Biology and Conservation of

Sea Turtles

Revised Edition

Edited by Karen A. Bjorndal

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Front cover: Adult female green turtle, *Chelonia mydas*, at French Frigate Shoals, the major migratory breeding site for this species in the Hawaiian Islands. Photo by G. H. Balazs.

Conservation Theory, Techniques, and Law

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Options and Limitations in the Conservation of Sea Turtles

ABSTRACT

The options for conserving sea turtles are limited by many things, but especially by the biology of the animals, themselves, and by our inadequate knowledge of them. These limiting factors include mysterious life cycles and obscure ecological relationships, long migrations across international boundaries, unknown population dynamics, unknown taxonomic relationships of different populations, nesting cycles of highly variable length, and an exceedingly long maturation time.

The combination of our incomplete knowledge about sea turtles and the numerous constraints imposed by their biology dictates a very conservative conservation strategy. Many of these limiting factors will not change markedly in the future. I conclude that the best we can do is to concentrate on the protection of existing wild populations, using the simplest and least risky techniques of conservation.

Fortunately, the techniques with the lowest risk and greatest promise are also those with the lowest cost and requiring the least elaborate technologies. (This is also true of conservation-related research.) Highest conservation priority should be given to the following items (listed in no special order): 1) protection of nesting grounds and aquatic habitats, including minimization of environmental disruption at these sites; 2) use of hatcheries and short-range transplantation of nests to protect eggs at the nesting beach; 3) conservation education; 4) control of international trade; 5) national and international coordination of conservation strategies; and 6) dissemination of improved fishing trawls (when available).

I accord lower priority to: 1) long-range transplantation of nests; 2) headstarting; 3) fisheries-type management of the turtle catch; 4) manipulation of sex ratios; 5) cottage industry turtle ranching; and 6) noncommercial captive breeding to maintain gene pools. Commercial ranching and farming cause a net drain on wild populations of sea turtles, and do not belong in

a conservation strategy.

It is no coincidence that the conservation methods that have the greatest potential for saving wild sea turtles are those not limited by the biology of these animals or by our ignorance of it.

Introduction

In the preamble to the Draft Conservation Strategy we wrote that "of the . . . factors . . . that determine the fate of sea turtles, only one, the biological factor, is nonnegotiable in a conservation strategy." This idea is of critical importance. No matter what we decide at this conference, and no matter what conservation measures are adopted later, if they are not in accord with the biological facts of life of sea turtles, they will not work. In other words, the options for conserving sea turtles are limited by the animals, themselves, and by our inadequate knowledge of them—limited to an extent rarely encountered in conservation.

The biological limiting factors include: mysterious and inaccessible life cycles for all species, with many of their ecological relationships totally obscure; long migrations that take turtles across international boundaries; unknown population dynamics; equally unknown taxonomic relationships of different populations; nesting cycles of variable length, which make yearly census data difficult to interpret, especially for green turtles; and an exceedingly long maturation time, which makes it likely that many of us will be in our graves before it is possible to know whether our conservation policies have done any good. Of course research will erase some of our ignorance, but most of these limitations are not going to change very much in the near future, and some are fixed in the genes of the turtles and will not change at all.

To see where the limitations apply, and to determine which conservation options have the greatest potential for success, it is necessary to examine critically the conservation techniques that have been suggested for sea turtles. Therefore, I will list many of them, as follows, with some of the technologically simpler and less expensive methods first.

Protection of Nesting Beaches

One of the simplest ways to conserve sea turtles is to make their nesting beaches sanctuaries, either by law or by official regulation. The effectiveness of this procedure depends mostly upon the local traditions of respect or disregard for laws and regulations, and upon the degree to which they are enforced. Another factor that can be important is the size of the reserve—whether it has enough depth to maintain the ecological integrity of the beach, itself, and whether it is wide enough to include the major turtle nesting areas. If conditions are favorable, it is sometimes possible to achieve considerable success in conserving sea turtles by using this technique, without the need to worry too much about the many subtleties of the biology of the turtles.

The simple protection of nesting beaches can be supplemented by a variety of practices designed to protect the area from destructive development, especially development related to tourism and recreation. Sella (this volume) has described how the removal of sand from Israeli beaches for construction purposes destroyed the nesting habitat there; and Witham (this volume) has listed the ways in which it is possible to lessen the human impact upon nesting beaches. This needs no further comment.

Another conservation technique that can greatly enhance the protection of nesting beaches (and sea turtles in general) is local conservation education. This technique is uncomplicated and relatively inexpensive, but it has been little used to date.

Protection of Feeding Grounds and Other Aquatic Habitats

Here the principle is the same as in the protection of nesting beaches, but the application is more difficult. It is far harder to delineate and patrol several thousand hectares of open water than to do the same for a few kilometers of linear beachfront. Nevertheless it can be done, as has been shown by the United States in protecting the turtle hibernaculum sites in the waters off of Cape Canaveral, Florida. Again, once it has been determined that turtles are using a particular area intensively for some purpose, it is not necessary to know too much more about them to effect simple conservation.

Sometimes it may be necessary to protect the aquatic ecosystem from damage by various kinds of human activities: destruction of reefs or reef faunas, and pollution by chemicals, silt, and other contaminants. Petroleum and related compounds are especially significant. Research concerning the responses of turtles to pollutants is lacking and would be interesting, but we do not need research to tell us that a 20-km oil slick is going to be bad for the turtles that get in its way, or, for that matter, that a reef that is repeatedly dynamited is not going to support a large population of hawksbills. As far as habitat degradation is concerned, it is important from the standpoint of management to remember that what happens upcurrent may determine what happens inside the reserve itself.

Management of Turtle Catch for Maximum Sustained Yield

One kind of active manipulation of populations in their aquatic ecosystems is the application of modern fisheries management techniques to sea turtles. Here I think we come to the first serious limitation imposed by sea turtle biology on a conservation option. I am not referring to the general criticism of the maximum sustained yield concept; this has already been well-covered by Dodd (this volume), and I agree with both him and Larkin (1977) in their conclusions. What concerns me are the specific problems caused by applying the methodologies developed for fish to the catching of sea turtles. We simply do not have the kind of long-term data on population dynamics and catch per unit effort that are necessary for even rudimentary fisheries management.

In addition, the slow growth rates of sea turtles make fisheries management of them especially difficult. Pritchard (this volume) reports extremely slow maturation rates for *Lepidochelys*, *Caretta*, and *Chelonia*. Balazs (this volume) has data that show that green turtles probably take several decades or more to reach sexual maturity. The danger of any fisheries management models applied to turtles is that the long lag time between turtle hatching and maturity will prevent managers from seeing the effects of their miscalculations during their tenure in the job, or during their lifetimes. Sea turtles are not like most commercial fish species, which mature much more quickly. What happens "now" to a managed turtle population is largely the result of past history, not current management practices, and this is very misleading. Our knowledge is such that sea turtle populations are not yet ready for fisheries management practices aimed at regulating the catch; if they ever are, it will probably be with dynamic pool models that take such variables as age structure of the population, growth rates, and mortality into account. But this kind of information may continue to elude us.

Manipulation of Eggs and Hatchlings at the Nesting Beach

There are 3 kinds of biological management at nesting beaches, each of which involves some interference with eggs and occasionally with hatchlings. Perhaps the least intrusive of these is the local nest transplantation method described by Stancyk (this volume). If this practice does reduce nest predation significantly, it may prove to be a boon to conservation. First, however, some fairly easy questions need to be answered. Will predators learn, in the course of a few nesting seasons, to find the artificial nests? Stancyk indicates that this is a possibility. Will nest transplantation fool predators other than raccoons in other parts of the world? Will the hatching rate be reduced in some places where workers may be badly trained and supervision is lax? Are the artificial nests being dug to the proper depth so that incubation temperatures and other microenvironmental factors are as natural as possible?

The removal of eggs to hatcheries is a more manipulative technique than short-range nest transplantation, and there is evidently enough of a difference to have resulted in a lower hatching rate under experimental conditions. Nevertheless, on beaches where natural hatching is low or nonexistent because of predation, hatcheries are clearly necessary. The Suwelo method (this volume) of protected incubation under natural conditions, coupled with immediate release of hatchlings after emergence is a safe and effective conservation technique, which also has the great advantages of minimal technology requirements and low cost. The principal danger is that the effort may be wasted if too small a percentage of local eggs are used; there is no guarantee that "15 percent of the harvested eggs," a figure cited by both Suwelo and his coworkers and by Siow Kuan Tow and Moll (this volume), will be enough to keep the populations in long-term equilibrium.

The discovery, described by Mrosovsky and Yntema (this volume), that incubation temperature can affect the sex of hatchlings, shows us that it is important to keep incubation conditions as natural as possible in the hatchery. Beyond this, the development of the elegant sexing method described by Owens (this volume) may tempt hatchery managers to use incubation temperatures to alter population sex ratios in some direction that is judged likely to increase fertility rates in the wild. I would caution against this. Our physiological understanding of sea turtles, primitive as it is, is far advanced over our genetic, evolutionary, and ecological knowledge. We have no way of knowing what deliberate manipulation of sex ratios will do to a population over the course of many years, thus there is a great potential for damage from such well-intentioned management schemes.

A final word about hatcheries: in looking at the data reported from Malaysia (Siow and Moll, this volume), I note that the different turtle hatcheries had markedly different annual rates of hatching (20 to 53 percent, 32 to 71 percent, 70 to 90 percent). Unless there is some trivial explanation for this, it might be worthwhile to find out what caused the differences, which are likely to transcend differences related to the species of eggs that are incubated.

The third and least natural method of manipulating eggs at nesting beaches for conservation purposes is to combine the use of hatcheries with headstarting programs, in which the hatchlings are raised to a size at which they are deemed to be less vulnerable to predation before they are released. Headstarting has become a common practice, and the existence of a headstarting program is often used to justify the removal of eggs from nesting beaches for other purposes such as commercial ranching and farming, or long-range transplantation efforts. I want to emphasize, however, that there has not been a proven return of an adult headstarted turtle to its nesting beach. This does not mean that headstarting does not work. But headstarting does involve removing a turtle from a complex and totally unknown sequence of experiences that it would have had in its natural environment, and that may play a necessary role in its development. Everything we know about development in other vertebrates indicates that the genetically programmed sequence of developmental events is distorted in an aberrant environment. The early life histories of sea turtles appear to be very elaborate and take place in a sequence of different environments; there is no reason to believe that environment is less important to them than to other vertebrates.

As Pritchard (1979) has said, the "captive rearing of hatchling sea turtles for release is an experimental procedure, and should never be used as a justification for higher levels of harvest of wild turtle populations, or conducted to the exclusion of direct release of hatchling turtles." There is nothing wrong with headstarting *as an experiment*, provided that it, together with all other uses of eggs and hatchlings, remains an insignificant percentage of the reproductive effort at a given beach. We often hear that survival of hatchlings in the first year of life is only 1 to 2 percent, and that therefore headstarting programs should receive high priority. Yet we should consider that the figure of 1 to 2 percent survival is pure conjecture, not based on one shred of evidence, and that the survival and reproductive success of headstarted turtles after release is also unknown.

Efforts to Establish New Nesting Beaches

There have been a number of these efforts, from the massive Operation Green Turtle, in the 1960s, to the present heroic attempt to give *Lepidochelys kempi* a new chance for survival at Padre Island. The latter program has the benefit of accumulated knowledge, and has been carefully thought out in most respects. Klima and McVey (this volume) identify 4 factors that are considered to be the minimum necessary for potential success of a long-distance transplantation program. These are: 1) natural incubation conditions and orientation exposure for hatchlings on the new beach; 2) headstarting of released turtles; 3) an adequate marking technique; and 4) biologically appropriate release conditions. Of these, only the second is questionable (although the third may be hard to achieve). Headstarting is questionable because, unlike the other "minimum" conditions, it offers the very real possibility of lowering rather than raising the chances for success of the transplantation program. By combining headstarting and long-distance transplantation in the same experiment, 2 sets of independent variables are mixed together. Should the effort to establish a new ridley nesting beach at Padre Island fail or achieve only limited success, we may never know whether it was the headstarting or the transplantation that did not work. It might be better to release the majority of transplanted hatchlings directly upon emergence from the nest, reserving the minority for headstarting. I would certainly advise that this be done in Israel, to maximize the chances for success of their transplantation effort.

In their paper, Klima and McVey give 5 reasons for headstarting *L. kempi*. I have discussed, without citing them, some of these reasons in the section on headstarting above, and in the "noncommercial captive breeding" section, below. But one of these reasons deserves comment here. Klima and McVey state, "to verify the establishment of a second nesting beach at Padre island a 'headstarting' program is required, to produce turtles which can be tagged to provide later identification." But because the tags are unlikely to last until the turtles reach maturity, this is a very weak justification for headstarting.

I want to make one more observation that concerns both headstarting and long-distance transplantation. These experiments are all designed with the idea in mind that hatchling—or even embryonic—turtles may be "imprinted" with the odor or taste of chemicals released by the sand of their natal beaches. This is certainly a possibility, and it costs very little to take it into account. But even though I am one of the originators of the beach imprinting idea, I still must agree with Hendrickson (this volume) that the hypothesis is totally unproven. It may be that other characteristics of the beach environment are more important: infrasound, magnetic field characteristics, nature of the offshore waters, and so forth. If this is so, then headstarting may produce defective animals unable to respond to the cues from their own, or any, nesting beach. Again, this reinforces my warning that headstarting should never be used as a complete substitute for natural nest emergence of hatchlings on their natal or adopted beaches.

Technology to Reduce Incidental Take

The development of this technology may prove indispensable for the conservation of many populations of sea turtles, and it should be pursued energetically. The existence of this research program, however, should not prevent us from recommending that certain critical sea turtle habitats be closed to shrimp and other fishing until trawls that exclude sea turtles are commercially available.

"Cottage Industry" Programs to Raise Sea Turtles for Subsistence, Cash Income, and Release

After the spectacular failure of the Torres Straits Islands turtle farming scheme, it is unlikely that this type of technique will receive widespread support from either conservationists or government officials. But ideas of this sort never seem to die, as we have seen at this conference, so some remarks are appropriate. First, as Nietschmann has repeatedly and lucidly explained, the introduction of cash payments for resources into a subsistence culture, the act of coupling such a culture to the world or regional economy, destroys both the resource and the culture. Cottage industry headstarting or ranching programs turn a subsistence resource into a market commodity. (They also emphasize the value of luxury goods, such as tortoise shell and turtle leather, which rightly have little worth in a subsistence culture.) Even the much simpler policy of buying eggs from native peoples for resale and for conservation purposes is fraught with some of the same risks, although the damage can be intangible and may not appear for a number of years. I accept Dr. Siow's statement (conference discussion) that egg purchase is sometimes necessary. But there is a danger in teaching people that conservation is always accompanied by a cash profit, and a certain danger in running conservation programs on the proceeds from the sale of a resource. We have discovered this in the United States, where state fish and game departments are supported by hunting fees—often with most unsatisfactory results. I think it is very wrong also to assume the superior attitude that peoples in poor countries are incapable of having or acquiring moral feelings of conservation.

Second, it is worth noting that both headstarting and farming are techniques that require sophisticated technology and a high level of scientific control. These features are not available to peoples emerging from subsistence cultures.

Insofar as cottage industry farming or the sale of a part of the egg harvest are based on the assumption that headstarting works, then they are even more risky as conservation ventures.

Control of International Trade

The control of international trade in turtles and turtle products cannot be faulted as a conservation tool from a biological point of view. More will be said about it in conjunction with the discussion of commercial farming, below.

Commercial Ranching, Plus Headstarting to Augment Wild Populations

Apart from any benefits associated with headstarting and the release of a small percentage of their captive turtles, turtle ranches are entirely detrimental to conservtion. The value of headstarting is sufficiently unproven so that it is not enough to justify any commercial ranching operation. In many other respects, ranching is similar to farming, discussed below.

Commercial Farming

I have written about commercial farming elsewhere (Ehrenfeld 1974, 1980) and have concluded that it is detrimental to the conservation of sea turtles for a number of reasons. I see no need either to repeat or to modify my argument now. We have heard some people reject the conservation premises upon which turtle farming is based, and we have heard others defend them. How does one decide between them? Remembering my purpose here to describe the nonnegotiable constraints that sea turtle biology places on various conservation techniques, I will limit my discussion of this controversy to a single table. I have based this table on a paper by Webber and Riordan (1976). The paper was entitled, "Criteria for candidate species for aquaculture," and in my table I have simply evaluated sea turtles according to the criteria of suitability that they list (see Table 1).

What this table says to me is that because of intractable, unchangeable limitations imposed by the biology of the sea turtles, ranching and farming will remain practicable only while international demand for all turtle products, especially the luxury ones of shell, leather, and stuffed animals, remains high, and while the prices of these products also remain very high. It will therefore be necessary for the industry to seek ever wider markets and higher prices if they wish to survive in an inflationary world. According to Mack, Duplaix, and Wells (this volume), the sea turtle is now "the most profitable wild animal in large scale international trade." This explains the survival, even expansion, of the biologically absurd turtle farming industry. We are told that Cayman Turtle Farm and other farms will saturate the markets for turtle products, while continuing to expand these markets. If turtles were gold, and someone found a complex, capital-intensive way to farm gold and make a modest profit, is it likely that the wild gold mines would be abandoned?

Noncommercial Captive Breeding: Preservation of Sea Turtles in Zoos and Aquaria

It has been suggested that we preserve the gene pools of *L. kempi* and possibly other endangered sea turtles by maintaining them in captivity in selected zoos, aquaria, or special breeding ponds. Insofar as this involves the use of a few (perhaps 50) captive-raised individuals, I can see little harm to the idea. But any significant use

Table 1. Suitability of sea turtles as candidates for aquaculture (closed-system farming): evaluation of biological and economic characteristics

Characteristics	*Suitable*	*Marginal or questionable*	*Unsuitable*
Growth rate			X
Ability to take advantage of natural food production in captivity			X
Ability to feed with inexpensive processed foods or waste products			X
Suitability for polyculture			X
Tolerance to crowding		X	
Easy access to unlimited supply of wild juveniles, or complete control of reproductive cycle (including economic control)			X
Short reproductive cycling time			X
Potential for genetic improvement		X	
Hardiness		X	
Initial capital requirements			X
Water purification and waste management costs		X	
Market demand	X		
Price of products	X		

of wild-caught *L. kempi* for captive propagation seems to me to be totally unwarranted, for at least 4 reasons. First, captive breeding programs to save endangered species have been notoriously unsuccessful in the case of species whose biology is complex and badly understood. The biology of sea turtles is complex and badly understood.

Second, in the absence of natural selection pressures, the gene pools of captive animals often undergo rapid and destructive change. The great zookeeper, Hediger (1955), vividly describes how wild animals in zoos or under domestication lose, after a number of generations, both their special sensory abilities and many of their special behaviors associated with reproduction. The difficulty of reintroducing captive-reared Hawaiian geese into their native habitat is but one of many examples.

Third, if we start preserving "gene pools" in captivity, where do we draw the line? Do we keep *L. kempi*, because it is a named species, but discard the Aves Island green turtles because they are considered just a subspecies? There are not enough facilities to save every endangered gene pool.

And fourth, there is always the possibility that showy and popular efforts to create captive breeding populations of sea turtles will drain away efforts and funds from conservation activities that deserve a much higher priority.

This ends my survey of options and limitations in the conservation of sea turtles. In looking over the list, I believe some principles emerge. Most important is that a combination of our incomplete knowledge about sea turtles and the numerous constraints imposed by their biology dictates a very conservative conservation strategy. I conclude that the best we can do is to concentrate on the protection of existing wild populations, using the simplest and least risky techniques of conservation. Fortunately, the techniques with the lowest risk and greatest promise are also those with the lowest cost and requiring the least elaborate technologies. This is also true of much of the research related to sea turtle conservation. And fortunately, most of the conservation techniques are not mutually exclusive and can be applied simultaneously. Finally, conservationists must remember that the results of their efforts, good or bad, are most likely to be seen by their children.

In Table 2, I have given my personal list of priorities for research and techniques of conservation. I have not included commercial ranching and farming in the list, because I believe that they have only a negative impact on conservation. While reading this table, I urge the reader to remember that, as Hendrickson (this volume) has clearly shown, the options and limitations for conservation of sea turtles vary markedly from species to species (see Table 2).

I do not mean to imply that the items in this table with medium or low priority should not be done, rather that they should be done only when we are sure that the effort will not divert needed workers or funds from more important kinds of conservation activity.

It is no coincidence that the conservation methods that have the greatest potential for saving wild sea turtles are those not limited by the biology of these animals or by our ignorance of it—namely, control of international trade, widespread conservation education, coordination of conservation efforts, and the simpler kinds of habitat protection. The greatest irony of this convention may well be that some of the most

Table 2. Priorities in the conservation of sea turtles

Priority	*Research*	*Conservation methods*
High	Life histories, especially migrations and the non-nesting portions; population dynamics; critical habitats; effects of egg manipulation (including temperature) and other hatchery-related research; taxonomy and related population genetics; simple, inexpensive, effective tagging methods; improved fishing trawls; effects of nesting beach alterations; turtle product species identification methods	Protection of nesting grounds and aquatic habitats, including minimization of environmental disruption at these sites and designation of critical habitats; short-range transplantation of nests, use of egg hatcheries; conservation education; control of international trade; intergovernmental and interorganizational coordination of conservation strategies; dissemination of improved trawls (when available)
Medium	Control of infectious diseases and parasites in captive animals, especially juveniles; study of biological effects of pollutants; nutritional research; fisheries management research; effects of headstarting and long-distance transplantation	Long range transplantation of nests; headstarting
Low	Effects of manipulations in closed-cycle breeding systems; some high-technology research (endocrinology, sensory physiology, etc.)	Fisheries management of turtle catch; manipulation of sex ratios away from the population norm; cottage industry ranching; noncommercial captive breeding to maintain gene pools

effective conservation actions we can take are not strongly dependent on any further increase in our knowledge of sea turtles.

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Farming and Ranching as a Strategy for Sea Turtle Conservation

ABSTRACT

Regional socio-economic conditions should be included in the formulation of a world strategy for marine turtle conservation. Current conservation principles are based on standards developed by affluent societies and are not necessarily effective in lesser developed countries. A rational approach to conservation of sea turtles in those areas would be to make it economically attractive. This can be accomplished by allowing captive-rearing of turtles, in particular the green turtle (*Chelonia mydas*).

Such projects can benefit conservation in 2 ways: first, by providing the economic incentive to protect the wild populations, which are the source of hatchlings for the project; second, by making it compulsory for the projects to include headstart programs, in which predetermined numbers of captive-reared animals are released to the sea at regular intervals. Marine turtles are a valuable natural resource with considerable economic benefit. International trade in marine turtle products cannot be stopped by resolutions or punitive measures; nor can the wild populations be rebuilt to optimal densities by hands-off policies. Taking advantage of the considerable reproductive potential, and by reducing drastically the high, early-age natural mortality through captive rearing, the wild populations may be increased by headstarting. The Convention for International Trade in Endangered Species (CITES) should make provisions to allow for ranching schemes, and for trade in captive-raised marine turtle products only so that developing countries will be provided with economic motivation to conserve their wild turtle populations.

Introduction

The world strategy for sea turtle conservation must consist of a mosaic of complementary courses of action which aim at the global goal of preserving marine turtle species. Conservation should be their only unifying feature.

The strategy developed during this conference ought to provide for adaptability to local socio-economic conditions, which can vary significantly from country to country. These conditions will greatly influence any conservation attempts. For example, wildlife conservation in North America and wildlife conservation in Latin America serve the same purpose—to protect the well-being of the species. The approach to that goal, if the strategy developed here is to be effective, will have to be quite different in the 2 regions. Where the halo effect of a show-business celebrity kissing a baby seal on some icefloe in Canada may serve conservation efforts in North America well, it will only provoke ridicule in lesser developed countries, and may even be counterproductive. It must therefore be strongly recommended that any world strategy agreed upon include heavy reliance on cultural and economic factors of the particular region involved. Such a strategy master plan will be infinitely more effective than a conservation ethic originating in the affluent countries, that is meant to be applied worldwide.

Conservation principles are based on a valid concept: respect for the rights of wildlife. At no time should this motivation for wildlife conservation be ignored. In fact, it must be included as an important guiding principle in the formulation of a world strategy. Unfortunately, this basic tenet of good conservation is not a salable item in developing countries, and we must adjust our strategy accordingly.

Most marine turtle habitats are located near the lesser developed countries of the world. The main concern of these countries is not the conservation of wildlife, but rather the exploitation of any ready resource in order to improve the standard of living for their citizens. Many examples show that only short-term benefits are being considered in resource-use decisions, while the long-term aspects are conveniently ignored—to be dealt with by future generations. This irrationality is by no means restricted to the developing nations; it has become a fine art in industrial countries as well. Signs, however, point to the growing awareness in some countries that natural resource conservation is not only compatible with economic well-being but is also essential to it. A case in point is the sudden concern of some East African nations for their wildlife resources. This concern is by no means motivated from compassion for the animals themselves but rather by the income derived from the tourists who come to see these animals. Marine turtles do not provide the spectacle the East African wildlife does to attract large-scale tourism. Instead, the strategy for their conservation should be based on a different, but nevertheless economic value.

Discussion

Sea turtles are well known as a commercially valuable natural resource. Management of some of their populations and controlled trade in their products should thus be considered a potentially constructive mechanism in the strategy for marine turtle conservation.

To some people these activities—trade and conservation—appear to conflict, but—if properly applied—they could well be the key to saving the species. Trade and conservation have for too long been automatically regarded as a dichotomy by many conservationists, but a reappraisal of the underlying philosophy may show that these two activities need not be mutually exclusive. International trade in sea turtle products will continue unabated and will probably increase as human populations increase. Unless we change tactics, and use trade to our advantage, wild turtle populations will become irreversibly depleted, maybe before the end of this century.

A few populations seem to be recovering as the result of protective measures (Pritchard, this volume) but it is highly questionable whether the legislative measures of the past decades have made any improvement in the status of marine turtle populations; continuation of current attitudes will be fruitless. The language of the developing world is one of economics. This suggests the inclusion of the following in the preamble of a rational strategy for turtle conservation in those countries: to conserve marine turtle populations it must be made economically atttractive to do so.

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is the proper forum to deal with these aspects. CITES provides a major step in a global effort to conserve endangered wildlife, where trade is an important factor in its endangered status. The problem with CITES, however, is that no provisions exist to take advantage of biological properties, such as reproductive potential, of certain animal taxa in order to boost their chances in the race against extinction.

Most presently endangered species have attained this dubious honor through man's activities, be it habitat destruction or excessive harvesting. For instance, no amount of conservation effort will restore the spotted cats to anywhere near their original numbers. They have been overhunted, their habitat is practically gone, and they are not particularly prolific. At best, we can hope to establish sanctuary ecosystems where these species can maintain themselves at current or slightly greater densities. On the other hand, some endangered species are reproductively prolific and the bulk of their natural mortality occurs in early life. Their chances for rapid population recovery are decreased if only natural processes are allowed to run their course. Marine turtles especially fit in this category, most of all the green turtle (*Chelonia mydas*), often called man's most valuable reptile. Utilizing the high reproductive potential of these animals, and simultaneously slashing their early natural mortality through captive rearing of hatchlings, offers a powerful tool to help rebuild and conserve these endangered species.

Despite the destruction of some sea turtle nesting beaches, by and large the feeding grounds are still intact. It would take two major courses of action to rebuild the wild populations: 1) reduce man's incidental and intentional catch of wild turtles; 2) restock the wild populations with captive-reared animals.

Reduction of man's incidental catch will necessitate closer cooperation with fishermen, whether local operators or international fishing fleets. Experience has indicated, at least in the Guianas, that fishermen do not like to catch marine turtles in their nets. An enmeshed mature turtle not only causes considerable damage to expensive nets, but it also reduces the target fish catch. To untangle a mature turtle is such an arduous task that most fishermen hack off the flippers and set the carcass adrift. Each year several such mutilated animals are stranded on Surinam beaches. When extrapolated over the western Atlantic, this number suggests a senseless waste of mature turtles at a stage in their lives when we can least afford to lose them. It is not uncommon for a single fisherman in the Guianas to set 1 kilometer of nets at a time. Multiply this by the number of local fishermen, then add the cumulative lengths of nets set or dragged by fishing fleets of several nations operating further offshore, and it becomes obvious that a lethal barrier is stretching across turtle travel routes in the southern Caribbean. Fishermen would be quite cooperative in accepting alternate net designs which would decrease incidental turtle catch. Antagonistic interaction with the fishing industry should be avoided; it resolves nothing, and the loss of their cooperation will also be a loss for marine turtle conservation.

To reduce the intentional catch of wild sea turtles, where such practice is illegal is, in general, a matter of wishful thinking. Anyone inclined to go out and catch a turtle will do so. Legislation or international resolutions will merely be an exercise in frustration. The only way to reduce this type of exploitation is to substitute an economically attractive alternative. This leads to the second course of action in conserving sea turtles: stocking the wild populations with captive-reared animals from commercial operations.

It was for this reason that during the second meeting of CITES, in San Jose, Costa Rica, in March 1979, some countries argued against tightening the definition for the term "bred in captivity." In spite of this, the U.S. proposed definition of the term was adopted by the convention in virtually original form. This definition should be considered a grave threat to conservation attempts based on captive-breeding schemes. The ramifications are that to initiate captive-breeding projects for marine turtles will no longer be economically attractive. A farm conforming to the definition requirements would need 15 to 20 years before it could engage in international trade of farmed turtle products. It would require several million dollars-worth of investment with no return to be expected for that period. Any plans for such a project by a developing country will be abandoned. As a result, the hunting pressure on wild turtles will increase.

A turtle ranch would be an economic asset for a developing country. It can be the source of much needed foreign exchange, and it would provide employment for some of the chronically unemployed people in those areas. These 2 aspects alone would make governments and local people aware that conservation of wild turtles can be economically attractive, because these animals form the source of supply for their captive-rearing operations. Developing countries would then have the motivation to protect the wild populations living in their territorial waters.

Preservationists in the industrial nations should clearly understand that without an economic incentive, the people of lesser developed areas in the world cannot be persuaded to care about conservation. Instead of imposing rigorous bans on international trade in captive-reared turtle products, a certain amount of flexibility should be maintained in the decision-making procedures to allow for it.

Based on this concept, and at the request of several member states to the Convention, the Secretariat of CITES was instructed to investigate the possibility of allowing ranching schemes for some marine turtles. This would eliminate the necessity of establishing and maintaining breeding stock for the operation in countries which have a viable green turtle population near their shores. CITES approval would enable some developing countries to utilize this valuable resource with a minimal investment, and give them the incentive to contribute to the conservation of endangered sea turtle species.

Captive-rearing of sea turtles for economic benefit alone does not implicitly aid conservation, but it can open the way for supplemental conservation efforts that local authorities will support and, much more importantly, that the local people will accept. As an additional conservation measure an internationally recognized turtle ranch should be required to include, among other things, a headstart program of releasing some of its turtles to the wild at regular intervals.

