being of *Homo sapiens*), the social and ecological costs of which are increasingly recognized. Dissatisfaction with natural science specifically and with the associated world view in general has focused attention on alternative ways of understanding nature. For example, traditional ecological knowledge is receiving attention not only in anthropology, but in major ecological journals (e.g. *Ecological Applications*, 2000, 10:5).

In their often cited article "*Uncertainty, resource exploitation, and conservation: lessons from history*", Ludwig *et al.* (1993) challenge the role of ecological sciences in managing resources. Their argument rests on the difficulties of achieving certainty in ecological research, and on the identification of conservation problems as 'people' problems (most prominently related to politics) requiring additional research. As fisheries scientists publishing in the journal *Science*, their argument generated much response about the role of ecology versus other disciplines in understanding the issues. A special issue of *Ecological Applications* (1993, 3) was published in response to Ludwig *et al.*'s original paper and, ten years later, the discussion continues.

One response to these debates has been an increased emphasis on interdisciplinary research, called for to bring natural and social scientists together. But such a call is more easily made than accomplished. Bradshaw and Bekoff (2001) argue that emphasis on interdisciplinary research represents a paradigm shift for the ecological sciences. Redclift (1998) discusses the 'deeply rooted epistemological differences' that surface whenever social and natural scientists meet.

In the world of sea turtle conservation, Frazer (1992) called attention to the dangers of narrowly scoped sea turtle research and conservation practice, and Frazier (2003) encouraged engagement with other disciplines. Research related to the socio-economic aspects of sea turtle conservation exists, some of it published (Bliege Bird & Brid 1997; Bliege Bird *et al.* 2001; Campbell 1998a, 1999, 2000 2002a, 2002b; Hope 2002; Jacobson and Robles 1992; Lagueux 1991; Lee & Snepenger 1992; Nietschmann 1973, 1979; Place 1988, 1991; Tisdell & Wilson 2002; Wilson & Tisdell 2001). It appears, then, that sea turtle research is becoming increasingly interdisciplinary. Or is it? It is certainly becoming multidisciplinary, but multidisciplinary work (i.e. involving multiple disciplines) is different than interdisciplinary work (i.e. working between disciplines), with the latter implying more than mere co-existence.

Based on my experiences working as a social scientist in a biologist dominated field, and drawing on the general arguments of Redclift (1998) and Bradshaw and Bekoff (2001), I outline below some of the specific challenges arising in interdisciplinary research, specifically as it relates to sea turtles.

Challenge 1: Knowing the other

Redclift (1998) suggests that, in general, there are preconceived ideas among natural scientists about what it is that social scientists do, and collaborations undertaken with such ideas in place often flounder. Two assumptions about what social science is and what social scientists do are discussed here.

Firstly, in biologist-dominated forums, like the Annual Symposium on Sea Turtle Biology and Conservation, I have seen a wide range of papers and posters categorized as social science, including descriptions of education programs, field trips, and conservation projects. While such descriptions often focus on people rather than turtles, involve human issues, and have merits of their own, they do not, by default of not being natural science, equal social science research. The failure to distinguish between social science research and more general descriptions of the human element in conservation programs contributes to beliefs about the 'fuzziness' of social science (see Challenge 4).

Secondly, social science research, like biological research, produces data and theory that can be used for policy-making, but is not a substitute for policy-making. In June 2002, I attended a preparatory meeting for the first Conference of the Parties of the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC). I was invited as a resource person on socio-economic aspects of the convention and, in that capacity, I suggested that the terms of reference for the Scientific Committee be made broad enough to include social scientists in its membership (the rational for this is detailed in Campbell *et al.* 2002). The suggestion received wide support, but one participant was wary, and argued that politicians and economists would dominate in all other aspects of the convention and the scientific committee was the one sacred refuge for unbiased, unpoliticized debate. While I was and remain sympathetic to the concern, it is misplaced, as it equates social science research with the political activity of policy-making. Economic research does not, by default, equal economic policy-making. Political scientists are not usually politicians. Social scientists are capable of producing unbiased, unpoliticized data (to the extent that any of us can; see Challenge 2).

Challenge 2: Sleeping with the enemy?

Perhaps one of the most important differences between the natural and social sciences is epistemological (Redclift 1998). In contrast to natural scientists, social scientists see human experience as bound up in perception, representation, and understanding of nature. For social scientists, reflexivity, or the examination of the researcher's role in research, is critical, and the research activities of a scientist, natural or social, are subjective processes "affected by the experiences and cultural context of the individual scientist" (Bradshaw & Bekoff 2001: 461). Furthermore, many social scientists study "the social processes that influence the practice and theory of science" (Bradshaw & Bekoff 2001: 461), a study that can make natural scientists uncomfortable. Interdisciplinary research forces an examination of how science functions as part of a larger system of knowledge, nature and society, and this examination is one many natural scientists are unwilling to undertake, as it challenges central beliefs about objectivity.

While social scientists question claims of objectivity, challenge assumptions of positivism, and criticize the oversimplification inherent in reductionist natural science, natural scientists have characterized social science as being value-laden, qualitative, and not "real" science. They criticize the lack of replicability, difficulties in determining causality, and lack of rigorous theory.

The long term separation of the disciplines and the history of mutual criticism are barriers to interdisciplinary research, but they are not insurmountable. Part of my own research involves examining how scientists perceive various conservation problems and, in one component of the analysis, I've considered how science is used to support different views on marine turtle conservation (Campbell 2002b). Several of the individuals who originally participated in my PhD research as interviewees have since been collaborators, and many have become my friends. There is no doubt that these relationships are strange ones, with individuals fulfilling multiple roles. It is hard work to balance academic integrity with respect for my subjects, their views, and the debt I owe them. I can't claim that I have always been successful in this, and I have sometimes learned the hard way that the nature of such complex relationships, and the systemic suspicion of the 'other', must be constantly acknowledged and monitored.

Challenge 3: The myth of 'easy' social science

Many people assume that social science is easier than natural science, even that it is common sense. For example, at a special session on 'Sea turtles and human culture' at the 2002 Symposium, social science was introduced as 'softer' science. As a consequence of this perception, non-specialists, including biologists, sometimes present data related to social science research. Often this is done without an adequate grounding in the relevant academic literature, and is particularly striking in some of the work done on the economic value of ecotourism, and evaluations of community participation (although this may be most conspicuous to me because it is close to my own work). Sometimes the tools used for data collection, e.g. opinion surveys, fail to meet the basic requirements of survey design and execution. Presented to an audience dominated by biologists, this work goes unchallenged. This is not simply an issue of academic integrity; there are practical consequences of conservation interventions designed on flawed research (biological or socio-economic).

Even when research is explicitly interdisciplinary, assumptions about the 'easiness' of social science can pervade. For example, Turtles in the Caribbean Overseas Territories (TCOT) is a UK-funded project to evaluate the status and exploitation of sea turtles in six Caribbean territories, and has both biological and socio-economic goals (Godley *et al.* 2002). While there has been a commitment to the socio-economic side from the outset, a full appreciation of what this involves in practice has evolved more recently. At a workshop held in August 2002 (Godley *et al.* 2002), sessions devoted to discussion and field-testing a socio-economic survey were long, difficult, and contentious, and extra time had to be found to continue them. Before the workshop, the project coordinators had assumed that this component of the project would be relatively uncontroversial and easily handled, while the biological training would be more challenging. Their position was reversed by the end, particularly after participating in field-testing the survey.

Challenge 4: Qualitative versus quantitative methods

The most successful interdisciplinary research involves social scientists working primarily in a quantitative tradition, while more interpretive traditions have less success (Redclift 1998). The wider the epistemological and methodological gaps, the greater the challenge to bridge them. It is one thing for a natural scientist to look at statistically analyzed results of a quantitative opinion survey, and quite another to appreciate the merit of an ethnographic account of local cultural practices.

When sea turtle biologists approach me to for advice on socio-economic research or invite me to participate in a project, they are most often interested in quantitative questionnaires. Just as there are strengths to questionnaires, there are also weaknesses associated with condensing human experience into a series of pre-determined 'choose one of five' scenarios, and researchers must be aware of these, as well as more qualitative options. Whether natural scientists are initially attracted to questionnaires because they most closely resemble research tools they are familiar with, or they feel questionnaires will be most easy to execute, or they are unaware of other options, or they've made a considered request based on an assessment of need, I'm never certain, but I suspect the attraction of numbers plays a key role. At the 1996 Symposium (Hilton Head), I presented survey data on the value and perceptions of tourism in Ostional, Costa Rica (Campbell 1998b), and used graphs and charts to illustrate results. One biologist commented that he appreciated the histograms, as it helped him understand the relevance of the work. Given many people's preferences for numbers, I usually agree to undertake quantitative assessments, even if I think a different approach would work better, and write this off as the price of collaboration. In doing so, I perpetuate this quantitative bias and limit the scope of interdisciplinary undertakings.

Challenge 5: Being heard

Publishing social science research in journals dominated by the natural sciences poses its own set of challenges, many of which arise through the peer review process. For example, I recently published in *Ecological Applications* (Campbell 2002b). The paper "*Science and sustainable use: views of marine turtle conservation experts*" looks at the ways science is used to support a variety of opinions on sea turtle use, and the role that views on uncertainty and other values play in the equation. I encountered two interesting problems in the peer review process.

Firstly, the comments I received suggest the reviewers were biologists. This was both a blessing and a curse; a blessing because the reviewers were interested in the argument and were familiar with incidents referred to and references cited, and a curse because they were not well positioned to comment on the research methods used in the study. For example, one reviewer suggested that in-depth interviews - ones that I traveled around the USA and Costa Rica to conduct, and spent hours devising, administering, transcribing and analyzing according to the demands of my discipline - be referred to as "casual conversations" (I refused). The same

reviewer went on to request that I conduct a variety of statistical tests on the interview data, tests entirely inappropriate for qualitative data.

Secondly, one of the points in the paper is that, because marine turtle science has many unknowns, opponents do not have to fully engage with each other's arguments, and can dismiss each other outright. I compare Meylan and Donnelly (1999) interpretation of hawksbill data with that of Mrosovsky (2000) to show that differences in opinion exist, rather than to suggest one analysis is superior. Nevertheless, one of the reviewers took issue with this comparison, suggesting Mrosovsky lacked the credentials to comment on the issue and that he had been paid by Cuba to write his book. The irony here, that the reviewer essentially reinforced my argument in his or her attempt to discredit Mrosovsky, fortunately was not lost on the editor.

Challenge 6: Being outnumbered

While the number of social scientists working on sea turtle conservation is undoubtedly increasing, we are still a minority. Some of the social scientists working on sea turtle conservation never attend the symposium, and publish only in their disciplinary journals. For many, turtles are a secondary issue, a species through which to consider social, economic, cultural and political issues of conservation. For example, Place's (1988; 1991) work on attitudes to the national park, sea turtle conservation, and tourism in Tortuguero, Costa Rica, is relevant to a broad sea turtle research audience. Her research is about conservation policy rather than turtles, however, and all of her work is published in social science journals. There is no history of social scientists dedicating themselves to sea turtles and immersing themselves in that research community, and there is no equivalent of the research groups produced by places like Florida Atlantic University or the University of Florida.

