Session II

Marine Turtle Management Goals and Criteria

Management Planning for Long-Lived Species
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Management and Conservation Goals for Marine Turtles
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Open Forum
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Management Planning for Long-Lived Species

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Abstract

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

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

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

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

Introduction

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

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

Growth Rates

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

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

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

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

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

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

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

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

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

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

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

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

Demographic Analyses

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

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

Table 2. Demographic Parameter
(after Musick 1999b)

s_i = survivorship at age or stage i

t_{mat} = age-at-maturity

t_{max} = longevity

m_x = fecundity

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

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

r = intrinsic rate of population increase

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

Management

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

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

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

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

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

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

Conclusions

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

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

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

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

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

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Management and Conservation Goals for Marine Turtles

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

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

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

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

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

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

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

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

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

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

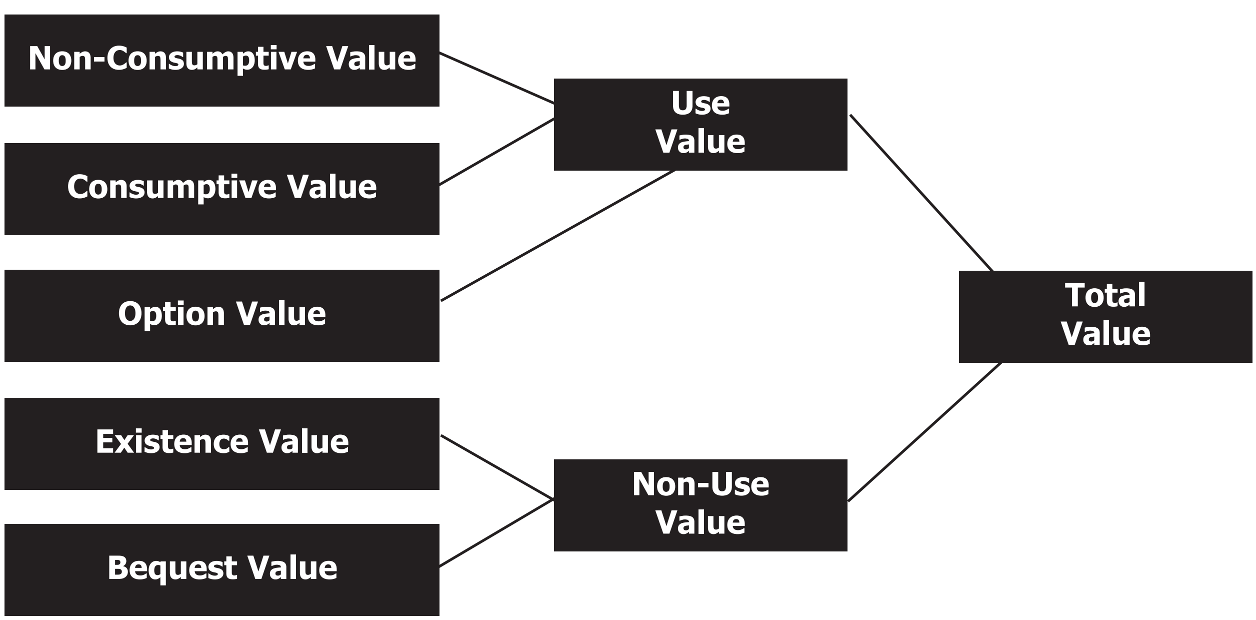

Figure 1. Total Economic Value of Sea Turtles (after Isaacs, 1998).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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Open Forum: Criteria and Benchmarks for Sustainable Management of Caribbean Marine Turtles

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M. Jorge (WWF) opened the discussion by asking the participants why they have come to this meeting. He reminded participants to remember Dr. Frazer's suggestion that the "value" of sea turtles should be the basis of conservation planning and the framework for management. He asked, "What do sea turtles mean to us and the people we represent?"[1]

R. Márquez (México) responded that in México there are five species of sea turtles that inhabit the Gulf and Caribbean coasts. Some populations are recovering, some are declining, some are stable. Economic needs are different in each area of the country: in the North the economy is booming, while in the South (Chiapas) the economic needs are so high that people have few resources. Each country has its own problems, and we have to solve them within our own countries.