Captive-rearing solely for the purpose of release to the wild is a noble goal, one that only affluent societies can afford. Even if such projects were financed by them in a developing country, its rationale would escape the local people, and the entire project would likely end up as a showcase for abuse and corruption.

Allowing subsistence hunting of marine turtles by selected indigenous people (Pritchard 1977) is merely an expedient attempt at turtle conservation by pacifying the natives' demand for unlimited access to the turtle resource. Even though the meat is sought after by many, there are also many natives who do not care to eat turtle meat; some favor only the eggs. Much of this has to do with cultural tabus.

What most of these people do have in common is the awareness of the value of turtle products on the international market, and they would like to capitalize on it. Given the choice, they would rather have the security of a regular income from employment at a turtle ranch than to be relegated to a steady diet of turtle meat.

International trade in turtle products will continue regardless of restrictions or resolutions. The most sensible thing to do is to acknowledge this fact of life and try to develop rational guidelines for this trade by using captive-reared green turtles so it will benefit conservation and the economics of developing nations. The use of prohibition-type tactics in trade restrictions will only encourage unscrupulous people to exploit, and thus destroy, the wild populations because the demand for sea turtle products cannot be legislated out of existence. Instead, national and international regulatory bodies should be empowered to provide controls for trade in farmed and ranched turtle products, with very stiff penalties to violators of established codes of operations. While the search for a practical labeling technique to distinguish captive-reared turtles from wild ones continues, rearing facilities, processing sites, and export and import stations must be rigorously inspected. Any violation must be severely punished by immediate cancellation of the internationally sanctioned operating permit. The cost and responsibility of such controls should be borne proportionally by the participants in each phase of the trade.

For conservationists the key attraction of commercial captive-rearing schemes, is of course, the headstart program. Headstarting should not merely be a secondary function of the facilities, but must be made an integral part of the overall management plan for the project. In fact, an internationally recognized permit

Table 1. Surinam marine turtle conservation program (*Chelonia mydas*)

Annual cycle

Natural (hands-off policy)		*Managed (Headstart)*	
Start	1,000,000 eggs	Start	1,000,000 eggs
Doomed	250,000 eggs	Ranch project and market	300,000 eggs
	750,000 eggs		700,000 eggs
Hatch failure (33 percent)	250,000 eggs	Hatch failure (28 percent)	200,000 eggs
To the sea	500,000 hatchlings	To the sea	500,000 hatchlings
Mortality to age 1 year (99 percent)	495,000	Mortality to age 1 year (99 percent)	495,000
	5,000 yearlings		5,000 yearlings
		Release captive-reared turtles	1,000 yearlings
			6,000 yearlings

Negative aspects

- No eggs for market will result in extensive poaching and destruction of nests of all marine turtle species nesting in Surinam.
- No eggs for market means loss of funds to hire beach personnel.
- No eggs for market will result in loss of public support on conservation measures and will almost certainly cause poaching of mature nesting females.

Positive aspects

- Sale of eggs provides funds to protect nests of all other marine turtle species in Surinam.
- Hatch failure of natural nests reduced through better predator control.
- Market availability of eggs has reduced egg poaching to almost nil.
- Management program enjoys full support of the Surinam people and there is no poaching of subadult or adult marine turtles.

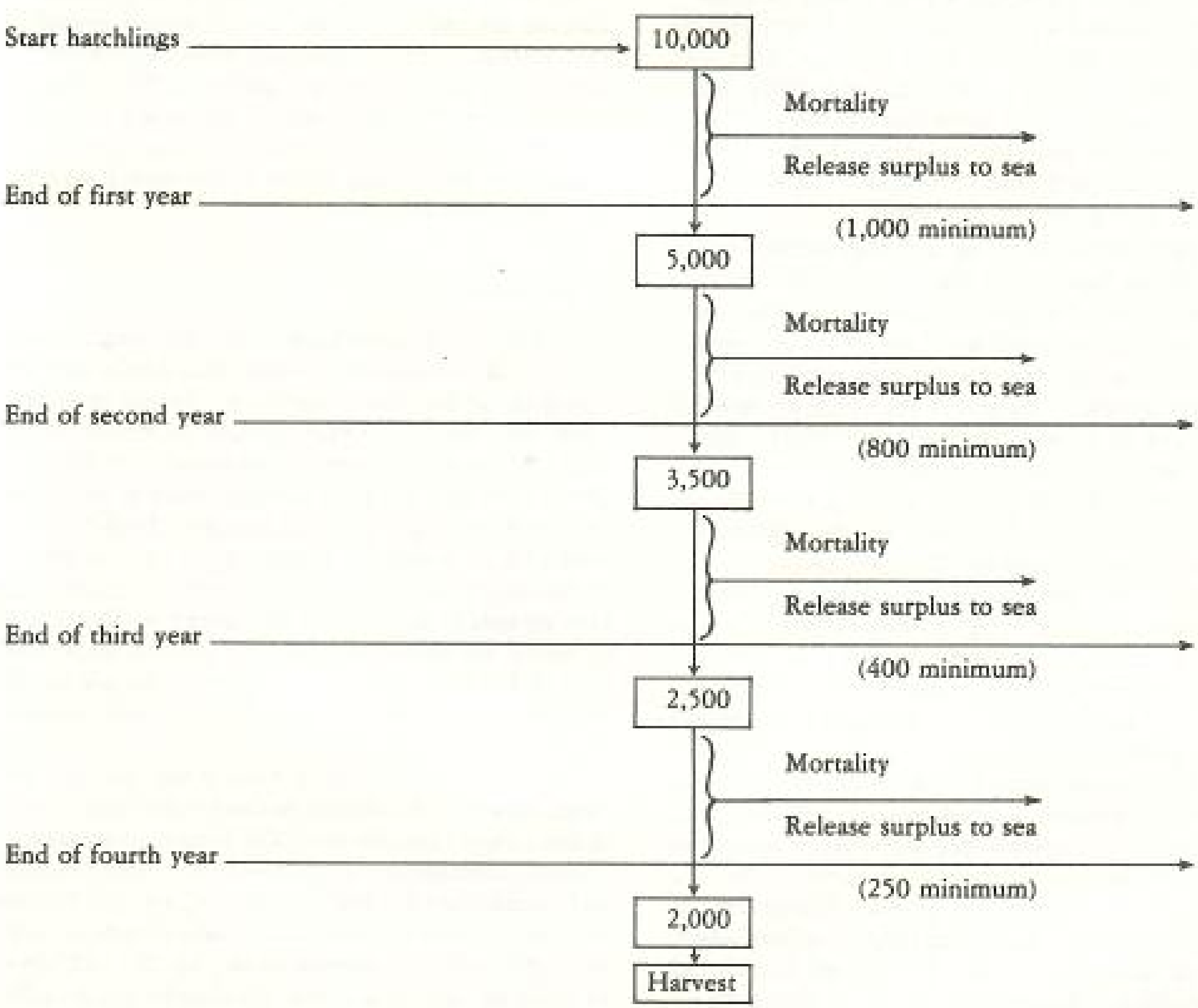
to operate a turtle ranch or farm must have this aspect as an obligatory feature.

The Surinam green turtle ranching project, which at this time is only a feasibility study, may serve to illustrate the concept. Of the 4 species of sea turtles nesting on Surinam beaches, the green turtle alone lays about one million eggs each year. A quarter of a million of these eggs would be destroyed by spring tides, if left unattended (Schulz 1975). This constitutes a great loss of a valuable natural resource, both in economic and conservation terms. Through the efforts of Surinam conservation organizations most of the so-called doomed eggs are harvested and sold under close supervision on local markets. Hatchlings for the ranching project also come from these eggs. Proceeds of the egg sales are used to finance conservation work in Surinam on all marine turtles nesting there. The rationale for the controlled egg harvest is shown in Table 1.

For commercial purposes, the ranch turtles are to be raised to an age of 4 years, when they will be harvested. This 4-year cycle is based on the results of a high protein diet. Experiments are in progress in Surinam with alternate local food sources but too little is known at this time to give specific growth rate data. Meanwhile, each year a certain number of turtles in each year class will be marked and released to the sea. The general program pattern is shown in Table 2.

As stated earlier, most natural mortality for sea turtles occurs during the egg and hatchling stage. It is a reasonable, and possibly optimistic, estimate that under natural conditions 1 out of every 100 eggs laid will become a turtle that reaches the age of 1 year. Or thinking in terms of eggs harvested for the project: with the Surinam headstart program, when 1,000 yearlings are released to the sea (as was done last year), the potential of 100,000 eggs is put back for the 10,000 hatchlings taken yearly for the project. The possible benefits to conservation of such headstart programs

Table 2. Turtle ranch pilot project with headstart program, Foundation for Nature Preservation, Surinam (STINASU)



are obvious. There are unknown aspects of headstarting, and the questions being raised are: 1) Will they survive in the wild, after having been raised in captivity? 2) Will they follow species-specific travel routes? 3) Will they find the feeding grounds of the parental stock? 4) Will they be accepted by the wild population, and be allowed to mate? 5) Will they find their nesting beach again as breeding adults?

As a result of tag returns and occasional sightings some of these questions can already provisionally be answered. Headstart turtles are surviving in the wild. Some tag returns which included weight and size information indicate healthy growth. From what is known of the behavior of wild green turtles in this area, the animals are dispersing in the anticipated directions. Some of the turtles released are already on the feeding grounds of the parental stock off the Brazilian coast. They have successfully negotiated the 2,000-odd km voyage from Surinam.

Whether the released turtles will eventually find their beach of origin again after they are mature is largely academic, especially for Surinam. The beach where they emerged as hatchlings will no longer be there—it will have shifted westward by 15 to 20 km, leaving inaccessible mudflats where once the original rookery was. Beach imprinting is still a theory and too much emphasis is placed on its significance in headstart programs. It is more important to provide recruits for the wild breeding stock than to speculate on a homing mechanism for some specific beach.

The merits of headstarting is the subject of intense debate. It has been stated that none of the headstart projects attempted so far has helped increase the numbers of wild turtles in the sea (Ross 1978). A negative appraisal of headstarting on these aspects often indicates preconceived bias and is not based on accumulated data or experience. Current protectionist strategy has not improved the lot of wild turtle populations, and it is time that philosophical discussions on the merits of headstarting make way for the practical application of such programs. Time is running out for the species. Only empirically derived data will provide the answers. With the current Surinam project, a start has been made for a long-term mark and release program of captive-reared green turtles. With subsequent releases of various age classes, emerging patterns may suggest testable hypotheses.

Ranching is a very attractive turtle utilization scheme for developing countries which have the resources, and the inclusion of a compulsory headstart program will be an acceptable feature to them. Additional scientific benefits derived from such projects should not be underestimated. Farming has already provided a wealth of data on various aspects of turtle biology. In addition, it has pioneered the development of techniques in using artificial nest boxes for the hatching of turtle eggs. The use of this tool alone has enabled Surinam conservation organizations to put more hatchlings in the sea than all other well-meant conservation efforts in Surinam put together. Captive-rearing projects provide an opportunity to study the turtles at close range. Results of such studies can form the basis on which to continue work with wild populations. The facilities can also be used to provide breeding stock of all sea turtle species for select conservation projects.

Too much publicity has been given to the disadvantages of commercial captive-rearing schemes for marine turtles. These claims are the opinion of some, but by no means all, turtle experts. Their views, however, are echoed *ad infinitum* by laymen. As a result, the negative publicity is widespread. The fact is that there are no hard data to show that commercial turtle farms or ranches are detrimental to the wild populations; it is pure conjecture. Equally positive arguments could well be provided, but these are usually suppressed in public interviews.

The data on increased trade in turtle products are undoubtedly valid (Mack, Duplaix, and Wells, this volume), but it must be kept in mind that as human populations are expanding, the use of natural resources will increase. There is hardly a commodity in the world whose trade aspects have not increased. Therefore, no number of trade restrictions will decrease the demand for turtle products. Pressure on wild sea turtle populations will thus persist unless an alternate source for the same product is provided.

Conclusion

A captive-raised green turtle can reach maturity in 8 to 12 years, considerably sooner than a wild one. By releasing captive-reared turtles to the sea at a time when they may reach reproductive condition sooner than wild ones, we accelerate recruitment to the population and thus improve natality, which is an important parameter of population increase. At this critical stage of marine turtle conservation the focus of efforts should be on increasing the numbers of sexually mature animals in the sea. By the largely passive action of letting the turtle's natural reproductive cycle take care of hoped-for population growth, the adherence to current conservation measures will invite disaster for the wild populations.

Through the millennia, a balance has emerged between natality and mortality factors for sea turtles. Man, in just a short time, has been able to upset this balance. Natural reproductive processes will be unable to adjust and compensate for this disturbance, and the species will lose. Nature needs an assist; man, despite his negative effects on the species so far, has the technique to build up the populations. Headstarting is a viable conservation tool, but it will not be feasible unless it are obvious. There are unknown aspects of headstarting, and the questions being raised are: 1) Will they survive in the wild, after having been raised in captivity? 2) Will they follow species-specific travel routes? 3) Will they find the feeding grounds of the parental stock? 4) Will they be accepted by the wild population, and be allowed to mate? 5) Will they find their nesting beach again as breeding adults?

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Through the millennia, a balance has emerged between natality and mortality factors for sea turtles. Man, in just a short time, has been able to upset this balance. Natural reproductive processes will be unable to adjust and compensate for this disturbance, and the species will lose. Nature needs an assist; man, despite his negative effects on the species so far, has the technique to build up the populations. Headstarting is a viable conservation tool, but it will not be feasible unless it is made economically attractive, which farming or ranching does.

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Does Sea Turtle Aquaculture Benefit Conservation?

ABSTRACT

As populations of sea turtles continue to decline, the aquaculture of various species, particularly the green, hawksbill, and olive ridley, has been proposed as a method whereby present population levels can be maintained while satisfying the demand for products. In this paper, I examine aquaculture as it may affect conservation of these species. The following topics are discussed: flaws underlying sea turtle aquaculture theory, the chances of increasing survivorship by aquaculture, relative advantages and disadvantages of aquaculture products to wild products, world wide food potential of aquaculture-derived meat, possible conservation benefits of aquaculture research, and other questions. I conclude that aquaculture could stimulate markets thus leading to a proliferation of farms and ranches with no conservation outlook, that it encourages the marketing of luxury products which then undermines local conservation laws and makes enforcement difficult if not impossible, and that farms may spawn ill-conceived yet well-publicized "conservation" activities that could mislead the consuming public into believing that sea turtles are recovering significantly. All could lead to the continued exploitation of wild populations. In addition, aquaculture is based on false premises about the extent of biological knowledge of the species and the applicability of the maximum sustainable yield concept to sea turtle harvest. The proliferation of turtle farms and ranches cannot be justified on conservation grounds.

RESUMEN

A medida que las poblaciones de las tortugas de mar continuan declinando, el aquacultura de varias especies, particularmente el de la tortuga verde, el carey, y la golfina, ha sido propuesto como un método por medio del cual los niveles de poblaciones presentes pueden ser mantenidos mientras se satisface la demanda de sus productos. En este estudio examino cómo el aquacultura de las tortugas de mar puede afectar la conservación de estas especies. Los siguientes tópicos son discutidos: defectos fundamentales en la teoria del aquacultura de las tortugas de mar; ¿incrementará el aquacultura la sobrevivencia de estas especies?; ¿son los productos derivados de aquacultura superiores a aquéllos obtenidos de las especies salvajes?; ¿alimentará a un mundo hambriento la carne derivada de aquacultura?; ¿beneficiará a la conservación la investigación de aquacultura? Otros problemas son también analizados. Concluyo que aquacultura podría estimular los mercados, de este modo conduciendo a la proliferación de criaderos sin perspectivas de conservación, que favorece la venta de productos de lujo lo cual detrimenta las leyes locales de conservación y hace difícil y a veces imposible el enforzamiento de las mismas, y que los criaderos pueden generar ideas erróneas pero bien difundidas de que realizan actividades de "conservación" lo cual alucina al público consumidor con la creencia de que las tortugas de mar están recuperándose significativamente. Todo esto puede determinar la continua explotación de las poblaciones salvajes. Además, aquacultura se basa en falsas premisas acerca de la extensíon del conocimiento biológico de las especies y la aplicabilidad del concepto de máximo rendimiento sostenible en la cosecha de tortuga de mar. La proliferación de criaderos de tortugas no puede ser justificado en bases de conservación.

There is no doubt among sea turtle biologists that the green turtle, *Chelonia mydas*, is threatened with extinction throughout large portions of its circumglobal range, nor is there doubt that many populations have been severely depleted through exploitation in past times by colonial powers (Parsons 1962), incidental take, subsistence take, habitat destruction, and through the demand of luxury markets in the modern world for turtle meat, eggs, soup, and shell. A valuable species often inhabiting places with little or no effective protection lends itself to exploitation. Turtle biologists throughout the world have voiced concern at this situation, and some have suggested ranching or farming of sea turtles as a way to maintain present population levels and yet satisfy the demand for products.

The idea of turtle farming or ranching is not new (Brongersma 1978a). Indeed, in some areas it developed into a local cottage industry although true captive culture through several generations was never achieved (Le Poulain 1941). At present, turtle farms and ranches appear to be proliferating. Perhaps the best known of these operations, and the closest to becoming a closed cycle farm, is Cayman Turtle Farm in the Grand Cayman Islands (see Hendrickson 1974 and Simon, Ulrich, and Parkes 1975 for an overview of this farm) which began operation in 1968 as Mariculture Ltd. Other farms and ranches are or have been located in the Torres Straits in Australia (Bustard 1972; Carr and Main 1973; Applied Ecology Pty, Ltd., 1978), Corail on Reunion Island (Hughes, personal communication), the Seychelles, South Yemen (Leitzell 1978), Mexico, Malaysia, the Philippines (Fontanilla and Carrascal-de Celis 1978), Indonesia (Suwelo, 1973), Suriname (Reichart, this volume), and perhaps additional areas. While conservation of the green turtle is not the primary motivation behind these operations, it is often raised as a justification for their establishment and continuance (see for instance Cayman Turtle Farm, Ltd., 1978). The question therefore arises about the validity of these organizations' conservation claims and techniques.

Proponents of sea turtle farming and ranching cite a number of arguments which they believe support their position; I will outline these briefly. I refer those who desire to review these arguments in greater detail to the following references: Hendrickson (1974), Reiger (1975), Ehrenfeld (1974), Brongersma (1978a, b), Reichart (this volume). These arguments are basically 4.

1) Farming will drive illegal turtle fishermen out of business by offering better and more uniform goods in large quantity thus satisfying market demand. By cornering the market, farms will thus eliminate poaching and result in the protection of beaches which otherwise might not receive any protection. In addition, the elaborate packaging will allow better enforcement of both local laws and international agreements, thus reducing illegal trade.

2) Turtle farms will supply a high source of protein in many areas suffering a protein deficient diet.

3) Turtle survivorship will be increased through the headstarting of young, the salvaging of doomed eggs, and the nonreliance on wild populations of adults, except occasionally to increase genetic variability.

4) Useful research will result, leading eventually to closed-cycle farming techniques that can be adopted throughout the world, to increased knowledge of basic turtle biology which, in turn, will further the conservation of wild populations, and to the development of methods for rearing species or populations verging on extinction. None of these arguments can be justified if subjected to careful scrutiny.

I will restrict my discussion to those operations whose purpose is to raise sea turtles, either by ranching or farming, to provide products for consumption or use to people other than themselves. This would include not only the wholesale commercial marketing of turtle products, such as practiced by Cayman Turtle Farm, but also such activities as the sale of shells or stuffed turtles to tourists even if the edible parts were consumed by the turtle raisers themselves. A ranch is defined as any operation that relies on wild-caught animals or eggs taken from natural beaches and which rears them to an appropriate slaughter size. A farm is a true closed-cycle system or one at least approaching a closed cycle, that is, it does not in any way rely on wild populations of turtles for present or future marketing. This definition of closed cycle is in accord with that adopted at the meeting of the nations that belong to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in San Jose, Costa Rica (19–30 March 1979). The discussion centers on the green turtle because it is most likely to be involved in farming or ranching; however, the arguments apply equally to other schemes advanced for the hawksbill (*Eretmochelys imbricata*) and olive ridley (*Lepidochelys olivacea*). Many of the ideas presented were initially set forth by Ehrenfeld (1974, 1980); his arguments are as apropos now as when first published.

Flaws in Sea Turtle Aquaculture Theory

Perhaps the major flaw underlying marine turtle aquaculture lies in the allegation that too little is known about the basic biology of the various species to insure that actions taken to set up a farm are not detrimental to wild populations, whether by removal of eggs or adults from their habitats for large scale breeding stock. As reviewed by Bustard (1979), we know virtually nothing of turtles during the "lost year," we know little about longevity, sex ratios, population size, reproduction, growth in the wild, recruitment, mortality, etc. Yet if marine turtle aquaculture is developed to a large extent, as its proponents advocate, it would be essential to know these characteristics to insure that during the initial development of closed-cycle operations, perhaps as long as 10 or more years, wild populations were not being severely harmed by removal of eggs and adults.

The argument is often raised that many of the eggs removed for aquaculture purposes are doomed eggs, eggs that would be lost through beach erosion, predation, or other natural causes. While some eggs are certainly doomed, these eggs can just as easily be moved to safe locations as be used for commercial purposes (Ehrenfeld 1980). Indeed, if they are truly doomed, would it not be better to allow them to be used by native peoples in need of high quality protein instead of being taken to be raised as adults to become gourmet items on the well-stocked tables of America and Europe? Ehrenfeld (1980) has also pointed out that there will always be more and more pressure to locate additional doomed eggs to supply various demands. This leads to another problem not only with doomed egg quotas, but any part of the population removed for commercial purposes; how are quotas to be set?

Because so little is known about the recruitment of turtles to the population, in reality we can only guess how many doomed eggs, nondoomed eggs, and adults can be removed while maintaining a viable wild population. Yet in most instances, egg quotas are set in advance based on limited past experience. While this is usually done carefully, the serious risks involved could lead to the extirpation of populations. For instance, the numbers of individuals nesting on a particular beach may fluctuate drastically. Thus, what was an acceptable level of egg removal 1 year would not necessarily be useful in predicting the next year's removal, or the removal of eggs several years hence. Only by long term investigations of nesting populations prior to exploitation could predictions be made with any degree of accuracy. Unfortunately, very few such studies have been undertaken. Schulz (1975), working in Surinam, has stated the problem clearly:

It is evident that the weak point in the scheme (removal of eggs) is the arbitrariness of the fixation of the quota. We know the feeding grounds and the migration route of the green turtle population nesting in Surinam. We have a good estimate of the average number of eggs produced per annum by a mature female and of the number of hatchlings that every year crawl to the sea. But actually we have no idea about the age distribution, the total reproduction of the population, the duration of life, the dispersion and other information on which an optimal-yield exploitation of the eggs should be based. And even if we could establish how many hatchlings are required to produce one mature female and how many eggs one female produces during her lifetime, there are no quantitative data available on mortality (including the catches in Brazilian waters).

Schulz also pinpoints another problem in both the conservation and exploitation of sea turtles in this passage, namely, that the exploitation or conservation activities of one country may be at odds with the activities in an adjacent country. How, for instance, is it possible to fix exploitation quotas for eggs in one country if all the adults go to another country where they are intensively harvested? Before accurately assigning quotas to insure adequate recruitment, it would be necessary to know where the adults go and the threats that they face. Yet such basic information is almost universally lacking or ignored, especially in many countries where aquaculture is being considered. Schulz (1975) continues:

So there is no answer to this basic problem of conservation, the problem of optimal yield: to what extent can the population nesting in Surinam be exploited for its eggs, maintain itself within a certain size range and at the same time yield a reasonably high production of eggs. The problem becomes practically unsolvable due to the fact that the population is also subjected to the capture of mature turtles in Brazilian waters (on which we are unable to exert even the slightest influence). There being no possibility of predicting the effect upon the population of the harvest of a certain amount of eggs, we can but do our best to continue with closely following the annual number of green turtle nests and to try to adjust the annual egg quota to this trend.

The future will learn whether in this it will be possible to balance the number of young turtles drowned in the nets of the rapidly growing number of shrimp trawlers and the catch of adults by Brazilian turtle catchers.

In this context, it would be well to note that even with the best of care in setting egg quotas for exploitation, such as in Sarawak, severe declines have still occurred (Harrisson 1976).

Schulz (1975) touches another topical question: whether or not sea turtles are proper subjects for aquaculture—the idea that they and their eggs are resources that can be harvested on a maximum sustainable yield (MSY) basis, at least during the initial development of a closed-cycle system. Proponents of aquaculture believe they can; I would disagree. The concept of maximum sustainable yield has been well regarded in the management of species, but as Holt and Talbot (1978) point out, "The embodiment of simplistic formulations in legislation has reinforced a belief that hypotheses, such as that the size of a stock essentially determines the yield it can sustain in perpetuity, have in fact been validated, and that the desirable state of a resource system can be exactly specified in terms of a single criterion. That belief does not survive scrutiny . . ." These authors discuss in detail the MSY concept and conclude that it.:

1) *focuses attention on the dynamics of particular species or stocks without explicit regard to the interactions between those species or stocks and other components of the ecosystem;*
2) *concerns only the quantity and not the quality of potential yield or other value from the resource;*
3) *depends on a degree of stability and resilience of the resource that may not exist;*
4) *focuses attention on the output from resource use, without regard to the input of energy, of other natural resources, and of human skill and labor required to secure the output;*
5) *may admit, and even encourage, overexploitation.*

Each of these criticisms applies to obtaining stock for sea turtle farms. How long would eggs need to be removed from beaches? Cayman Turtle Farm and its predecessor obtained eggs for over 10 years, yet have still not developed a true closed-cycle operation (Dodd 1978; Leitzell 1978). Eggs have been taken on a MSY basis, a basis which in fact has no support in the case of sea turtles, and which, as pointed out by Holt and Talbot (1978), is not a conservation technique by itself (also see Larkin 1977, and Ehrenfeld, this volume, for a discussion of the MSY concept). How long would adults need to be removed from wild populations? This is still not clear. Cayman Turtle Farm and its predecessor have reportedly spent over $17,000,000 to date, yet have had only limited success in developing a closed-cycle system. During over 10 years of operation, they have continued to rely on eggs and adults from wild populations. It is this developmental period, when wild stocks could be most severely affected, that aquaculture proponents so often overlook. I do not mean to single out Cayman Turtle Farm as a culprit; however, anyone wishing to set up turtle farms should consider its experience and examine carefully the concepts underlying development of initial stock as well as the need for profit while attempting a closed-cycle system.

The arguments enumerated above are directed at the establishment of farms, but they apply equally to ranches since ranches make no pretense about ever ending their reliance on wild populations. The underlying assumptions remain that turtles can be harvested on a MSY basis (not valid) and that enough is known about sea turtle biology and population characteristics to set take quotas (also not valid). Proponents may allege that ranching may divert continuous take of adults but, as will be discussed later, this argument is weak.

Will Aquaculture Increase Survivorship?

Proponents of aquaculture claim that increased survivorship will result if a proportion of young from doomed eggs or eggs layed from captive adults are raised to juvenile size and then returned to the sea. Unfortunately, while there has been much speculation about rates of survivorship and recruitment, as Ehrenfeld (1974) and Bustard (1979) point out, nothing is known about these factors in wild populations. Therefore, our best guesses about the number of juveniles to be returned to maintain a population are just that—guesses. While it is indeed better to release some young instead of allowing whole clutches to wash into the sea, the wholesale removal of eggs from good beaches cannot be justified by saying that only 1 percent would survive anyway. The assumption of a solid survivorship value is not based in fact (Hirth and Schaffer 1974). It is also not certain that all aquaculture operations would be willing to return a proportion of juvenile turtles to the ocean.

When, where, and how would juveniles be released? The green turtle is very site-specific when nesting (Carr 1975; Carr, Carr, and Meylan 1978), and Rainey (personal communication) has shown that as many as 5 genetically identifiable populations may dwell in the Caribbean alone. Before a release could be successful, the genetic identity of each individual and each wild cohort's approximate location would have to be known. Each turtle would have to be taken to that area and released. Many operations may not be willing or able to shoulder the high expenses and careful recordkeeping this would entail. And still the problem of imprinting and other aspects of a young turtle's life history would have been ignored (Ehrenfeld 1974, 1980, and Pritchard 1979).

Finally, it is argued that survivorship will increase should local people become accustomed to ranching instead of harvesting wild eggs and adults. It is difficult to understand how this would be so unless 1) *every* individual in an area was involved in the ranch and thus had a stake in its operation, and 2) there was no outside market for products. Simultaneous fulfillment of both conditions is unlikely (Applied Ecology Pty, Ltd., 1978). Altruism is unlikely (for example, stopping harvest of an available exploitable commodity, Hardin 1977), and worldwide demand for turtle products reaches every sea turtle location (Balazs and Nozoe 1978). Again, how many eggs and adults could be ranched without hurting the wild population?

Are Aquaculture Products Superior to Wild Products?

Proponents of aquaculture claim that products of farm-raised sea turtles, except oil or calipee, are superior in quality (thick, clear, less-scarred scutes; softer and more flexible leather; better tasting meat) to products of wild populations (Leitzell 1978). While the subjective nature of this claim has been pointed out (Ehrenfeld 1974), the difficulty of insuring that wild turtle products do not enter commerce make the claim irrelevant. For instance, how does a customs agent decide the relative beauty of a tortoise shell comb? Hendrickson (1979) has shown that biochemical analysis cannot now distinguish wild turtle meat, leather, or shell products from those derived from aquaculture, even if each article carried across a border by tourists or each shipment could be analyzed. Thus, the wholesale marketing of such items could undermine local laws designed to protect wild populations. Anyone could label a can of meat as being from a turtle farm; customs inspectors could not tell the difference. Leitzell (1978) provides additional evidence of the impossibility of enforcing exemptions for aquaculture products from trade restrictions.

Dodd (1978) has also questioned the assumption that superior products will drive cheaper ones off the market. The assumption is wishful thinking and totally ignores worldwide business and marketing practices. If a demand is created, as indeed any business must do to show a profit and satisfy shareholders, products will be marketed to satisfy the demand. In fact, "less superior" products might be cheaper and find a greater market than those of aquaculture farms. The marketing of "superior" products could thus seriously harm wild populations indirectly and lead to further exploitation of depleted stocks. There is no reason to believe that a person of modest means would not be as happy with a wild sea turtle product as a wealthy person with an aquaculture product.

Proponents of aquaculture claim that no new markets would be stimulated by "superior" aquaculture products. However, both Leitzell (1978) and Ehrenfeld (1974) have convincingly argued that such claims are unfounded. An industry that does not cultivate both existing and new markets is an industry with a short future. The intentions of Cayman Turtle Farm and its predecessor in this matter are clear from the advertising accompanying promotions (Leitzell 1978). The advertising attending turtle product marketing would undoubtedly stimulate demand which would be filled from wild populations. The interest generated by a single large commercial farm should be more than enough evidence of the potential for large markets throughout the world (Mack, Duplaix, and Wells, this volume). It is folly to believe that illegal poaching and the proliferation of farms, often without any attempt at conservation, would not try to satisfy this market. It is also unlikely that farms would refrain from selling their products until they achieve closed-cycle status (Dodd 1978).