There are consequences to being outnumbered. Firstly, it is difficult to pursue integration of natural science and social science on a large scale; the numbers don't work. Secondly, all of the challenges outlined above are aggravated by the small number of people affected by them and aware of the need to address them. Finally, it can be an isolating experience. I sometimes feel like a broken record pleading, once again, for more attention to social science (I have been teased for ending all of my articles with such a plea). My ego aside, there are academic implications of the latter feelings; criticism may be muted, questions withheld - both important to academic integrity - for fear of annoying the majority.

Where To From Here?

In spite of the challenges outlined above, there is much to be gained via interdisciplinary research. The most immediate benefits are for individual researchers, as interdisciplinary research is academically and personally rewarding. Interdisciplinary collaboration forces us to wrestle with and appreciate the views of others, and to expand our own understanding of both issues being studied and different research approaches and methods. During TCOT field work in the Turks and Caicos Islands, I snorkelled on coral reefs in search of juvenile hawksbills, and helped excavate a nest on an isolated beach. While I have witnessed biological work at many sea turtle nesting beaches, this was the first chance I had to participate in it. It was a 'eureka' moment for me. Besides being a great deal of fun, I finally understood what all of the fuss over turtles is about. As my own research focuses on the human dimensions of sea turtle conservation, I can be quite passionate about the trials of rural communities living with globally-valued charismatic turtles. The hands-on turtle experience in Turks and Caicos provided balance and helped me appreciate where sea turtle enthusiasts are coming from. This balance can only enhance my research. I won't speak for my colleagues, but I hope their experiences were similar (if not quite as enjoyable) when exposed to socio-economic research.

But interdisciplinary research isn't just about individual gain. The big pay-off will come through conservation gains, with collaborations ideally yielding data that can feed into workable programs that start to address biological and socio-economic objectives. Interdisciplinary sea turtle research is in its infancy and it's too early to judge successes and failures, but if we can make interdisciplinary research work, we will be further ahead than if we continue to work in isolation. The challenges outlined above will not be easily overcome, but awareness of them is a good place to start the process.

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Sea Turtle Conservation along the Atlantic Coast of Africa

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Modern surveys of the Atlantic coast of Africa for sea turtles began as early as 1957 by Carr (1957), Carr & Hirth (1962) and Brongersma (1995). Research and conservation efforts over the last few decades, although hampered by financial, political and logistical difficulties, have revealed that the region is important for sea turtles. All six of the Atlantic species have been reported to occur from Morocco to South Africa: green turtle (*Chelonia mydas*), leatherback (*Dermochelys coriacea*), hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), loggerhead (*Caretta caretta*) and Kemp's ridley (*Lepidochelys kempii*). Significant sea turtle habitats have been identified, including green turtle feeding grounds in Banc d'Arguin, Mauritania (Fretey 2001), Corisco Bay, Equatorial Guinea/Gabon (Formia 1999) and Mussulo Bay, Angola (Carr & Carr 1991); green turtle nesting beaches in the Bijagos Archipelago, Guinea Bissau (Catry *et al.* 2002), São Tome and Principe (Dontaine & Neves 1999) and Bioko Island, Equatorial Guinea (Tomás *et al.* 1999); olive ridley nesting and feeding grounds throughout the Gulf of Guinea (Dontaine & Neves 1999; Fretey 1999; Fretey 2001; Tomás *et al.* 1999); leatherback nesting in southern Gabon (Billes & Fretey *in press*); hawksbill developmental habitat in Cape Verde, São Tome, Equatorial Guinea and Cameroon (Fretey *et al.* 2002; Formia & Fretey *in prep.*). Although species status and population trends are still largely unknown, in the past few years sea turtle work along the Atlantic coast of Africa has gained momentum, and here we report on recent advances in research and conservation in the region.

Conservation activities on local and national levels

Sea turtle projects are underway in most countries. Although many are still in the initial stages (basic data collection and identification of threats) and availability of adequate funding is a major constraint, significant progress has been achieved. For instance, in Macaronesian waters, work on loggerheads has been carried out for several years by universities in Madeira and Azores and the Archie Carr Centre for Sea Turtle Research, University of Florida. In Cape Verde, several important loggerhead nesting sites are studied intensively by a team from the University of Las Palmas (Canary Islands).

Work in the region of Joal-Fadiouth and Palmarin in Senegal has halted turtle meat consumption and the sale of carapaces. The Makasutu Wildlife Trust, a local NGO, is currently surveying and protecting nesting sites in Gambia. In Guinea Bissau, studies on reproductive behaviour and satellite tracking of nesting green turtles have been carried out in collaboration with the Marine Turtle Research Group, University of Wales Swansea.

In collaboration with the CNSHB (Centre National des Sciences Halieutiques de Boussoura), the existence of suitable hawksbill nesting sites in Guinea has been confirmed. The difficult task of establishing sea turtle conservation in Sierra Leone since the end of the civil war has been undertaken by the Conservation Society of Sierra Leone and the Njala University College. The SAMFU/Liberia Sea Turtle Project has been active at several sites designated as significant nesting and foraging habitats in southeastern Liberia.

In Côte d'Ivoire, a local sea turtle project, in collaboration with SOS Fôrets and several university students, has been studying a sea turtle nesting beach on the remote eastern coast, but current war and funding concerns may hinder future efforts.

The Ghana Wildlife Society and the Ghana Wildlife Division have identified significant sea turtle habitats and have been carrying out research and monitoring activities, conservation education, and enforcement of legislation. A financial scheme benefits villagers who participate in the turtle conservation project, providing credit to invest in new enterprises.

In Togo, university-based research and the national association Agbo-Zegue are carrying out an awareness campaign, as well as coastal surveys to gather information on species abundance and distribution.

In Benin, the Musée des Sciences Naturelles - Nature

Tropicale ONG (with assistance from BIOTOPIC) has succeeded in raising environmental awareness in several coastal villages, where local committees regularly monitor turtle occurrences and enforce protection laws. Initiatives underway include nest translocation to protected hatcheries, a tagging programme, and training of local technicians.

In Akassa, Nigeria, thanks to extensive conservation education by the Akassa Community Development Project, sea turtles are recognised as an essential part of the natural heritage; most nests are protected and live stranded turtles are released.

Ecotourism, beach surveys, monitoring activities, and community development are among the activities pursued by the sea turtle organization Kulu-man, based in Ebodje, Cameroon (in collaboration with the Projet GEF d'Amenagement et de Conservation de la Biodiversité de Campo-Ma'an). Ebodje has been twinned with a town in France, with subsequent social benefits to fishermen and turtle poachers. In addition, a research station has been set up and efforts are underway to establish a marine reserve. The Cameroon Wildlife Conservation Society is active within the Doula-Edea faunal reserve further north.

In Equatorial Guinea, coastal surveys, monitoring of capture and consumption, awareness campaigns, and training of park guards have been carried out on a wide scale through CUREF- Conservación y Utilización Racional de los Ecosistemas Forestales de Guinea Ecuatorial, Cardiff University, and ECOFAC-Conservation et Utilisation Rationnelle des Ecosystemes Forestiers d'Afrique Centrale. Full-scale monitoring and protection have been implemented only in Bioko, including night patrols by local villagers and an ecotourism programme run by the NGO Asociación Amigos de Doñana, although their work was interrupted by political unrest in 1998. Since 2001, the Bioko Biodiversity Protection Programme has resumed sea turtle monitoring and protection in southern Bioko.

Long-term studies on the ecology of the feeding grounds and a comprehensive conservation project are planned for the unique green turtle feeding ground in Corisco Bay (Equatorial Guinea and Gabon), and plans are afoot for the establishment of a vast trans-border marine reserve. In southern Gabon, priorities for this globally important leatherback nesting population include a tagging programme, a study on the effects of predation on reproductive success, as well as designing *in-situ* nest protection systems, and decreasing the level of poaching near villages. Beach surveys are carried out by local NGOs Nyamu, Aventures Sans Frontières (ASF), Ibonga and WWF-Gabon. Recently, Argos satellite transmitters have been fixed on nesting females in order to track their movements upon leaving the beach, thanks to collaboration between Nyamu, ECOFAC and the CNRS/CEPE of the University of Strasbourg, France. Conservation efforts are being extended to the Congolese section of the nesting beach within the Conkouati reserve, and the IUCN has proposed the creation of a trans-border marine reserve between Gabon and Congo to include all the most significant nesting areas. In collaboration with the Wildlife Conservation Society, ASF has also been carrying out conservation activities in the Gabonese section of Corisco Bay and in Pointe Pongara (the popular resort near the capital, Libreville), and monitoring the sea turtle meat and egg market in the capital.

In São Tome and Principe between 1998 and 2001, Projecto Tato carried out complete coastline surveys, regular monitoring of significant nesting beaches and of turtle captures at sea, nest relocation in protected hatcheries, as well as awareness campaigns among locals, students, tourists, government officials and tortoiseshell artisans. Although funding for Projecto Tato was ended in 2001, conservation efforts have been resumed thanks to the NGO MARAPA, which built two new egg hatcheries at the end of 2002. Sea turtle conservation initiatives are underway in other range countries, including Morocco, Mauritania, Democratic Republic of the Congo, Angola and Namibia.

International conservation initiatives

In May 1999, the Convention on the Conservation of Migratory Species of Wild Animals (CMS) organized an international conference for the conservation of sea turtles of the Atlantic coast of Africa in Abidjan, Côte d'Ivoire, with support from the French government, IUCN-France and WWF-West Africa. A Memorandum of Understanding was formulated to politically seal the decision for regional co-operation. To date, 19 States have signed the Memorandum of Abidjan, and several others, including some European countries, are preparing to do so. In May 2002, the First Meeting of Signatory States to the Memorandum of Abidjan was held in Nairobi, Kenya. A regional conservation plan for sea turtles was developed further at this meeting, which is meant to apply to all the countries ranging from the Straits of Gibraltar to the Cape of Good-Hope, including the islands of Macaronesia, Saint-Helena, Ascension, and the Spanish territory of Ceuta. This vast programme, initiated by the CMS, is complemented by Programme Kudu (the vernacular name for sea turtle in several African languages), an umbrella organisation aimed at coordinating and supporting the activities of

national groups (comparable to WIDECAST in the Caribbean region). In turn, Kudu is divided into three networks: TOMAO (Tortues Marines d'Afrique de l'Ouest) for northern West Africa from Mauritania to Guinea, WASTCON (West Africa Turtle Conservation Network) for southern West Africa from Sierra Leone to Nigeria, and PROTOMAC (Protection des Tortues Marines d'Afrique Centrale) for Central Africa from Cameroon to Republic of the Congo. A regional office and database have been established in Libreville, Gabon, with assistance from the Coopération Française and the European Union programme ECOFAC.

Current threats

Most of the threats affecting sea turtles along the Atlantic coast of Africa are not exclusive to this part of the world, although their accumulated effect makes the situation particularly challenging for the well-intentioned conservationist. Poverty of coastal inhabitants is often associated with the absence of basic infrastructure and services, such as clean water, health care, transportation and access to basic commodities. Where sea turtles are relatively abundant, they are considered significant sources of food and income, and villagers depend on them to supplement their fishing and crop harvests. In areas with large turtle aggregates, such as green turtle feeding or nesting grounds (Equatorial Guinea, Gabon, São Tome and Principe), organised market systems have developed around exploitation of meat, eggs and other products. Demand from the upper and middle classes in large cities drives this market to intensive harvests.