M. E. Herrera (Costa Rica) explained that, with regard to the Caribbean coast of Costa Rica, efforts similar to those suggested by Dr. Frazer should be undertaken. Specifically, there must be a commitment to offering alternatives [to sea turtles] in order to provide income. At present, eco-tourism brings tourists and this provides alternative income. Recently Costa Rica abolished the law that allowed for a legal harvest of sea turtles. Illegal harvest continues, but there is an interest by others to learn about eco-tourism activities in Tortuguero and elsewhere and to emphasize non-consumptive values and uses for sea turtles.

E. Carillo (Cuba) stated that use exists in the region, and the important issue is how to manage this use – preferably with joint planning and management – in order to achieve sustainable utilization. She noted that her purpose in attending the meeting was to learn more about management. She said that improvements had been made in Cuba in the area of national management planning, as well as research of nesting and migration patterns. She suggested that the nations of the Caribbean "do something together" in order to protect sea turtles in domestic and international waters. She also shared information about a program in Cuba that involves training personnel (including fishermen and students) to participate in data collection.

S. Poon (Trinidad) described a co-management program in Trinidad where Government works in partnership with local NGOs to protect nesting leatherback turtles at some of the most important nesting beaches (for that species) in the Wider Caribbean Region. The challenge is to expand these programs to include mitigation for threats at sea (mainly incidental catch) and to eliminate contradictions in the national regulatory framework (specifically between fisheries and wildlife legislation).

M. Jorge (Moderator) asked why leatherbacks have declined in [Pacific] Mexico. Are these high-profile population collapses the result of mismanagement at the local level, or do we all need to look beyond our own waters and forge partnerships to protect shared stocks?

R. Márquez (México) responded that each species has its own peculiarities. México has had conservation and management programs in place for leatherbacks for 20 years... but leatherbacks tagged on Méxican nesting beaches are routinely killed in Chile by pelagic fisheries. We have to reach international agreements on conservation of these species.

M. Jorge (Moderator) asked whether there are any additional remarks on the domestic capture of turtles.

R. Kerr (Hope Zoo) stated that more resources are needed for local communities. In Jamaica, it is not possible to enforce existing laws without support from local communities. Therefore, we must get local people more involved. A national network of community members, land owners, divers, students, fishermen and interested citizens was formed in Jamaica with assistance from WIDECAST several years ago, and this has provided a model for involving communities in population monitoring and record-keeping.

N. Frazer (UFL) noted that México had been successful in increasing the numbers of Kemp's ridleys in recent years, and he wondered what would happen if the government were to pull out of that long-term conservation program.

R. Márquez (México) explained that 30 years ago sea turtle biologists had to defend themselves from the community in Rancho Nuevo. But today the community supports the conservation efforts. Even if the government pulled out, the activities would continue. Poachers are captured with the help of the local people.

M. Jorge (Moderator) concluded that there had been a change of attitude and perspective because of local "buy in."

R. Ryan (St. Vincent & the Grenadines) described the situation in St. Vincent where the government has adopted a policy of sustainable use for all marine resources. He explained that his country was willing to cooperate with nations in the region in the management and/or conservation of sea turtles, given the limited financial and technical resources. To this end, a number of states recently formed a group called the "Caribbean Turtle Management and Research Group" (CTMRG), whose purpose is facilitate collaboration on research and management issues.

M. Jorge (Moderator) asked for additional information on the program in St. Vincent. Why had the policy of sustainable use been implemented?

R. Ryan (St. Vincent & the Grenadines) responded that the policy was based partly on a tradition of consumptive use and the revenues that come from it.

R. Connor (Anguilla) informed the meeting that, prior to 1995, Anguilla had open and closed seasons for sea turtles. Now a five-year (1996-2000) moratorium is in place in order to give local biologists and policy-makers a chance to evaluate the status of sea turtles and make recommendations to government about their long-term management. With assistance from WIDECAST, a national management plan is under development. Some fishermen would like to see the moratorium lifted, as they feel that turtle stocks have increased. He noted that his purpose in attending the meeting was to learn more about how to monitor local sea turtle stocks.