Will Aquaculture Meat Feed a Hungry World?

The notion that the green turtle will provide a valuable source of protein for hungry people may be the weakest argument to justify aquaculture. Turtle farms are capital-intensive operations and will likely remain so for some time to come (Ehrenfeld 1974). They entail large holdings, advertising, and marketing networks that can be financed only by pricing products to cover costs. The main markets for such products are Europe, Japan, and America, areas not suffering from protein want. Instead, turtle soup and meat are sold as luxuries in gourmet restaurants and stores. Before being banned in the United States, soup sold at $1.85 the 13-ounce can, hardly fare for the poor. Even Cayman Turtle Farm has abandoned the protein argument, admitting that the real market is for polished shell, not meat (P.C.H. Pritchard, personal communication.)

As noted, the large scale removal of eggs to supply a large, and probably foreign-financed company may rob local people of a limited protein source. The market stimulation caused by the proliferation of turtle farms could also lead to the conversion from a protein-sufficient, subsistence economy to a protein-deficient, cash economy, as happened in Nicaragua (Nietschmann 1972; 1979; this volume), as people exploit their resources at the urging of foreign buyers.

Could turtle ranches supply needed protein within a limited geographical area? Perhaps. However, it would depend on whether the turtles are allowed to exploit their proper trophic level (Ehrenfeld 1974) or are fed and raised on high quality protein, as has often been done on turtle farms and ranches (Hendrickson 1974).

For anything but natural-diet feeding, a source of income will have to be derived to offset feeding costs, thus raising questions of production for a market and outside financing (Applied Ecology Pty, Ltd., 1978). In this case, the main purpose of the ranch now becomes production, not feeding local people.

What if turtles are fed on turtle grass (or equivalent natural diet)? In this case, a ranch would become unnecessary since turtles could be caught for subsistence use without the bother of penning them. The Miskito did this for centuries without apparent harm; only when an outlet to supply the world market became available did their way of life change radically (Nietschmann 1972). With healthy populations of turtles, ranches become unnecessary to serve the needs of local coastal people.

Will Aquaculture Research Benefit Conservation?

Proponents of aquaculture contend that valuable research is performed which will eventually benefit the conservation of wild populations (Cayman Turtle Farm 1978). Undoubtedly some beneficial research will result which may have application to rearing turtles in captive propagation, such as the critically endangered Kemp's ridley (but see Leitzell 1978) or as offshoots of other investigations (Applied Ecology Pty, Ltd., 1978). However, the vast majority of research projects will of necessity be concentrated in areas dealing with raising sea turtles for market, such as nutrition and disease control in crowded conditions. For instance, of the 61 research projects cited by Cayman Turtle Farm in their lawsuit concerning U.S. import prohibition of sea turtle aquaculture products, only 4 related directly to the natural history and conservation of *Chelonia mydas* (Cayman Turtle Farm 1978; Dodd 1978). The rest dealt with various aspects of turtle farming or laboratory-related studies of physiology and endocrinology. While interesting, such studies are often not vital to the continued existence of the species and cannot be used to justify continued exploitation of this species (but see Owens, this volume). Operations not as well funded as Cayman Turtle Farm could hardly be expected to finance much conservation-related activities without commercial application. Commercial farms and ranches are, after all, just that—commercial. They do not raise turtles for conservation but for profit. Research derived from aquaculture ventures is not worth the risk to wild populations.

Other Problems

There are a number of other problems with the aquaculture of sea turtles, such as disease and infection control, physical housing and maintenance, costs of upkeep and marketing, and the potential release of individuals via natural disaster, thus introducing what may be ill-adapted individuals into local gene pools. Ehrenfeld (1974) discusses these in detail. While many problems, such as disease, may be overcome in time, the solutions to problems associated with housing and so on are capital- and labor-intensive thus insuring that sea turtle products will remain luxuries. Indeed, economic pressures have recently forced farm closings in Australia (Cooper, personal communication) and Indonesia (Polunin and Nuitja, this volume). This further weakens the conservation argument of aquaculture proponents.

Why is interest in sea turtle aquaculture today so prevalent? For one reason—it could be profitable because of the potential luxury market. All other arguments in its favor are secondary to this although I do not mean to imply that all proponents favor trade. Do we need luxuries at the expense of declining populations? Brongersma (1978b) states, "Although one may consider turtle products as luxury, one does not give up luxury to which one has become accustomed, especially not at a time when the standard of living has become very high." This is a surprising sentiment and should be examined closely by all countries where aquaculture is being considered. It is also debatable. For instance, many countries have curtailed trade in crocodilians and spotted cats without hurting their economy or standard of living. It is important that the markets are not likely to be in the countries where the turtles are raised, nor in most cases is the capital locally available. Aquaculture encourages the exploitation of species universally recognized as endangered or threatened, usually as a result of exploitation in world trade. Sea turtle aquaculture encourages this continued exploitation and encourages native peoples to rely on dwindling resources. As King (1978) has pointed out, the only way to protect commercialized species is by a universal ban on such trade.

Conclusion

In the brief amount of space available, I have set forth the major evidence against the aquaculture of sea turtles. Aquaculture: 1) stimulates markets which further stimulates the proliferation of farms and ranches; 2) encourages the marketing of farmed products for the luxury trade which then undermines local conservation laws; 3) farms may spawn ill-conceived yet well publicized "conservation" activities. All of the above lead to the exploitation of wild populations which may then decrease local standards of living over a long period of time. Sea turtle farms and ranches are based on false premises about the extent of biological knowledge of the species and about the applicability of the maximum sustainable yield concept. Are aquaculture ventures justified in the future? Perhaps, but only after populations are allowed to rebuild to the point where they are no longer endangered or threatened. At present, sea turtle aquaculture can only be considered a threat to the survival of these endangered species.

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Headstarting the Kemp's Ridley Turtle, *Lepidochelys kempi*

ABSTRACT

A summary of the international program to restore and preserve the Kemp's ridley turtle is provided. The program can be divided into 3 main parts: 1) enhancement of nesting success and survival at Rancho Nuevo, Tamaulipas, Mexico; 2) establishment of a second breeding population at Padre Island National Seashore in Texas, and 3) an experimental study to evaluate the concept of headstarting.

In 1978 the Galveston headstart turtle program obtained a 68 percent survival rate and released approximately 2,000 juvenile turtles. The Kemp's ridley turtle is best reared in individual containers to avoid aggressive behavior. Immediate treatment of damaged or ill turtles with antibiotics provided a 95 percent recovery rate. The turtles were released at 3 locations in the Gulf of Mexico. All turtles received flipper tags, and selected turtles released at Everglades National Park and Homosassa, Florida, were equipped with radio transmitters to allow radio-tracking by plane and boat. The yearling turtles did not remain in the areas where released and exhibited pelagic behavior rather than benthic orientation. One animal recovered at Jekyll Island, Georgia, 8 months after release showed an increase of 2,700–4,000 g in weight and provides evidence that 1 of the project objectives, to demonstrate survival after release, may have been met.

Introduction

The Kemp's ridley turtle, *Lepidochelys kempi,* is an endangered species that nests primarily on a single beach in the western hemisphere—Rancho Nuevo, in the state of Tamaulipas, Mexico. In 1947, over 40,000 nesting females used this isolated beach; however, the nesting population in recent years has ranged between only 200 to 500 females a year. Unless positive steps are taken to protect the nesting beach and improve recruitment, the species is threatened with extinction.

Representatives of the U.S. Fish and Wildlife Serv-

Table 1. Summary of nesting and hatching success of Kemp's ridley turtle

Year	*Number of nests collected*	*Estimated number of nesting females*	*Total number of eggs*	*Number of eggs in corral*	*Number of eggs in styrofoam containers (Mexico)*	*Number of eggs in styrofoam containers (Padre Island)*	*Hatching rate in corral (percentage)*	*Hatching rate in styrofoam containers (Mexico) (percentage)*	*Hatching rate in styrofoam containers (Padre Island) (percentage)*
1978	711	450	85,000	65,000	18,000	2,000	57	64	88.1
1979	950	500	97,600	89,000	6,500	2,100	68	80	85.6

Source: U.S. Fish and Wildlife Service.

ice and the National Park Service presented an action plan for the restoration and enhancement of the Kemp's ridley turtle to representatives from the Texas Parks and Wildlife, National Marine Fisheries Service and the Instituto Nacional de Pesca who met in January 1977 in Austin, Texas. This group of state and federal scientists agreed to the proposed plan, which provides for: 1) enhancement of nesting success and survival at Rancho Nuevo, Tamaulipas, Mexico; 2) establishment of a second breeding population at Padre Island National Seashore, Texas[1]; and 3) an experimental study to evaluate the concept of headstarting.

An international program to implement the plan was begun in 1978, and this paper discusses the initial results of the cooperative effort to save the Kemp's ridley from extinction with special emphasis on the headstarting aspects of the program being conducted at the National Marine Fisheries Service, Southeast Fisheries Center's Galveston Laboratory.

Enhancement of Nesting Success and Survival, Rancho Nuevo, Mexico

The Instituto Nacional de Pesca and the Fish and Wildlife Service joined forces on the beach at Rancho Nuevo to protect the eggs and nesting adults and to document the present nesting intensity. Mexican marines patrol the beach to keep predators and poachers away, and Mexican and U.S. biologists record the number of turtles, nests and eggs. Nests are marked at the time of nesting, and the eggs removed and placed in man-made nests within a fenced corral to minimize predation by man and wildlife. A small number of eggs are placed in styrofoam hatching chests for protection and for movement to the United States as part of the establishment of a second breeding population and the headstarting program. In 1978 over 85,000 eggs were collected and protected and in 1979 almost 100,000 eggs were incubated (Table 1). The program is considered successful because more hatchlings have gone to sea than in the years immediately preceding the cooperative international program. We are unaware of the hatching rate before the collection and protected incubation program was initiated in 1978, but we assume because of reduced predation by wildlife and man that the present hatching success is significantly greater now than before.

Establishment of a Second Breeding Population at Padre Island

Not until 1961 was Rancho Nuevo identified as the prime nesting area for Kemp's ridley turtles (Carr 1963; Hildebrand 1963). Small numbers of Kemp's ridley turtles have nested periodically along the lower Texas coast during recent years. The National Park Service requested the Fish and Wildlife Service to conduct a study of the feasibility of establishing a second Kemp's ridley nesting population at Padre Island National Seashore as part of the restoration plan. The study showed that nests laid on Padre Island had been fertile, and that the beach slope and profile and sand grain size at Padre Island were similar to those at Rancho Nuevo. Some differences were noted between air and water temperatures but these were considered insignificant, especially during the nesting season.

The cooperating agencies agreed to attempt the establishment of a second nesting population at Padre Island National Seashore. The mechanical and biological problems associated with transplanting sea turtle eggs have been resolved over many years of effort, and the process is now routine for experienced personnel. However, the mechanisms of imprinting hatchling sea turtles to a given beach are not understood. Factors complicating evaluation of transplanting programs are the enormous mortality of hatchlings in their first year of life and the lack of suitable tagging methods for new hatchlings.

The agencies identified the following factors as the minimum necessary for the potential success of a transplant program to establish a second nesting colony.

1. A natural orientation exposure for hatchlings on the proposed natal beach and near shore waters. Incubation should occur in the sand from the proposed natal beach to ensure proper chemical imprinting dur-

1. 1978-ABC-IV-0751, No. 27611-8786- (Mexican Permit); 1979-ABC-IV1258, Exp. 4287- (Mexican Permit).

ing the incubation period.

2. A captive rearing program of 6 months to 1 year to bring the hatchlings up to a size where, presumably, predator mortality will be reduced and the turtles can be tagged.

3. An adequate technique for marking juvenile turtles to allow recognition as adults.

4. A release program that places the young in the proper area and habitat so they enter the environment at an appropriate place and time in association with naturally occurring young of the same year class.

There was also concern that the low populations remaining in Mexico could not support any removal of eggs for such a program. It was decided, however, to limit the removal of eggs for a transplant program to a small number (less than 5 percent) and that the number of yearling turtles supplied by the headstart program would outweigh any losses of eggs because of the natural high mortality rate during the first year.

In 1978 and again in 1979, approximately 2,000 eggs were obtained from egg laying females at Rancho Nuevo. The eggs were not allowed to touch Rancho Nuevo sand, but were caught and placed in styrofoam containers containing Padre Island sand and then flown to Padre Island for incubation and imprinting. The hatchling turtles were allowed to walk down the beach, from what biologists considered the probable nesting area, to the water where they were allowed to swim a few minutes before being collected and transported to Galveston. Our educated guess is that imprinting on natal beaches occurs during incubation and during the walk down the beach into the water and the swim away from the beach. The study's experimental design provides the hatchlings with this imprinting potential.

Experimental Headstart Program

The culture and later release of turtles in the sea as a means of increasing turtle populations, headstarting, is an unproven management concept. The technique, though practiced by commercial turtle farmers and some government conservation agencies, has never been scientifically tested to determine the degree of reliability as an acceptable management technique. The headstarting program will provide answers to questions raised by researchers concerning the fate of cultured turtles in the sea, such as: 1) Do they survive after release? 2) Do they breed and do they breed where released or on natal beaches? 3) What is the optimum marine habitat to release post hatchlings or juvenile turtles?

Headstarting Kemp's ridley turtles was identified as a major component of the overall recovery plan for this species because: 1) the population has seriously declined to a level that might prevent natural recovery unless recruitment is improved by assisting hatchlings through the first year; 2) in order to verify the establishment of a second nesting beach at Padre Island a headstarting program is required to produce turtles which can be tagged to provide later identification; 3) the project lends itself to scientific evaluation of the headstart technique for turtle management; 4) the headstart period can be used to provide valuable information on the life history of the species; and 5) maintaining hatchlings in captivity provides a possible brood stock should the species face immediate extinction because of an environmental disaster.

The decision to involve the Galveston Laboratory in the Kemp's ridley turtle experiment headstarting program was unanimously approved by U.S. Fish and Wildlife, Texas Parks and Wildlife, U.S. National Parks Service, Instituto Nacional de Pesca, and the National Marine Fisheries Service in the multiagency action plan of January 1978. The rationale for the decision was that the Galveston Laboratory had the necessary physical plant to support the program. The laboratory is the one closest to the natural nesting population and has extensive expertise in aquaculture and has had experience rearing loggerhead turtles, *Caretta caretta*.

Turtle Culture

The Galveston Laboratory has reared turtles for the past 2 years utilizing commercial feeds, semiclosed raceways, and individual containers. Growth and survival rates are carefully recorded and techniques have been developed to control disease and to minimize aggressive behavior between turtles. The ultimate objective is to develop optimal culture techniques and to obtain information on early life history of marine turtles. During July and August 1978, 3,081 Kemp's ridley turtle hatchlings were brought to Galveston and placed in a facility designed to provide optimum water quality and disease control. These turtles had come from 2 incubation and imprinting sites: 1,226 were hatchlings from Rancho Nuevo, Mexico; 1,855 had been incubated and allowed to go to sea at Padre Island National Seashore in the hope of imprinting them to a new beach so that a second nesting population could be established (Table 2).

Continuous modifications of the holding systems and disease treatments have led to increased survival and disease control. The survival until 9 May 1979, the time of the final release, was 68 percent. Several individuals had reached 1,200 g, but the average size at both release times was about 600 g.

The present holding system contains 15 raceways each with 106 buckets with perforated bottoms, 9 tanks 2-m in diameter also containing perforated buckets and 210 individual basins. Four 24,000-liter insulated reservoir tanks are equipped with immersion heaters to

Table 2. Headstarted Kemp's ridley hatchlings received and released in 1978 and 1979

Site of imprinting	*Arrival date*	*Number*	*Average weight (g)*	*Number released*	*Survival released (percentage)*
Padre Island	3–8 August 1978	1,855	17	1,321	71
Rancho Nuevo	11 August 1978	1,266	17	749	61
Padre Island	7–24 July 1979	1,658	14.5	—	—
Rancho Nuevo	26 June 1979	188	14.5	—	—

warm the water in winter. This system allows for the individual maintenance of 2,000 turtles. Two 40,000-liter waste treatment tanks process turtle wastewater before the effluent is released from the facility.

Results of experiments to determine optimum foods and feeding rates disclosed no significant differences between combinations of fresh foods and turtle pellets, and turtle pellets alone. No difference in growth rates was observed between single or multiple daily feedings. Pelleted turtle feed was chosen for its convenience and good growth results, but we do feel that feeding live shrimps, crabs and fish before release helps prepare young captive turtles to feed in the wild. The turtles did not hesitate to feed on natural foods when presented with live foods. Figure 1 shows no difference in the average growth rate between Rancho Nuevo and Padre Island imprinted turtles fed pelleted food. Turtles reached an average size of 153 g, 336 g, and 587 g in 3, 6, and 8 months, respectively (Wheeler, NMFS, personal communication).

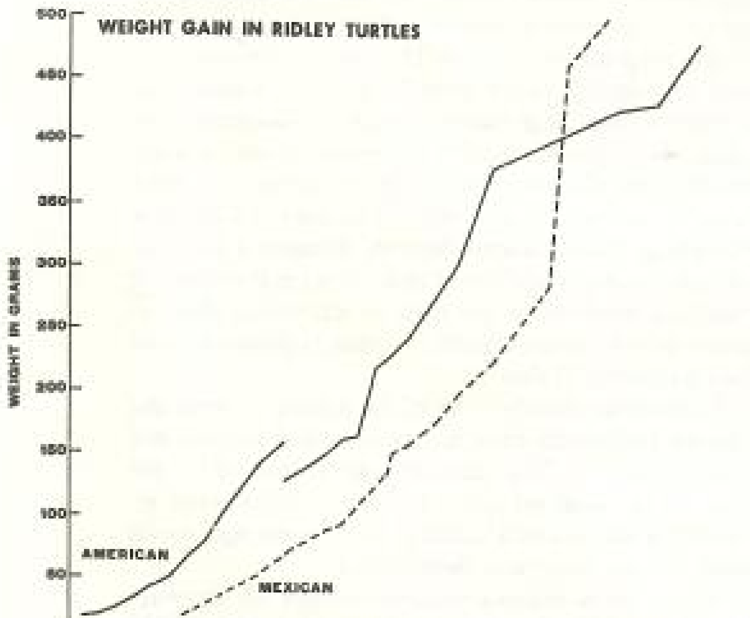

Figure 1. Average growth-in-weight curves for cultured Kemp's ridley sea turtles hatched at Rancho Nuevo, Mexico, and Padre Island, Texas.

Disease Control and Behavior

Aggressive behavior between turtles was the greatest problem in holding Kemp's ridley turtles. The physical damage caused by biting opened the way for secondary infections, which would cause death if not treated in time. Early detection of damage and immediate treatment with ampicillin and other antibiotics resulted in recovery of 95 percent of the damaged turtles. Healing was facilitated by isolating damaged turtles in individual buckets within a raceway. This was adopted as the best way of preventing the damage that leads to infection and mortality. Also, labor was reduced once turtles were placed in buckets within the raceway.

Behavioral experiments to determine methods of controlling aggressive behavior have been started and preliminary results show there is a hierarchy within groups of turtles; certain turtles are more aggressive than others regardless of hierarchy; and high temperature and corresponding higher activity lead to more aggression (Howe, University of Houston, personal communication). This work is continuing, and we will use the information obtained to design better holding facilities for turtles, in the hope of enabling us to culture the majority in groups for easier maintenance.

Disease is a major problem in the mass culture of Kemp's ridley turtles. At least 16 kinds of disease conditions have been observed in the headstarting program, and some have been significant causes of mortality (Leong, NMFS, personal communication): eyelid infection, emaciation syndrome, fungal infection of the lung, peritonitis, and intestinal obstruction. These diseases are particularly noticeable in group-held turtles, which are under more stress than individually held turtles. Techniques to improve diagnostic capabilities, i.e., X-ray and hemotological analyses, are being developed.

Release of Cultured Turtles

The release and later nesting of cultured turtles is the aim of the program. The release location of cultured turtles is extremely important in that Drs. Carr, Hildebrand, Márquez, and Pritchard, and our staff, have agreed to select sites that place young turtles in the habitat they would normally encounter in the wild.

Unfortunately, there is little information available concerning distribution of juvenile ridley turtles. After searching the literature and reviewing unpublished data, we have concluded that south Florida and Homosassa, Florida, are suitable habitats for releasing cultured juvenile turtles. In 1979, we planned to release 400 g cultured turtles as soon as enough of the 1978 year class achieved this size. By February, several hundred turtles were ready for release. South Florida was selected as the best location for the mid-winter release because of the warmer water temperatures and the natural occurrence of the species in the area. A total of 525 Padre Island imprinted turtles were released between 22 February and 5 March 1979 at Everglades National Park. A second site was selected for a spring release off Homosassa, which appears to provide an ideal habitat for green turtle populations. Ridley turtles had historically made some use of this area. A total of 1,368 turtles, of both Rancho Nuevo and Padre Island imprinted turtles were released off Homossassa on 8

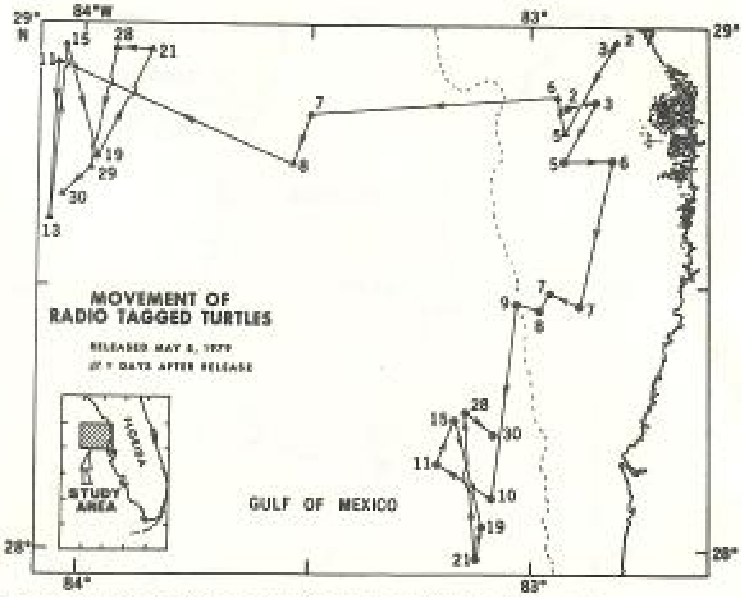

Figure 2. Chart of tagged radio tracked Kemp's ridley turtles released 8 May 1979 off Homosassa, Florida.

Table 3. Recovery of Kemp's headstarted turtles

Released	*Recovered*	*Days out*	*Condition*	*Rereleased*
1. Cape Sable	Florida Keys	49	Healthy[1]	Yes
2. Cape Sable	Del Ray Beach, Fla	21	Injured[1]	Yes
3. Cape Sable	Florida Keys	14	Healthy	Yes
4. Cape Sable	Florida Keys	25	Healthy	Yes
5. Cape Sable	Florida Keys	32	Healthy	Yes
6. Cape Sable	Miami, Fla.	47	Weak	Yes
7. Cape Sable	Pompano, Fla.	66	Healthy	Yes
8. Cape Sable	Key Biscayne	26	Thin[2]	Yes
9. Cape Sable	Florida Keys	32	Healthy[1]	Yes
10. Cape Sable	Florida Keys	40	Feeding	Yes
11. Cape Sable	Florida Keys	31	Slow	Yes
12. Cape Sable	Miami, Fla.	54	Tar	Yes
13. Cape Sable	Florida Keys	55	Healthy	Yes
14. Cape Sable	Florida Keys	17	Healthy[1]	Yes
15. Cape Sable	Florida Keys	28	Dead	No
16. Cape Sable	Florida Keys	31	Poor	Died
17. Cape Sable	Jekyll Island, Ga.	234	Excellent[3]	Yes
18. Homosassa, Fla.	Mississippi Sound	51	Healthy[4]	Yes
19. Homosassa, Fla.	Port Everglades	120	Healthy	Yes
20. Homosassa, Fla.	Homosassa, Fla.	1[5]	Healthy	Yes
21. Homosassa, Fla.	Homosassa, Fla.	1[5]	Healthy[1]	Yes
22. Homosassa, Fla.	Clearwater, Fla.	19	Healthy	Yes
23. Homosassa, Fla.	Homosassa, Fla.	1[5]	Healthy	Yes
24. Homosassa, Fla.	Weeki-Wachee Springs	48	Healthy[1]	Yes
25. Homosassa, Fla.	Port Richie, Fla.	42	Healthy	Yes
26. Homosassa, Fla.	Homosassa, Fla.	1[5]	Healthy[1]	Yes

1. Flipper injured or gone.
2. Found in parking lot.
3. Gained 2,700–4,000 g.
4. Increase of 394 g in weight.
5. Easy to catch.

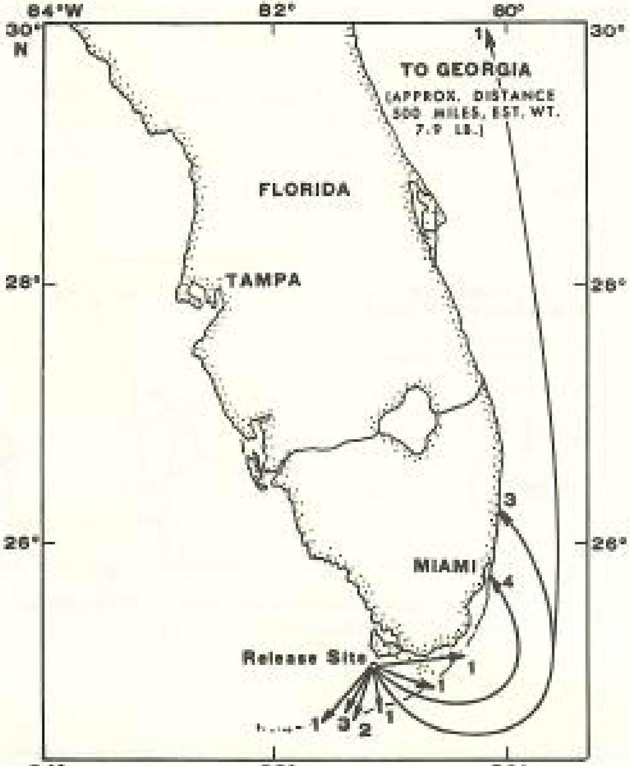

Figure 3. Recoveries of flipper tagged turtles released 22 February 1979 to 5 March 1979 at Everglades National Park.

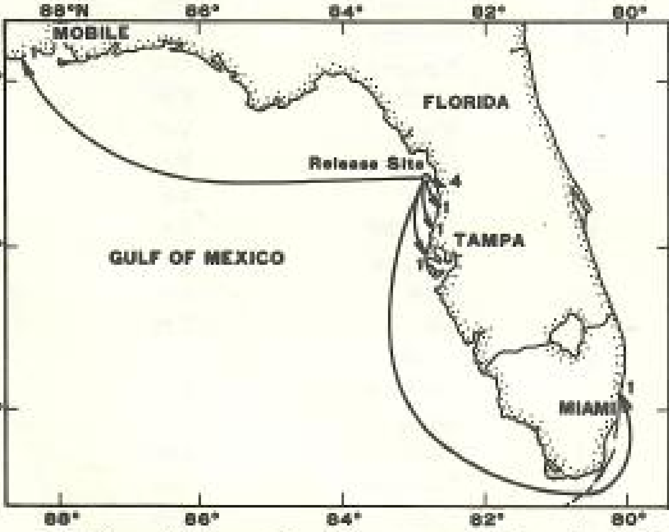

Figure 4. Recoveries of flipper tagged turtles released 9 May 1979 at Homosassa, Florida.

and 9 May 1979. A third area was Padre Island's National Seashore Park, because of the attempt to establish a second nesting beach at that location, at which 98 turtles were released in July.

An integral part of this year's program was to determine the movement and survival of the young Kemp's ridley turtle after release. All released turtles were tagged with monel flipper tags, and 10 to 12 turtles in the first 2 releases were equipped with small radio-transmitters and were followed by plane and boat. Some turtles were tracked for as long as 30 days; diving behavior and movement were observed.

Preliminary analysis shows that the transmitters were essential in determining probable movement of the released group. Many of the radio-tracked turtles were observed diving and behaving normally during the 30-day tracking period. Several transmitters became detached during tracking, indicating that a better means of attachment is necessary. Because of possible detachment of transmitters we visually verified attachment of the transmitters to the turtles by locating the transmitters from planes and directing a boat to the site for location using a hand-held receiver and visual verification. Using this method we were able to find several transmitters that had broken away. We were also able to verify the attachment of a transmitter to a turtle after one week thus validating all earlier plane observations. The movements of 2 turtles after the Homosassa release are plotted in Figure 2. These turtles were representative of 2 trends of movement observed in the 10 turtles with radio-transmitters. One group of radio-tagged turtles tended to move offshore (west) and another group moved along shore (south). They remained in the immediate area of the release for 5 to 6 days and then a significant movement of 80 to 160 km occurred, either west or south. The turtles stayed in the same general area until the completion of the 30-day tracking period. We are now trying to relate the movement observed to wind and wave conditions recorded during the tracking period.

The recovery of flipper-tagged turtles through September 1979 has been surprising; thus far, 27 head-started tagged turtles have been recovered—17 from the South Florida release, 9 from the Homosassa release (Table 3). Twenty-five recovered turtles were captured alive and released; most appeared active and in good health. The turtles recovered from the Everglades Park release were found in the Florida Keys, Biscayne Bay and up the east coast to Delray Beach, Florida. Eight months after release, the weight of 1 turtle recaptured off Jekyll Island, Georgia, had increased 2,700 to 4,000 g. The turtles recovered from the Homosassa release were found south of the release point to Tampa, but there were recoveries from Biloxi, Mississippi, and Fort Lauderdale, Florida (Figures 3 and 4). Several recoveries have occurred after 6–8 weeks.

Many of the recoveries occurred within estuary systems or inside of barrier islands, indicating a possible orientation to brackish-water conditions. We feel, however, that it is still too soon to make any conclusions regarding yearling turtle habitat preference.

These results tend to confirm that headstarted Kemp's ridley turtles survive in the wild and that a major question concerning the effectiveness of the program can be answered in the affirmative.

Future Plans for Kemp's Ridley Headstart Program

In July 1979, 1,846 hatchling Kemp's ridley turtles were received in Galveston. This year the turtle research program will emphasize studies of the early life history requirements of marine turtles. Behavioral studies to help in the modification of aggressive behavior and to determine orientation to chemical and physical parameters will be conducted. Further work will be done on developing systems for holding the turtles in groups and on the development of semiclosed systems, which will reduce the need to heat large volumes of water during the cold winter months. Special attention will be given to improving disease diagnosis and control. We also hope to consolidate the information gained thus far into a manual on turtle diseases and cures.