Hawksbill shell is used to make ornaments and souvenirs for sale to tourists, particularly at holiday destinations such as São Tome and Principe. Oil from leatherback fat and crushed skulls are thought to have medicinal properties and are used in the West African countries of Ghana, Togo, Benin and Cameroon. Sea turtle carapaces are also sometimes incorporated in traditional religious ceremonies, although local beliefs and myths focusing on sea turtles may also be a source of protection for the species (such as in Ghana, Republic of the Congo, Benin and Côte d'Ivoire).

In addition to direct exploitation, sea turtles are affected by several indirect threats. Commercial fisheries (many from east Asian countries) operating in the Gulf of Guinea, particularly between Ghana and Gabon, are thought to incidentally capture a large number of sea turtles in their gear, mainly olive ridleys and leatherbacks (specific research on the subject has recently been initiated). Over-harvesting and damaging of marine ecosystems by industrial trawlers may lead to decreases in fish catch by small-scale fishermen and, in turn, lead to greater dependence on other resources, such as sea turtles.

The Gulf of Guinea is also the focus of extensive and rapidly increasing oil exploitation activities. Vast oil reserves have been discovered in the last decade in areas which also host important sea turtle habitats (e.g. Corisco Bay, São Tome), and drilling activities by large oil corporations, associated with pollution and habitat destruction, are increasingly serious threats.

Marine and coastal pollution are also widespread in industrial and urban areas, and garbage litters many developed beaches. Okoume timber lost at sea by logging companies washes up onshore and obstructs nesting beaches in Gabon, Equatorial Guinea and Cameroon. Coastal erosion due to sand mining, harbour building and irregular current flows has compromised the suitability of long stretches of coastal areas as nesting sites, particularly between Ghana and Nigeria.

Environmental awareness, and the concepts of finite natural resources and the importance of protecting biodiversity for future generations are not widespread. Generally, governments along the Atlantic coast of Africa have inadequate regulatory legislation focusing on environmental issues, and enforcement of species protection laws is often scarce or absent. Where legislation has established protected areas or prohibited use of sea turtles and turtle products (all countries appear to have laws fully or partially protecting some or all species), poaching remains widespread, especially since extreme poverty means there is often little else available. Even in Nigeria, the only country requiring the use of Turtle Excluder Devices by its trawling fleet, numerous strandings have been reported of turtles entangled in trawler nets.

Political instability and civil wars often hamper conservation activities. Both Sierra Leone and Liberia have recently emerged from years of devastating wars. Republic of the Congo and Nigeria are plagued by high insecurity, social and religious tensions, and the previously wealthy and stable Côte d'Ivoire has now plunged into what may well escalate into civil war. Sea turtle conservation initiatives in these countries may be negated by difficulties in establishing safe, long-term field projects and enforcing national legislation, or by shifting pressure on natural resources. In many countries, wealth from the large-scale exploitation of resources such as oil, minerals and timber has not yet filtered through to the majority of people.

As in many developing countries, conservation initiatives must operate within the daily constraint of coastal villagers needing the sustenance provided by the species being protected. It is essential that any proposed

protection measures be associated with careful campaigns stressing the socio-economic benefits of conservation and of sustainable use of natural resources, as well as initiatives providing viable, sustainable livelihoods. The latter is often too easily ignored, in favour of blanket bans on exploitation of threatened resources. Seed funds and expertise are seldom available to set-up alternative enterprises, to provide stable sources of income, and to bring basic services improving the quality of life. In addition to financial and logistical difficulties, undertaking conservation initiatives must bear in mind several essential precautions. A fine balance must be achieved between what might be viewed as foreign interference and empowering of local projects. Although sometimes lacking in scientific background, the most effective initiatives tend to be those undertaken locally, such as in Benin, Gabon, and Ghana. On the other hand, it is essential for local projects to receive national and international support, to be made aware that many of the challenges and issues they face are common world-wide and that successful approaches and solutions have been devised that may be applicable within their context. Due to remoteness and the difficulty of accessing information and means of communication, many African sea turtle projects are not taking advantage of the power derived from working synergistically.

Sea turtle conservation in Africa is still relatively young and offers great potential and scope for the establishment of successful initiatives. In spite of the challenges, the past few years have shown many advances in our knowledge of sea turtles along the Atlantic coast and conservation efforts initiated in different countries have been encouraging. Much remains to be done - for example, baseline surveys are still lacking from potentially significant habitats in Mauritania, Senegal, Guinea, Sierra Leone, Nigeria, Angola, and Namibia. Management strategies must be designed and implemented soon, before populations become depleted beyond recovery, and should be based on the best available knowledge. Several tag returns (e.g. Bellini *et al.* 2000; Marcovaldi *et al.* 2000; Pritchard 1973) and genetic studies (Formia 2003) have shown the inter-connectedness of African sea turtle populations with those present in the western Atlantic. Many surprises may still be in store, including the possibility that some individuals use nesting areas on both sides of the Atlantic Ocean (Fretey 1992). The migratory nature of sea turtles reminds us that it is impossible to ignore threats affecting the same population in sometimes very distant parts of its range; international coordination is an essential aspect of conservation efforts.

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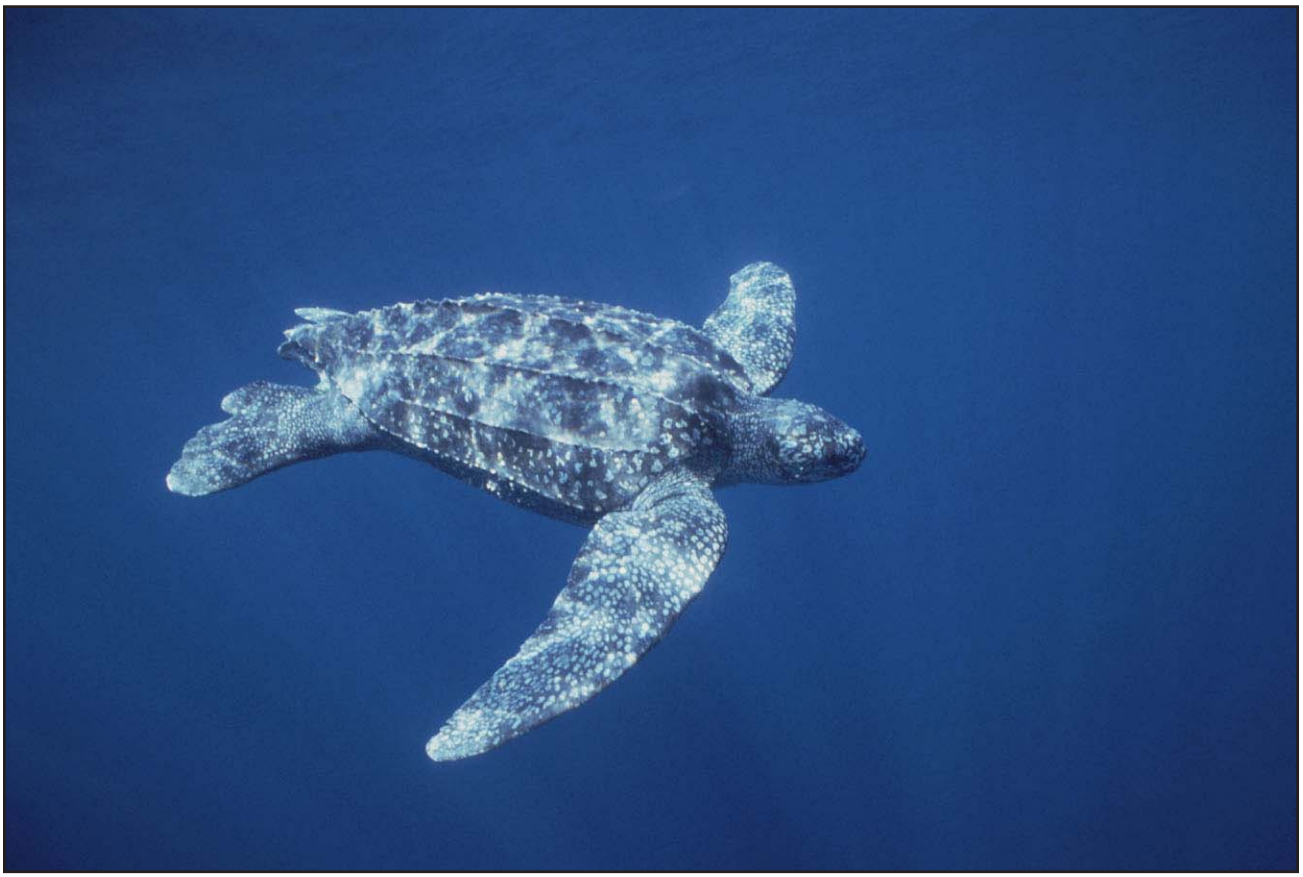

Leatherback sea turtle (*Dermochelys coriacea*) in Mexican Pacific. © Doug Perrine/seapics.com

Marine Turtles in Latin America and the Caribbean: A Regional Perspective of Successes, Failures and Priorities for the Future

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Latin America: One Region with Many Facets and Great Diversity

For historic, political and social reasons a major portion of the Western hemisphere is routinely referred to as 'Latin America'. This region extends from Mexico to Tierra del Fuego; with few exceptions the lands were colonised by either Spain or Portugal, and today the dominant languages are either Spanish or Portuguese. From Mexico to Panama (i.e., Central America except for Mexico) there are 8 nations; in South America there are 12 nations (including two that are landlocked, and one overseas department of France); and the insular Caribbean has 24 nations, 10 of which are dependencies of European countries (France, The Netherlands, the United Kingdom). In addition to Spanish and Portuguese, the official languages of Latin American countries include Dutch, English and French.

With island possessions that extend eastward to Brazil's Trindade Island, 1200 km off the continental coast in the south Atlantic and westward to Chile's Easter Island, 3585 km off the continental coast in the south Pacific, the marine and coastal areas included in Latin America are enormous and diverse, and extend from the tropics to sub-polar regions.

Although there is sometimes a general opinion that Latin American nations and Latin American peoples are much the same, there is in fact a tremendous amount of diversity at multiple levels, both within and between nations. Ethnic groups, for example, include Native Americans; descendants of African slaves, European colonists, and Indonesian and East Indian indentured labours; and mestizos (a mixture of Native Americans with other ethnic groups) and mulattos (a mixture of black Africans with other ethnic groups). The histories, cultures, political structures, societies, and economic development differ tremendously between different Latin American countries. Hence, the perceptions of, and responses to, conservation issues are highly variable.

Marine Turtles and Their Habitats in Latin America

Only one species of marine turtle does not occur in Latin America, the Australian flatback (*Natator depressus*); and the region is of tremendous importance for the remaining six species. The only significant nesting area for Kemp's ridley (*Lepidochelys kempii*) is in Mexico (TEWG 1998); the only nesting areas for the black or Eastern Pacific green turtle (*Chelonia mydas*, sometimes called *'Chelonia agassizii'*) extend along the Pacific coasts from Mexico to Galapagos, Ecuador (Seminoff 2002), and some of the largest nesting concentrations of green turtles (*Chelonia mydas*) are on mainland and island beaches of the Caribbean (Seminoff 2002). One of the world's largest nesting concentrations of leatherbacks (*Dermochelys coriacea*) is in Suriname and French Guiana (Spotila *et al.* 2000); one of the world's largest nesting concentrations of hawksbills (*Eretmochelys imbricata*) is on the shores of the Yucatan Peninsula, Mexico (Meylan & Donnelly 1999); about half of the major massed nesting concentrations for olive ridleys (*Lepidochelys olivacea*) rely upon Pacific beaches from Mexico to Costa Rica (Pritchard & Plotkin 1995); and many of the loggerheads (*Caretta caretta*) that occur in Latin American waters stem from major nesting populations in southeastern USA or Japan, depending on whether they are in the Atlantic or Pacific Oceans (Bolten & Witherington 2003). Hence, in addition to major nesting areas, Latin America provides vast and diverse feeding areas for marine turtles, as well as important developmental habitats and migratory corridors.