J. Horrocks (UWI) asked whether anyone knew the countries that had joined the CTMRG.

R. Ryan (St. Vincent & the Grenadines) responded that the CTMRG countries are St. Vincent and the Grenadines, St. Lucia, Dominica, Antigua and Barbuda, St. Kitts and Nevis, Colombia, Venezuela, Trinidad and Tobago, and Cuba. Fisheries institutions within each country are the participants [B. Mora from Venezuela later clarified that Venezuela was still evaluating the CTMRG and hadn't made any decision on whether or not to join].

N. Frazer (UFL) asked, "What happens to fishing livelihoods when moratoria are repeatedly instituted and then lifted? Who can benefit from that kind of cycle?"

R. Márquez (México) explained that prior to 1973, México had a moratorium. His country's experience with lifting moratoria was quite negative. After 1973, turtle fisheries were opened again only for cooperative organizations, but the industrial organizations got involved and over-exploitation began. The moratorium was re-instated in 1990. Now there is pressure to open the market once again for olive ridleys in the Pacific. He noted that the government will do it differently this time (if the moratorium is lifted once again), and will provide for better protection. He also noted that the conditions are not the same today as in the past. He agreed that cycling on and off moratoria does not allow fishermen to survive.

S. George (St. Lucia) said that in islands like St. Lucia fishermen have come a long way in the last 6-

8 years with regard to management decisions. St. Lucia imposed a moratorium (on sea turtle capture) in 1995 without the collaboration of the fishermen, and they resented it. St. Lucia has limited enforcement capacity and a limited ability to conduct research. Collaboration on subregional and regional levels would provide valuable information that the government could not afford to compile alone.

M. Hastings (BVI) stated that the BVI also has had experience with a moratorium, as well as with open and closed seasons. The situation is complicated, but is eased somewhat by the reality that younger fishermen are not attracted to the turtle hunt. Many of them, in fact, have been incorporated into monitoring programs. He asked R. Maáquez whether egg poaching had contributed to the leatherback collapse in México.

E. Delevaux (Bahamas) followed-up on the discussion of alternatives for fishermen and described how local fishermen and NGOs had requested the government to designate certain areas as conservation parks. About 20% of these areas are Marine Parks. The Bahamas has benefited by being an ecotourism destination. At present there is a total ban on the harvest of hawksbills, and seasonal and size limits on greens and loggerheads. The total annual catch is unknown.

R. Márquez (México) responded to M. Hastings by saying that the poaching problem is a complex one, and its effects really depend on the species. If a population is stable, low levels of poaching may not constitute a serious management issue. On the Caribbean coast of México the majority of the populations are depressed; thus, there is a need to protect 100% of the nests. Mexico has seen the results of over-exploitation; for example, in the loss of whole populations of olive ridleys on the Pacific coast.

C. Parker (Barbados) indicated that the turtle fishery had been managed in Barbados since about 1880. He suggested that there were four basic components to be considered in a successful fisheries management program: enforceability, education, alternatives (such as tourism and/or offshore fisheries), and co-management. The history of turtle management in Barbados provides examples of these factors. The legislation used to regulate turtle harvesting from 1880 to 1998 was almost impossible to enforce. As populations continued to decline, a complete ban was adopted in 1998. Fortunately, the rapid development of offshore fisheries since the 1940's and a boom in the tourist industry have offered economic alternatives to turtle fishing. In addition, an intensive education and public awareness program led by Bellairs Research Institute, the University of the West Indies, and the Fisheries Division sensitized the public to the conservation needs of sea turtles. Finally, the Fisheries Division has recently promoted co-management policies (including stakeholders in the process) for the management of fisheries resources, with the rationale that persons are more likely to abide by the regulations that they have helped to formulate.

M. L. Felix (St. Lucia) asked C. Parker how Barabdos has dealt with incidental catch.

C. Parker (Barbados) responded that gill nets are set for flying fishes in certain areas but, on the whole, sea turtle bycatch is not a large problem. Nets that are most likely to catch and kill turtles have been prohibited since 1998.

G. Allport (Dominica) stated that Dominica is currently the Chair for the CTMRG, which in part takes its mandate from harmonized OECS (Organization of Eastern Caribbean States) seasons and regulations. Most of the Eastern Caribbean islands face similar situations and thus a collaborative approach among fisheries offices is advantageous. The CTMRG provides a venue for sharing data and training personnel. For example, a two-week training program was held in Cuba in 1999. Members of the CTMRG have pledged to support each other, and the Group is promoting the sustainable use of sea turtles. Fisheries Departments are considered an essential link between fishermen and experts.