If labor and space permit, other species of turtles will be maintained so that early life history requirements between species can be compared. Tagging and release studies will be continued to obtain additional information on survival and movement after release.

The final evaluation of the program will take many years as we must wait for the effects of our work to appear on nesting beaches, either at Rancho Nuevo, Padre Island, or elsewhere. The actual age to sexual maturity is not known, but estimates range from 5 to 10 years and older.

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Worldwide Incidental Capture of Sea Turtles

ABSTRACT

Incidental capture and mortality resulting from capture are currently recognized as a threat to the survival of certain species of sea turtles. Evaluation of the effects of mortality resulting from incidental capture in some species has received increased scrutiny. This paper presents a review of incidental capture of sea turtles resulting primarily from commercial fishing activities, presents estimates of capture and mortality rates for turtles in North American waters, and discusses implications of capture and mortality. Encirclement nets, set nets, longlines, seines, and shrimp trawlers are responsible for varying rates of capture and mortality. Shrimp trawlers are considered to capture and drown more sea turtles worldwide than any other form of incidental capture. An excluder panel designed for otter trawls may potentially reduce incidental mortality rates of some species to tolerable levels.

Introduction

Most species of sea turtles have suffered an alarming worldwide decline in numbers. Although none have become extinct, some species are now clearly endangered; others are threatened in portions of their ranges.

Historically, marine turtle conservation has consisted of preservation by reducing, managing, or eliminating the direct take of animals. We have focused on the establishment of nesting sanctuaries and the elimination or control of legal and illegal harvest of eggs and individuals in order to perpetuate populations. These efforts have been partially successful; most governments have made progress in establishing nesting sanctuaries and enacting laws regulating harvest (Carr, Carr, and Meylan 1978). Enforcement of these laws still leaves much to be desired in many areas of the world, but the trend is positive.

Some species of sea turtles are affected by stresses other than direct take or nesting area disturbances in various areas of the world. These stresses are associated with the incidental or accidental capture of these animals by commercial and noncommercial interests. Hillestad, Richardson, and Williamson (1978), Pritchard (1976), and others have raised the question of the impact incidental capture may have upon certain species. Carr, Carr, and Meylan (1978) summarizes this concern and state that incidental capture may administer the coup de grace to some.

Our purpose here is to review, in summary form, the worldwide incidental capture of sea turtles and to discuss the implications of incidental capture upon various species.

Incidental Capture

Incidental capture of sea turtles is primarily related to the commercial fishing industry. However, turtles are captured as nontarget species as a result of other activities in many parts of the world.

Shoreline Set Nets

These nets, which include those used for commercial fishing and for reducing shark populations near bathing beaches, usually are set near shore and remain stationary for certain time periods.

Our knowledge concerning the regular capture of turtles by sturgeon nets is centered on the South Carolina coast in the southeastern United States. These nets are set perpendicular to the shoreline near river entrances in the early spring. The nets entangle sturgeon ascending rivers on spawning runs; these nets also entangle and capture sea turtles (primarily *Caretta*). Historical data on turtle captures by sturgeon nets are lacking, but mortality apparently is high.

Sturgeon fishing has declined in recent years in the Southeast; consequently, turtle captures have also declined. The state of South Carolina regulates this fishery and limits the sizes of nets and dates of their use to a period in the early summer prior to the arrival of large numbers of turtles. Incidental capture of sea turtles in sturgeon nets now appears to be low in this area and probably constitutes an insignificant threat to turtles in the coastal waters of the Carolinas.

In Natal and northeastern Australia, set nets are used to capture sharks near bathing beaches. Thirty-one *Caretta caretta* (63 per cent of total catch) were caught in shark nets in Natal in 1968 (Hughes 1969). Green turtles accounted for 35 percent (17 animals) of the capture. One hundred seventy-six (majority *Caretta*) turtles were captured between 1965 and 1968; 85 *Caretta* and 49 green turtles were captured after 1968 (Hughes 1974). Most of the animals were subadults; only one female was fully mature. Hughes (1974) suggests that the larger turtles may migrate in deeper water outside of the littoral zone where nets are set.

Fifty-seven turtles were captured in Cairns Inlet shark nets in northeastern Australia between 1971 and 1974 (Limpus 1975). Most were *Chelonia mydas* and *C. depressa*; 1 *Lepidochelys olivacea* and 1 *Dermochelys coriacea* were captured.

The potential impacts, if any, of incidental capture of sea turtles in Natal and Australian waters have not been evaluated.

Fisheries Set Nets

The fisheries industry employs numerous types of set nets throughout the world; those capturing sea turtles probably are encirclement nets. Drownings of turtles in shrimp and menhaden nets are increasing (Carr 1972). Although we have been unable to locate other published references relating to the capture of sea turtles by menhaden nets, we know that sea turtles have been observed in these nets in southeastern U.S. waters (D. Harrington, Marine Extension Service, Georgia, pers. comm.). Most likely other fisheries employing encirclement nets capture sea turtles also, but nothing is known of the rates of the spatial and temporal aspects of this incidental capture. Mortality rates also are unknown, but, since these nets (especially menhaden) allow turtles to surface while entangled, mortality may be low.

Longlines

Longlines (48 km in length) are used by fisheries worldwide, and turtles are occasionally taken by this method. Few references to incidental capture on longlines exist; however, a *D. coriacea* has been reported captured on a shark longline off Ireland (Atkins 1960). Cato, Prochaska, and Pritchard (1978) report that 230 kg of *C. mydas* were taken by longline for commercial purposes in Florida in 1962. Observers from the National Marine Fisheries Service presently are aboard Japanese longline fishing vessels in the Gulf of Mexico and the Atlantic. Fishing is conducted primarily for tuna with the incidental catch of various sharks and billfish. Although representing thousands of hours of fishing effort, few turtles have been captured by these vessels. Thus longline fishing probably catch and injure few turtles.

Seines

Seines, especially when pulled from shore, occasionally capture sea turtles. Six hundred and eighty kg of *C. caretta* were captured by haul seines in Florida in 1962 (Cato, Prochaska, and Pritchard 1978). Two *D. coriacea* were captured by seines near Panacea, on the Gulf coast of Florida, in March and April of 1962 (Yeager 1965). Hillestad captured a yearling *C. mydas* with a beach seine off Blackbeard Island, Georgia, in 1972. Although some sea turtles are captured by seining, this form of incidental capture is probably insignificant.

Shrimp Trawlers

Worldwide, the shrimp trawling industry seems to capture more sea turtles than any other commercial fishery. Shrimp, distributed throughout the world, are in constant demand. Trawling is concentrated primarily in the relatively shallow waters near shore in both temperate and tropical zones. Many of the most intensively trawled waters are adjacent to major sea turtle nesting beaches or feeding grounds.

All species of sea turtles are captured by shrimp trawlers. The majority of captures appear to consist of *C. caretta*, *C. mydas*, *C. depressa*, and *L. kempi*. *L. olivacea* are captured in certain areas but fewer than *L. kempi*; *D. coriacea* and *Eretmochelys imbricata* are least caught.

In the following discussion we review the worldwide incidental capture of sea turtles by shrimp trawlers geographically and, when possible, by species from a spatial and temporal perspective.

AUSTRALIAN WATERS

Cogger and Lindner (1969) discuss sea turtles of northern Australia and report that *E. imbricata* and *C. depressa* are taken by Australian-Japanese prawn trawlers. No quantification of the *E. imbricata* catch was given, but most animals were subadults. Apparently most size classes were reflected in the catches.

Limpus (1973) reports on 3 female *C. caretta* that drowned in trawl nets of shrimpers off Queensland. He states that female loggerheads were caught by trawlers 0.5 to 4 km offshore only during the nesting season. Also in this region, otter trawls in 10 m of water caught up to 3 females per trawl per hour. Males rarely occurred in the same area during the nesting season. Limpus (*op. cit.*) did not have sufficient data to evaluate *Caretta* captures and mortality.

AFRICAN AND INDIAN OCEAN WATERS

Very little has been reported on the incidental capture of sea turtles by trawlers in this area.

SOUTH AMERICAN WATERS

Sea turtles have been captured in fair numbers by trawlers off French Guiana; these animals were mostly *L. olivacea* (Pritchard 1969). Fourty-four green turtles tagged in Surinam during their peak nesting period (March to May) were recovered by trawlers the following October through March (Pritchard 1973). Pritchard submits that green turtles ". . . are more likely to be caught when actually enroute from the nesting ground; exhausted and spent after months of reproductive activity, they lack the ability to avoid nets . . ." However, the number captured may have been a function of varying trawler activity; no data were given on the trawling season.

Thirty-nine *L. olivacea* tagged in Surinam were recovered by shrimp trawlers in 1 year (Pritchard 1973). This finding led Pritchard to speculate that the carnivorous ridley may enhance its capture by continually searching for prey and running a higher risk of capture.

Three male and 3 female *L. olivacea* were captured in experimental trawls by the RN *Calamar* off Surinam in 1967–68. All were adults; most were captured in the fall.

As the result of a tagging study of *C. caretta* on the Caribbean coast of Colombia, Kaufman (1975) suggests that shrimp trawlers operating off the nesting beach are a significant cause of mortality for turtles in that area. *C. caretta* numbers have been depressed there for some time.

CENTRAL AMERICAN WATERS

All shrimp grounds in Central America are trawled, but precise data are lacking to evaluate the capture and mortality of sea turtles in these waters. Carr, Carr, and Meylan (1978), in discussing the West Caribbean green turtle colony, comment on trawler captures of sea turtles ". . . trawlers have moved into new ground: the trawls now used are much larger than they once were, and the usual haul time nowadays is long enough to drown many turtles caught." These factors increase the chance of turtle captures, and the latter increases the possibility of death.

NORTH AMERICAN WATERS

Commercial trawling on the South Atlantic and Gulf of Mexico coasts of the United States and Gulf coast of Mexico probably accounts for a large percentage of worldwide trawler-related captures and mortality of sea turtles.

In temperate waters, loggerheads and Kemp's ridleys are frequently captured. *C. caretta* have comprised the bulk of the catch in South Carolina and Georgia (Hillestad, Richardson, and Williamson 1978; Ulrich 1978), although immature greens and ridleys occur infrequently. Approximately 500 ridleys have been captured annually by shrimp trawlers from Cuba, Mexico, and the United States (Márquez 1976). Ridleys have also been captured off Louisiana (Liner 1954; Dobie, Ogren, and Fitzpatrick 1961), off south Texas (Carr 1961), and in the Florida Keys (Sweat 1968). Ridleys have been killed in trawls off Veracruz, Tabasco, and Campeche, Mexico (Pritchard 1976).

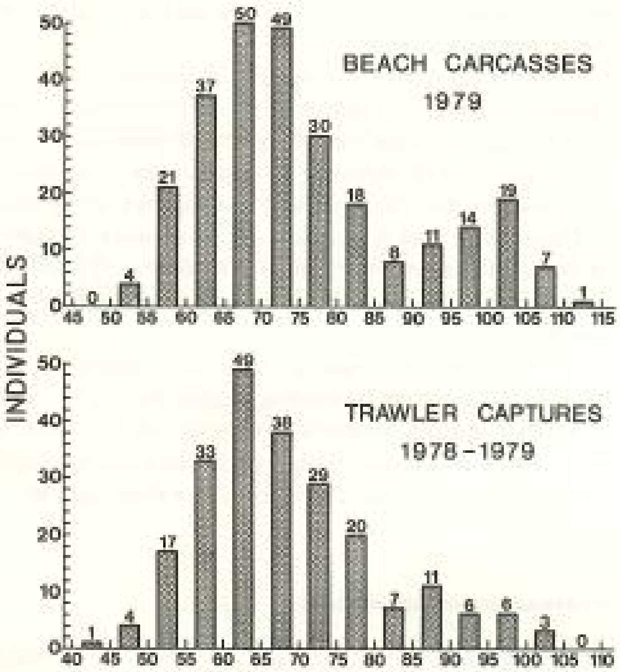

Figure 1. Comparison of size distribution of 269 *Caretta caretta* stranded on Georgia beaches, 1979 (top), and 274 turtles captured by shrimp trawlers, Georgia and South Carolina, 1978–79 (bottom).

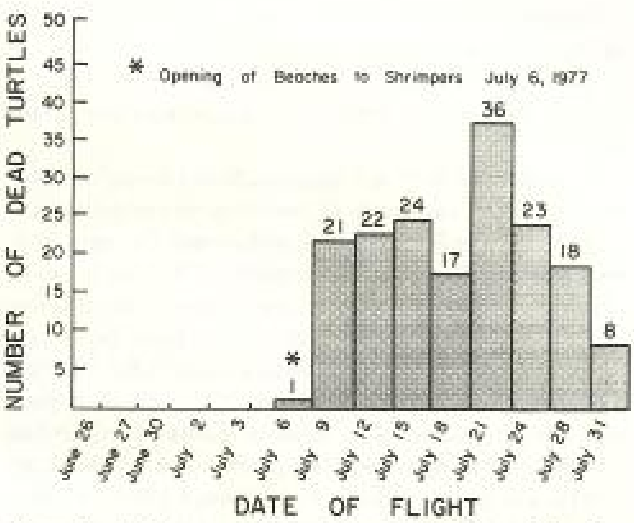

Figure 2. Aerial survey of dead sea turtles on Georgia beaches 26 June to 31 July 1977.

Infrequently, shrimpers have captured leatherbacks along the Georgia and South Carolina coasts (Schwartz 1954). Hillestad has observed 2 dead leatherbacks in Georgia and has interviewed 2 shrimpers who have caught them off shore of Georgia. At least 2 leatherbacks have been captured by shrimpers off Louisiana (Dunlap 1955).

Quantification of Incidental Capture and Mortality in U.S. Waters

Only in recent years have data become available to quantify incidental capture in U.S. waters. Initially, data sets were based on interviews. Among these were Cox and Mauerman (1976), Ulrich (1978), and Hillestad, Richardson, and Williamson (1978). Cox and Mauerman (1976) and Anonymous (1976, 1977) present interview-based summaries of incidental capture and mortality of turtles by shrimpers in Texas, Louisiana, Alabama, and western Florida. The highest reported capture rate was 1 turtle every 27 fishing days in Florida (6 turtles a season). Louisiana shrimpers captured 1 turtle in 53 fishing days (4 a season), Texas shrimpers about 5 turtles a season, and Alabama shrimpers 1 turtle in 72 fishing days (about 2 a season).

Mortality estimates from Alabama, Florida, and Louisiana shrimpers ranged from 21 to 25 percent. Estimates from Texas were 16 percent. In 1978 observers were placed on board Texas shrimp boats to record incidental captures as part of a National Marine Fisheries Service program to evaluate experimental trawling. Their observations generally confirmed capture and mortality rates for Texas waters as reported above. In 1976 Hillestad, Richardson, and Williamson (1978) interviewed the captains of the 321 vessels of the Georgia fleet and observed incidental captures aboard selected vessels. The data indicated capture of 0.09 turtles per hour of trawl for a 5.7 month season and mortality of 7.9 percent. Based on these data and on the resident fleet size of 321 vessels, 30.7 turtles were captured per vessel-year in Georgia and 778 sea turtles were drowned. (These data do not include out-of-state shrimpers who fish in Georgia and unload their catches elsewhere.)

Onboard observation of captured sea turtles in Georgia indicate that most are subadults (Figure 1). Beach strandings of carcasses reflect the same relationship: 88 percent subadults, 12 percent adults (Figure 1). Beach strandings are highly correlated with shrimping activity (Figure 2) and provide an index of shrimper-induced mortality.

South Carolina shrimpers captured 1 to 3 turtles a week, and mortality was estimated at 18.2 percent in 1976 and 43.3 percent in 1977 (Ulrich 1978).

During 1978 and 1979, observers were placed on board commercial shrimp vessels during the brown and white shrimp season of South Carolina, Georgia, and northeastern Florida. Observers were placed aboard vessels in Key West during the pink shrimp season there.

Figure 3 shows the size distribution of 224 turtles captured in Georgia and South Carolina in 1978–79. These turtles were primarily subadults, supporting interview-based data presented earlier. Figure 4 summarizes the temporal distribution of this catch. Peak capture occurred in July, which coincided with peak nesting in Georgia and South Carolina.

Size distribution and total number of both trawler captures and beach strandings were similar in the subadult size classes. Beach strandings of large animals exceeded trawler capture, however.

Discussion and Implications

Data from various studies presented earlier quantify captures and mortality of sea turtles in certain North American waters. Clearly, captures are high in certain areas and at certain times, such as in the temperate waters of South Carolina and Georgia during mid-summer shrimp season when inshore shrimping is permitted. Incidental capture is low in the Key West–Dry Tortugas area during the winter pink shrimp season. Capture rates are fairly low in most reaches of the Gulf of Mexico, compared to captures in the Georgia Bight.

Mortality rates vary widely in North American waters. Mortality apparently is influenced by many factors such as turtle size and condition at capture and trawl duration. Evidence indicates that smaller turtles drown more quickly than larger turtles, i.e., they are less capable of enduring long trawl periods. This fact may bias the observed recorded size distribution of captured subadult animals. (Subadult animals should be more prevalent in the populations and they should be encountered more commonly by the trawls.) There is insufficient evidence to indicate whether small animals are capable of evading trawls. Ogren, Watson, and Wickham (1977) report that 2 of 3 adults failed to evade the trawl during experiments in the Gulf.

Within the nearshore waters of Georgia, it is common to recapture the same turtle in the same day, often immediately following the initial capture. Such turtles are probably more prone to drowning than turtles not previously captured. The probability of recapture is high in Georgia and South Carolina waters due to the very large trawling effort expended in a small area. For example, the Georgia fleet of 321 vessels annually covers an area equivalent to 75,061 km² within a 860 km² coastal area. A typical Georgia commercial shrimper trawls an average of 23,383 ha per day.

In a recent study (Hillestad, Richardson, and Williamson 1978), most Georgia and South Carolina shrimpers trawled for approximately 2 hours with nets

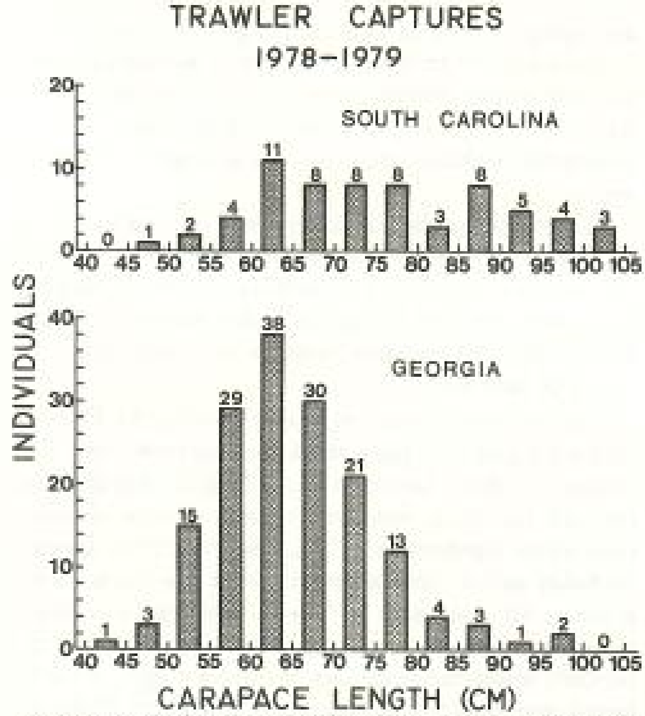

Figure 3. Size distribution of 224 sea turtles incidentally captured by shrimp trawlers, Georgia and South Carolina, 1978–79.

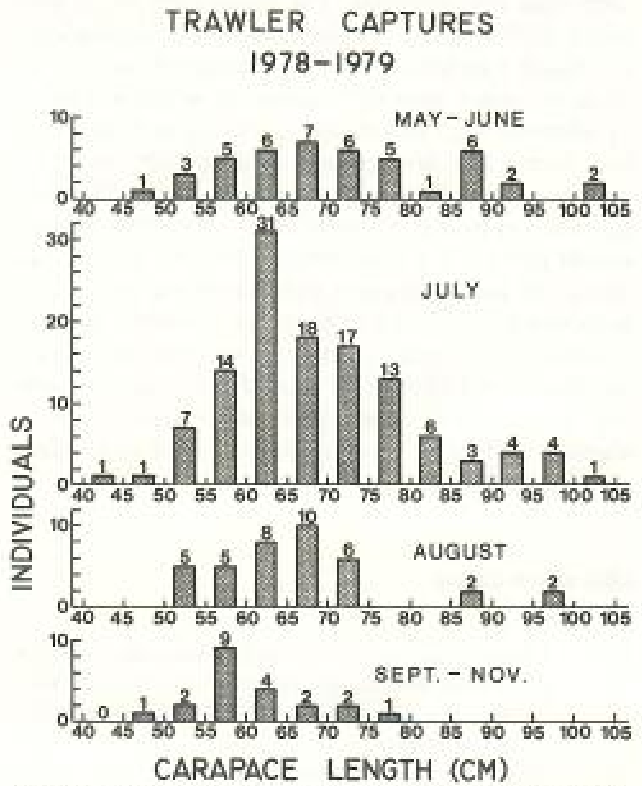

Figure 4. Temporal distribution of 224 sea turtles incidentally captured by shrimp trawlers, Georgia and South Carolina, 1978–79.

averaging 17.2 m in width. A highly significant correlation existed between numbers of turtles captured and net widths greater than 12.4 m. A similar correlation ($p < .01$) existed between capture rates and net widths for Alabama and Louisiana shrimpers in certain waters.

The foregoing data do not permit the evaluation of incidental capture, i.e., capture and mortality data must be analyzed in relation to population levels, recruitment into the population, and other factors. The fact of capture and mortality must be separated from the effect of mortality.

It is intuitive that any mortality incurred by Kemp's ridley is significant since stocks are currently very depressed, perhaps beyond their biological threshold to recover. In North American waters, capture of leatherbacks by trawlermen is low. Therefore, this species probably suffers little mortality from this cause. Most green turtles captured in North American waters are subadults. Capture rates of green turtles are low, apparently lower than captures of ridleys which probably have lower total population levels. The effect of North American incidental capture and mortality of green turtles is probably less significant than direct harvesting (Carr, Carr, and Meylan 1978).

The loggerhead is the most commonly captured sea turtle in North American waters and presently is probably more capable of sustaining trawler-induced mortality than other species. The species has large, protected nesting beaches in northeastern Florida, Georgia, and South Carolina, and large numbers of this species occur in these waters each spring and summer. Due to its relatively high abundance, *Caretta* is well suited for field testing and development of an excluder panel for otter trawls (Seidel and McVea, this volume). This vanguard effort by the National Marine Fisheries Service should provide the basic solution to reducing incidental capture and subsequent mortality of sea turtles. The reduction of incidental capture and mortality, the continuation of successful efforts to protect nesting beaches, and the control of directed take of sea turtles throughout the world will, it is hoped, enable sea turtle populations to recover from their threatened and endangered conditions.

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Development of a Sea Turtle Excluder Shrimp Trawl for the Southeast U.S. Penaeid Shrimp Fishery

ABSTRACT

In 1978, a 3-year project was initiated to develop a sea turtle excluder trawl for use in the Penaeid shrimp fishery of the southeastern United States. The National Marine Fisheries Service (NMFS) with cooperation of the commercial shrimp industry is presently testing several basic trawl modifications to reduce incidental sea turtle capture without significantly reducing shrimp catch efficiency. Initial design concepts, prototype selective trawl methodology, and summarized field evaluation data for sea turtle excluder trawls are discussed.

The decline of many sea turtle populations throughout their ranges has been well documented during the last 2 decades (Carr 1952; Pritchard 1969; Rainey and Pritchard, no date). Factors contributing to reduced turtle stocks include: 1) overexploitation for a variety of turtle products including human food, 2) destruction of nesting habitat due to coastal development, 3) predation, 4) inadequate protection, 5) natural mortality, and 6) other man-induced mortality including incidental capture in demersal trawls.

Although migration and aggregate nesting of sea turtles undoubtedly have evolutionary significance, these predictable behavior patterns have resulted in serious predation by man and beast. Unfortunately, certain areas of seasonal turtle concentration overlap with productive demersal trawl fisheries. Incidental turtle capture and mortality by trawlermen alone might not significantly affect population stability, but in addition to other known mortality sources, undirected take could have significant impact on already reduced sea turtle stocks.

The Penaeid shrimp fishery of the Gulf of Mexico and midwestern Atlantic represents one of the most important commercial fishery industries of the world. In general, shrimp seasons in the southeast fishery region open in mid-June and continue through December with the pink shrimp (*Penaeus duorarum*) season occurring in the Dry Tortugas from January through April. Intensive shrimping occurs during the opening weeks of each season with boats from neighboring coastal states participating in areas of predicted high shrimp density. The highly productive near shore waters of South Carolina, Georgia, and eastern Florida, though limited in fishing area, receive fishing pressure from these representative states as well as pressure from coastal states of the northern Gulf of Mexico. This fishing effort early in the shrimp season coincides with peak sea turtle concentrations in limited areas primarily adjacent to the major nesting beaches of the loggerhead turtle (*Caretta caretta*) along the continental United States. Other sea turtles including Kemp's ridley (*Lepidochelys kempi*) are occasional visitors in these waters and are accessible to trawling activities. Sea turtle incidental capture by demersal trawls in these areas has been known for some time, but only recently have incidental capture rates been determined for these areas. An incidental sea turtle capture rate of 0.09/hr during a 6.7 month, 1976–77 Georgia shrimp season indicates the severity of the problem (Hillestad, Richardson, and Williamson 1978).

As the need to protect declining sea turtle stocks became more apparent, some protection was provided by the Endangered Species Act of 1973, regulations, and intensified enforcement. The Act, however, has no mechanism which specifically addresses the inadvertent incidental capture of listed endangered animals; therefore, a direct conflict with standard shrimping techniques became inevitable.

In an effort to mediate the problem, protect threatened and endangered sea turtle species, and insure the viability of the shrimp industry activities in high turtle density areas, the National Marine Fisheries Service (NMFS) initiated a gear development project to reduce significantly capture and mortality of these animals in shrimp trawls. If successful, the selective shrimp trawl should allow the coexistence of sea turtles and shrimp harvest in areas of seasonal sea turtle abundance. The project was assigned to the Harvesting Technology Branch of the National Marine Fisheries Service, Southeast Fisheries Center Laboratory, Pascagoula, Mississippi. The project goal is to develop and introduce a shrimp trawl to the commercial shrimp industry which will greatly reduce sea turtle captures without significantly reducing shrimp production.

Attempts to develop selective shrimp trawls which can reduce the amount of fish bycatch in the northeast Pandalid shrimp fishery (High, Ellis, and Lusz 1969) and the southeast Penaeid shrimp fishery (Watson and McVea 1977) have been relatively successful depending primarily on the bycatch species composition. These designs utilize water flow patterns within the trawl to mechanically separate target species from nontarget species through strategically placed webbing barriers. Underwater observations of sea turtle interaction with towed demersal trawls (Ogren, Watson, and Wickham 1977) suggests an alternate approach for separating sea turtles from the shrimp catch. Observed animals tend to outswim the trawl, but once overtaken, scutes and claws become entangled in the webbing. It was apparent from these observations that conventional "within trawl" separation concepts would not effectively separate turtles, and a barrier placed ahead of the trawl was conceived to deflect the turtles up and safely over the headrope. The forward excluder barrier (Figure 1) is hung from the headrope of the trawl to a separate groundline connected between the trawl doors. Additional floats are added to the headrope to maintain the desired trawl height above bottom and provide a measure of stability to the barrier.

In addition to reducing sea turtle captures, an excluder trawl must also maintain effective shrimp production. Unless this capability can be demonstrated, the shrimp industry will not accept use of the trawl without legislation and enforcement. It is hoped that the development of the sea turtle excluder trawl will be successful and that use of the trawl can be initiated in problem areas without legal conflicts developing between the shrimp industry and other environmental concerns.

Maintaining shrimp catch efficiency of selective trawls in the various areas of the United States where turtles are incidentally captured is complicated by behavioral differences among the 3 species of commercially important Penaeid shrimp. White shrimp (*Penaeus setiferus*) tend to disperse in the water column in response to tidal flow and shrimping intensity, resulting in the use of high-opening trawls when white shrimp increase in the catch composition. On the other hand, brown shrimp (*Penaeus aztecus*) and pink shrimp (*Penaeus duorarum*) tend to remain close to the bottom even when stimulated by intensive fishing pressure. Therefore, fishermen want trawls with maximum spread and low height opening to cover as large a bottom area as possible with each drag. This behavioral difference between the brown and white Penaeid shrimp necessitates 2 completely different net configurations. The situation is further complicated by the U.S. shrimp fishery's use of a considerable number of different net designs.

In November 1977, a feasibility study was conducted to determine methods for sea turtle separation as well as possible reductions in shrimp catch efficiency using a forward barrier design concept. During 100 hours of comparative double-rigged trawling, a standard trawl to excluder trawl turtle capture ratio of 9:1 was obtained with a shrimp loss of less than 30 percent. With these encouraging results, plans were made to conduct 1978–79 field evaluation studies of various

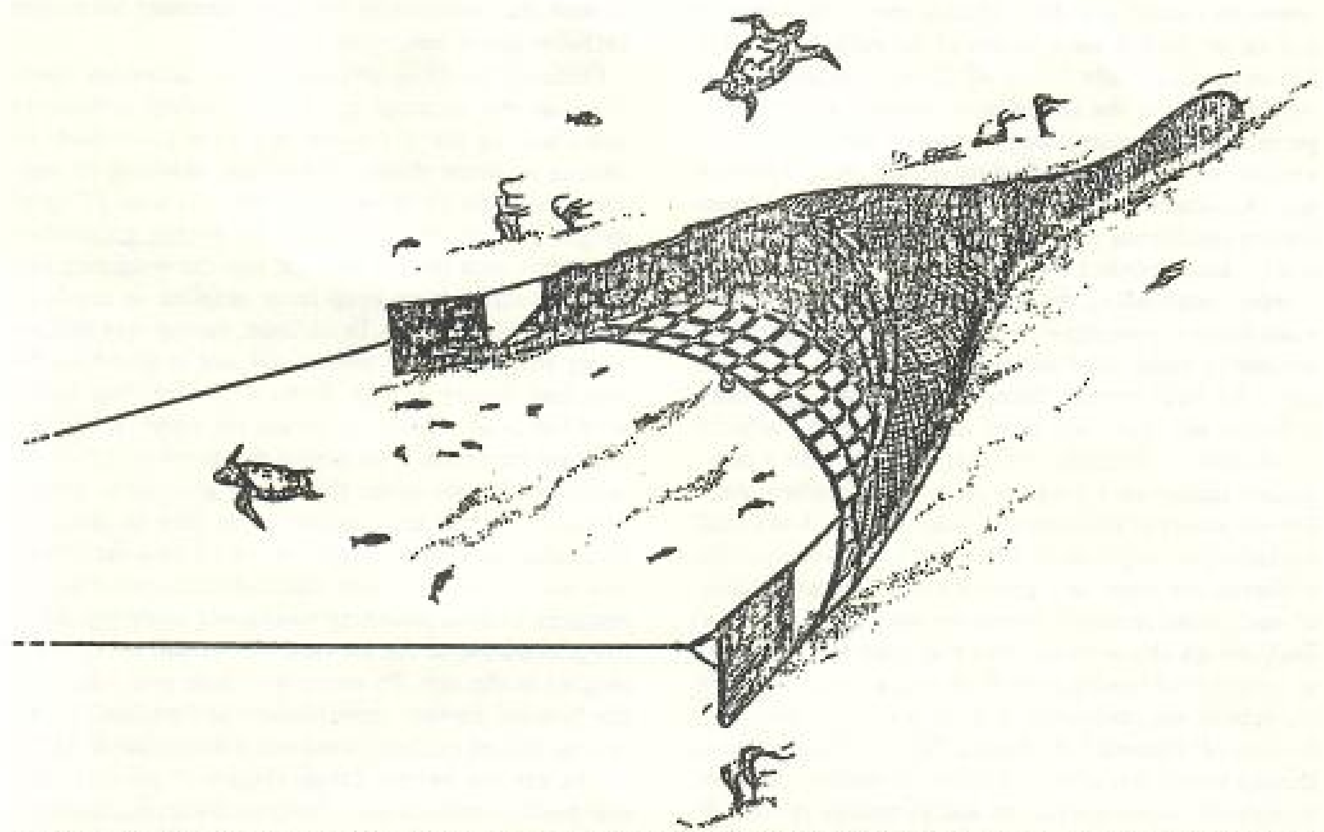

Figure 1. Forward panel sea turtle "excluder" shrimp trawl. Courtesy Southeast Fisheries Center, Harvesting Technology Unit.

excluder trawl designs on selected shrimp grounds of the coastal United States.