The Status of Marine Turtles and Their Habitats in Latin America

Despite this richness in species, large sizes of many populations, and diversity and extent of important environments, Latin America also provides lucid examples of mismanagement of the animals and their habitats. Perhaps the clearest case is that of the Kemp's ridley, which was literally brought back from the brink of extinction, and now, after decades of dedicated and costly work is in the early stages of recovery (TEWG 1998). Many populations of the other five species in the region have experienced dramatic declines, and in some cases they have become ecologically and

economically extinct. The case of the green turtle in the Caribbean, devastated by overexploitation during colonial times, is probably the best understood (Jackson 2001; Jackson *et al.* 2001), but numerous populations of hawksbills (Meylan & Donnelly 1999), olive ridleys (Pritchard & Plotkin 1995), loggerheads (Bolten & Witherington 2003), and leatherbacks (Eckert & Bjorkland in press) are also known to have decreased markedly over the past century.

In certain nesting areas, where conservation programs have been sustained for at least two decades, there are clear indications of recovery. The better known increases include: hawksbills in Yucatan (Garduño *et al.* 1999); olive ridleys in Brazil (Castilhos *et al.* in press); leatherbacks in St. Croix, US Virgin Islands (Boulon *et al.* 1996) and some Caribbean beaches of Costa Rica, such as Playa Negra and Playa Gandoca (Chacón in litt.); green turtles at Tortuguero, Costa Rica and Yucatan, Mexico (Seminoff 2002); and olive ridleys at Escobilla, Mexico (Márquez 2000). In general, however, the documented cases of recovering populations stand out as exceptions against a background of decimated populations.

Direct exploitation, or overkill, is often attributed to these declines, and in a few cases there is archaeozoological evidence that pre-Columbian peoples reduced the abundance of exploited populations (Frazier 2003 in press), a phenomenon that has been established for many New World animals, including scores of examples of evolutionary extinction (e.g., Kay & Simmons 2002). However, without a doubt, European colonization heralded major increases in rates of resource extraction, involving the ecological and economic extermination of various populations (Jackson 2001; Jackson *et al.* 2001). Most of the above examples of increasing population trends have been preceded by a decade or more of sustained and significant reduction in the number of nesting females killed annually on the respective beaches.

In more recent times less conspicuous, but equally insidious negative impacts on marine turtles have been caused by incidental capture, particularly in modern fishing operations; vast habitat destruction, especially on tropical nesting beaches through development of resorts, hotels, and other human enterprises; and marine and coastal pollution, often caused by human activities that are not immediately obvious to the lay public, such as light, nutrient, thermal, and chemical pollutions (Lutcavage *et al.*1997). A global entrepreneurial trend to turn sandy, tropical shores into tourist destinations with hotels, beach and near shore activities, etc. has resulted in the destruction of large numbers of nesting beaches throughout Latin America. The development and intensification of fisheries, including increased availability and use of synthetic fibres and internal combustion engines, with amplified market pressures to catch and export more fisheries products, and an ever-escalating spiral of increased fishing effort has created gargantuan problems with incidental capture and mortality throughout most of the region.

Development of Conservation Activities in Latin America

Although marine turtle work was active in Costa Rica as early as 1955 (Carr, 1967), one of the longest running national programmes for marine turtle conservation began in Mexico, nearly 30 years ago (Márquez *et al.* 1976), and the national programme in Suriname began 35 years ago (Reichart & Fretey 1993). The national programmes in Brazil (TAMAR) (Marcovaldi & Marcovaldi 1999) and French Guiana (Girondot & Fretey 1996) also have decades of experience. In the last decade nearly every country in Latin America has developed a marine turtle program, some incipient such as in Argentina and Uruguay, and some highly developed and integrated with various activities including monitoring, investigation, environmental education, community participation, etc. In some countries, such as Costa Rica, Guatemala, Mexico and Peru, there are multiple projects, with varying degrees of coordination. The results of national workshops and meetings in Colombia (Amorocho *et al.* 1999), the Guianas (Kelle *et al.* 2000; Shouten *et al.* 2001) and Mexico have been published (Benabib & Sarti 1992; Frazier *et al.* 1993).

In addition to activities conducted at a national level, there are regional networks. The Wider Caribbean Sea Turtle Conservation Network (WIDECAST) has been active for 22 years, integrating participation from diverse sectors of virtually every Caribbean nation. WIDECAST collaborators have produced sea turtle recovery action plans (STRAPs) for 11 Caribbean nations: Antigua and Barbuda, Aruba, Barbados, Belize, British Virgin Islands, the Netherlands Antilles, St. Lucia, St. Kitts and Nevis, St. Vincent and the Grenadines, Suriname, and Venezuela. WIDECAST has also trained or promoted the training of many hundreds of biologists and managers throughout the region, developed standard procedures for conservation and research, promoted community involvement, and enhanced the level of awareness of sea turtle issues amongst policy-makers. The Central American Sea

Turtle Network (RCA) serves as a forum for the seven Central American countries, from Belize to Panama, to exchange information and expertise, and this has been active since 1996. Another example is the Marine Turtle Conservation Program of the Guianas (for Guyana, Suriname and French Guiana).

In many respects these regional activities follow the lead of the earlier Western Atlantic Turtle Symposia, or 'WATS' (Bacon *et al.* 1984; Ogren *et al.* 1989), and have led to strong range state support for continuing regional dialogues (Eckert & Abreu 2001). Meetings specifically designed to reach the needs of Latin American stakeholders are also convened on a regular basis. Since 1994 there has been a two-day meeting of Latin American specialists immediately before the Annual Symposium on the Biology and Conservation of Sea Turtles. These reunions provide a forum for the exchange of information and contacts at a regional level, and the annual Latin American meeting has attained certain organizational and political importance in the Annual Symposium (Barragán 2002).

Because of the migratory nature of marine turtles, it is widely realized that collaboration and true cooperation between projects (within and among nations) is essential to complement site-restricted activities. Integration and sharing of information and scientific data enables the development of more effective monitoring, which provides the foundation for timely, and more meaningful, more integrated responses to conservation problems.

In this respect the Latin American region plays a unique role in the promotion of international cooperation for the conservation of marine turtles and their habitats. Between September 1994 and September 1996 a total of 27 countries and 4 intergovernmental organisations, as well as numerous other specialists from academic, conservation, NGO, and other organisations, participated in the development of the Inter-American Convention for the Protection and Conservation of Sea Turtles ('IAC'). The objective of this treaty – open to all states in the Americas – is '*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, socioeconomic and cultural characteristics of the Parties.*' There is no doubt that the hard work and dedication of scores of marine turtle specialists throughout the region has been instrumental in the advancement of this treaty (Frazier 2000), and this experience has served as an important case study at a global level (Bache 2002). Indeed, the IAC has served as a model for the development of other international instruments concerned with the development of multilateral accords for the conservation of marine turtles and their habitats.

Priorities for the Future

"*Perhaps the most significant need for the region is to build on its networking capacity and to make a genuine commitment to managing and monitoring sea turtles stocks on a population scale. This scale transcends national boundaries and necessitates that governments understand and take into account the effects that management decisions in one country will have on sea turtles in another country. A good level of sharing and coordinated decision-making is the next challenge for a fully integrated and successful conservation strategy." (*Karen Eckert In litt*).* Expanding on these sentiments, Diego Amorocho concluded that *"Public awareness, information dissemination and community involvement need to be strengthened at local and regional levels. Strategies including incentives and alternative livelihood practices must be identified and fostered to encourage community involvement in the decision-making process for policy planning and conservation management. A combination of "top down" and "bottom up" approaches must be considered for improving public participation in sea turtle conservation in Latin America. In addition, national policies and conservation measures need to be harmonized with international law and cooperative regional agreements in order to guarantee the protection of sea turtles and their vital habitats over their entire distributional range in America.*" (Amorocho 2002).

Several priority actions include:

- Evaluate and support the mitigation of the root problems of unsustainable development, social and political instability, and inequitable economic growth.
- Strengthen and expand the efforts of local conservation groups, particularly those working in the field, to involve coastal communities.
- Strengthen cooperative efforts at coordination and organization between different sectors: public and private; governmental, academic and non-governmental; local, national and international. The development of the Inter-American Convention for the Protection and Conservation of Sea Turtles is an example of how this policy can be implemented on a regional level.
- Standardise protocols and databases that employ the same methodologies and terms,

including the development of a glossary for technical terminology and concepts, that will facilitate integration between activities and communications in the region, a better understanding of the status of shared populations and enhance effective decision-making for the conservation of marine turtles and their habitats in the region.

· Develop a strategic plan for each country, as well as an overall plan for the region, with clear prioritisation of responses to major threats, the development and maintenance of protected areas, and the identification of conservation objectives/goals, while respecting different social, economic, political, cultural and environmental situations.

· Enhance capacity building, interchanges, and periodic evaluations of data and activities between projects.

· Develop investigations to identify population structure, or management units, particularly through the use of molecular genetics.

· Develop and implement on-board observer programs for identifying and evaluating problems of incidental catch in mechanised fisheries.

· Develop and implement national plans to mitigate incidental capture and mortality in various fishing activities.

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Marine Turtle Conservation in South and Southeast Asia: Hopeless Cause or Cause for Hope?

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All species of marine turtles except the Kemp's ridley (*Lepidochelys kempii*) occur within Asian waters, and of these, all except the Flatback (*Natator depressus*), nest in the Asian region. The Flatback is confined to waters of the Australian continental shelf, but feeding turtles have been recorded in the Indo Pacific area (Limpus *et al*. 2001). Marine turtle populations in Asia have been depleted through long-term harvests of eggs and adults, and as by-catch in the ever-growing trawl fisheries. Since turtles are indicators of the health of various and diverse marine ecosystems, these losses reflect a void in mankind's ability to sustain the present health of the oceans. Commitments made by many Asian governments at the Rio Convention have, for the most part, failed to curb the declines leading to the loss of what are among the last descendants of the planet's prehistoric age.

Despite the many turtle-related laws in Asian countries, governments have generally had little success with turtle conservation, and sea turtles and their habitats along with many other environmental issues are not high on their list of priorities. Even occasional efforts from governments and other agencies rarely translate into success at the ground level. However, governments are often forced to demonstrate good intentions and some measure of success, often resulting in misleading claims and assertions. An example is the frequent reports of exaggerated numbers of turtles nesting in Orissa, even though the population may really be in decline (see Shanker *et al.* in press). Similar is the case with the so-called success of green turtle conservation in Sabah, Malaysia (see Chan 2001; UPM *et al.* 1996), where populations have been steadily increasing, though nearly all eggs are moved to hatcheries, which produce 100 % females due to warm development temperatures (Tiwol & Cabanban 2000) resulting in skewed population sex ratios. Even given today's understanding of the problem, less than 20 % of the hatchery is shaded to counter this error. In another instance, when the USA imposed regulations on the import of shrimp, calling for the use of turtle-friendly fishery gears such as Turtle Excluder Devices (TEDs), the governments of India, Malaysia, Pakistan and Thailand opposed the move and won a case at the World Trade Organisation (Oravetz 2000). Though the Asian governments may have shared the US concern for sea turtles, they opposed the US position to protect their political agendas and since then have mostly failed to require or enforce the use of TEDs in their trawler fleets. The only losers in this case are the sea turtles, many of which continue to be accidentally captured in trawl fisheries.