K. Eckert (WIDECAST) agreed that sustainable use, whether consumptive or non-consumptive, was the ideal goal. To this end many governments have committed themselves to management initiatives, including open and closed seasons and other regulations. The question is, "How are the effects of these management interventions evaluated? How do we know that a course of action is, in fact, sustainable?" She asked G. Allport how sustainability was evaluated in Dominica, and whether or not the monitoring of index nesting beaches and foraging grounds provided information useful to evaluation.

M. Jorge (Moderator) suggested that the meeting take note of the example of the Galapagos, where fishing for depleted sea cucumbers was re-opened for three months as a result of intense public pressure following an economic crisis in Ecuador. The fishery was re-opened for purely economic and political (as opposed to biological) reasons. The result was disastrous for the resource.

G. Allport (Dominica) described the turtle fishery in Dominica as "small". She noted that the Fisheries Department was intensifying its research and developing a management plan. In the meantime, management efforts were continuing. She emphasized the value of a regional management plan, especially for small countries with limited domestic resources.

M. L. Felix (St. Lucia) discussed the fact that the Eastern Caribbean islands are geographically very close, and that the turtles move between the islands. She agreed that sharing information on best practices and participating in regional collaboration were advantageous to small island states.

R. Ryan (St. Vincent & the Grenadines) noted that in St. Vincent, public education programs have been instituted and that this is also a valuable component of management. Local sea turtle stocks seem to be stable. The government's objective is to monitor the turtle populations and to acquire relevant training for personnel.

N. Frazer (UFL) commended members of the CTMRG for working together toward shared goals. He agreed that the road is difficult, but reminded the meeting of the Chinese philosopher who said that a journey of 1,000 miles begins with the first step.

M. Hastings (BVI) said that this was the first time he had heard of the CTMRG and, being an OECS country, he inquired how the BVI might participate. He asked for information from CTMRG countries on their standard methodology for monitoring.

M. L. Felix (St. Lucia) responded that the Group does not as yet have much data or many resources at its disposal. The Group is "still working the monitoring program out."

R. Kerr (Hope Zoo) expressed her concern that Jamaica did not have a comprehensive assessment of the status of its local [sea turtle] populations. From what data are available, it seems clear that hawksbills have been extirpated in many areas of Jamaica. Evaluating the precise status of hawksbills is not easy. The peak nesting period is between May and October, but nesting occurs throughout the year and often in remote areas. Comparatively faint nesting signs make it difficult to determine when a hawksbill has successfully nested. Each country has to do the best it can, taking both its own needs into account and those of the region. Regional cooperation is commendable. She asked, "Whose turtles are they?" All of ours? None of ours?

M. Hastings (BVI) agreed and said that the BVI faces similar challenges with its hawksbills. Volunteers walk the beaches to count hawksbill nests, but additional training is needed.

M. G. Pineda (Honduras) explained that isolated research has been conducted in Caribbean Honduras since the 1980s. In the North, a marine reserve has been in place for three years with university student volunteers. Local volunteers and NGOs have also given their support to leatherback and loggerhead turtle protection efforts. In the Miskito Cays area there is a high consumptive use of turtle products. Education is just starting in many areas. There is a need for much more research, and to involve communities at local and regional levels. Fisheries legislation in Honduras is outdated; open and closed seasons are in place.

R. O. Sanchez (Dominican Republic) observed that sea turtle management is complex, and characterized by two peculiarities among species: long-life and migratory habits. There is a permanent moratorium in the Dominican Republic, but enforcement is inadequate. He said that the experience of the Dominican Republic with regard to natural resources was that restrictions alone do not work. The local people must be involved in management. Fishermen often have very poor living conditions, and we must take this into account. Education of fishermen and the general population is certainly needed. Turtle fishing is not only for consumption, but also to make souvenirs for tourists. We are discussing this in an air-conditioned room, but the issue is how to reach these fishermen. Regional collaboration is commendable. The pressure to use natural resources is growing as human populations increase. We have to reflect on this. Restriction for sake of restriction will require an army of law enforcement.