Development

Environmental groups want to reduce incidental capture of sea turtles, even to the point of prohibiting shrimping in some areas. This attitude stems partly from decreasing turtle populations in general with particular concern over protecting the remnants of the Kemp's ridley population, and the somewhat hesitant approach various agencies have demonstrated while addressing this critical problem. Such fishing restrictions, however, could be disastrous to the shrimp industry. Since the excluder trawl offers an acceptable solution to all interested concerns, a 3-year schedule was accepted as a reasonable time period in which to accomplish development of the trawl. Three years, however, is not much time to establish a design concept, develop prototype trawls, sufficiently field test the trawls, and demonstrate the trawls' feasibility to the industry. Development is further restricted by the relatively short seasonal concentration-overlap of shrimp and turtles in a given area. In addition, even in areas of large turtle concentrations, captures occur infrequently aboard individual vessels; therefore, many hours of test dragging are required to produce enough turtle captures to establish test trawl efficiencies. Owing to these experimental restraints, Government-owned or chartered research vessels alone could not develop the trawl and establish its efficiency in a 3-year period. The active participation of shrimp industry vessels was required to continuously evaluate prototype designs and modifications under actual commercial conditions.

Representatives of the shrimp industry and progressive vessel captains agreed to participate in the project and cooperate in the trawls' development. A relatively large number of participating commercial shrimp vessels were enlisted to test the prototype nets and to evaluate the many different net characteristics under different commercial conditions. In a show of good faith, the commercial vessel captains agreed to provide their assistance basically at "no gain." A cooperating vessel's only consideration realized was protection against reduced shrimp production associated with extreme prototype excluder trawl designs. All participating shrimp vessels are double-rigged trawlers. The test net is installed on 1 outrigger and towed simultaneously in direct comparison against the same size standard net. If a shrimp loss does occur in the test net, the vessel is reimbursed for this loss. Although participation and cooperation is voluntary, at the end of the test season (3 to 4 months) the vessel owner is given a trawl of his choice, essentially in repayment for the use of his standard trawl during the test. In addition, a full-time observer is placed aboard each vessel to record test data. During the 3- to 4-month evaluation period, each design of the excluder trawl is fished commercially 10 to 12 hr/day (usually 6 day/week). Without the cooperative industry-government project and active participation of the commercial shrimp vessels, an adequate evaluation of the many different net characteristics that must be tested under actual fishing conditions to produce an effective trawl could not be accomplished.

After establishing the basic design concept of a forward barrier, prototype nets with various design characteristics being used industry-wide had to be developed for field testing. Since shrimp boats tow many different net types and sizes, many different excluder trawls had to be built and prepared for direct comparison against each cooperating vessel's standard trawl. Development of efficient net designs in which to install excluder panels properly, fitting excluder panels to the different net sizes, and pretest evaluation and tuning of each trawl required extensive use of scuba divers. Each design characteristic was prepared and evaluated at commercial towing speeds by scuba divers working on nets in approximately 8 m of water on hard sand bottom off Panama City Beach, Florida. A commercial shrimp vessel was obtained under continuous charter to support diving operations and prototype net development. To date, the project diving activity has been a major effort to evaluate new trawl designs and prepare excluder trawls properly for testing on the large number of commercial shrimp vessels in the project.

Results

The first test season began in June 1978 in the mid-western Atlantic and continued through the summer in the northern Gulf of Mexico off Texas and Louisiana. It was terminated in March 1979 after 3 months of trawl evaluation on the Dry Tortugas pink shrimp grounds. A total of 27 shrimp vessels participated in these studies. Results for this effort are presented in Table 1. The forward excluder panel was initially tested because it seemed to offer the best potential for reducing turtle cpatures based upon behavioral observations and results of the 1977 feasibility study. Although data indicate the forward barrier reduces turtle captures relatively well, certain problems related to the weighting system made the design difficult to handle on deck particularly in rough seas. In addition, excessive shrimp loss during seasonal white shrimp concentrations was inherent in the forward barrier design. It also became apparent by the end of the first test season that it would be inappropriate to continue attempts to develop barrier patterns for the almost exhausting variety of trawl designs. Instead, one efficient basic trawl design was required that could 1) fish competitively with the different standard trawl types in use and 2) provide the construction flexibility necessary for proper excluder panel installation.

Difficult handling associated with accessory hardware on the excluder trawl and tangling sometimes when putting the net overboard were particularly irritating to those shrimp fishermen unwilling to regiment the deployment of their gear. At least 22 kg of weight were required to hold the barrier groundline in contact with the sea bottom, and the weighting system was difficult to keep from tangling in the large mesh webbing barrier. In addition, during very shallow water shrimping, sea turtles did not respond to the repelling nature of the forward barrier, but rather sounded in an attempt to escape the trawl. When this reaction occurred, it increased the possibility that the turtle would pass under the barrier groundline and be captured. Very likely, turtles in an area of intensive shrimping are also caught more than once a day. When this occurs, an alive but stunned turtle reacting abnormally to an approaching trawl could easily trip under the groundline of the forward barrier and become entangled in the net. To overcome these problems with the forward barrier, development and evaluation of a reverse barrier excluder trawl was initiated late in 1978.

The reverse barrier design (Figure 2) provides several positive options for solving problems encountered in previous excluder designs. Late 1978 results with this design indicated a significant increase in shrimp catch efficiency (Table 1) and a decrease in previous operational handling and tangling problems. Reverse barrier trawls have considerably more overhang with the barrier laced from the headrope to the footrope, and white shrimp in the water column tend to be trapped under the trawl headrope before encountering the barrier. Only turtles small enough to pass through the barrier mesh can be captured since the entire mouth of the trawl is covered by the barrier. The excluder panel mesh size can also be selected to be as restrictive as possible as long as it does not reduce shrimp catch efficiency.

Preliminary 1979 reverse barrier fishing results presented in Table 2 summarize drags completed during the East Coast brown shrimp season. Of the 2 barrier mesh sizes being tested, data clearly indicate the 66-cm stretch mesh superior to that of the 81-cm barrier. Twenty-four turtles were captured in standard trawls pulled simultaneously against the 66-cm excluder trawl which caught only 3 turtles for a separation rate of 87 percent. Shrimp loss associated with the 66-cm barrier ranged from 2 percent to 36 percent during tests with the Super X-3 Tongue Trawl. These results include data from the entire test period, although early recorded shrimp loss rates were significantly reduced aboard some vessels during the study as indicated by Table 3. Removal of floats and the addition of weight to the tongue improved contact with the sea floor, and

Table 1. Trawl catch results

Time	Area	Number of vessels	Greatest percentage turtle separation	Percentage shrimp loss	Number of tows	Hours fished
Forward panel						
26 Jun–15 Dec 1978	East coast	15	75	25–45	1,424	3,438
15 July–15 Dec 1978	North Gulf of Mexico	6	Insufficient turtles	17–35	985	4,723
6 Jan–31 Mar 1979	Florida–Tortugas Gulf of Mexico	6	Insufficient turtles	25–45	195	901
Reverse panel						
21 Jun–25 Jul 1979	East coast	7	100	0–25	390	882

Table 2. 1979 Turtle excluder fishing summary

Trawl type	Barrier type	Turtle reduction (percentage)	Shrimp loss (percentage)
Flat	Forward 51 cm mesh	—	53
Jib 2-seam	Forward 81 cm mesh	—	42
Flat, 2-seam	Reverse 51 cm mesh	—	29
Jib	Reverse 81 cm mesh	—	23
Super X-3	Reverse 66 cm mesh	86	28
Super X-3	Reverse 81 cm mesh	0	33
Super X-3 "Tongue"	Reverse 66 cm mesh	89	17
Super X-3 "Tongue"	Reverse 81 cm mesh	0	25

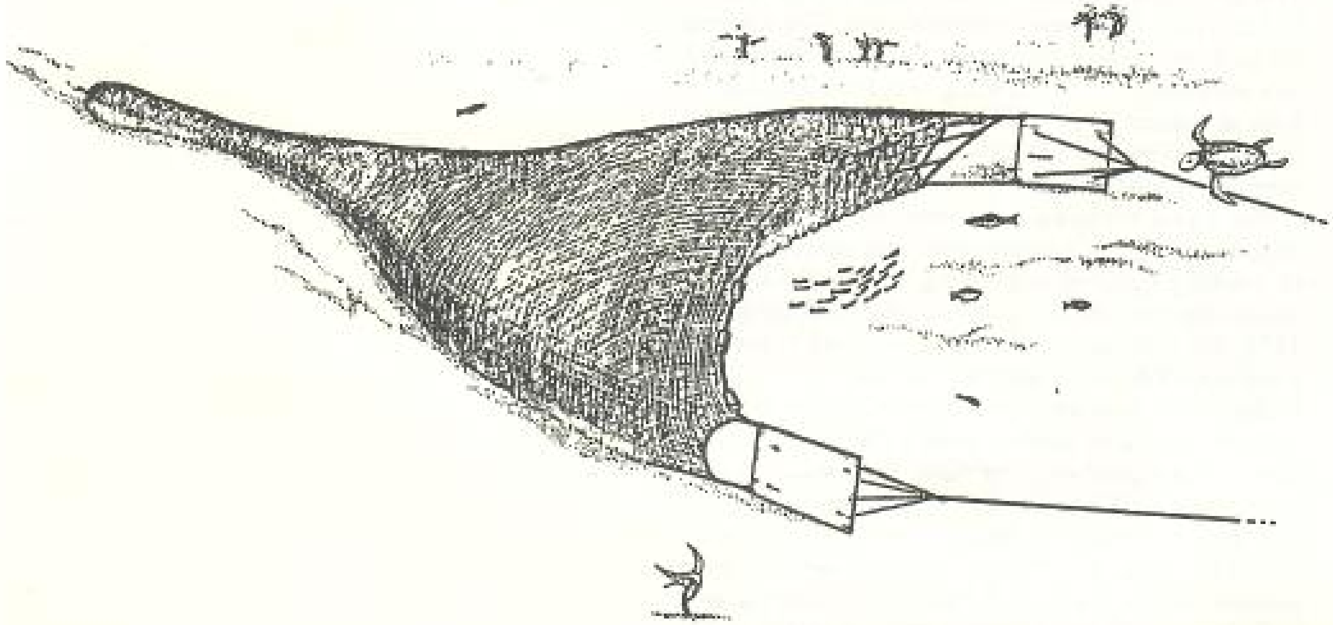

Figure 2. Reverse panel "excluder" shrimp trawl. Courtesy Southeast Fisheries Center, Harvesting Technology Unit.

Table 3. Gear modification log, Vessel Code "A"

Rigging description for excluder trawl	*Shrimp loss percentage*
1) Initial Rigging 12 (2.7 kg) floats 8 mm Loop chain 91 cm Tickler chain	67
2) Removed 6 floats	37
3) Add 2 floats, add 11.3 kg to tongue	8
4) Two floats removed, tickler chain −122 cm	24
5) All floats removed, tickler chain −91 cm	8
6) Replaced 11.3 kg weight with 6.8 kg weight, added 4 floats	19
7) Barrier removed	9[a]

Note: Standard trawl = 15 m semiballoon trawl. Excluder trawl = 15 m super X-3 tongue trawl, barrier code RN26.

a. Increase.

shrimp loss was reduced to 8 percent aboard Vessel A. With the barrier completely removed, the Super X-3 Tongue Trawl was 9 percent more efficient than the standard 15-m semiballoon (control trawl).

Once the gear technical team tunes the trawl and leaves the vessel, some captains in their honest attempt to improve trawl efficiency continued to make changes to the rig. These changes, although sometimes beneficial, are more often detrimental to the gear performance. The single most difficult problem associated with the reverse barrier, however, is related to the vertical lift created as the barrier moves through the water. This lift causes the trawl to fish light on the bottom and can result in an increased shrimp loss. To overcome the problem, project personnel are presently working on a weighting system that will give continuous positive bottom contact. Once accomplished, the reverse barrier excluder trawl will be able to produce shrimp catches very nearly equal to that of a standard trawl.

The 3-year project for development of a sea turtle excluder trawl is on schedule. First-year objectives were successfully accomplished, changes indicated by field test results were incorporated into the trawl design for 1979, and 1979 results are being analyzed to provide direction for final year test and evaluation during 1980. Significantly improved catch rates of shrimp and very good reduction in turtle captures are indicated with the reverse barrier excluder trawl. Differences in fishing vessels, catch composition, topography, animal behavior on the various shrimp grounds, the broad spectrum of trawl types in use by the commercial shrimp industry and the logistical problems of maintaining gear and observers aboard a large number of vessels in different locations have presented difficult problems. Accomplishments to date, however, show considerable promise that a successful sea turtle excluder trawl will be available for introduction to the U.S. shrimp industry by the end of 1980 field testing.

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Recovered Sea Turtle Populations and U.S. Recovery Team Efforts

ABSTRACT

A few sea turtle populations, once depleted by heavy human exploitation, are known to have recovered to some degree. They include the loggerhead and leatherback populations in Natal, South Africa; the green turtle populations of Europa Island; and possibly the green turtle populations of Florida and Mussau, Papua New Guinea. Nevertheless, a recovery is always highly protracted and requires virtually complete protection in order to take place. Turtle populations that have been subject to massive egg exploitation may continue to decline for a decade or more following complete protection, as adults die of natural causes and are not replaced because of reduced or absent age-classes corresponding to the years of egg exploitation. On the other hand, populations subject to heavy harvesting of female turtles but that were not exposed to intensive egg collection may start to show recovery as soon as the population is protected; but such recovery is still very slow and in the short term may be masked by normal fluctuations in numbers of nesting turtles.

A false impression of recovery can be given either by unknown conditions prompting an abnormal fraction of the nesting population to nest in a given year, or by deteriorating conditions in adjacent nesting areas forcing ever-increasing numbers of turtles to nest on the remaining intact beaches.

The functions of the U.S. National Marine Fisheries Service-Fish and Wildlife Service Southeastern Region Sea Turtle Recovery Team are described. The team is appointed to write a recovery plan to delineate the tasks necessary for the restoration of all sea turtle populations in the southeastern region to a status that would not require their being listed as endangered or threatened. No recovery team is currently planned for the western region (U.S. Pacific Territories), but data-gathering in that area has been initiated.

In recent years it has been recognized that many, indeed most, sea turtle populations in the world are depleted to a greater or lesser extent, and responsible governments are undertaking efforts to protect and restore such populations so that they may once again become abundant, stable and of potential resource value. However, the slow maturation time of sea turtles, their migratory habits, and the heavy odds against a given hatchling reaching maturity combine to make the results of any turtle conservation plan less than immediately obvious. The data base is still too incomplete for me to be able to give a clear prediction as to what can be expected when one gives a previously overexploited turtle population either partial or complete protection, but the question is still worthy of discussion. Certain phenomena can give the impression that a turtle population is recovering when it is not in fact doing so, and these need to be considered. On the other hand, some turtle populations have been protected for several or even many years and have still failed to recover. Indeed, many turtle biologists and conservationists have become so discouraged by the nontangible results of their protective efforts that they are beginning to question quite seriously whether a depleted turtle population has the potential to recover, however thorough the protection. These ideas shall be discussed in turn.

For most species of sea turtle, gradual recovery—or depletion—of a population is masked by year-to-year variations in numbers of turtles that arrive on the nesting beach, since turtle populations are usually evaluated in terms of the number of nesting females. At other phases of their life cycle, reliable means of population census have not been developed. Factors whose nature is still not understood bring a much higher proportion of adult females into breeding condition in some years than in others. Carr, Carr and Meylan (1978) show that at Tortuguero, Costa Rica, an estimated 15,426 turtles nested in 1972, 5,723 in 1974, and 23,142 in 1976; but despite this variation there is no evidence that the turtle population suffered a marked decline from 1972 to 1974 from which it more than recovered by 1976. Both predation and conservation efforts were of comparable magnitude throughout this period, and no natural castastrophes were reported; it is simply a case of subtle climatic, feeding, and other factors having brought a great number of turtles into breeding condition in 1972 and 1976, with concomitant reduced nesting in adjacent years since green turtles almost never nest in successive years.

Similarly, Limpus (1978) reports that, throughout Queensland, Australia, green turtle nesting almost failed to take place at all during the 1975–76 nesting season, yet in the following season nesting was back up to almost typical levels. As an example of extreme fluctuation, 1,100 green turtles nested on Heron Island in 1974–75, but only 19 turtles nested there in 1975–76, even though the population remained unexploited. Clearly, under circumstances such as these, overall changes in the turtle population are extremely hard to detect, and must be evaluated either by careful transects of feeding areas or by taking multiyear averages of numbers of turtles seen nesting.

The ridley turtles of the genus *Lepidochelys* frequently if not typically nest annually; consequently, they are less susceptible to apparent fluctuations such as occur with the green turtle, and counts of nesting females provide a more reliable guide to the overall status of the population. However, it is not yet known whether ridleys show a labile 1- or 2-year cycle; but annual nesting may well be the norm—Pritchard (1969) reports that, of 445 nesting olive ridleys tagged in Surinam in 1967, 214 were found renesting in 1968. Allowing for mortality, tag loss, and turtles missed, this is an impressive recovery percentage.

Another circumstance that may give an unwarranted impression of a recovering population occurs when turtles are observed to nest in steadily increasing numbers in a protected area because they are progressively displaced from neighboring beaches by natural or artificial disruptive or distructive forces. As an example, the loggerhead turtles nesting at Cape Romain, South Carolina, have shown an impressive increase in numbers over the last 3 decades (Baldwin and Lofton, 1959; Hopkins et al., in press). But this may be attributable not so much to a recovering population as to human development or disruption of adjacent beaches forcing more and more turtles to nest within the undisturbed beach area in the Cape Romain Wildlife Refuge.

Indeed, predation on the abundant nests at Cape Romain by raccoons is so intense that recruitment is almost zero, and a population collapse can be envisioned in the near future.

Similarly, Schulz (1975, this volume) has documented the increasing numbers of leatherback turtles nesting in Surinam, especially on the beaches in the Marowijne River; the increasing numbers are as follows:

Year	*Number of nests*
1964	95
1967	90
1968	200
1969	305
1970	255
1971	285
1972	380
1973	900
1974	785
1975	1,625
1976	670

Year	Number of nests
1977	5,565
1978	2,160
1979	3,900

Nevertheless, it would be wrong to conclude that overall the leatherback population nesting in the Guianas is increasing. The real explanation is that the neighboring French Guiana beaches, which provide nesting grounds for the world's largest known colony of the species, were undergoing progressive erosion in 1964–75, and increasing numbers of the breeding leatherbacks were displaced toward the still intact or accreting beaches of Surinam.

Some turtle populations have not only failed to recover, but have also undergone conspicuous further decline even though they have been offered strong protection. For example, the only significant colony of the olive ridley turtle (*Lepidochelys olivacea*) in the western Atlantic nests on a small beach called Eilanti in Surinam. Protection of this colony from egg collectors was instigated in 1967 and 1968, when the Surinam Forest Service, the World Wildlife Fund, and I cooperated in a program of egg purchases from the local Carib Indians. The entire season's production—nearly 300,000 eggs a season—was thus purchased, the eggs were incubated, and the hatchlings released. In subsequent years, it has been illegal to exploit ridley eggs in Surinam, and this edict has been enforced; protection of the nesting beach has been effectively 100 percent from 1967 to the present. Yet the number of ridleys nesting at Eilanti decreased as follows during those years:

Year	Number of nests
1967	2,455
1968	2,598
1969	1,074
1970	1,266
1971	1,249
1972	1,051
1973	690
1974	638
1975	531

The numbers of ridleys nesting on the neighboring Marowijne beaches dropped similarly during this period, from 465 nests in 1968 to 201 in 1975. A modest increase was recorded, from 95 to 236, at the other Surinam nesting beach (Bigisanti), but this increase was far from sufficient to account for the drop reported from the other beaches. Schulz (this volume) report that the decline has continued in the last few years; 1,070 nests were made in the whole of Surinam in 1975, 1,160 in 1976, but only 1,030 in 1977, 870 in 1978 and 795 in 1979.

Similarly, the only known population of the Kemp's ridley (*Lepidochelys kempi*) whose sole nesting ground is in the vicinity of Rancho Nuevo, Tamaulipas, Mexico, has undergone a marked drop despite the presence of vigorous beach patrols and a hatchery since 1966. In 1966, the largest *arribada* or nesting aggregation of the season included about 1,338 females, while other arribadas the same season were estimated or counted at 200, 150 to 200, 98, 20, 200, and 25, giving a total of around 2,100 nests, not counting the nests made by sporadic individuals on intervening days. In 1977, the twelfth year of good protection, arribadas of the following size were recorded: 45; 200; 50; 40; 60; 20; 170; 6; 15; and 15 totaling 621. Slight increases were logged in the next 2 years—924 nests in 1978 and 1,013 nests in 1979.

Two factors probably caused the turtles to continue to diminish despite protection of the beach:

1) Both species of ridley are very subject to accidental mortality in shrimp trawlers. Most of the tag recoveries from these 2 populations were reported by shrimpers, and in many cases the turtles were not returned alive to the sea. This factor alone may be sufficient to prevent the recovery of a highly depleted population even if beach protection is good. However, it is also probable that recruitment of young adults into the population during the years in question has been extremely depressed. For many years prior to the instigation of beach protection in 1967, the Carib Indians collected every single egg laid on the beach at Eilanti. It is not entirely clear how long this had been the case, but certainly the habit was well established when I first visited the beach in 1966; each Indian had rights to eggs in a certain section of the beach, and they knew well when to expect an arribada. Consequently, almost no hatchlings were produced by this population for many years prior to 1967, and thus a drop in population would be inevitable as adult turtles died off. The population would be expected to level out and start rising again as hatchlings from the 1967 and subsequent seasons started to reach maturity, but this reversal of trend was not apparent by 1979. Márquez, Villanueva, and Peñaflores (1976) calculate that *L. olivacea* reaches sexual maturity at an age between 7 and 9 years, but these data were based on specimens in semicaptivity in an estuary in Jalisco, Mexico.

I want to analyze the case of the Kemp's ridley population in some depth, not because it is a recovered population, but because it has failed to recover even though many observers would have expected or hoped for recovery already in view of the considerable resources that have been and are being invested in this population, the only population of the species in existence. Perhaps we can, by analyzing the situation and bringing together available knowledge, initiate some predictions of when recovery may start to become visible.

The history of the Kemp's ridley population prior to 1966 is poorly documented. The largest arribada in 1947 was estimated from a film to have numbered about 40,000 nesting turtles, but no real data exist on the size of subsequent arribadas until 1966. However, Hildebrand (1963) gathered some fragmentary information on populations—and exploitation levels—during these intervening years. Hildebrand was informed in 1958 that each year an Arab came to the beach and departed with a mule train numbering 40 or 50 animals each loaded with sacks of ridley eggs to sell on the Tampico market. Another informant reported that 4 or 5 turtles had nested on the beach on 13 May 1960, and that the following day, from an aircraft, "turtles could be seen all along the beach."

From information such as the above, it appears likely that, for a number of years preceding the installation of the conservation camp in 1966, the eggs of Kemp's ridley were subject to methodical and nearly complete exploitation by man. Further evidence is provided by Adams (1966), who reported meeting an egg collector in 1963 who had sold over 20,000 eggs, and who reported that many others were doing likewise. Adams also reported from his interviews with the head of the Rancho Nuevo *ejido* in 1964: "We were told many different stories of how the number of turtles had decreased in the last few years. How buyers from Tampico and Mexico City would come every year and leave with truckloads of eggs for ready market in the cities. How boats would lay offshore and scoop up thousands of live turtles and cut them open just for the eggs."

The breeding population of Kemp's ridleys may have collapsed to close to the present levels between 1969 and 1970. Vargas (1973) illustrates by means of histograms the estimated sizes of arribadas of *kempi* during 1966 to 1970. From these charts, the total numbers of turtles in arribadas of these years were:

Year	*Number of turtles*
1966	1,800
1967	5,000
1968	7,000
1969	10,000
1970	900

I have no explanation for the rapid build-up during 1966–69, nor the collapse in 1969–70. However, Casas-Andreu (1978) reports 6 arribadas during the 1970 season, on 17 April, 1–3 May, 16–17 May, 27 May, 2 June, and 10 June. Vargas indicates no arribadas at all during April 1970 in his histograms, and his estimate for the total numbers nesting in arribadas in 1970 (900) is less than half that of Casas-Andreu (2,000). It is possible that the arribadas of earlier years were only approximately estimated and rounded off to the nearest thousand, so it is quite possible that the rise and collapse of the population as indicated by Vargas' figures were more dramatic than justified.

In 1973, I was informed by villagers at Rancho Nuevo that about 1,000 turtles had nested on 28 April and that all the eggs had been taken. Subsequent monitored nesting was as follows: 3 May, 21; 13 May, 133; 14 May, 8; 15 May, 4; 18 May, 7; 19 May, 57; 22 May, 2; 28 May, 50 to 75; 30 May, 1; 2 June, 4; 8 June, 5; 11 June, 9; 12 June, ca. 36, and 19 June, 3. By this time, the fragmentation of the arribadas into small groups or solitary individuals was becoming apparent.

It is fair to assume that recruitment of hatchling Kemp's ridleys into the population was extremely low for some years preceding protection in 1966. This, together with the omnipresent shrimp trawlers, may account for the progressively declining numbers on the nesting beach subsequent to 1970. It is within our estimates of the maturation time of Kemp's ridley (Márquez 1972) calculated that Kemp's ridley takes 5.5 years to reach minimum breeding size, and 7 years to reach average breeding size) to suggest that the slight up-turn in numbers of breeding ridleys in 1977–79 indeed reflects the "new wave" of recruitment of 1966–69 and subsequent years. However, more years of data will be necessary to confirm this.

A few data are available on the ability of populations of the loggerhead turtle (*Caretta caretta*) to recover following protection of eggs and nesting adults. Richardson et al. (1978) initiated a tagging and hatchery program for this species at Little Cumberland Island, Georgia, in 1965. Beach patrols were not so intensive that all turtles nesting were tagged, but each year a substantial proportion of turtles was tagged, and the ratio of tagged individuals to neophytes was calculated. The proportion of neophyte individuals progressively decreased from 100 percent in 1965 and 97 percent in 1966 (some turtles had been tagged in 1964) to 30 percent in 1975 and 27 percent in 1976. The regression curve was linear, indicating an apparent complete lack of recruitment of new animals into the population. Up to 1964, predation on eggs by raccoons had probably been extremely intense, but subsequent to that time 6,000 to 10,000 hatchlings were released annually. It appears likely that the subsequent 12 years of beach patrols were insufficient for even the earliest of these hatchlings to reach maturity. The only alternative explanations are that 100 percent of the hatchlings failed to survive (since survival of even 6 to 10 animals would have been revealed in the analysis of the neophyte ratio), or that the turtles nested on other beaches. The latter explanation would require as a corollary that turtles hatched on other beaches would sometimes nest on Little Cumberland, but the evidence suggests otherwise. However, Ehrhart (1979) found that turtles tagged while nesting elsewhere in Florida and even in Georgia nested at Merritt Island in 1978.

When nesting turtles are subject to regular killing by man, the nesting colony is likely to show progressive and often rapid depletion. Bass et al. (1965) report on the first year of work (1963–64) on the loggerhead colony at Tongaland, South Africa, where the nesting females had been subject to a significant level of predation by local people for several seasons, though the practice was thought to be "fairly new," and loss of eggs had apparently not been serious. For each season since 1963–64 beach patrols were conducted throughout the nesting time, and predation by man on eggs and turtles was largely brought under control.

As Hughes (this volume) has shown, the number of loggerheads nesting at Tongaland showed a steady rise in subsequent years. The number of years (16) is sufficient for the overall population trend, unmasked by year-to-year fluctuations, to be revealed. With a progressive increase from fewer than 90 nesting turtles in 1963–64 to approximately 400 in 1978–79, this appears to be our first example of a recovered, or at least recovering, population. The history of the leatherback population in Tongaland has been identical, and the species has shown a corresponding recovery under protection, from fewer than 25 nesting females in each season from 1963–64 to 1970–71, to more than 50 nesting turtles each season from 1973–74 to 1978–79 (Hughes this volume).

Certain populations of the green turtle (*Chelonia mydas*) can also be considered possible candidates for "recovered" or "recovering" status. To demonstrate recovery and determine the rate at which it can occur, we need to select situations where a population has been subject to heavy exploitation of breeding adults, followed by a protracted period of protection. Europa Island, in the Mozambique Channel, may be a suitable example, although unfortunately the former exploitation there, though undoubtedly heavy, is inadequately documented. However, Frazier (this volume) reports that organized turtle exploitation may have begun on Europa as early as 1860, but was probably not consistent until 1903 when the first settlement was established. Between 1903 and the passage of protective legislation in 1933 exploitation was probably heavy. Paulian (1950) reported large numbers of turtle bones still to be seen in the northern part of the island. However, recovery now appears to be complete, and recent visitors report a nesting green turtle population so large that it is probably self-limiting (by nest destruction by later turtles nesting in the same spot). Even so, numbers of turtles nesting each year appear to be strikingly variable. These are reviewed by Hughes (this volume), who quotes 4,000 to 5,000 turtles nesting in 1970–71, 3,000 in 1973–74, 1,500 in 1977–78 and 9,000 to 18,000 in 1978–79.