For many parts of Asia there is still a vacuum with regards to knowledge of marine turtle populations. We present here a brief review of the status of marine turtles in South and Southeast Asia in the areas where most study and management efforts have been undertaken, major threats to populations and habitats, and highlight problems of particular importance. We also evaluate the general outlook for turtles and present major considerations for their conservation.

CURRENT STATUS OF SEA TURTLES IN SOUTH AND SOUTHEAST ASIA

Most populations in Asia have declined in recent years, some to the brink of extinction; though there are a few cases in which protection over the last 30 years has restored turtle populations. Major nesting populations in the region are as follows:

Leatherback: The only major nesting sites in the Indian ocean / Southeast Asian region are on Bird's Head peninsula, West Papua, Indonesia, where ~5000 nests are deposited per year (Halim *et al.* 2001; Putrawidjaja 2000) and Great Nicobar island, with about 2000 nests per year (Andrews & Shanker 2002). Nesting also occurs at a few other sites in the Andaman and Nicobar islands (Andrews *et al.* 2001) and Godavaya, Sri Lanka with ~ 300 nests per year (Ekanayake *et al.* 2002).

Green: Green turtles are the most widely distributed species, with regionally important populations occurring in Indonesia (10,000-20,000 nests per year; Halim *et al.* 2001), East Malaysia (Sabah and Sarawak Turtle Islands combined: up to 10,000 nests per year), Peninsular Malaysia (2,000-3,000 nests per year; Chan 2001; Nasir *et al.* 1999) and the Tawi-Tawi Turtle Islands, Philippines, (10,000-20,000 nests are deposited per year; Trono 1991). Myanmar has a reported 500

nests per year (Thorbjarnarson 2000) while in Thailand 200-300 nests are deposited yearly in the Gulf of Thailand, and possibly a similar number on the Andaman sea coast (Chantrapornsyl 1993). Green turtles also nest in Pakistan (~1000 nests per year; Asrar 1999), Gujarat, India (Sunderraj *et al*. 2001), Lakshadweep (<1000 nests per year; Tripathy *et al.* 2002) and the Andaman and Nicobar Islands (>1000 nests per year; Andrews *et al.* 2001), Sri Lanka (Dattatri & Samarajeeva 1982), and the Maldives (Frazier *et al.* 2000). All these populations are believed to have declined. In Vietnam, Con Dao has an average of 230 females per year (1995 to 2001) (Nguyen Thi Dao 1999; WWF/Con Dao unpublished data) and the total Viet Nam nesting population(s) is likely to be around 250 females per year (Hamann *et al.* 2002).

Hawksbill: In Malaysia, 400-600 nests are deposited per year in the Sabah Turtle Islands (Pilcher & Lamri 1999), and between 200-300 nests are produced per year in Melaka (Peninsula Malaysia). Nesting in Indonesia is higher, with a total of 1,000-2,000 nests per year (Chan 2001; Nasir *et al*. 1999). In the Indian subcontinent, hawksbill nesting is restricted to Lakshadweep (Tripathy *et al.* 2002) and the Andaman and Nicobar islands (Andrews *et al.* 2001).

Olive Ridley: Olive ridleys nest in Pakistan (Asrar 1999) the east and west coasts of mainland India (Kar & Bhaskar 1982) and Sri Lanka (Dattatri & Samarajeeva 1982), Bangladesh (Islam 2002), Myanmar (Thorbjarnarson *et al.* 2000), and Andaman and Nicobar islands (Andrews *et al.* 2001) and small populations are found in Vietnam (Hamann *et al.* 2002), Malaysia and Australia. Important sporadic nesting occurs at Tamil Nadu with ~4000 nests per year (Bhupathy & Saravanan 2002), Andhra Pradesh with up to 10,000 nests year (Tripathy *et al*. unpublished data) and Andaman and Nicobar islands with ~1000 nests per year (Andrews *et al.* 2001). The single most important breeding area is Orissa on the east coast of India, which has three mass nesting beaches (Gahirmatha, Devi River mouth and Rushikulya) where >100,000 turtles nest during arribadas at Gahirmatha and tens of thousands nest at the other sites (Shanker *et al.* in press). This species is mostly absent in Southeast Asia. Myanmar and Brunei record activity exceeding 300 nests per year, and Indonesia, Malaysia and Thailand have less than 50 nests per year (Chan 2001; Nasir *et al.* 1999). It is currently difficult to estimate the population size in Viet Nam, however it is likely to be 10s of nests per year.

Loggerhead: The only significant nesting site is in Myanmar, with about 60 to 100 nests per year (Thorbjarnarson *et al*. 2000). This is a conservative estimate taking into account the potential mis-identification of loggerhead and olive ridley turtles.

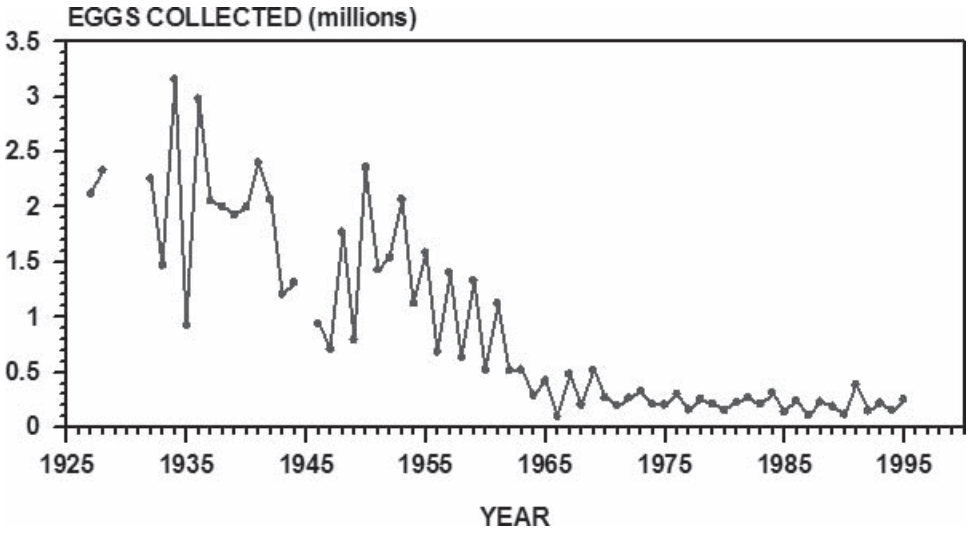

Figure 1. Long-term trend of egg collection at the Sarawak rookery in East Malaysia, showing no recovery after sustained egg harvests (Limpus *et al.* 2001).

POPULATION TRENDS

Green turtle population sizes have, for the most part, decreased throughout their range in the region. Turtles have been taken for their meat and have become by-catch in the ever-increasing fisheries. Coupled with this, the thorough and systematic harvest of eggs in many parts of Southeast Asia results in few hatchlings reaching the sea, such as occurs in many parts of Indonesia (Pilcher 1999). This has occurred in Sarawak, Malaysia, where the harvest of green turtle eggs was an industry right up until the 1980s, and this near-complete harvest of eggs over decades caused the collapse of the nesting population (Fig. 1). After more than twenty years of conservation efforts, the population has not shown signs of recovery (see Limpus *et al*. 2001). It is important to note that with long-term conservation efforts, some populations are starting to stage a comeback (see below).

Hawksbill populations have also declined at nearly every rookery in the region, as exemplified by the population at Suka Made, Indonesia (Limpus *et al*. 2001), for which data from recent years indicate a near-collapse of the nesting population. However, there is evidence that some populations may be stable at present, such as those in Malaysia (Chan & Liew 1999; Pilcher & Lamri 1999).

The leatherback turtle and its eggs have been over-harvested and lost to fisheries as by-catch, with many populations at the brink of extinction, most notably at Terengganu in Malaysia, where nesting declined from 10,000 nests per year in 1950s to less than 20 nests per year in recent years (Chan 2001).

Olive ridleys appear to have declined in Bangladesh (Islam 2002), Myanmar (Thorbjarnarson *et al.* 2000) and Sri Lanka. At Hawkes Bay (Pakistan), there has been a dramatic decline despite a hatchery program (Asrar 1999). In some areas, declines may have been arrested by local conservation programs such as the one in Madras, India, where eggs have been collected by conservation volunteers and incubated in hatcheries since 1974 (Shanker 2003). In Orissa, the fishery related mortality has resulted in over 90,000 dead turtles since 1994 (Pandav 2000; Biswajit Mohanty pers. comm.), which may have caused a severe decline in the population (Shanker *et al.* in press). Over 50,000 turtles may have been harvested each year in the 1970s (Biswas 1982; Das 1985), but later implementation of wildlife laws drastically reduced this harvest (Dash & Kar 1990). Numbers of turtles appeared to rise in the 1980s following the ban on commercial trade, but may now be declining due an increase in fisheries-related mortality (Shanker *et al.* in press). Although most estimates of nesting are unreliable (see '*Poor Data'* below), the failure of mass nesting events in three of the last five years, and a consistent decrease in the size of breeding adults between 1996–2002, suggests a potential or imminent decline (Shanker *et al.* in press).

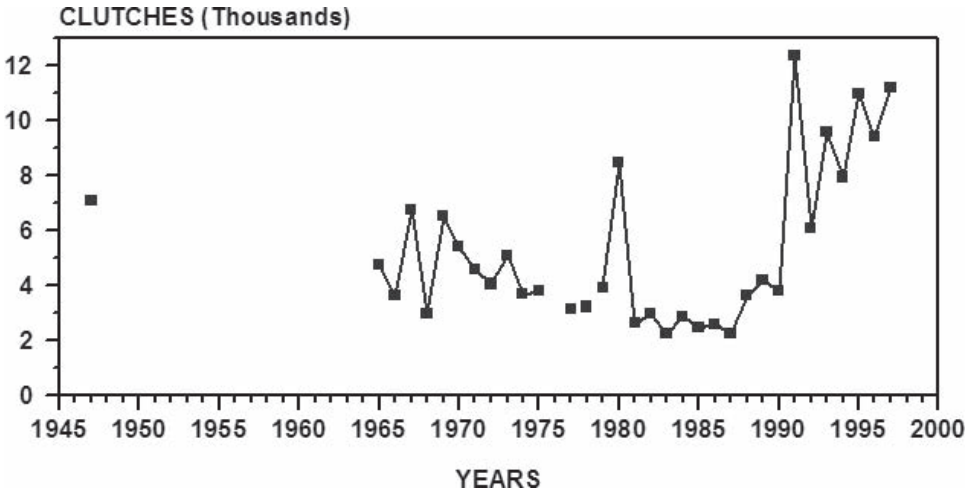

Figure 2. Green turtle recovery at the Sabah rookery in East Malaysia. These data must, however, be seen in a much longer timeframe context, as the rookery releases millions of female hatchlings and few male ones, a bias which is likely to have a profound impact on the population trends in the coming 30 years (Limpus *et al.* 2001).