E. Carillo (Cuba) recommended that nesting beaches be monitored in order to evaluate management success. With regard to R. Kerr's earlier remarks, she agreed that it is difficult to monitor nesting beaches, and especially for hawksbill turtles, but it is not impossible. There is a need to train local people to participate, and to find the money to do this. Since we cannot modify the behavior of the sea turtles, we must modify our own behavior. In Cuba we did this, with the support of students and fishermen, and we have had very positive results.

R. Kerr (Hope Zoo) responded that Jamaica, being a relatively small country, is not in a position to implement a monitoring system like Cuba's, which has put great effort into its programs. Other countries may not be able to do this either. There must be a strong commitment, with resources behind it, to obtain accurate and consistent data that are useful to managers. More emphasis should perhaps be placed on models that will help managers make thoughtful decisions in the absence of complete data.

J. Jeffers (Montserrat) said that Montserrat is still rebuilding following the volcanic explosions in 1998, and that the country has lost 2/3 of its fishing areas. Due to economic problems, some fishermen have returned to harvesting 8-10 turtles per year. This year a leatherback was found nesting on the island. Efforts are being made to support conservation by upgrading legislation and restricting beach sand mining. The British government is asking Montserrat to do more to protect sea turtles.

S. Tijerino (Nicaragua) said that Nicaragua also has legislation that conserves sea turtles. The green turtle and olive ridley are partially protected. However, some 60% of the population is unemployed and consumption of sea turtles has increased as a result of these economic circumstances. Nicaragua is seeking credible alternatives for coastal communities. The government is trying to determine how to establish sustainable alternatives, such as were described by N. Frazer in his presentation. A control program is very difficult to implement. Poverty in coastal areas is often due to poor fisheries management. A commitment to communities and to people, as well as to sea turtles, is needed.

E. Possardt (USA) explained that there has been an intense investment and commitment in the USA for sea turtle conservation for many years. This has included mandatory use of Turtle Excluder Devices (TEDs) in the shrimp industry, for example, and buying expensive beachfront nesting habitat in order to preserve nesting grounds. These efforts have shown positive results for our nesting populations, but no matter what is done in one country, others can undermine these programs. For example, fisheries in the eastern Atlantic may be undermining our long-term efforts to protect loggerhead turtles. No matter what we do, we are all in the same boat. As neighbors sharing an important resource, we need to agree on shared goals. I am looking forward to working in partnership with all of you who are here.

K. Eckert (WIDECAST) noted that there is a great deal of information available in the region (e.g., growth rates, diet, nest frequency, remigration intervals), and agreed with many of the delegates that information-sharing should be a priority. Some types of information (such as from satellite telemetry) can be quite expensive to gather and results can be very useful to managers over a wide area, whether or not they participated directly in the research. Local emphasis should focus on gathering information specific to local management needs. She asked, "Do you need to monitor every beach?"... and answered, "Probably not." She recommended that efforts focus instead on selected Index Beaches – relatively accessible beaches where nesting is predictable and comparatively high. She recommended that managers stick to the basics and emphasize data-gathering with a direct bearing on management questions, especially monitoring trends in local breeding and foraging assemblages.

She noted that it takes dedication to gather baseline data, but agreed with E. Carillo that remaining optimistic is important and duplicative effort should be avoided.

M. L. Felix (St. Lucia) expressed her desire that the meeting make time to discuss sustainable management.

M. Isaacs (Bahamas) explained that, in the Bahamas, turtle fishing is opportunistic. There is a refugee problem on isolated islands, and an enormous problem with poaching in the southern Bahamas. Enforcement is very difficult and regulation alone is pointless; sustainable management requires community collaboration.

M. Jorge (Moderator) concluded the session by noting the long tradition of sea turtle use in the region, and the broad-based interest in finding ways of accommodating resource use, especially at the community level, while at the same time ensuring a future for the resource. He said that he hoped the meeting would have time to address non-consumptive use also, including eco-tourism, and that meeting participants would think about regional mechanisms as they continued to build regional consensus. Referring to N. Frazer's presentation, he asked participants to think about how to achieve the goal of stable population levels.

[1] The interventions documented by the Minutes of this Plenary Session (Open Forum) were filtered through translators, rapporteurs, and editors before being finalized in these Proceedings. Every effort was made to ensure a fair representation of the views presented. Any misinterpretations or errors are the sole responsibility of the editors.