Another population that may have some claim to be in at least an early stage of the recovery phase is the green turtle in Florida. However, a difficulty in the argument is that, although numerous texts make casual mention of green turtles' once having nested in numbers in Florida, there is extremely little available in the way of first-hand accounts to document this. As Carr and Ingle (1959) observed, "Other writers apparently assumed that breeding occurred in Florida because the grazing flats on the Gulf Coast and in the Indian River were so heavily populated with turtles. This does not necessarily follow. It is possible that nesting loggerheads, and the feeding aggregations of green turtles in adjacent waters may have been incorrectly assumed to be aspects of one phenomenon."

At any rate, the Dry Tortugas definitely were once an important green turtle nesting ground, though the greens there were exterminated many years ago and today apparently only loggerheads nest there.

In recent years, there has been an increasing trickle of records of green turtles nesting on the Atlantic coast of the Florida Peninsula; these may represent the remnant of a once major nesting colony. Carr (1952) wrote that there had been no report of a green turtle nest on the Florida coast for 40 years, and while there was far less activity by herpetologists looking for nesting turtles during those years than there is today, it seems surely true that there could not have been much nesting by the species in Florida during those years. Carr and Ingle (1959) reported the first 2 definite breeding records for the Florida coast—1 on 11 July 1957 2 miles north of Vero Beach, Indian River County, and 1 on 27 June 1958 at Hutchinson Island, Martin County. In subsequent and recent years, Ross Witham working on Merritt Island, Brevard County, have reported regular, though not abundant nesting by green turtles. Ehrhart (1979) reports as follows regarding *Chelonia mydas* nesting on Merritt Island: "In five previous summers we had seen a total of only 11 individuals of this species and never more than 3 per year at KSC. In 1978, no less than 14 were encountered there and we have definite records of 23 nesting emergences . . . Only one of the *Chelonia* was a recapture from a previous year.

"There is good evidence that greater numbers of green turtles nested elsewhere on the east coast of Florida as well and that a larger than usual contingent nested at Tortuguero, Costa Rica, the major Western Hemisphere Rookery. As a result, some sea turtle biologists now feel that there may be 300 to 400 adult females left in the Florida population, rather than the 100 to 200 formerly proposed."

Similarly, Witham has found that green turtle nests on Hutchinson Island increased erratically but steadily from 2 in 1967 to 45 in 1975 and to 61 in 1978. Therefore, while the data base on the original population, its exploitation, and subsequent protection is defective, it seems a reasonable hypothesis to suggest that a once great nesting population of green turtles in Florida that was virtually wiped out by intemperate exploitation is now showing some initial but definite signs of a comeback.

One other green turtle population may be in a recovering or recovered phase. This population both grazes and nests around Mussau Island, north of New Ireland in the Bismarck Sea. Visiting this island in 1978, I was informed by the local people that green turtles had, in former times, been heavily exploited and had become scarce. However, in the early 1930s, the entire island population had converted to the Seventh Day Adventist Faith, and as a tenet of this belief had ceased to eat sea turtles. Occasional animals were taken by outsiders in subsequent years, but not many. I was impressed to see large numbers of surprisingly tame green turtles of both sexes and both juvenile and adult sizes on the reefs and in the shallows off Mussau. The green turtles there were far more conspicuous and seemingly abundant than anywhere else in Papua New Guinea, and while the past status of the species is based purely on the memory of village elders, it seems reasonable to consider the Mussau green turtle population has recovered after about 45 years of conscientious protection.

Rapid recovery of a green turtle population that has been subject to complete or nearly complete egg exploitation is probably impossible. Data now being gathered in several parts of the world suggest that green turtles, although having the potential to reach maturity in about 8 years under captive conditions and on a high protein diet, grow extremely slowly in the wild. For example, the average growth rate of immature green turtles in the 46 to 59 cm range in the Galápagos Islands was determined to be only 0.53 cm/yr by Green and Ortiz (this volume). Slightly higher rates were found in the southern Great Barrier Reef of Australia by Limpus 1979, namely an average of 1.31 cm/yr for turtles in the 60 to 90 cm range. Only slightly greater growth rates have been found in Mosquito Lagoon, Florida by Mendonça (personal communication). Doubtless the precise growth rate depends upon the feeding environment in which the animal finds itself, and Balazs (this volume) has documented that, in the Hawaiian archipelago, growth rates are much more rapid around the southernmost, biggest island, Hawaii itself, than in the smaller, more northern islands.

The accumulating data suggest that green turtles typically take several decades to reach maturity under natural conditions. Thus, a population that has been heavily overharvested for eggs, such as the Sarawak Turtle Islands population, may have to be completely protected for several decades before the nesting population "bottoms out" and finally starts to rise again. Apparent increases before such an interval for any green turtle population are almost certainly the result of the normal year-to-year fluctuations discussed earlier in this paper.

Recovery Teams and Recovery Plans

The concept of the recovery team was conceived by Earl Baysinger of the United States Fish and Wildlife Service, and was developed by the Office of Endangered Species. The intention of the concept is that the Service should designate a small working group of experts on a particular endangered species. These experts are usually drawn primarily from government agencies but also include representatives of the academic and private sectors, whose duty is to draw up a multistep plan that, if conscientiously executed, would bring about the recovery of the species to the point where it could be taken off the Endangered Species List. Team members are instructed to concern themselves purely with biological considerations rather than attempting to interpret political considerations. The plan finally agreed upon by a recovery team is then submitted to the regional director (FWS or NMFS as appropriate), who distributes it to interested agencies and other parties for comment. After modification, if necessary, the plan is sent to the director for final approval. The Endangered Species Act also provides that "critical habitat" may be declared for an endangered species, and once so declared, projects within that area that have federal funding or require a federal permit must demonstrate themselves to be free of adverse impact upon that critical habitat. Teams may make their views known as to what they recommend to be the critical habitat for their species, though the designation of the habitat is not one of the team's responsibilities.

The essentially volunteer nature of recovery teams has resulted in some recovery plans' taking a long time to be finished, and recently Congress has made its intentions clear that teams should receive "adequate funding." Recently, some recovery plans have been drawn up by a single individual working under contract to the Fish and Wildlife Service.

Three sea turtle species—the hawksbill, leatherback, and Kemp's ridley—were added to the U.S. Endangered Species List in 1973, but the question of agency jurisdiction, necessary for the establishment of recovery teams, was not resolved until about 5 years later. The eventual memorandum of understanding between FWS and NMFS established that the Department of the Interior should have jurisdiction over turtles on land and that the Department of Commerce should have jurisdiction over turtles while they were in the water. This resulted in such allocations of duties as Interior's having responsibility for controlling the importation of illegal turtle products, and Commerce having responsibility for the development of devices to minimize incidental catch of turtles by shrimp trawlers and others. It was also decided that the recovery team should be a joint responsibility, but with National Marine Fisheries Service (Department of Commerce) having the lead role and the responsibility of providing team funding.

A Southeast Region Sea Turtle Recovery Team has been formed, accountable primarily to the NMFS Southeastern Regional Director. It has responsibility for all 6 species of sea turtles found in the southeast region and has a larger budget than Department of Interior Teams ($10,000 annually rather than $2,000). The team is unusually large—12 members—who represent the National Marine Fisheries Service (2 members); Fish and Wildlife Service; Natural Resource Departments of South Carolina, Georgia and Florida; the Caribbean Fishery Management Council; the academic world; the citizen conservation movement; the commercial trawling industry; the Florida Audubon Society; and the South Carolina Wildlife and Marine Resources Department. The team also has approximately 30 formal consultants.

The team is considering not only species whose range extends within the United States but also specific populations whose members migrate between U.S. and foreign waters. The plan thus will present numerous recommendations to foreign governments. The team was directed by the regional director to include in the recovery plan relevant social, economic, and political information.

Because of the international nature of sea turtle conservation and the recognition that a population or a species can be properly protected or conserved only if the management program extends over all phases of the life cycle, the team gave considerable thought to the delineation of the populations over which it would deliberate. It was decided that all populations would be included that ever resided within the waters of the U.S. Southeastern Region, which as defined by the National Marine Fisheries Service includes the coast and adjacent waters of the entire U.S. Gulf Coast, the Atlantic Coast as far north as Virginia, the U.S. Virgin Islands, and Puerto Rico. This definition, it was felt, was compatible with both the NMFS directives and biological reality.

The team is thus interested in Kemp's ridley, whenever and wherever it is to be found. It will also include consideration of the olive ridley. Although this species is only known to nest in South America in the West Atlantic, individuals occasionally reach the Greater Antilles, including Puerto Rico and are frequently caught accidentally by U.S.-based shrimp trawlers.

Green turtles nesting in Florida are of special interest to the team which also proposes to follow all Caribbean populations of this species as well as the population nesting in Guyana. The Surinam population not only appears to be under good management already but also has been shown to migrate only to the east, towards Brazil, after nesting, so it was felt there was no need to include it in the plan. Neither did it meet the criteria for inclusion.

The plan will devote major attention to the loggerhead in the United States. Not only does this species comprise over 98 percent of all marine turtle nestings on mainland United States, but it is also subject to 2 pressures—excessively high egg predation by raccoons and heavy losses of subadults and adults in shrimp trawls—that may well cause its reasonably abundant populations to collapse in the next 2 decades.

Caribbean populations of the loggerhead will also be included in the plan, but not those of Brazil or the eastern Atlantic.

The nesting and reef-dwelling hawksbills of the U.S. Virgin Islands, Puerto Rico, and Mona will be of special interest to the team. However, it will address itself to this species generally throughout the Caribbean.

Recovery teams have been criticized as being excessively academic, merely formalizing already obvious species survival strategies, and increasingly becoming an end in themselves rather than the first step in saving threatened and endangered species. Another criticism is that the formation of a recovery team and its subsequent 1 or 2 years of deliberations over a recovery plan dangerously delays the instigation of necessary protective measures. These criticisms can be answered.

Without a recovery plan, a species may receive attention only if it happens to catch the imagination of an authority on the species who can devote the necessary time and attract the necessary resources to instigate recovery procedures. Moreover, such a haphazard, piecemeal approach may result in neglect of vital aspects of the recovery procedure. For some highly localized species, a recovery plan may be as simple as a single action or recommendation; but for a group as complex and far-flung as sea turtles, the formation of a recovery team ensures the logical definition of the recovery process, the identification of all its necessary components and the designation of agency responsibility.

The second criticism also does not apply in the case of the Sea Turtle Recovery Team. In no way are protective measures, recovery procedures, or relevant research being delayed until the work of the team is finished. While private interests and individual states carried most of the burden of responsibility for sea turtle conservation for several decades, the federal agencies are now making up for lost time most commendably. The stage was set by the passage of the Endangered Species Act and the listing of the various species as threatened or endangered; currently, only *Chelonia depressa*, endemic to northern Australia, is not listed. Subsequently, the National Marine Fisheries Service started a major research program to solve the problem of incidental capture of sea turtles in shrimp trawls, and is currently involved with a 10-year head-start program for the critically endangered Kemp's ridley and a wide variety of sea turtle research programs, being conducted mostly by the private sector under contract. The U.S. Fish and Wildlife Service has also been active, and, among other things, has the primary responsibility for the U.S. contribution to the beach protection effort for the Kemp's ridley nesting ground at Rancho Nuevo, Mexico. Other federal agencies involved in one way or another with sea turtle research include the National Park Service and the National Aeronautics and Space Administration.

As already mentioned, the existing Sea Turtle Recovery Team has responsibility for the southeastern region only. For the present time, no team is proposed for the western region. Nevertheless, NMFS Hawaii is in the early stages of planning a major research and data-gathering program in the western region. Even though there are very few sea turtles on the West Coast of the U.S. mainland, Hawaii has a small but important population of green turtles, and various populations of green turtles and hawksbills are scattered through the endless islands of the Trust Territory (Micronesia) and other U.S. Pacific Islands, including Guam and Samoa. Knowledge of these populations is at a much earlier stage than that of the turtles of the Southeastern Region; the need for a recovery team will be addressed once the problems have been defined.

If marine turtles are to be saved from further depletion and ultimate extinction, strong action by many governments and concerned conservationists will be necessary in many countries. But I have confidence that the recovery team will play more than a parochial role. All 6 threatened or endangered species of sea turtle—the green turtle, leatherback, loggerhead, hawksbill, Kemp's ridley, and olive ridley—are found in the southeastern region, at least marginally, and thus fall within the sphere of interest of the recovery plan. Moreover, even if the U.S. initiative fails to achieve any significant action by other nations, we should not forget that the marine turtle populations over which the United States has technical jurisdiction are spread over far more of the globe than just U.S. mainland waters. This jurisdiction includes the thousands of islands and 3 million square miles of ocean in the Pacific Trust Territory; the 1,000-mile long Hawaiian chain and adjacent waters; Samoa; Guam; and, in the Caribbean, Puerto Rico, and the U.S. Virgin Islands.

But it is our hope that the recovery plan will, in fact, receive the approval of other nations so that integrated and comprehensive plans for the restoration of all populations of sea turtles will be established and agreed upon in a true spirit of international cooperation for a common cause.

Finally, I should mention that even though I happen to be co-leader of the Southeastern Sea Turtle Recovery Team, I have presented this summary of information on the team and its functions purely as a private individual, and opinions expressed are mine alone.

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Planning for Protection of Sea Turtle Habitat

Introduction

Planning for habitat protection involves 2 steps: the identification of the habitat upon which the resource is dependent, and the elaboration of criteria and implementation of regulations to insure that habitat degradation will be prevented and that habitat improvement will occur. In the case of sea turtles, habitat has generally been thought of as the nesting beaches. However, sea turtle habitat goes far beyond simply the nesting beaches. Marine turtle habitat characteristics have been described by Rebel (1974) and more recently by Schwartz (1978).

Threats to Habitats

Man's ability to produce environmental and ecological perturbation and his inability to perceive or predict the environmental and ecological consequences of this perturbation have led to what Bella and Overton (1972) term an "environmental predicament: man's ability to modify the environment will increase faster than his ability to foresee the effects of his activities." Man has been modifying the environment throughout history. Yet, it is only in the last half century that these perturbations have begun to stress the integrity of the earth's ecosystems. Man is not only a part of the environment, but he is also inextricably linked with all ecosystems. We are only now beginning to appreciate the effects of our technological society on the resources and organisms on which we depend for sustenance and survival. We are also increasingly aware of our effects on species such as marine turtles.

Witham (this volume) as well as others have demonstrated that human encroachment of sea turtle nesting habitat is perhaps the primary cause of the decline of sea turtle activity in many areas. Declines in nesting populations of green and loggerhead turtles over a 3-year period on Hutchinson Island, Florida are attributed by Worth and Smith (1976) to expanding urban development including reduced background vegetation, artificial lights, human activity, and increased predation by raccoons brought about by the displacement of the raccoon population as a result of construction activities. On Kiawah Island, South Carolina, Dean and Talbert (1975) observed that nesting activity was lowest in areas where beach homes were present and where restriction on lighting and beach traffic were lacking, even if the beach appeared ideal for nesting. Additionally, they found that areas which appeared geomorphically unsuitable to nesting were "increasingly utilized by turtles due to the areas' isolation and lack of human activity." They conclude that "only because of highly limited development in the past have the Kiawah loggerheads not encountered the human pressures evident on other Charleston beaches." Lund (1974) suggests that the consequences of coastal strand development may be more profound in northern states than in southern states such as Florida. The Carolina seashores attract people during the summer nesting season whereas Florida beaches are primarily utilized in the winter. This effectively "increases the chances of disrupting nesting turtles with bonfires, vehicles, lights, etc." Coastal development and construction in nesting areas are considered the greatest threats to sea turtles in Queensland, Australia by Bustard (1972). He also cites oil exploration and mineral sands mining as posing threats to sea turtle nesting grounds. Dean and Talbert (1975) observed that increasing development along South Carolina beaches has resulted in the displacement of loggerhead females to more protected nesting grounds (Cape Romain National Wildlife Refuge, Belle W. Baruch Institute for Marine Biology, and the Santee Coastal Reserve of South Carolina's Heritage Trust Program). The increase in loggerhead turtle nesting in the Cape Sable area of Everglades National Park is thought to be related to the park's establishment in 1947. Davis and Whiting (1977) suggest that increasing developmental pressure surrounding the park resulted in the displacement of turtles to the park beaches from pressured areas. Caldwell (1962) suggests that the abandonment of the Jekyll Island rookery in favor of the beaches of the Cumberland Islands in Georgia was due to human and developmental encroachment on Jekyll Island.

The blowout on 3 June 1979 of the oil drilling rig IXTOC-I in the Bay of Campeche has resulted in the release of crude oil into the Gulf of Mexico at reported rates of 15,000 and 30,000 barrels per day. Drilling of a relief well or capping of the well is not expected until mid-November. Of prime consideration is the potential impact of this oil on the nesting habitat of the Kemp's ridley turtle and on the long-term effects from oil fouling of both adults and hatchlings. Fortunately, more than two-thirds of the 1979 hatchlings had entered the Gulf of Mexico before the spill. The remainder were released off the coast of Florida and within *Sargassum* patches offshore of Rancho Nuevo. As of this writing, 1 dead ridley, 6 dead green turtles, and 5 oil-fouled but recovered green turtles have been associated with this spill in U.S. waters. This oil spill has demonstrated that planning for habitat protection of sea turtles must include the oceanic environment. Even after surface-oiled beaches have been cleaned, one must wonder about the fate of buried oil. How will an oil layer within the nesting beach affect the eggs or the hatchlings? Would oil, either on the surface or buried, be cause for the female to reject a nesting beach? The head start program (Wauer 1978) carried out by Mexico and the United States at Padre Island National Seashore and the Galveston Laboratory of the National Marine Fisheries Service may prove futile if nesting beaches, migration routes, and feeding grounds become fouled by oil. Thus, habitat protection for sea turtles involves not only the protection of nesting areas from development and intense human presence, but also the protection of nursery habitats, hibernation areas and dispersal and migratory routes from pollution.

The habitats within which sea turtles hibernate (Felger, Cliffton, and Regal 1976; Ogren and McVea, this volume) must be included in habitat protection. Data must be obtained on these populations so that activities such as fishing, dredging, or construction can be scheduled to prevent interference with the populations.

Lund (1974) suggests that fluctuations and movements of nesting populations may be due to the temporary disruption of nesting beaches caused by beach erosion and stresses "the importance of federal wildlife refuges, national parks and national seashores, state parks and even public beaches as possible reservoirs of turtle nesting in the future." In the United States, the largest and most significant nesting populations of sea turtles occur within federal wildlife refuges, national parks and national monuments. The loss of turtle nesting habitat outside these areas is thought to be due primarily to the urbanization and development along active or potential nesting beaches (Lund 1974). In Australia, Bustard (1972) sees the establishment of national parks as a means of protecting sea turtle nesting grounds from habitat degradation, although this is not without its problems since aboriginal populations are granted the right to exploit wild populations within these areas.

Many prime turtle nesting habitats are found on barrier islands and beaches. The very dynamic nature of these systems requires jurisdictional and legal planning in order to maintain the continuity of the area if the habitat moves due to physical or successional changes. In this regard, buffer areas must be sufficiently large to provide for long-term variations of the critical area. Clark (1976) states, "tragically, the barrier islands are increasingly the focus of intense real estate speculation and development activity, setting up a strong conflict.

Natural values and public access problems are rapidly lost in the face of the seashore building boom. More than half of the major barrier islands and beaches are already fully committed to private housing and commercial enterprise."

Habitat Protection

We must approach the problems of sea turtle habitat protection in an integrated way:

The establishment of a few parks and reserves is a hopeful sign but is also only a partiel approach. There is no alternative to massive, integrated effort of scientists, social scientists, lawyers, politicians and public relations personnel in a regional, worldwide attack on the problem. Ecological science must take a lead since the primary need is to modify man's lifestyle to the realities of ecosystems which he is far from understanding or controlling in the sea and coastal zone, but which he is presently destroying (Ray 1976).

How can we plan for the protection of sea turtle habitat when we know very little about their critical habitats? How are sea turtles able to return to their natal beaches? What sensory cues, if any, does the female receive from the beach that allow her to choose or reject a particular area? How important are migration routes, and growing and hibernation bays and lagoons? We do know that human encroachment in the form of developments, industry, lights, vehicles, and activity nearby and within nesting areas have profound consequences to the sea turtle population; that onshore and offshore mining and accidents associated with petroleum exploration and exploitation may adversely affect sea turtle habitats. Research is beginning to provide answers to some of these questions.

One planning method, termed the diversity approach (Bella and Overton 1972), calls for the uneven distribution of man's environmental perturbations. "Developmental efforts are confined to a number of selected systems and regions while specific steps are taken to prevent and even reduce development in others." This approach has been in progress along the southeastern coast of the United States, although it does not appear to be by design. Rather, intense development has not been permitted to occur along some turtle nesting beaches and on barrier islands as a result of the establishment of federal wildlife refuges and national seashores, and state parks, and the participation of local communities as on Little Cumberland Island, Georgia, and private organizations as on St. Catherines Island, Georgia. These activities remove the pressure of development from sea turtle nesting habitat, yet intense peripheral development occurs nearby. Recognizing the limitations of present ecological knowledge when considering whether or not to preserve an area, the environmental predicament leaves open the option of including the area without the traditional accompanying specific proof.

Ray (1976) proposed a planning methodology in which "ecosystems science" served as the basis for marine conservation. The framework he developed is equally applicable to sea turtle habitat protection. In this methodology he suggests that ". . . First we must work toward the identification of critical areas and the buffer zones upon which the critical areas depend." The U.S. Fish and Wildlife Service and the National Marine Fisheries Service have proposed (44 Federal Register 159: 47863-64, 15 August 1979) a legal definition of "critical habitat":

(1) the specific areas within the geographical area occupied by a species, at the time it is listed in accordance with section 4 of the Act. [Act refers to the Endangered Species Act of 1973, 16 U.S.C. 1531 *et seq.*] *on which are found those physical or biological features (i) essential to the conservation of the species and (ii) which may require special management considerations or protection, and (2) specific areas outside the geographical area occupied by a species at the time it is listed in accordance with the provisions of section 4 of the Act upon a determination by the Secretary that such areas are essential for the conservation of the species.*

The surrounding areas on which the critical habitat depends are defined as buffer zones. The designation of a critical habitat may prove difficult in some instances due to the sea turtle's mobile nature. However, the environmental predicament provides us with the ability to designate habitat as critical.

Reserves and Parks

Sea turtles are endangered and threatened by man, and by setting aside habitats as either reserves, preserves, or parks, we protect not only the habitat but also the species. However, as Ray (1976) points out, ". . . what . . . reserves cannot do is survive intact outside . . . the ecosystems of which they are only a part." A buffer zone, therefore, "must be established to include the support systems which usually derive largely from outside . . ." As part of any plan to preserve critical habitats, long-term research is required not only of the habitat but also of the species itself. The greater our understanding of the sea turtle in terms of reproductive biology, hatchling survival, dispersal patterns, and growth, the better equipped we will be to protect its habitat. The problems associated with the establishment of parks and reserves in Third World nations have been addressed by Western and Henry (1979).

Buffer zones, as discussed by Ray (1976), ". . . are created to protect the core . . . buffers must accommodate the shift of the core in cases of biological, ecological, or geomorphological change, for example,

. . . the movement of beaches. . . . Buffer zones may differ fundamentally from the core by not being under the direct ownership or jurisdiction of the agency managing the core area. Therefore, control of human activity within the buffer may be through administrative action, easements, or by other means . . ." In identifying or establishing boundaries for core areas "entire ecological units (habitats and communities)" should be included.

The planning process and management only begins with the designation of a habitat vital to the survival of the sea turtle, and core and buffer zones protected from human encroachment. In planning habitat protection, whether by designation as a critical habitat within a reserve, refuge, or park, activities outside of the buffer area or habitat boundary must be addressed. The National Parks and Conservation Association (1979) found that out of 203 national park system superintendents surveyed in the United States, nearly two-thirds stated that their areas suffer from incompatible adjacent activities including residential, commercial, industrial, and road development, grazing, logging, agriculture, energy extraction and production, mining, and recreation. These activities were cited as having an adverse effect on water, air and terrestrial resources. Activities hundreds or thousands of miles removed from the habitat sites must also be considered. The placement of shoreline protection structures to reduce erosion updrift of a nesting beach may prove helpful to the area being protected, but the reduction of sediment transport to the rookery area could cause erosion and eventual loss of the habitat. Of a more recent nature, the IXTOC-I oil well failure in the Bay of Campeche suggests that we must be prepared to deal with and protect areas from oil impact not only at the state level but also internationally. International cooperation is essential. Planning must be achieved prior to such events so that the resource is not jeopardized by improperly applied recovery or rehabilitation methods.

International Reserves for Protection

The creation of international wildlife refuges or protected regions in which resource management would be coordinated internationally rather than locally, would be a step toward solutions. Iran set the precedent for this form of cooperation at the United Nations Conference on the Human Environment in Stockholm in 1972, when its government offered to cede its sovereignty in the National Park Sashte Argan in favor of international control (Kopp and Yachkaschi 1978). However, this may no longer be recognized. Since nesting and nursery areas, migratory routes and other such areas are critical to the propagation and survival of sea turtles, these areas could be included in International Protected Areas so that all aspects of the turtles' life history would occur within an area cooperatively managed by a single entity. Most protection of widely ranging turtles should occur at such a level, for the best efforts by one nation or state could be negated by a laissez-faire attitude of another. The listing of such regions in the World Heritage Trust Program (UNESCO, undated) would bring recognition not only to endangered and threatened turtles but also to their life history requirements which depend on ecological rather than on political boundaries. The State of Massachusetts has provided for resource preservation by designation of areas of critical environmental concern (Massachusetts Coastal Zone Management, undated). In California, Areas of Special Biological Significance have been identified for protection (J. W. Hedgeth, personal communication).

Planning Strategy

Planning for the protection and management of sea turtle habitat should include the following procedural considerations and should take place both nationally and internationally.

1) Coordinated surveys should be made of sea turtle nesting, growing and hibernation areas, and migration routes. These surveys should include known and suspected sea turtle areas. The habitats and community structure, as well as the type and intensity of sea turtle activities, within each area should be summarized. A listing of natural and human-related perturbations occurring within or near each habitat should be compiled. The surveys do not need excessive detail and can be based on literature reviews and secondary sources. They should, however, be comprehensive and "should attempt to identify natural units both irrespective of political or legal boundaries" (Ray 1976). By identifying the habitats, the nature of sea turtle activity, and perturbations, priority areas can be selected for protection.

This is not simply a call for another survey. Previous surveys have been site- or nation-specific and have not provided the comprehensive data base needed for the worldwide protection of marine turtles and their habitats. This is a request, however, that we begin to assemble and update continuously, under 1 organization, and in 1 format, all the information now available on sea turtles in general and their specific habitats.

2) High priority areas would be considered for inclusion as critical sea turtle habitat.

3) Methods of protecting critical sea turtle habitat would be appropriate to its status as public or private property. Habitats within refuges, reserves, or parks would be assessed to determine the degree of protection afforded the habitat by enabling legislation and the management policies in existence. In some in-

stances, management practices might be suitable. Many significant sea turtle habitats located within the United States and its territories already have some protection by virtue of their inclusion in, for example, national parks: Canaveral National Seashore, Everglades National Park and Buck Island Reef National Monument; wildlife refuges: Cape Romain National Wildlife Refuge; federal reserves: Kennedy Space Center; private ownership: Little Cumberland Island and St. Catherines Island, Georgia; and critical habitats: Sandy Point, St. Croix, U.S. Virgin Islands. In those areas where the habitat is already under protection, planning should include the identification of core areas, possible expansion or enlargement of buffer zones or restrictions of human and vehicular access, or fishing activities during nesting or hibernating seasons. Critical sea turtle habitat which is unprotected or not directly under the control and protection of public agencies or private organizations would require "executive action for the immediate protection of certain most critical areas or to cause cessation of harmful practices" (Ray 1976) until ecological research demonstrated otherwise. This is especially clear in view of the environmental predicament which suggests that our ignorance is large. A sea turtle would be better served if such areas were identified and protected. This action would be followed by legislation (Environmental Law Institute 1977) at either national or international levels directed at the establishment of a park, reserve, or refuge encompassing the habitat and a large buffer zone. This is not to imply that, once identified, all critical areas and buffer zones must be protected, for it is clear that these areas and zones will include large portions of the world's oceans. Our ability to protect these areas through restrictions on fisheries, shipping, and coastal development would be difficult at best.

4) In high priority habitats the planning process must include research and management programs tailored to individual sites to be protected. Research efforts directed toward non-nesting biology and ecology of those species most threatened by human activity are essential. These would provide the information necessary to make trade-offs between preserving pristine oceanic ecosystems containing marine turtles and man's exploitation of the sea in such a way as to protect enough habitat with sufficient safeguards to ensure the survival of sea turtles. Management must recognize the socioeconomic issues within and surrounding habitats but not allow existing issues, policies, and practices to deter it from taking firm steps to protect the habitat. This action would include the identification of the "legal and financial means by which preservation may be achieved" (Ray 1976).

Following the general worldwide survey of sea turtle nesting, growing and hibernation areas, and migration routes, each habitat must be described and all available information compiled in an internationally accepted computer-compatible format. The following types of information should be acquired: name of area; geographical location; latitude and longitude; surface area; physical features including beach slope and texture; ecologically dominant biota including sea turtle species and their relative abundances, predators, and vegetation lines; special values (scientific, recreational or other interest); conservation status, degree of naturalness, degree and nature of any threats; present ownership or jurisdiction; character and use of contiguous land and sea areas emphasizing effectiveness as buffer zones; proposed purpose or present use of area; knowledgeable contacts; and references to both scientific and popular literature.

By programming the above information for computer storage and retrieval, and by updating the information periodically, the status of all worldwide sea turtle habitat can be ascertained. This system would permit us to, among others, determine those habitats most threatened and needing immediate action.

In order to accomplish this, an international steering committee should be formed and protective action begun. This committee, formed of ecologists, public interest groups, planners, social scientists, and environmental lawyers would coordinate the acquisition of the data and recommend habitats needing immediate protection to the international community. In consultation with the involved states, programs would be developed to protect high priority sea turtle habitats without regard to political boundaries. The United Nations Educational, Scientific, and Cultural Organization (UNESCO) or the International Union for Conservation of Nature and Natural Resources (IUCN) might possibly serve as the administrative organization for the establishment of such a steering committee.

The task before us is not simple. Our goal is high, nothing less than the protection of the very habitats upon which marine turtles depend for survival. It can be achieved, but it will require cooperation and hard work at national and international levels.