Lastly, there are suggestions that conservation measures can have positive results, as not all populations are currently in decline. For instance, in Sabah, East Malaysia, following long-term complete protection of nesting females and eggs, green turtle populations are on the rise (Fig. 2) even though the population had declined by an estimated 54% before these rises started to occur (see de Silva 1982; Groombridge & Luxmoore 1989). At present it is impossible to say whether the population rise is entirely a result of conservation measures, however, given the available information, they are likely to be a significant factor. This highlights the need for conservation efforts in Southeast Asia, and for the world for that matter, to be long-term (several decades) and ongoing exercises.

MAJOR THREATS

Marine turtle populations have long been exploited throughout the Indian Ocean and Southeast Asian region (for a review, see Frazier 1980). Human activities that directly or indirectly threaten marine turtles include the harvesting of eggs and turtles, fishery related mortality, inappropriate management practices, destruction or modification of habitats, pollution, mariculture and tourism. In many cases, it has been the combination of modern fisheries (mechanisation and fishing gear) and traditional practices (turtle harvesting) that has resulted in drastic declines in recent years.

Adult mortality - Each year over 5000, and possibly as many as 10,000 green turtles are killed on the Indonesian island of Bali for religious and cultural reasons (Halim *et al.* 2001). In Bali and surrounding waters the green turtle is almost extinct, and most of the turtles landed at Benoa now come from further afield. Many nesting turtles on Indonesian beaches are also collected, and some boats collect as many as three hundred turtles on a trip, which can extend out to Aru, Southeast Sulawesi, East Kalimantan, Irian Jaya, Madura, Timor and Flores. Recent scientific efforts have determined that some of these turtles may also originate from Australia, the Philippines and Malaysia (see Lindsay & Watson 1995). Additionally, 25 % of the turtles are male, indicating harvesting also occurs at foraging/courtship grounds. Recent efforts by WWF Indonesia appear to be having success in reducing the number of turtles landed in Bali (I.B. Windia Adnyana and K. Sarjana Putra, pers. comm.), the decrease of which may be reflected regionally, possibly even for the population increases indicated by Chaloupka & Limpus (2001) for Australia.

In Orissa, the incidental mortality in trawl nets has increased from a few hundred each year in the 1980s to ~15,000 each year since 1999 (Pandav 2000; B. Mohanty pers. comm.). Recently, gill nets have also been identified as causing significant mortality in Orissa (Wright & Mohanty 2002) and along the rest of the Indian coast (Rajagopalan *et al.* 2001). Several thousand green turtles were killed annually in the Gulf of Mannar for trade in Sri Lanka and India, and while this has declined since the implementation of wildlife laws in both countries, many turtles are still caught opportunistically (Bhupathy & Saravanan 2002; Hewavisenthi 1990). The trade in tortoiseshell also continues in Viet Nam (Duc 1995; Pham Thuoc *et al*. 2002), Sri Lanka (Richardson 1997) and other countries.

Egg collection - The collection of eggs in Southeast Asia is widespread, and one of the main threats to turtle survival in the region. In the early 1970s, less than 10% of eggs were retained for incubation in hatcheries in peninsular Malaysia. In 2001, the percentage of eggs protected in Peninsula Malaysia has been increased to approximately 50%. The remainder are marketed by the licensees (Siow & Moll 1982). Over 4,100,000 eggs were harvested in Sarawak between 1967 and 1978, of which only 2 % were transplanted to hatcheries. The population has declined steadily with little chance of recovery (Fig 1). In contrast, in Sabah, from 1965 to 1978, a total of over 6,000,000 eggs were collected, of which slightly over 2,700,000 were transplanted to hatcheries, of which ~66 % hatched (Siow & Moll 1982). Depredation of nests by feral animals is also widespread in many South Asian areas (Bhupathy & Saravanan 2002; Dattatri & Samarajeeva 1982; Islam 2002; Sunderraj *et al.* 2001; Tripathy *et al.* in review).

The tale of the Turtle Excluder Device - At the center of international dialogue, and viewed as a crucial factor in turtle conservation are Turtle Excluder Devices (TEDs) to minimise incidental capture of turtles in trawl fisheries. The reason this has become an issue stems from a USA decision whereby all countries exporting shrimp to the USA are to use TEDs on their trawlers, a requirement many developing countries in Asia took reservation to, citing illegal implementation of World Trade Organization (WTO) trade restrictions. This issue led to international lawsuits, and while the USA recently won its appeal against claimant nations, and is free to implement restrictions while working in close collaboration with exporter States, it is not clear if this will be an effective mechanism to enforce the use of TEDs (see Bache 2001; Bolton 2001).

Bekko (tortoiseshell) industry - Hawksbill shell is used widely in the manufacture of trinkets and jewelry. The meat is generally not eaten, so the animals are killed simply for their shells, and the tortoiseshell industry has been responsible for the massive declines in the wild populations over the past four or five decades simply for the animals' shell. The trade in tortoiseshell continues to this day in many Asian countries including Indonesia, China, Korea, Viet Nam, and others, even though CITES member countries do not trade legally in the product. While CITES does not have any control over domestic trade, it should have some form of control over international trade, which in many cases it does not. As an example, in Viet Nam (a CITES signatory nation) the international movement of tortoiseshell is widespread, with tortoiseshell available at Duty-Free shops at airports to make it easy for tourists to unwittingly become part of the problem. Recently, in April 2002, the Viet Nam government developed local legislation which has outlawed the capture, use and sale of marine turtles and their products. Awareness raising incentives were initiated in late 2002 to help promote the local enforcement of this law.

Poor management practices – The last 30 years have witnessed a meteoric increase in scientific knowledge on marine turtles, their environmental needs, reproductive cycles, habitat requirements and the like, but little of this knowledge is yet incorporated into conservation projects in Asia. For example, temperature dependent sex determination and sex ratios have been well studied and documented, even for this region, but in Sabah, open and unshaded beach hatcheries continue to produce 100 % female hatchlings (Tiwol & Cabanban 2000), and while a 50:50 ratio is not necessarily a requirement for survival, the complete lack of one sex most definitely is. Experimental studies have shown hatchlings in hatchery enclosures tire and utilise valuable energy (Pilcher 2001), but retention of hatchlings for several days, such as those in programmes in Myanmar, Thailand (Chantrapornsyl 2002), and Sri Lanka (Hewavisenthi 1993) for the sake of tourism robs hatchlings of vital offshore migration cues. There is a clear need for management practices to adapt and reflect the biological needs of the turtles themselves, and for the appropriate information sources to be made available in several languages to managers in the region. Indeed, the issue of language is another stumbling block in the region, whereby many managers simply do not have access to the required information in their own languages. It is imperative that pertinent sections and manuscripts of widely available current literature documentation be translated if local communities and managers are to make use of the valuable array of scientific and technical knowledge currently available.

Lack of basic research – Research has been relatively advanced in India, Malaysia and Thailand, while the remainder of Asian nations generally lack the funding and other resources to carry out scientific research. Many countries have surveys and monitoring programs, but these are often not standardised over multiple seasons to provide accurate population trends.

Poor data – Over the last thirty years, various groups of researchers, government officials and non-government organisations have been involved in the conservation and monitoring of turtle populations in the region. Since standardised methods have not been used to estimate female populations at beaches, the reliability of these estimates must be questioned. For example, when >20 publications on arribadas in Orissa were reviewed, the numbers quoted by different authors and different agencies did not agree even when the data was ostensibly from the same source (Shanker *et al.* in press). This places grave doubts on the validity of these counts and makes the assessment of population trends very difficult. In Malaysia data sets have been collected over many years, but for many of the older records, reconciliation of the (supposedly) linked data sheets was rarely possible (N. Pilcher pers. obs.). In Viet Nam, nesting data sets can be correlated with the hatching data sets in less than 30% of cases (N. Pilcher pers. obs.). An example of a case where unreliable data has further endangered marine turtles exists in Orissa, India, where credibility of data has meant that conservation efforts have suffered severe setbacks (see below).

Hype and Hysteria in Orissa - Since the discovery of the Gahirmatha Olive ridley rookery in the 1970s, it has been hailed as 'the worlds largest' or 'highly endangered', sometimes even simultaneously (Shanker *et al.* in press). Clearly however, both statements cannot be true and in Orissa, the hype generated by conservationists and the counterclaims by trawler owners that sea turtles die of migration fatigue, labour pain and pollution (Shanker & Mohanty 1999) have led to a polarization that has hindered conservation and prevented the implementation of the use of TEDs. The absence of reliable estimates and population trends has also hindered conservation action, obscuring the real status of turtles, and leading government agencies and

some stakeholders (eg. trawler owners) to downplay concerns and minimise efforts for conservation (Shanker *et al.* in press). Clearly, there is a need for collaboration between scientists and managers, to determine if the Olive ridleys in Orissa are indeed declining, which can only be achieved by careful and objective monitoring, solid scientific research and information sharing.

POLICY AND LEGISLATION

A major obstacle in the legislative processes throughout the region prior to 1982, and in several cases till today, has been the improper listing or complete omission of marine turtles from wildlife ordinances and other legislative instruments. In many cases marine turtles were considered under Fisheries regulations, in which the basic premise was exploitation rather than conservation. Only in the last decade have major advances been made toward rectifying these deficiencies, and marine turtles are now, for the most part, listed by name and often as unique groups of individuals. Today, there are national laws to protect turtles in all but a few countries. Comprehensive reviews of this legislation exist for India (Upadhyay & Upadhyay 2002), and for the Southeast Asian Region (Pilcher 2001). In addition, there are international resolutions, conventions and legal instruments, applicable in particular to the Asian region, which cite marine turtles or even list them as the primary basis for the instruments. Most countries are now signatories to CITES (http://www.cites.org/), and many are signatories to CMS or one of its agreements (www.wcmc.org.uk/cms/), as well as other international treaties. Among these are the ASEAN Memorandum of Understanding on the Conservation of Marine Turtles; the Turtle Islands Heritage Protected Area (TIHPA), the first trans-frontier protected area for marine turtles in the world; and the recently–concluded Memorandum of Understanding on the Conservation and Management of Marine Turtles and their Habitats of the Indian Ocean and South-East Asia, which took effect on 1 September 2001, following the conclusion in Manila in June 2001 of a comprehensive Conservation and Management Plan. An Advisory Committee was recently appointed following the first Meeting of Signatory States in Bangkok this January 2003 (for details, see www.wcmc.org.uk/cms/).

THE REST OF THE STORY

Certainly in South and Southeast Asia there are sufficient laws to protect marine turtles, though probably not sufficient to protect their habitats. Strict enforcement of protective laws and other conservation programs in the last 30 years in Asia suggest, that in a few cases, long-term conservation efforts can help maintain and restore turtle populations. But laws alone do not work. Given the high human densities in the region, it is almost impossible to protect turtles without involving local communities, and it is hard to justify the need for protecting sea turtles to the economically and socially marginalized. Unfortunately, government agencies, non-government agencies, biologists and conservationists have not always shown adequate commitment to improving the welfare of these communities as part of their conservation agenda. Nor have they, for the most part, attempted to or even been inclined to involve these communities in the decision-making process. It is little wonder that there is no acceptance of the laws, making them nearly impossible to implement and enforce, especially given the available resources. Hence, while international instruments and national laws have their role, they achieve little without grassroots-level consultation and a deep commitment by governments and conservationists to the welfare of local communities.