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Disruption of Sea Turtle Habitat with Emphasis on Human Influence

ABSTRACT

The effects of human activity on sea turtle nesting habitats were assessed by reviewing published and unpublished Florida nesting data. Disruptions caused by residential, recreational, and business use of beach fronts include impacts from artificial lights, physical barriers such as jetties, groins, and sea walls, and vehicular traffic on beaches. Negative effects associated with petroleum production are also presented. Management techniques for mitigating these impacts are recommended.

Introduction

Disruptive alterations of sea turtle habitat result from both short-term and long-term human activities, as well as from natural causes such as erosion, accretion, and high tide flooding. Hirth (1971), while mentioning that nocturnally nesting sea turtles could be scared by ". . . barking dogs, lights, etc.," discussed primarily natural disruptions to their beach rookeries. Man's most apparent disruptive activities are related to beach front development which increases artificial lights, structures, and human activity.

LeBuff (1973) stated, without citing references, "The negative effect that development and increased public use has on marine turtle nesting has been well documented in the southeastern United States." While not firmly established, it seem probable that until rather recently most sea turtle rookeries have been in coastal areas where development was minimal or nonexistent. Lund (personal communication) mentioned a lack of suitable nesting beach and an apparent increase in false crawls in the seawalled area of Jupiter Island. Conversely, Mann (1977) noted that nesting females on Florida's southeast coast did not avoid lighted, developed beaches or favor undeveloped beaches.

Disruption of nesting habitat due to development has been assessed by reviewing published and unpublished Florida data. While in many areas, developed and undeveloped, have not been systematically studied, existing data yield information useful in evaluating artificial disruption of nesting and other nearshore habitats. A review of some available data follows.

Discussion

The most obvious and best studied impact of beach development is artificial lighting. Daniel and Smith (1947) reported that emergent hatchlings could ". . . sometimes be stimulated to crawl back onto the sand . . . ," in response to artificial light. Hendrickson (1958), McFarlane (1963), Ehrenfeld (1968), Mrosovsky and Carr (1967), Mrosovsky and Shettleworth (1968), Mrosovsky (1972), and Philibosian (1976) documented positive phototactic responses. Mann (1977) noted up to 100 percent landward movement where landward light intensity exceeded seaward intensity. He further reported post-emergent hatchling death rates from 0.02 to 95.96 percent, with lower percentages occurring where barriers, natural or man made, prevented hatchlings from crawling to the landward horizon. High relief barriers, by disrupting the landward movement of hatchlings, apparently permitted hatchlings to reorient toward the sea when dawn's light became stronger than landward artificial light. Condition and fate were not determined for misoriented hatchlings that eventually reached the sea after extensive terrestrial meanderings.

The light orientation propensity of young sea turtles has suggested the need to study the possible effects of lighted, permanent structures at sea. These structures attract sizeable populations of pelagic fishes (Mertens 1976; Hastings, Ogren, and Mabry 1976). Since fish predation is considered to be a major cause of hatchling mortality (Hirth 1971), young turtles attracted to lighted, offshore structures might be subjected to increased predation.

Nesting sites have been degraded or lost because erosion control structures have made unsuitable topographic changes at several beaches within sea turtle nesting ranges. Jetties at inlets are man's earliest physical beach alterations. Erosion and accretion patterns around inlet jetties are determined by sand transporting currents; erosion occurs on the down current side and accretion on the up current side (Anonymous, 1955). Inlet jetties without sand-transfer systems result in long-term erosion and accretion. Eroded areas frequently become unsuitable for nesting when high tides cover beaches to the vegetation line. Accreting areas continue to provide suitable nesting habitat.

Groins (short jetties at noninlet areas of beaches) are erected in an attempt to control beach erosion; their effects are similar to those of inlet jetties.

More recently, rip rap, a wall made up of loose stones, has been used along the surf zone of existing groins in an attempt to overcome their ineffectiveness. Rip rap alone is used as a stop-gap to protect upland structures. Groins and rip rap have dubious effectiveness in protecting or restoring eroded beaches. Use of rip rap is unsatisfactory when it hampers turtle access to suitable nesting beaches.

Seawalls, in several configurations, have been used in attempts to control erosion. They are made of concrete, steel, or a combination of both; some have vertical walls, others have curves designed to impart a recurving motion to incoming waves. One type of seawall is made of waffle-like elements built along an upward slope under the existing beach. Because seawalls fail to prevent beach erosion, the present trend is to use rip rap as a stop-gap measure and sand nourishment to rebuild eroded beaches.

Beach nourishment is usually done by dredging suitable offshore sand and pumping it onto the beach. Sand shifting and settling after deposition on beaches may limit initial use by turtles for nesting. Sand pumped onto an eroded beach with nests may trap hatchlings (Mann 1977); therefore nourishment should be limited if possible to non-nesting seasons. Dredging during non-nesting months may not be possible due to winter sea conditions, however endangered eggs can be safely moved for protected incubation (Witham and Futch 1977).

Recreational, residential, and business use of beach fronts has resulted in construction of condominiums, hotels, motels, restaurants, fishing piers, and electric generation facilities. In some areas, extensive development occurred before there was any interest in assessing its effects. In other areas, development proceeded after the problems were recognized, but before management plans were implemented.

Florida's coastal construction management program began in 1970 with the enactment of Sec. 161.052 Florida Statutes (F.S.). This law required a 50-ft setback from mean high water. Difficult to enforce, this law was amended (Sec. 161.053 F.S.) to establish a surveyed set-back line in cooperation with individual counties. An example of a development prior to the set-back law is a motel built on former dunes resulting in a lighted beach which encourages nightly guest activity. Turtle nesting appears to decrease within the limits of increased human activity. False-crawling females that deposit eggs elsewhere could benefit hatchlings which would otherwise be disoriented by the motel's lights. A compatible development having its buildings well behind the dune line does not interfere with either nesting females or emergent hatchlings. However, problems resulting from increased beach activities could be a factor during nesting seasons (Mann 1977).

Vehicular traffic on beaches can affect rookeries in several ways. Some densely populated areas use heavy beach cleaning equipment which is capable of digging up or collapsing nests (Mann 1977). In other areas, recreational off-road vehicles are sometimes used extensively and make ruts deep enough to dig up or collapse nests. Recreational use of horses causes similar problems. Depressions created by these activities can entrap seaward bound hatchlings.

Tar balls, which result from oil spills (Dedera 1977), soil beaches. One beach cleaning contractor (J. Peart, personal communication) estimated a tar content ranging from 5 to 50 percent in the approximately 180 metric tons of seaweed and other debris he removes annually. In addition to its frequent appearance on beaches, tar is widely distributed in oceanic environments (Wade et al., 1976). Accumulating observations (Kleerekoper and Bennett 1976; Witham 1978, unpublished data) suggest adverse effects upon small sea turtles by oil and tar. These effects require quantitative and qualitative investigations, and, in the interim, efforts must be made to reduce the amount of hydrocarbons entering the seas.

The cooling water taken from the ocean by electric generation facilities entrain larger turtles in cooling canals. The offshore intake structure of Florida Power and Light Company's St. Lucie Plant may look like a reef to some turtles, suitable for resting, and these turtles are subsequently drawn into the cooling system. Actively feeding leatherbacks probably follow large numbers of jellyfish into the intake. More than 130 turtles of 3 species—loggerhead, *Caretta caretta*, green turtle, *Chelonia mydas*, and leatherback, *Dermochelys coriacea*—were removed from the St. Lucie intake canal in 1 year (D. Worth, personal communication). About 16 percent of loggerhead and green turtles were dead when removed from the system; the remainder were tagged and released. Three leatherbacks were released alive, but at least 1 had severe skin abrasions from being caught in a net.

Evidence from Florida demonstrates continued use of nesting habitat by turtles in developed and developing areas. Mann (1977) reported nesting densities ranging from 2 to 80/km from Delray Beach to Lauderdale-by-the-Sea. He commented that "Many females did nest on highly developed beaches, with bright background lighting, tall buildings, human activity, and dredged sands very different from those which would naturally be present, even though some of the more natural beaches available nearby were only lightly nested." Fletemeyer, (personal communication 1978) reported 12 nests/km on the 8.4 km of brightly lighted, highly developed Ft. Lauderdale beach. Some of his data suggest that human activity, rather than lighting alone, reduces nesting activity. Wagner (personal communication 1978) reported 352 nests on 4.2 km of beach at Boca Raton. More than 16,000 loggerhead and 1,500 green turtle hatchlings were released as part of the city's nest protection work. Hutchinson Island nesting surveys (Gallagher et al., 1972; Worth and Smith 1976; Henderson, personal communication) used nest counts on 9 1.25-km beach sections to estimate nesting populations. These surveys reported total nest counts of 1,412 in 1971, 1,263 in 1973, and 1,446 in 1975, although during this time there was continued coastal development. Where development or use is detrimental, damage can be mitigated by management techniques. These techniques include transplanting endangered eggs, collecting hatchlings, and nourishing beaches as well as restricting beach use, shielding lights, and removing barriers.

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Conservation and Management of Sea Turtles: A Legal Overview

ABSTRACT

This paper provides an overview of existing national legislation and international conventions pertaining to the conservation of sea turtles. The impact that the draft Law of the Sea Treaty might have on sea turtle conservation in its elaboration of new state rights and responsibilities over ocean space and marine resources is also considered. Two reference appendices are provided to applicable legal materials.

The present legal situation is unsatisfactory as national legislation has been piecemeal and uncoordinated throughout the ranges of the sea turtles, and insufficient use has been made of international conventions to develop common conservation approaches. Enforcement difficulties are also touched upon. Future legal requirements to better conserve sea turtles, their eggs and their habitats are suggested. However, legal initiatives are dependent upon advances in knowledge of the ecological requirements of sea turtles.

The long term conservation of migratory species requires international cooperation. The newly adopted Convention on the Conservation of Migratory Species of Wild Animals, which covers all sea turtles, is suggested as a possible vehicle for this cooperation, while the increased utilization of regional conservation conventions is also promoted.

As a matter of priority, attention is urged to the improvement of national legal measures. The expected delay until the Migratory Species Convention can come into force and have sufficient parties to become an effective instrument, the time necessary to either develop new or to improve existing regional conservation conventions, the advances in scientific knowledge that are required for framing effective international conservation and management programs, and the importance that individual state action can have in conserving particular sea turtle populations are all cited as reasons for devoting immediate attention to improving the situation at national level.

Finally, two legal approaches that could be taken to

control the specific problem of incidental take of sea turtles in fishery operations are suggested.

Introduction

In this paper a brief overview is provided of the existing legal situation pertaining to the conservation of sea turtles, followed by observations for future legal initiatives at both national and international level to better control the exploitation of sea turtles and to conserve their habitats.

The legal situation to date has not been fully satisfactory. Conservation measures have been taken predominately at national level, and these appear to have been haphazard and insufficient when the total range of the various turtle species is concerned. Only recently have there been significant international developments: at global level, the Convention on International Trade in Endangered Species of Wild Fauna and Flora, which can effectively control international trade in live specimens and products, and the newly adopted Convention on the Conservation of Migratory Species of Wild Animals, which could provide a global framework for comprehensive conservation and management measures for sea turtles. At regional level there are also promising initiatives to either strengthen existing general conservation conventions or to elaborate new ones.

Ultimately the conservation (which means sustained use as well as protection) of marine migratory species which pass into and out of areas under national jurisdiction, requires a coordinated international approach. However, this cooperation will no doubt take time, and so improved national provisions must be promoted as the immediate means for the conservation of sea turtles and their habitats.

A few caveats should be mentioned about the role of law in the conservation process.

First of all, law should be seen as just one piece of the puzzle for conservation. It can reinforce and strengthen all other aspects, but requires the right circumstances to be effective. This means fitting legal measures within the applicable social, political and economic framework.

Second, in the field of nature conservation, meaningful legal advances are possible only if predicated upon advances in scientific knowledge (for sea turtles on such factors as range and migration routes).

Third and finally, even the most sophisticated and well-intentioned law is worthless if it is not effectively enforced. Enforcement problems can stem from a number of sources: lack of political will; inadequate personnel, finance or equipment; lack of public awareness; social and economic problems; or legal obstacles such as lack of agency cooperation within a government. Specific enforcement difficulties in regard to sea turtle conservation cannot be considered in this overview paper but enforcement is a very serious problem which must be addressed if conservation programs for sea turtles are to be effective. More will be said on this point below.

Current National and Provincial Legislation

Appendix I provides citations to some 70 current conservation laws and regulations directly applicable to sea turtles. In analyzing these enactments, it is evident that present legislation has been piecemeal (for example, most only deal with one aspect of the problem, such as the collection of eggs), and legal provisions have not been coordinated between jurisdictions (for example, open season dates set in various countries).

Current International Conventions

Cooperative efforts to conserve sea turtles are addressed by one regional (the African Convention on the Conservation of Nature and Natural Resources), and two global conventions (the Convention on International Trade in Endangered Species of Wild Fauna and Flora, and the Convention on the Conservation of Migratory Species of Wild Animals). The first two are in force; the last remains open for signature until 22 June 1980. Data concerning these conventions may be found in Appendix II.

Two other regional conventions, the Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere and the Convention on the Conservation of Nature in the South Pacific, are also structured to directly deal with the conservation of selected species as both provide that lists of taxa that merit special importance be maintained by their contracting parties. Unfortunately, concrete actions for cooperative conservation programs that might benefit sea turtles have not yet been achieved under either, although it is being increasingly recognized that the Western Hemisphere Convention could provide a valuable mechanism for regional conservation in the Americas for migratory wildlife including local populations of sea turtles. The main problem with this latter convention is the lack of an administrative mechanism to facilitate implementation. In addition unlike other international conservation conventions, it does not contain an agreed list of species that all parties undertake to conserve, but rather provides for individual national listings of species to be protected (whose effect to other parties is very unclear). Also, the section of the convention calling for the conservation of migratory species is limited to birds.

The possibility of developing new regional conservation conventions for West Africa and Southeast Asia is now being explored within UNEP and ESCAP respectively. Although it may be several years before anything comes of these, efforts should be made to have these agreements comprehensively and directly cover the conservation of living resources, including sea turtles.

Many existing international agreements have an indirect impact upon sea turtle conservation. These include conventions dealing with protected areas, pollution control, and fishery operations. It is not possible to consider each in this brief overview paper. Instead, a few are cited as conventions which *could* prove useful for sea turtle conservation, and the special problem under fishery conventions—incidental take of sea turtles—is alluded to below.

Examples at regional level include the Convention for the Protection of the Mediterranean Sea Against Pollution and the Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, and at international level include the Convention on Wetlands of International Importance Especially as Waterfowl Habitat and the Convention Concerning the Preservation of the World Cultural and Natural Heritage. It must be underlined, however, that these conventions are all either too specialized, or suffer from too many other inherent weaknesses to provide substantial contributions to sea turtle conservation.

Finally, attention needs to be given to the draft Law of the Sea Treaty as that instrument will have great impact upon the framework for both national and international measures for sea turtle conservation. The following is a brief description of the three existing conventions of direct relevance and the Law of the Sea draft text.

African Convention on the Conservation of Nature and Natural Resources, 1968

This convention, in force since 1969, was developed to provide a comprehensive basis for the conservation of natural renewable resources (soil, water, flora and fauna) throughout Africa. All marine turtles are covered by the convention, being listed as Class A protected species which are totally protected throughout the entire territory of the parties, with taking allowed only under special circumstances.

The convention needs to be more fully implemented throughout Africa. This could be best fostered through the functioning of an active secretariat. However, in relation to the conservation of sea turtles the convention will still be somewhat inadequate. Eggs are apparently excluded from coverage, nationals of parties are not covered by the provisions of the convention when they operate outside national territory, and most seriously, the regional application of the convention may preclude coverage of the full range of some sea turtle populations involved.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 1973

This convention was designed to prevent the extinction of species and to assist in the improvement of their status by controlling strictly international commerce in listed species, their products and derivative parts. Since entry into force in 1975, CITES has shown that it can be an effective mechanism for international cooperation.

Three Appendices to the Convention list the species covered. Appendix I includes species that are threatened with extinction. Consequently, international trade in these species and their products and derivatives is subject to very strict regulation, being authorized only under exceptional circumstances. Appendix II species are those which either may become threatened with extinction if international trade is not regulated, or species which must be subject to regulation in order that trade in these first species may be controlled. Appendix III is of less significance, including species which a particular party identifies as being subject to regulation within its jurisdiction and for which cooperation is requested from the other parties to control trade in the species.

Sea turtles have been subject to much discussion and consideration by the parties to CITES. The parties have for the most part been able to agree upon stringent trade controls for all sea turtles with the following presently included on the convention appendices:

	Appendix I	*Appendix II*
Cheloniidae	*Caretta caretta* *Chelonia mydas* *Eretmochelys imbricata* *Lepidochelys kempii* *Lepidochelys olivacea*	Cheloniidae spp. (all species)
Dermochelyidae	*Dermochelys coriacea*	

Two parties maintain reservations in regard to Appendix I listings for particular sea turtles—France for *Chelonia mydas* and *Eretmochelys imbricata* and Italy for *Chelonia mydas*. This means that for those listings, France and Italy respectively are not considered to be party states and may therefore engage in international trade in the species without observing the Appendix I provisions.

Convention on the Conservation of Migratory Species of Wild Animals, 1979

The Migratory Species Convention was developed in response to the need for a global system for the conservation of migratory animals. It recognizes that migratory species, a term very broadly defined in the convention, are a resource to be conserved and managed by all states that exercise jurisdiction over any part of the range of the species. It is a framework convention which is intended to provide direction and guidelines for further conservation agreements for migratory animals as well as to provide directly a mechanism for individual states to unilaterally conserve endangered migratory species.

Two appendices to the convention list the species selected for coverage. Species may be listed in either or both appendices. Appendix I includes endangered species for which immediate and stringent conservation measures by the party states along the range of listed species ("Range States") are required. Appendix II species are those recommended to be the subject of agreements by their Range States. This appendix is in fact the heart of the convention, as it implicitly recognizes that agreements between states (particularly for groups of migratory species) are essential to conserve and manage migratory species. The basic elements for the agreements are set forth in the convention in the form of guidelines. Agreements are to be comprehensive, with consideration given to research requirements, exchange of information, conservation of habitats, removal of or compensation for obstacles to migration, procedures for coordinating action to suppress illegal taking and so forth.

The appendices developed at the Bonn Diplomatic Conference at which the convention was concluded were purposely kept short, and were adopted as initial expressions of the types of species to be covered by the convention. Nevertheless, sea turtles are well represented, with *Lepidochelys kempii* and *Dermochelys coriacea* entered onto Appendix I and all species of Cheloniidae and Dermochelyidae entered onto Appendix II.

Draft Law of the Sea Treaty

The Third United Nations Conference on the Law of the Sea has had as its task the elaboration of a new treaty that will set out the rights and obligations of states for the future use of the oceans and their resources. The conference apparently is winding down to a conclusion, with a consensus already finding its way into international law on many of the crucial issues (as may be seen in the current draft text[1]). Under these circumstances some aspects of the future legal regime of the seas can be evaluated with a degree of certainty.

One portion of the draft treaty that seems to be firmly in place is the treatment of jurisdictional limits and the related rights and responsibilities for coastal states regarding the conservation of living resources in areas under their jurisdiction.[2] From the previous situation of 3- and 12-mile limits, coastal states are now able to claim jurisdiction over resources in areas that might extend beyond 200 miles from their shores. However, the Law of the Sea Conference has never had the conservation of marine species as its major focus, and conservationists repeatedly have pointed out gaps in coverage in the draft texts. Much future attention in other fora will need to be given to remedy the more important conservation deficiencies of the treaty.[3]

A brief review of the new jurisdictional framework under the draft treaty text is useful for an indication of how this new legal regime might affect the conservation of sea turtles.[4]

INTERNAL WATERS

These are the waters on the landward side of a baseline which is normally the low-water line along the coast (Articles 5–8). They are not covered by the Law of the Sea text as they are legally considered to be part of the coastal "land." Such waters are of tremendous ecological importance since they include estuaries, lagoons and other inshore areas. In view of the text's silence, coastal states are free to conserve, or may legitimately exploit, living resources in these areas without obligation under this treaty. It may also be interpreted that the silence of the treaty means that coastal states are free to control all forms of pollution, or conversely to pollute, with impunity in these waters.

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1. Informal Composite Negotiating Text/Rev. 1, UNCLOS document A/Conf.62/WP10/Rev.1 28 April 1979. Article numbers referred to below concerning the Law of the Sea refer to the numbers in this text.

2. FAO reports in document COFI/78/Inf.9 that as of 1 April 1978 out of some 130 coastal states, 85 already claim fishery jurisdiction beyond 12 miles, with 67 of these claiming limits of 200 miles either as exclusive economic zones, fishery zones, extended territorial seas or in other terms.

3. See *Conservation and the New Law of the Sea—IUCN Statement on the Informal Composite Negotiating Text UNCLOS III*, February 1978 Morges, Switzerland, which was widely distributed within and outside of the Law of the Sea Conference. This Statement pointed out IUCN's evaluation of the conservation deficiencies of the draft treaty and provided proposals in the form of draft articles for improving those aspects of the text.

4. For a more detailed treatment of the new jurisdictional situation, see de Klemm, *Conservation and the New Informal Composite Negotiating Text of the Law of the Sea Conference*, Environmental Policy and Law, vol. 4, no. 1, Lausanne, April 1976. This article refers to the previous version of the Law of the Sea text, but it is still relevant as the text has not been changed regarding these jurisdictional points.

TERRITORIAL SEA

Each coastal state is given the right in the treaty to establish the breadth of its territorial sea up to a limit of 12 nautical miles measured from its baseline (Article 3). The coastal states have the same authority for conservation or exploitation in the territorial sea as in internal waters. However, coastal states cannot prohibit innocent passage of foreign ships in these waters, although they may establish shipping lanes (Article 17). This exception has relevance for pollution control and establishment of protected areas.

EXCLUSIVE ECONOMIC ZONE

EEZs are areas that coastal states are free to establish under the treaty which can extend up to a maximum distance of 200 nautical miles to sea measured from their baseline (Article 57). In their EEZ, coastal states have sovereign rights for the purpose of the preservation of the marine environment and for the exploitation of both living and nonliving natural resources (Article 56). Coastal states are charged with the determination of their capacity to harvest living resources in this area, and subsequently with the setting of an allowable catch figure, along with the obligation to avoid overexploitation (Articles 61 and 62). Consequently coastal states may regulate or prohibit resource exploitation by other states within these zones.

Nevertheless, all states enjoy the freedom of navigation in the EEZ area (Article 58) and although this right is qualified later [Article 211 (6)], it is a point which again has implications for marine pollution and for the establishment of protected areas. Other states are obliged to conform to the coastal state's laws in regard to vessel source pollution within EEZs, but such laws must accord with international practice (Article 211).

HIGH SEAS

All remaining waters comprise the high seas (Article 86). Therein states enjoy the right of freedom of fishing and navigation (Article 87), subject, of course, to any international agreements the states have undertaken on the subjects. Pollution on the high seas by ships is regulated by a few provisions of the treaty, but as there is no global enforcement agency, enforcement is left to the flag states or to port states (Articles 94, 210, 211, 216–220).

Special jurisdictional limits also apply to the continental shelf regime but those need not concern us here.

These new jurisdictional limits, already unilaterally adopted by many states, greatly alter the traditional legal regime of the oceans. For example, the former principle of freedom of the seas for fishing has been seriously eroded since the vast majority of fishing operations are carried out in areas which will now come under coastal state jurisdiction.[5]

Sea turtles pass through all of the jurisdictional zones mentioned above. Because of extensions in national jurisdiction, certain coastal states shall largely be responsible for the conservation of sea turtles during much of their life cycles. This could be a welcome turn of events as coastal states having greater authority can undertake more comprehensive conservation measures than in the past. Nevertheless, this could be anything but an improvement should some of these coastal states prove unable or unwilling to take needed conservation measures in their extensive areas, as they alone have the authority to so act therein.

The migration routes of many sea turtles cross the waters of several coastal states. Thus, the failure of some states to take proper conservation measures could easily negate the efforts of other states along the range of the species. Several articles of the draft Law of the Sea Treaty advocate cooperation by states directly or through appropriate international bodies for conservation, management or optimum utilization of migratory species (Articles 63–67), but these are unfortunately only general principles for cooperation and do not point the way for concrete results.

In sum, the new Law of the Sea significantly alters the "rules" for state responsibility and rights over marine species, but it does not provide proper guidelines for conservation or sustained exploitation of these species. Furthermore, the division of ocean space into national areas on a greater scale than in the past, although potentially advantageous for conservation, can be an unwelcome development as far as migratory marine species are concerned since a precise system for international cooperation is not provided. A serious gap for the conservation of these species may result, and it must be faced in other international arenas.

Future Legal Requirements

In the foregoing many inadequacies in present legal provisions for the conservation of sea turtles were noted. On the national level, existing legislation apparently has not been adequate to maintain or improve the status of the species. At international level insufficient attention has been given to the problem of sea turtle conservation with only control of international trade in sea turtles and their products now apparently well in hand. Furthermore, in the elaboration of the new Law of the Sea Treaty, conservationists have been dismayed by the omission of provisions for the framing

5. *Supra*, note 2: FAO estimates that as much as 90 percent of future fishery operations will take place in areas under national jurisdiction.

of conservation responsibilities for coastal states while these states are given new authority over the resources in tremendous areas of ocean space. Under these circumstances, urgent attention must be given to improving legal provisions if sea turtle populations are to be maintained or enhanced.

Requirements at National Level

As mentioned above, a threshold problem for improving legal measures is one of scientific information. Law cannot be created in a vacuum. Data must be provided as to the range, migration routes, critical habitats and the ecological requirements of sea turtles so that appropriate conservation legislation can be framed. However, the premier problem for sea turtle conservation will certainly be that of political will at national level. From the legal point of view, assuming that scientific input is satisfactory, there are already plenty of tools available for conservation, but these must be seized by governments. Two necessary types of legal enactments at national level are legislation that comprehensively considers sea turtles as far as exploitation is concerned (addressing local use as well as international trade), and legislation that preserves sea turtle habitat. For the former, there is the precedent of comprehensive action being taken by 1 country (the United States) for particular marine species (marine mammals) with a great success.[6] For the latter, there again are precedents for the establishment of marine (and of course land) sanctuaries.[7]

Requirements at International Level

Even with the appropriate political will for enlightened national measures, the conservation and management of migratory species require cooperation between states. One framework for a common international approach now exists in the new Migratory Species Convention, and so it is timely to consider in more detail the treatment that this convention gives to the various requirements and problems of sea turtle conservation.

All sea turtles are included under Appendix II to the Migratory Species Convention, being recommended to be the subject of conservation agreements, and in addition, two species, *Lepidochelys kempii* and *Dermochelys coriacea* have been included in Appendix I to be the subject of stringent unilateral measures. The convention is predicated upon the principle that all the states along the range of a migratory species must participate in its conservation and management.

Scientific judgement will determine the states which will constitute the range states for given species of sea turtles. Regional arrangements for identified distinct populations (which can be considered separate "migratory species" under the convention) will provide certain political and practical advantages. However, if migration routes go beyond regional areas, a more global approach will be required (see the discussion above on the African Convention). One attempt was made in 1969 to establish a regional agreement for *Chelonia mydas* by Costa Rica, Nicaragua, and Panama. That convention was not enacted and the attempt has since been abandoned by the three countries.[8] Such efforts should be encouraged in the future, if they are based upon the conservation of distinct populations.

By mandating measures for the conservation of Appendix I species, and by setting guidelines for the provisions of agreements on Appendix II species, the Migratory Species Convention should ensure that a large measure of harmonization will exist in the legal provisions of the states along the range of marine turtle species.

The convention contains quite clear provisions concerning the exploitation of listed species. For Appendix I (endangered migratory species) exploitation will be allowed only under exceptional circumstances and if the exploitation does not operate to the disadvantage of the species. In the case of Appendix II species, the convention recognizes that exploitation can be an integral part of conservation and management but that it must be controlled to ensure sustainable benefits.

The convention contains several provisions concerning habitat conservation including directions for the restoration of habitats that have been previously degraded and the establishment of reserve areas for both Appendix I and II species.

The convention acknowledges the crucial role that scientific research must play in the determination of conservation measures. A Scientific Council is established that will provide scientific advice to the parties and promote the undertaking of research. Furthermore, the guidelines for agreements include reference to the need for provisions to be made within the agreements to facilitate research work.

As noted earlier, difficulties in the enforcement of national conservation enactments have often been cited as a major problem in efforts to conserve sea turtles. For developing countries, primary enforcement difficulties can often be traced to lack of resources and

6. Marine Mammal Protection Act of 1972, Pub.L.92–522. 21 Oct. 1972.

7. See, for example, for marine areas, the U.S. Marine Protection, Research and Sanctuaries Act of 1972, Pub.L.92–532, 23 Oct. 1972 which provides for the establishment of marine sanctuaries necessary for the purpose of preserving or restoring areas (which may extend out to the edge of the continental shelf) selected for their conservation, recreational, ecological or aesthetic values.

8. Letter from J. de J. Coneja, Subdirector de Coordinación Económica, Ministerio de Relaciones Exteriors y Culto, San José Costa Rica, 2 November 1978.

trained personnel as well as the underlying economic aspects of the problem. The Migratory Species Convention implicitly recognizes that certain parties will require assistance in the form of financial aid and expertise to allow them to fully implement the convention and leaves the details to be worked out in the various agreements under the convention. A special resolution was included in the Final Act to the convention that urged the parties promote financial, technical, and training assistance for developing countries to enable them to fully implement the convention and also urged international and national aid organizations to give priority in their programs to assist developing countries under the convention.

Experience has shown that international conventions can expedite and guide national legislation. Two reasons have been cited for this: 1) states having assumed an international responsibility to take an action are bound to act effectively to meet this responsibility; and 2) certain states, because of their internal political systems, are able to go farther with their national legislation if it can be based upon an international convention than would be politically feasible without it.

The Migratory Species Convention would thus seem to be a promising means to facilitate international cooperation for the conservation of sea turtles. The reaction of governments shows clearly that there is support for the concept of a migratory species convention. However, several of the most influential states were not able to support the convention at the Bonn Conference, principally because these countries could not accept the application of the convention to marine species. Fortunately, the controversy over marine species was largely confined to marine fish, with all but one delegation favoring the inclusion of sea turtles under the ambit of the convention.

A frequently cited worry of the states that could not support the inclusion of marine species in the convention was that the Migratory Species Convention might conflict with future obligations being developed at the Law of the Sea negotiations despite the fact that a provision was made in the Migratory Species Convention for the Law of the Sea text to prevail should there be any conflict between the two. In any event, there should not be any contradictions as the Migratory Species Convention serves to provide specific rules for the principles of cooperation set forth in the Law of the Sea text. It is hoped that objections to the Migratory Species Convention based upon potential incompatibility with the new Law of the Sea will soon be overcome with the adoption of that treaty.