Various individual projects do work. When it comes to *in situ* conservation measures, among the most successful are nest adoption programmes, volunteer programmes, and turtle-based ecotourism. Nest adoption programmes involve 'selling' nests on the beach, which are allowed to hatch naturally, to members of the public and tourists, often providing a certificate of 'ownership/ adoption'. In many cases these are purchased from egg harvesters holding concessions for the beach involved. These programmes are in place in Bali, Derawan and Sanggalaki (Indonesia), Pulau Redang (Malaysia) and in Thailand. Volunteer programmes, such as the ones on Pulau Redang and at Ma'Daerah in Terengganu, Malaysia, use "self pay" volunteer programs or provide workers at little or no cost to care for nesting turtles and incubating eggs, while collecting data on turtle reproductive success and nesting trends. Turtle-based ecotourism, as in the case at the Sabah Turtle Islands Park, provides income for conservation activities. The Turtle Conservation Project (TCP) in Sri Lanka has initiated community-based programs in southern Sri Lanka, and monitored populations and trade, considerably raising the awareness with regard to sea turtles in the country. Recent public awareness projects with significant scientific content have also sprouted in the Maldives (A. Azeez pers. comm.). In Bangladesh, monitoring and conservation programs are in place in St. Martin's island, one of their main nesting beaches for olive ridleys and green turtles (Islam 2002). In India, conservation projects by students and local fishing

communities at numerous sites along the east and west coasts have enhanced awareness considerably (see Shanker 2003, and references therein). A national level sea turtle conservation project has, for the first time, surveyed the entire coast of India for status and threats (see Shanker & Choudhury 2001), and has also had some success in involving fisheries agencies in turtle conservation, particularly in TED promotion programs (Choudhury 2003)

At regional levels, the development of trans-border agreements or multi-lateral instruments serves to promote awareness and commitment at the national level. At the national level, individual State, District or Provincial rights over natural resources, which often conflict with overriding national legislation or goals, are frequently constraints behind successful conservation measures. At the international level, turtles migrate across borders with little regard to visas and residence permits, promoting the need for bi- and multi-lateral treaties. Examples of successful bilateral policies already exist in the region, the Turtle Islands Heritage Protected Area (TIHPA) between the Philippines and Malaysia being a good example. Other trans-border approaches should also be investigated in the region, particularly among Thailand, Cambodia and Viet Nam, between Indonesia and Australia, and between the northern Indian Ocean nations.

To date, little use of existing information has been made, while at every level, there is a need to incorporate existing scientific, technical and traditional knowledge into management plans. Any potential national management plan has to have the acceptance of the general public, and this is not yet commonplace. Much of the current legal infrastructure in most Asian countries was arrived at without the participation of the general public, and this translates into problematic compliance and nearly impossible enforcement. The required acceptance can be gained through discussions at public fora, through meetings at the provincial level and down to the community level, raising awareness and benefits to the people of the need to preserve marine turtles and the ways in which conservation efforts will impact their lives and livelihoods. This calls for greater dialogue between the stakeholders and transparency and participation in the decision making process.

It is time for the people of the region to understand that turtles are an important component of marine ecosystems, that they offer benefits far beyond the tangible, and that their conservation is a public process, not that of a handful of dedicated individuals. For this there is a need for a widespread awareness campaign, coupled with programmes which (1) assess the socio-economic status of those affected by changed management strategies and if necessary provide alternative livelihoods, (2) are supported by contemporary knowledge and sound research and monitoring techniques.

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Australian flatback sea turtle (*Natator depressus*) returns to the sea after nesting on Curtis Island, Queensland, Australia. © Doug Perrine/seapics.com

NEWS AND LEGAL BRIEFS

This section is compiled by Kelly Samek. You can submit news items at any time online at <http://www.seaturtle.org/news/>, via e-mail to news@seaturtle.org, or by regular mail to Kelly Samek, 2811 SW Archer Road G-49, Gainesville FL, 32608, USA.

AFRICA

Group Raises Alarm on Marine Turtle Poaching

An animal rights group has appealed to the Congolese authorities to revise the existing endangered species law to include marine turtles among the country's protected animals. ''Despite the benefits that sea turtles bring, they are being massacred by coastal residents for food or for economic reasons,'' says Alexis Mayet, president of the Congolese Educational Association for the Environment and Nature (ACEN), a non-governmental organisation. In its latest survey, ACEN says poachers had destroyed 63 turtle nests along the six-kilometre Conkouati Park, an animal reserve, between December 2000 and February 2002. According to ACEN, the presence of a research team, on the coast, managed to reduce the predation rate from as high as 100 to 28 percent. Both the collection of eggs and the killing of turtles are regarded as poaching, an offence punishable by law in Congo. Source: *IPS*, 22 January 2003.

THE AMERICAS

Environmentalists Petition US Supreme Court to Hear the Case of the Sea Turtles

The Sea Turtle Restoration Project and partner organizations have filed a formal petition with the US Supreme Court requesting that the nation's highest court overturn a ruling from the Federal Court of Appeals that upheld State Department guidelines that weakened a provision of the US Endangered Species Act, and made sea turtles more vulnerable to drowning in shrimp nets. The decision to weaken the guidelines was influenced by rulings at the World Trade Organization. The other petitioners were Humane Society of the United States, American Society for the Prevention of Cruelty to Animals and Todd Steiner. One of the cruxes of the petition focuses on how the Court of Appeals sanctioned the State Department's right to interpret the provision in order to appease the WTO, even though it was contrary to the intent of Congress. Source: *Sea Turtle Restoration Project* press release, 6 November 2002.

Woman Sentenced to Six Months for Smuggling Thousands of Turtle Eggs into US

A California woman was sentenced to six months in prison for smuggling nearly 2,900 sea turtle eggs into the United States. Maria Dolores Flores, 38, purchased the eggs in her native El Salvador in March 2000. Federal inspectors discovered them wrapped in foil and hidden in luggage coming through Houston's Bush Intercontinental Airport en route to Los Angeles. Flores was indicted in August 2001 on federal charges of smuggling sea-turtle eggs without a permit. She was arrested in Los Angeles and agreed to plea guilty. Flores' sister, Ena Lillibet Reyes, was sentenced to five months in prison last year for smuggling turtle eggs. Turtle eggs are a delicacy in some cultures and can fetch $4 to $5 each on the black market. Source: *Associated Press*, 21 November 2002.

Costa Rica Seeks US Help to Protect Turtles

The Costa Rican environment minister has written to Florida Governor Jeb Bush, asking the state to take steps to protect green sea turtles and their habitat in Florida waters. Carlos Manuel Rodriguez, Costa Rica's Minister of Environment and Energy, asked Governor Bush to take "all possible steps" to protect Florida's green sea turtles and reef habitats near the Florida coastline that the turtles use for foraging and resting.

The letter draws attention to the potential harmful impacts that planned and ongoing beach nourishment projects in Florida could have on nearshore reefs. In recent years, genetic analysis has shown that juvenile sea turtles that congregate on the nearshore reefs south of Sebastian Inlet in Indian River County, Florida come from throughout the Caribbean and Atlantic to forage on the abundant green algae that grows on the reefs. A large percentage of these immature turtles have been genetically linked to the sea turtle nesting beaches at Tortuguero, Costa Rica. Source: *Environment News Service*, 26 November 2002.

Concern over Padre Island Drilling

Environmentalists say they were disappointed, but not surprised at a National Park Service decision to approve more gas drilling on Padre Island, the world's longest undeveloped barrier island. The Laguna's warm, hypersaline waters are considered critical habitat to several species of endangered sea turtles and a roster of exotic birds. When the federal government took over the 133,000-acre barrier island in 1962, it purchased surface rights, but not the subterranean. National Park Service employees say they can only do their best to make drilling companies as careful as possible. Source: *Associated Press,* 22 November 2002.

Erosion Washing Away Wildlife Refuge in Indian River

As the Pelican Island National Wildlife Refuge approaches its centennial, the federal government is planning to spend millions of dollars to save the battered pelican getaway. The island in Indian River County is home to more than 30 species of birds. Loggerhead sea turtles also nest along its banks. Decades of storms, tidal flows and more boat wakes have eroded the island to 2.2 acres—half the size it was 30 years ago. Last February, the federal government dumped 250 tons of oyster shell from a Black Hawk helicopter to build a protective barrier between the island and the waves. But keeping the island in place for the next generation may depend on more drastic measures from a dredge. The US Army Corps of Engineers plans to shore up the island with the lagoon bottom it dredges up from the nearby Intracoastal Waterway. Source: *Associated Press*, 23 November 2002.

Atlantic Gillnets Restricted to Protect Sea Turtles

Gillnet fishing will be banned in federal waters off much of the Mid-Atlantic coast during most or all of the year to protect migrating sea turtles, the National Marine Fisheries Service (NMFS) has announced. The closures, based on historic sea surface temperatures, will bar fishing with gillnets with a mesh size larger than 8 inch (20.3 cm) stretched mesh in the Mid-Atlantic Exclusive Economic Zone. The closures will take effect on January 2, 2003. Federal waters north of the North Carolina/ South Carolina border at the coast, and south of the Oregon Inlet, will now be closed at all times to large mesh gillnets. Source: *Environment News Service*, 5 December 2002.

Fertile Turtle Astounds Local Researchers

Some call her Maui Girl, but a more appropriate name might be Fertile Myrtle. She's a 22-year-old green sea turtle that in 2000 crawled onto a Lahaina area beach, dug a hole and laid eggs. She did this not once, but three, maybe four times that summer. This was big news then because "5690," Maui Girl's official number, was the first green turtle to nest on Maui in half a century. This turtle had an official number because in 1980 she'd been enrolled in a tagging study to try a more permanent type of tagging which involved swapping a small plug of light shell from a turtle's underside with a dark plug from its back. To compare the progress of grafted turtles to nongrafted turtles, some hatchlings received only a metal tag. So far, this turtle is the only one of that batch, grafted or not, ever seen again. It's possible, however, that others are around but have lost their metal tags. Besides having her 20-year-old tag still intact, Maui Girl has marveled researchers with the production this year of an exceptionally large number of offspring. Maui Girl returned to Lahaina in May of 2002. Source: *Honolulu Star-Bulletin*, 8 November 2002.

A Gift for California's Sea Turtles

WiLDCOAST and the Turtle Island Restoration Network announced today that the California Coastal Commission, in a unanimous vote, decided to support conservation programs and the creation of safe habitat for rare and endangered sea turtles by resolving to: ensure to the maximum extent possible that California's waters shall remain biologically productive and healthy enough to support viable populations of sea turtles; urge the United States Fish and Wildlife Service and National Marine Fisheries Service to work with Mexican law enforcement and resource agencies to halt the illegal trade in endangered sea turtle meat; urge consumers and retailers to follow sustainable seafood guidelines; urge the National Marine Fisheries Service to issue regulations modifying Turtle Excluder Device regulations; urge the public and government agencies to reduce the discharge of trash into ocean waters; and encourage lawful efforts by NGOs to challenge the World Trade Organization's interpretation of the international Turtle Excluder Device policies. Source: *WILDCOAST and Turtle Island Restoration Network* press release, 13 December 2002.

Shrimpers, Environmentalists Decry Foreign Competitors, But Can't Unite

Environment activists trying to save endangered sea turtles along the Texas Gulf Coast and around the world are asking the U.S. Supreme Court to make the federal government clamp down harder on foreign shrimpers who want to sell their catch in America. Texas shrimpers, meanwhile, are organizing with shrimpers from other states to protest foreign competitors' "dumping" cheap shrimp into the U.S. market and dragging down prices. It would appear the shrimpers and the environmentalists, who have been battling each other for years over how best to keep the shrimp industry going while protecting the turtles, now have a common enemy. But don't expect them to join forces. In recent years, the Sea Turtle Restoration Project (STRP) has sued the federal government, claiming the State Department, under pressure from the World Trade Organization, has weakened the TED regulations for foreign shrimpers, making them difficult to enforce. The environmentalists have argued their point successfully in lower courts, but the federal government won the latest round before the U.S. Court of Appeals in Washington, D.C. Now the STRP is asking the U.S. Supreme Court to enter the fray, arguing, among other things, that the case presents a separation-of-powers issue. A decision on whether the justices will take the case is expected in the coming months. Source: *Houston Chronicle*, 2 December 2002.

Mexico's Mana has Helped Release 1 Million Sea Turtles

The Selva Negra foundation, created by the Mexican rock group Mana, has released more than one million sea turtles as part of an environmental program in place since 1995, members of the group said. Last week, the members of the well-known rock-pop group volunteered at the Chalacatepec Turtle Camp, on Mexico's Pacific coast, where they urged people to protect the environment and helped release several hundred baby turtles into the sea, according to news reports Saturday. Fher Olvera, leader of Mana, and biologist Cecilia Martinez, in charge of the camp, told the press that the myth that turtle eggs have aphrodisiac powers is just that: a myth. They also spoke out against the use of turtle skins to make shoes and accessories. Source: *EFE*, 23 December 2002.

Sands of Time

The beaches of Indian River County are a haven for threatened sea turtles, boasting one of the greatest concentrations of loggerhead sea turtle nesting in the world. But as a result of erosion and a beach renourishment project aimed to halt it, the reproductive future of these gentle giants may be in jeopardy, according to sea turtle experts. A $9.5 million renourishment project at Ambersand Beach Park in north Indian River County will pump sand onto a 2.5-mile stretch of beach south of Sebastian Inlet State Park. How the almost 508,000 cubic yards of new sand may affect sea turtle reproduction is one of several environmental concerns associated with the project. When nesting does occur, beach renourishment can affect hatchling success. In addition to sand quality, other factors such as the profile of the new sand must be taken into account. Source: *Sebastian Sun*, 6 December 2002.

Biologists Raising Turtles for Conservation Find Disturbing Gender Trend

As part of a large-scale project to preserve loggerhead sea turtles, researchers from three institutions have been raising about 1,200 hatchlings though their first months and are now releasing them after identifying the animals' genders. These ongoing studies are already revealing an unexpectedly small percentage of males among baby turtles collected from Carolina and Georgia beaches, which could have negative implications for the future of the entire Southeastern loggerhead population, the investigators report. Scientists, conservationists and students have collected a total of about 1,200 baby loggerheads from 10 beaches as far south as Miami and brought them to the Duke Marine Laboratory, a Florida Atlantic University facility at Boca Raton and the Mote Marine Laboratory in Sarasota, Fla. The loggerheads are all being grown to the size needed for them to safely undergo minor surgical procedures known as laparoscopies to determine their genders. This involves a small incision to briefly insert a tiny scope and examine the babies' gonads. Following a two-week recovery period, the turtles are then ferried out from shore to begin their lives at sea in the warm waters of the Gulf Stream. Source: *AScribe Newswire*, 17 December 2002.

Shrimpers Upset Over Turtle Policy

A new federal policy to protect endangered sea turtles is unnecessary in the Gulf of Mexico and will devastate Louisiana's shrimp industry, shrimping leaders said. Officials with the National Marine Fisheries Service said the agency will issue a rule within weeks requiring wider turtle excluder devices, which are meant to allow turtles to escape shrimping nets. Nets without the excluders can snare and drown turtles. Louisiana shrimpers are especially angry because the state's inshore waters aren't prime turtle habitat. Biologists have operated 10- and 16-foot test trawls on a regular basis here since the 1960s and never have caught a sea turtle. Federal researchers, however, say the rules are necessary to protect at least five species of sea turtle native to U.S. waters, particularly the Kemp's ridley sea turtle. Source: *Associated Press*, 26 December 2002.

Two Wells Added to Anti-drilling Lawsuit

The Sierra Club filed an amended lawsuit adding two newly permitted natural gas wells to a complaint intended to stop oil and natural gas drilling on Padre Island National Seashore. Filed in Corpus Christi federal court, the complaint against the US Department of the Interior also seeks to halt heavy truck traffic to the authorized drilling sites called Lemon and Lemon-Seed wells. The reason behind the lawsuit is to protect the nesting grounds of the endangered Kemp's ridley sea turtles. Source: *Corpus Christi Caller-Times*, 6 December 2002.

Rules on Trapped Turtles Eased for Utility

After a record number of sea turtles swam into the intake canal at Florida Power's energy complex last year, officials said they would seek to avoid exceeding a federal limit again by requesting there be no limit. The petition was denied, but the National Marine Fisheries Service, in a decision recently made public, greatly expanded the live "takes" it will allow at the plant. Florida Power is permitted 75 takes in one year, up from 50 over a two-year period. Lethal takes were also increased, to three per year from three every two years. Sea turtles are most likely drawn to the intake canal in search of food. The rocky entrance provides suitable cover for crabs. Source: *St. Petersburg Times*, 28 November 2002.

ASIA

Lifeline Thrown to Endangered Sea Turtles

More than 20 Asian and African countries have agreed to step up efforts to save sea turtles from egg poachers, suffocating fishing nets and tourist encroachment, a United Nations environmental expert said. Representatives of 40 Indian Ocean and Pacific rim countries gathered in Bangkok this week to discuss the deal, in the knowledge that the leatherback and hawksbill turtles could disappear from the region within a decade. Most countries are expected to sign by next week. Governments will spread the message that uncontrolled egg collection is unsustainable. They will also promote turtles as a tourist attraction and encourage fishermen to modify nets to let turtles escape. Source*: Reuters*, 24 January 2003.

Workshop for the National Action Plan for Marine Turtle Conservation in Viet Nam

The Fisheries Resources Conservation Department of the Ministry of Fisheries, in cooperation with IUCN—The World Conservation Union, organized the First National Workshop for the Development of the National Action Plan for Marine turtle Conservation in Viet Nam to serve as an initial step in the development of a National Action Plan for marine turtles. Over the last seven months The Ministry of Fisheries, IUCN, WWF and TRAFFIC have coordinated a marine turtle conservation project in Vietnam. The broad objectives of this project are to (1) determine the extent of the illegal trade of marine turtle products in Viet Nam, (2) record the distribution, abundance and threats to marine turtles in Viet Nam, (3) prepare a National Action Plan that will guide future conservation efforts, (4) awareness raising on marine turtle conservation through pilot community–based activities at priority provinces. Source: *IUCN press release*, 28 November 2002.

Dodgy Cambodian Turtle Kills Three, Poisons 94

A sea turtle has killed three people and poisoned more than 90 others in a remote coastal village in Southeast Asian nation, officials have said. The offending beast was netted by fishermen in the Gulf of Thailand before ending up on the menu of the village in Mitapheap district, near the Cambodian port of Sihanoukville. Source: *Reuters*, 7 December 2002.

Concern Over India Turtle Deaths

The discovery of dead turtles, over the past two months, has provoked protests from environmentalists across India. They are said to have been killed by fishing trawlers despite stringent laws which make it mandatory for the boats to use special protective devices. A survey conducted by the Delhi-based Wildlife Protection Society of India and its affiliate in the eastern state of Orissa points to the alarming rise in the death of turtles in the area. Officials say more than 100,000 turtles are estimated to have died in the last decade in Orissa - more than 16,000 in the last year alone. With fishing boats not using mandatory turtle-excluder devices, thousands of the turtles perish every year after suffocating in their nets.

Under India's wildlife protection laws, killing or trapping these turtles can attract a six- year jail term. Biswajit Mohanty, coordinator of Operation Kachhapa, aimed at protecting the turtles and increasing public awareness, blamed the authorities for the continuing deaths of the turtles.
Source: *BBC,* 9 January 2003.

Homeward Bound

WWF Indochina's Marine and Coastal Programme has called on fishermen along the coast of Vietnam to exercise a degree of caution when they cast their nets over the next few months after researchers received news of a unique study that involved tracking three loggerhead sea turtles by satellite as they travelled between Singapore and Japan. The study is the result of coordinated efforts between Nagoya Aquarium in Japan and Underworld World Singapore.

The Loggerhead turtles involved in the study were all bred in captivity in Japan in 1996 and sent to Underwater World in 1997. Dr. Uchida, director of Nagoya Aquarium, has predicted the turtles would swim back to Japan once they were released into the wild. In order to put this hypothesis to the test, all three turtles have been fitted with GPS tracking devices so their location can be monitored through the Argos satellite network. The first turtle was released in Singapore on October 22, the second on October 29 and the third on November 5.
Source*: Vietnam Investment Review*, 2 December 2002.

EUROPE

Black Tide Brings Misery to Galicia

Hopes that oil from the wreck of the sunken tanker Prestige would remain on the sea floor faded at the weekend when a new 11,000-tonne slick moved perilously close to the beaches and fishing grounds of north west Spain. When it sank 140 nautical miles off the shore on November 19th, the Bahamian registered Prestige took around 50,000 tonnes of its cargo of 77,000 tonnes of heavy fuel oil down to the sea bed. Although everyone agreed the pressure of the water two miles deep would cause the corroded tanks to split, experts could not agree whether the oil would come to the surface or whether the cold water would cause it to congeal and remain on the bottom. There is also great concern for other nearby areas which are breeding grounds for many species of shark, dolphin, porpoise, seal and turtle.
Source: *The Guardian,* 2 December 2002.

OCEANIA

Net Database Helps Identify Derelict Nets

There are more than 90 types of discarded fishing nets continually washing ashore and creating tons of accumulated litter on northern Australian beaches. Local fishermen tell of "a dolphin and turtle graveyard" among discarded fishing nets that drape the cliffs of Cape Wessell off northeast Arnhem Land. WWF-Australia has published a guide to enable easy reporting and identification of the nets as a first step to keeping them out of the environment. The illustrated guide lists net mesh, color and twine size, net use, and likely country of origin. It will be distributed free to all members of the public, including fisheries and indigenous communities, who use the beaches and waters of the Northern Territory and northern Queensland.
Source*: Environment News Service*, 9 December 2002.

Device Allows Export of Prawns to US

Queensland's prawn trawlers will again be able to export their catch to the US because of new State Government regulations designed to minimise the risk of turtles being netted. Standard turtle excluder devices, will become mandatory on all Queensland prawn trawlers. Source: *The Courier-Mail*, 7 December 2002.

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It is requested that a copy of all publications (including technical reports and non-refereed journal articles) be sent to both:

1) The ACCSTR for inclusion in both the on-line bibliography and the MTN. Address: Archie Carr Center for Sea Turtle Research, University of Florida, PO Box 118525, Gainesville, FL 32611, USA.
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