9. For example, Article XVIII of the Migratory Species Convention provides that it will enter into force on the first day of the third month following the deposit of the fifteenth instrument of ratification, acceptance, approval or accession. This might be compared with the Endangered Species Convention which only required 10 instruments, yet took over 2 years to enter into force, and perhaps only now 6 years later is it really becoming effective. The amendment of existing regional conventions would similarly be a long-term process.

Required Immediate Legal Action

Even if concerned states take concerted international action to conserve sea turtles by means of the Migratory Species Convention or other international instruments, it may be some time before such agreements either come into force and have a sufficient number of parties to make international cooperation meaningful, or, in the case of certain existing regional agreements, are adequately strengthened to provide significant benefits to sea turtles.[9] In the meantime, the conservation situation for sea turtle species cannot be allowed to further deteriorate, and so there is a need for states to gear up in anticipation of strong formalized agreements. Cooperation, for example, could begin among interested states in joint research and management efforts.

International agreements, although ultimately necessary to conserve migratory species, should not be solely relied upon as the answer for the future conservation of sea turtles. In addition to the problem of delay until they might provide benefits mentioned above, there are several reasons to give precedence to national legislation for sea turtle conservation. For one, national measures will be required to implement the provisions of international agreements. Also, until sufficient knowledge is gained as to the range and migration routes of sea turtle populations, common international management action might not be fully effective, forcing attention to continue to be focussed at national programs. Finally, for certain sea turtle populations conservation measures may only be needed from individual states (for example, some sea turtle populations may not migrate, or may only be subject to exploitation within the jurisdictional boundaries of 1 state).

Finally, incidental take of sea turtles in fishery operations deserves special concern as a matter of priority. The Migratory Species Convention treats a country whose ships incidentally take a particular species of sea turtle as a range state for that species, and that country will be expected to join in a common conservation program with the other range states of the species.[10] Still, as it may be quite a while before the convention can be brought into play, two other legal actions could be taken.

1) Include provisions to regulate incidental take operations in national legislation: These should encompass efforts to regulate alterations in fishery gear, to

10. See Migratory Species Convention Article I (h) and (i) on this point.

close fishing in certain areas and at certain times, and possibly to follow the approach taken in the U.S. Marine Mammal Act[11], which regulates the importation of commercial fish caught using methods that resulted in the incidental killing or injury of marine mammals.

2) Include provisions to regulate incidental take operations in international fishery agreements: At international level, fishery commissions should be urged to regulate the taking of nontarget species by also mandating appropriate gear and closing areas and seasons as necessary when sea turtles congregate in large numbers. In several cases amendments might be required for international fishery conventions to provide jurisdiction over nontarget species, but as many of these conventions are being renegotiated in view of the new Law of the Sea, the time might now be propitious for raising such amendments.

Conclusion

The conservation situation for sea turtles can be improved if increased attention is given to legal steps at both national and international level through:

1. immediate attention to the strengthening and/or develoment and enforcement of comprehensive national legislation which regulates the exploitation of sea turtles and their eggs, and protects sea turtle habitat, and

2. the coordination of national measures through international cooperation. The new Migratory Species Convention appears to provide the best framework for this cooperation, and it deserves support from all those interested in the conservation of migratory species in general and sea turtles in particular. To complement this global effort, strong regional conservation conventions should be promoted for distinct populations of sea turtles. Several existing conservation conventions require scrutiny and strengthening before they can provide significant benefits for sea turtles.

Finally, in order to determine gaps in existing legal coverage, and to set priorities for future legal action, it will be extremely useful to maintain a systematic inventory of relevant national legislation and international conventions concerning sea turtles.

11. *Supra*, note 6.

Appendix 1. National legislation directly concerning sea turtles

The following is a listing of the national and provincial legal instruments available at IUCN's Environmental Law Center in Bonn which specifically deals with sea turtles. Within IUCN's collection of some 18,000 legal texts from over 130 States, a great number of enactments can be found which, although not specifically mentioning sea turtles, can be extremely important for sea turtle conservation (for example, texts for protected areas, marine pollution, fishery conservation, etc.). Furthermore, this appendix does not contain references to legislation that is only used to implement the Endangered Species Convention, it being considered sufficient to list the parties to that convention in Appendix II recognizing that those states have taken the obligation to enact national regulations for international trade in sea turtles and their products.

Given the difficulties involved in acquiring legal texts throughout the world, this appendix is necessarily incomplete even for enactments which directly concern sea turtles. IUCN would consequently be most grateful for information as to additional relevant laws in force as well as assistance in their acquisition.

Australia

Fisheries Act, 1952–68
IUCN no. 805680 (J–952031300)

Australia–Northern Territory

Fisheries Ordinance 1965–67
IUCN no. 805860 (J–965000000)

Australia–Queensland

Fisheries Act, 1976
IUCN no. 805730 (J–976121600)

Bahamas

The Fisheries Act, 1969
IUCN no. 807580 (J–969052800)

The Marine Products (Fisheries) Rules (1954)
IUCN no. 805730 (J–954092300)

Belize (UK)

Fisheries Regulations (1967)
IUCN no. 811990 (J–967000000)

Bermuda

The Fisheries Act (1972)
IUCN no. 808700 (J–972051200)

Brazil

Law No. 5197 of 3 January 1967
Protection of the Fauna
IUCN no. 810920 (H–967010300)

Portaria No. 3 481 – DN (Lista Oficial de Espécies Animais Ameacada de Extincao da Fauna Indigena) (1973)
IUCN no. 810920 (H–973053100)

Cayman Islands (UK)

The Marine Conservation (Turtle Protection) Regulations, 1978
IUCN no. 817300 (H–978091900)

The Marine Conservation Law (1978)
IUCN no. 817300 (H–978091401)

The Endangered Species Protection and Propagation Law (1978)
IUCN no. 817300 (H–978091400)

Costa Rica

Ley de Pesca y Caza Maritimas (1949)
IUCN no. 826150 (I–949011100)

Decreto Ejecutivo No. 9 del 24 Mayo de 1963
IUCN no. 826150 (I–963052400)

Decreto No. 5680 Parque Nacional de Tortuguero (1975)
IUCN no. 826150 (R–975110300)

Cyprus

Regulation 8A – Fisheries Law Ch. 35 1971
IUCN no. 827770 (J–971000000)

Dominica

Forestry and Wildlife Act, 1976
IUCN no. 943370 (H–976062200)

Ecuador

Ley de Proteccion de la Fauna Silvestre y de los Recursos Ictiologicos (1970)
IUCN no. 832300 (H–970111700)

Fiji

Fisheries Ordinance (1942)
IUCN no. 833400 (J–942010100)

Fisheries Regulations (1965)
IUCN no. 833400 (J–965020600)

Gabon

Décret-Loi no. 22/PM du 30 décembre 1960, les taux de permis de chasse, taxes d'abattage, taxes cynégétiques et licences de chasseurs professionels
IUCN no. 837900 (I–960123000)

Gambia

Fisheries Act, 1971
IUCN no. 838640 (J–971000000)

Ghana

Wildlife Conservation Regulations, 1971
IUCN no. 841340 (H–971043000)

Gilbert and Ellice Islands (now Kiribati and Tuvalu)

Wildlife Conservation Ordinance, 1975
IUCN no. 841800 (H–975052800)

Grenada

Birds and other Wild Life (Protection of) Ordinance (1957) (as amended)
IUCN no. 848540 (H–957012600)

Guadeloupe

Arrêté portant réglementation de l'exercise de la pêche marine côtière dans les eaux du département de la Guadeloupe (1979) No 79–6 AO/3/3
IUCN no. 836050 (J–979032600)

Guyana

Fisheries (Aquatic Wild Life Control) Regulations (1966)
IUCN no. 850650 (J–966000000)

Guyane (France)

Arrêté no. 69 239–ID/2BAG réglement la capture des tortues de mer, la récolte de leurs oeufs et l'utilisations de ces produits dans le Département de la Guyane (1969)
IUCN no. 835060 (J–969022600)

Honduras

La Ley de Pesca (1959)
IUCN no. 851700 (J–959051900)

Iran

Game and Fish Law
Khordad 2526 (June 1967) as amended Esfand 2533 (March 1975)
IUCN no. 857400 (I–967000000)

Ivory Coast

Loi no. 65–255 du août 1965, relative à la protection de la Faune et à l'exercise de la chasse
IUCN no. 864040 (H–965080400)

Kenya

The Wildlife (Conservation and Management) Act (1976)
IUCN no. 869160 (H–976021300)

Madagascar

Ordonnance no. 62–079 établissant un droit de sortis sur les animaux sauvages (1962)
IUCN no. 878030 (H–962092900)

Malaysia – Sabah

The Fauna Conservation (Turtle Farms) Regulations, 1964
IUCN no. 879870 (H–964062600)

Malaysia – Sarawak

Wild Life Protection Ordinance (1957)
IUCN no. 879900 (H–957000000)

Malaysia – Trengganu

Turtles Enactment, 1952
IUCN no. 879960 (H–952012000)

Mauritius

Fisheries Ordinance, 1948
IUCN no. 883000 (J–948021700)

Mexico

Disposiciones sobre la captura, approvechamiento y comercializacion de la tortuga marina (1968)
IUCN no. 883680 (H–968090000)

Montserrat (UK)

Turtle Ordinance (1951)
IUCN no. 885760 (H–951000000)

New Caledonia (France)

Dispositions de l'Arrêté rendant exécutoire la délibération no. 220 du 3 août 1977
IUCN no. 836980 (H–977080300)

Nicaragua

Decreto No. 937 (Reformas a la Ley Especial sobre Pesca) (1964)
IUCN no. 891690 (J–964101100)

Decreto (Isla del Venado; 1960)
IUCN no. 891690 (I–960101100)

Decreto reglemento la explotacion y prohibe la destruccion de las tortugas (1958)
IUCN no. 891690 (I–958082000)

Pakistan–Baluchistan

Baluchistan Wildlife Protection Act, 1974
IUCN no. 869130 (H–974072200)

Pakistan–Sind

The Sind Wildlife Protection Ordinance, 1972
IUCN no. 896120 (H–972040600)

Panama

Decreto Ejecutivo no. 104 (Por el cual se adiciona el Decreto Ejecutivo no. 23; 1974)
IUCN no. 897020 (H–974090400)

Saint Lucia

Turtle, Lobster and Fish Protection Act, 1971
IUCN no. 943395 (J–971060700)

Saint Vincent (UK)

Birds and Fish Protection Ordinance (1901)
IUCN no. 943390 (H–901000000)

Senegal

Décret no. 67–510 du 30 mai 1967 portant Code de la Chasse et de la Protection de la Faune
IUCN no. 911600 (I–967053000)

Seychelles

Turtles Ordinance (1925)
IUCN no. 912000 (H–925000000)

Turtles Regulations (1929)
IUCN no. 912000 (H–968071700)

The Green Turtles Protection Regulations (1968)
IUCN no. 912000 (H–96807100)

Solomon Islands (UK)

The Fisheries Ordinance, 1972
IUCN no. 812020 (J–972000000)

The Fisheries Regulations, 1972
IUCN no. 812020 (J–972000001)

Sri Lanka

Fauna and Flora Protection Ordinance (1938)
IUCN no. 933000 (H–938030100)

Surinam

Hunting Act (1954)
IUCN no. 887590 (I–954000000)

Trinidad and Tobago

Fisheries Ordinance (1916 as amended to 1975)
IUCN no. 926880 (J–916000000)

Protection of Turtle and Turtle Eggs Regulations, 1975
IUCN no. 926880 (H–975090800)

Thailand

Fisheries Act (1947)
IUCN no. 923780 (J–947011300)

Turks and Caicos Islands (UK)

Fisheries Protection Ordinance, 1949
IUCN no. 929720 (J–94908300)

Fisheries Protection Regulations, 1976
IUCN no. 929720 (J–976000000)

United States

Endangered Species Act of 1973
IUCN no. 933000 (H–973122800)

Florida

Florida Statutes Section 370.12(1) Chapter 74 20
IUCN no. 933500 (H–000000000)

Hawaii

Regulation 36: Relating to the protection of marine turtles (1974)
IUCN no. 933600 (H–974041100)

New York

Conservation Law § 11–0536–6
IUCN no. 934650 (H–00000000)

North Carolina

General Statutes – Subchapter 101 – Endangered and threatened species
IUCN no. 934700 (H–979072800)

Texas

Parks and Wildlife Laws, § 978d–1, P.C. (1971)
IUCN no. 935200 (H–97100000)

Regulations for Non-game species
IUCN no. 935200 (H–000000002)

Regulation for Endangered species
IUCN no. 935200 (H–000000001)

Virgin Islands (UK)

Endangered Animals and Plants Ordinance, 1976
IUCN no. 942900 (H–976052800)

Appendix 2. International conventions providing for cooperative conservation measures for sea turtles

African Convention on the Conservation of Nature and Natural Resources

Date of adoption	15/9/1968	Date of entry into force	9/10/1969
Place of adoption	Algiers	Depositary	Organization for African Unity

Parties	*Entry into force (day/month/year)*	*Parties*	*Entry into force (day/month/year*
Central African Emp.	16/4/1970	Niger	26/2/1970
Djibouti	7/5/1978	Nigeria	7/5/1974
Egypt	12/5/1972	Senegal	24/2/1972
Ghana	9/10/1969	Seychelles	14/11/1977
Ivory Coast	9/10/1969	Sudan	30/11/1973
Kenya	9/10/1969	Swaziland	9/10/1969
Madagascar	23/10/1971	Tanzania	22/12/1974
Malawi	6/4/1973	Uganda	30/12/1977
Mali	3/7/1974	Upper Volta	9/10/1969
Morocco	11/12/1977	Zaire	13/11/1976

Convention on International Trade in Endangered Species of Wild Fauna and Flora

Date of adoption	3/3/1973	Date of entry into force	1/7/1975
Place of adoption	Washington	Depositary	Switzerland

Parties	*Entry into force (day/month/year)*	*Parties*	*Entry into force (day/month/year)*
Australia	27/10/1976	Mauritius	27/07/1975
Bahamas	20/06/1979	Monaco	18/07/1978
Bolivia	04/10/1979	Morocco	14/01/1976
Botswana	12/02/1978	Nepal	16/09/1975
Brazil	04/11/1975	Nicaragua	04/11/1977
Canada	09/07/1975	Niger	07/12/1975
Chile	01/07/1975	Nigeria	01/07/1975
Costa Rica	28/09/1975	Norway	25/10/1976
Cyprus	01/07/1975	Pakistan	19/07/1976
Denmark	24/10/1977	Panama	15/11/1978
Ecuador	01/07/1975	Papua New Guinea	11/03/1976
Egypt	04/04/1978	Paraguay	13/02/1977
Finland	08/08/1976	Peru	25/09/1975
France	09/08/1978	Senegal	03/11/1977
Gambia	26/11/1977	Seychelles	09/05/1977
German Dem. Rep.	07/01/1976	South Africa	13/10/1975
Germany, Fed. Rep.	20/06/1976	Sri Lanka	04/05/1979
Ghana	12/02/1976	Sweden	01/07/1975
Guatemala	05/02/1980	Switzerland	01/07/1975
Guyana	25/08/1977	Tanzania	26/02/1980
India	18/10/1976	Togo	23/01/1979
Indonesia	26/03/1979	Tunisia	01/07/1975
Iran	01/11/1976	United Arab Emirates	01/07/1975
Israel	16/03/1980	United Kingdom	31/10/1976
Italy	31/12/1979	United States	01/07/1975
Jordan	14/03/1979	U.S.S.R.	08/12/1976
Kenya	13/03/1979	Uruguay	01/07/1975
Liechtenstein	28/02/1980	Venezuela	22/01/1978
Madagascar	18/11/1975	Zaire	18/10/1976
Malaysia	18/01/1978		

Convention on the Conservation of Migratory Species of Wild Animals

Date of adoption	23/6/1979
Place of adoption	Bonn
Date of entry into force	—
Depositary	Federal Republic of Germany
Open for signature	Bonn, to 22/6/1980

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Problems of Enforcing Sea Turtle Conservation Laws in Developing Countries

ABSTRACT

Sea turtle conservation laws should cover the turtles themselves, their eggs, and their habitats with special reference to nesting beaches and forage grounds. In some countries, the problems start here. There may be no specific conservation laws for sea turtles, or the laws may be inadequate in terms of scope or penalties. This situation may be a result of jurisdictional ambiguities. It is not always clear which governmental department or bureau has jurisdiction over sea turtles.

The actual implementation or enforcement of the laws may be regarded from various aspects. The geography of island nations and archipelagoes makes the task difficult. The majority of these are developing countries in the tropics.

When the inhabitants of these countries are considered, several points come to light. By definition, the economies of these countries are smaller than those of the developed nations. Consequently, economic pressures, if not actual survival needs, may make some members of the population oblivious of conservation laws. Sometimes, the problem is plain ignorance of the law. Some of the people have not received adequate education and hence are unaware of conservation concepts. In other situations local populations may have traditional rights and practices which are not superseded by the national or general laws. The continued exercise of these traditional practices would not be problematical except that the populations of these countries have increased so much that the exploitation of sea turtles may have reached dangerous levels.

Enforcement agencies in some developing countries may be hampered in their conservation law activities. Too often there are not enough enforcers or wardens. Similarly, their equipment (such as patrol craft) may be insufficient, as may be the operational budget. Then, there is always the problem of the laxity for one reason or another of a certain percentage of the police force. In some countries, all this may be further complicated by a widespread or regional degeneration of the peace

and order.

Other factors such as the external world demand for turtles and turtle products, the profit motive of the middleman, and the inadequacy of public information contribute to the difficulty of conservation law enforcement.

Introduction

This paper draws heavily on the author's familiarity with problems of enforcing marine resource conservation laws, especially with respect to corals. Difficulties in enforcement are quite similar for the various marine resources and for most developing countries.

The treatment of the topic is from a general viewpoint without indicating specific countries. Time constraints in the preparation of the manuscript imposed this format. The reader is referred to the papers of Navid and Bavin in this volume for some of the specific laws concerning sea turtle conservation. As may be noted, these laws may refer to the turtles themselves, to their eggs, or to their habitats.

The Inadequacy of Laws

Not all countries with sea turtles have conservation laws to protect these resources. In some countries, the laws concerning sea turtles may be inadequate in scope or in strength. For example, some laws protect the turtles but do not cover the eggs. Few countries have laws protecting turtle habitats. If there are protective regulations covering rookeries, there may be none protecting the feeding grounds, or vice versa. In some situations, laws protecting habitats may have as their primary object some other commodity and apply only incidentally to turtles. An example of this are protected coral reef areas where hawksbills are known to forage.

If the penalties for the violation of conservation laws are light, unscrupulous traders may disregard the laws and pay the fines from the profit of their harvest.

Jurisdictional Ambiguity

Jurisdictional ambiguity may appear trivial on the surface, but in some countries it may be a real issue. Jurisdiction over sea turtles may be ambiguous or overlap with respect to agencies concerned with sea turtles. This usually results in poor enforcement especially if the wrong agency is given the jurisdiction. In most countries marine turtles fall under fisheries departments while in others they are under the wildlife or forestry departments, or both. The rationale here is that while they are in the water, they are fisheries resources; when on land, they are wildlife species. Needless to say, the departments or agencies concerned do not have equal law enforcement capabilities.

Problems in Implementation

Even where laws leave no jurisdictional ambiguities, problems of enforcement may arise due to several other factors.

The first difficulty may be one of geography or physiography. Many developing countries are island nations or archipelagoes. One needs only to consider the South Pacific island countries and such archipelagoes as the Philippines with some seven-thousand islands and Indonesia with nearly twice that number. It is physically impossible to watch every island visited by marine turtles. Dangerous reefs or weather conditions make many of these islands inaccessible by sea. As for land travel, many islands have poor or no roads to turtle beaches. These constraints make it very difficult, if not impossible, for law enforcers to cover much of the area where turtles are found. On the other hand, hunters and traders who are familiar with local conditions or who employ local inhabitants often gain access to turtles in these areas.

The second difficulty arises from the subject people. In developing countries, many coastal people are subsistance fishermen or hunters. Economic pressures to support families, usually large, may make some members of the population oblivious of conservation laws. When the dictum is "Anything that moves is fair game," turtles will not be spared. When fishing is poor, a large piece of protein that swims by is not going to be protected by its carapace and plastron. If it is a question of food on the table or obeying the law, one can guess what the choice will be. Then, too, many rural peoples have never even heard of the laws promulgated in the city.

Another scenario may be that of simple, uneducated folk who cannot understand new conservation regulations promulgated by their government as a result of the recommendations of a distinguished group of turtle biologists and other authorities gathered in Washington, D.C. to save the turtles from extinction. They may never even have heard of Washington, much less of "missing arribadas." And what they cannot understand, they cannot accept and follow.

Mention has been made in this conference of traditional rights and practices that are not superseded by national legislation. The exercise of such traditional rights would not normally be problematical except for the fact that the populations have outstripped the traditions. Because of large human populations in many countries, some traditional practices need to be modified.

The third difficulty in enforcement pertains to the law enforcement agencies. Too often there are not enough police or wardens. Even if the personnel is sufficient, the equipment may be insufficient. Patrol craft and land vehicles are often scarce. Should there be alternate modes of transport, operational funds may be inadequate. If there is only a small budget for travel, the enforcers cannot go to the field.

The financial inadequacies may manifest themselves in other ways. A poorly paid warden may not do his job conscientiously especially if it entails risks. Unscrupulous traders may offer the poorly paid civil servant with incentives to apply the law more strictly in some areas while leaving other areas unpatrolled. Related to this is the problem of favoritism or selective enforcement because of bonds of blood or friendship. Extended families are commonplace in developing countries.

Banditry and the breakdown of peace and order are conditions more likely to prevail in developing countries than in developed areas. An unstable region makes the enforcement of conservation measures more difficult.

Other Problems

Conservation problems in developing countries often arise or are aggravated because of external factors. Poaching by foreign vessels in the territorial waters of developing countries is one example. More often, it is world demand for turtles and turtle products that leads to the depletion of resources in developing countries because some of the local inhabitants are only too eager to earn foreign exchange. In these conditions, profit seeking middlemen can prosper by putting conservation low in their list of priorities, and subsistence fishermen and hunters are often exploited by their own countrymen.

Related to this is an inadequate public information system that leaves even conscientious citizens ignorant about the issues. This ignorance may extend to government officials in different parts of the administration who may unwittingly contribute to the negation of conservation measures. Thus, while the departments involved in conservation may be trying their best, other departments dealing with trade, cottage industries, or export promotion may continue to follow policies that conflict with conservation.

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Enforcement of Restrictions on Importation of Sea Turtle Products

Without a doubt commercial trade has a devastating effect on sea turtle populations. We know that sea turtle products remain in great demand in the international market-place. I believe that controlling their importation and exportation throughout the world is one of the most effective methods of sea turtle conservation. In order to control this commercial trade, we have established an elaborate import control system.

Before discussing these control mechanisms let me emphasize that I do not suggest that our procedures should be implemented by other nations. However, these procedures work for us, and there may be some techniques that would be helpful to other nations depending on their location, capabilities, and problems.

First, let me briefly explain the federal laws which give us the power to protect sea turtles. For many years our states have enforced laws which protect nesting sea turtles and their eggs. These laws restrict the taking, possessing, and selling of turtles, their eggs and products as well as destruction of their nests. In addition federal law protected sea turtles on federal refuges for many years. But it was not until the Lacey Act was amended in 1969 that the Federal Government was authorized to enforce restrictions on sea turtle importations. The Lacey Act is a law originally enacted in 1900 which makes it a federal crime to import into the United States any wildlife that has been taken, transported, possessed or sold in violation of the law of a state or a foreign country. The 1969 amendments made this statute applicable to sea turtles for the first time.

Also in 1969 the Endangered Species Act was passed which imposed importation prohibitions on species listed by the Secretary of the Interior as endangered. This law was replaced in 1973 by a new act which allows the Secretary to compile a list of endangered species, that is those in danger of extinction, and threatened species, defined as species which if not protected may become endangered within the foreseeable future.

In 1970 the hawksbill, leatherback and Kemp's ridley were listed as endangered. In 1978 certain populations of the green turtle and olive ridley were listed as endangered and all other populations listed as threatened. Also in 1978 the loggerhead turtle was listed as threatened. All of that may sound very complicated to someone who is trying to differentiate between the threatened and endangered status of certain populations. Nevertheless, from an enforcement standpoint, importation of such turtles or their parts or products is prohibited without a proper permit.

In September of 1978 Cayman Turtle Farm filed suit to prevent us from enforcing such restrictions against their products. Pending the outcome of this review the regulations were not applied to products from their operation. In May of 1979 the U.S. District Court for the District of Columbia ruled that these restrictions do apply and importation was prohibited. Presently all U.S. restrictions apply to all such turtles and their products.

The United States is also a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), and the provisions of this Convention apply to the importation and exportation of sea turtles and their products.

In summary, without proper scientific permits it is unlawful for any person to import into the United States any of the six sea turtles which are listed as threatened or endangered. In addition, it is unlawful to sell any of these sea turtles or their products in interstate or foreign commerce, or to transport them in interstate or foreign commerce in the course of a commercial activity.

Now let us look at how the United States enforces these sea turtle restrictions. There are over 300 Customs ports of entry where persons and cargo can enter the United States legally. All of these ports of entry are staffed by officers of the U.S. Customs Service, and they are authorized to enforce laws and regulations concerning fish and wildlife importations, including sea turtles and their products. The U.S. Customs Service is the initial screen, and we rely heavily on them to interdict illegal wildlife importations. Backing up the Customs Service are Special Agents and Wildlife Inspectors of the U.S. Fish and Wildlife Service. In addition, the National Marine Fisheries Service has enforcement officers who work closely with us to provide federal protection to sea turtles.

One of our basic enforcement tools is the "designated port of entry." There are only eight of the over 300 Customs ports designated for general wildlife importations. These are: New York, Miami, New Orleans, Chicago, Los Angeles, San Francisco, Seattle, and Honolulu. All wildlife importations, with certain exceptions, must enter the United States through one of these 8 designated ports. One exception is for certain personal effects that accompany the traveler. Another exception is by permit which allows importations at specific nondesignated ports during specified periods of time. These are subject to inspection so that control is still maintained. There are also exceptions to the designated port requirement along the Canadian and Mexican borders for importation and exportation of wildlife which originate in either country. Basically, all wildlife entering the United States through commercial channels from other than Canada or Mexico must enter at one of the eight designated ports. Thus, we funnel most wildlife importations into a few major ports where close screening can be performed. If wildlife arrives at a nondesignated port, the Customs officer simply redirects the shipment to proceed in bond to the nearest designated port.

At each of the designated ports the U.S. Fish and Wildlife Service employs Wildlife Inspectors. These inspectors are trained in wildlife identification and the intricacies of wildlife law which relate to import restrictions on all fish and wildlife and their parts or products. When Customs officers discover a wildlife shipment, they refer it to our Wildlife Inspectors who determine whether the shipment may legally enter the country.

To assist these Wildlife Inspectors in performing their job we have a special wildlife importation and exportation declaration form which must be filled out before most wildlife can be legally imported into the United States. These declarations include the name and address of the consignee and consignor, a description of the wildlife by common and scientific name, quantity involved, declared value, and country of origin. The importer must also declare that any foreign wildlife permits required have been obtained and are accompanying the shipment and that the shipment is otherwise legal under all foreign and domestic law. It is also the responsibility of the importer to properly identify and declare the wildlife which is being presented for entry.

We also have regulations which require that all containers and packages containing wildlife and wildlife products be conspicuously marked on the exterior of the package with the name and address of the shipper and the consignee and a complete description of the number and kinds of wildlife included in the package or container. For extremely valuable shipments a special permit can be issued to allow a symbol to be marked on the container in lieu of the other information. Marking of containers is important because it alerts Customs officers and Wildlife Inspectors that wildlife is contained in a particular shipment and thus requires special scrutiny. Often unscrupulous importers and exporters move wildlife in packages labeled machine parts, old clothing, leather goods or under some other description which does not come close to wildlife. It is obvious to us that this is an area where wildlife smugglers feel threatened and it provides a valuable enforcement tool.

Wildlife Inspectors make physical inspections of wildlife shipments as an additional means of gaining compliance. It is impossible for us to inspect physically all wildlife shipments; so our inspectors spot-check shipments or portions of shipments. They inspect the contents of the packages and containers as well as all accompanying documents, permits, and other papers. We attempt to do a paper inspection of every shipment and a physical inspection of as many shipments as is possible given the manpower resources and the volume of shipments at the particular time.

Each wildlife importation is subject to special clearance procedures by the U.S. Fish and Wildlife Service. Before the Customs Service allows a wildlife shipment to enter domestic commerce and "clear Customs," it requires our Wildlife Inspectors or agents to stamp the wildlife declaration and other import documents cleared for entry.

On many occasions wildlife shipments arrive with incomplete foreign documents or without the requisite importation permits. These shipments are held in Customs custody or released under bond pending the receipt of the required documents. If the appropriate documents are not forthcoming in a reasonable period, the matter is turned over to a Special Agent of the U.S. Fish and Wildlife Service for investigation. In addition, even after clearance has been granted by a Wildlife Inspector and the shipment has entered the country, we can use a procedure called "post clearance investigation." That system is invoked where we have released a shipment erroneously and discovered additional information that indicates the shipment is illegal. Clearance by a Wildlife Inspector is not a certificate of legitimacy and post clearance investigations are a possibility.

Under our new system of licensing, all persons in the business of importing or exporting wildlife or their parts or products will have to obtain a specific license from the U.S. Fish and Wildlife Service to engage in such business. This licensing system will not only furnish names and addresses of all people in the wildlife importing and exporting business so that we may communicate with them regarding laws, regulations and procedures, but it will also require them to keep books and records and make reports, as we deem appropriate, concerning their import and export activities. It will also allow us to inspect their facilities to verify their compliance with wildlife statutes. We expect this new enforcement tool to be very productive in bringing about compliance.

All of these tools give us an effective system for enforcing importation laws. We know, however, that there is still illegal traffic in wildlife. We are doing our best to interdict these illegal shipments, but there are several problem areas.

First of all, the sheer volume of wildlife importations is staggering. In 1978 alone over 13.1 million wildlife hides and skins were imported, along with 368,000 live birds, 2.5 million live reptiles and amphibians, 152,000 game trophies, 260 million tropical fish, and over 187 million individual products manufactured from wildlife. These figures are particularly staggering when you realize that they include only declared and documented shipments which are ostensibly legal. Smuggled wildlife, of course, is not declared and therefore not included in these figures. The exact extent of illegal traffic is unknown, but based on actual seizures and intelligence we believe it may run as high as 10 to 25 percent of total wildlife shipments depending on the species involved.

Another major problem is the tourist traffic, that is, the individual traveler who goes abroad and buys wildlife items, including sea turtle products, and brings them back to the United States. Under our domestic legislation there is no exception, and a tourist cannot bring into the country a sea turtle product that he has purchased abroad. The problem is obviously the same as for declared shipments, that is, the sheer volume of passengers entering the United States every year makes it impossible for either Customs or the Fish and Wildlife Service to adequately inspect for such items. Tourists bringing back wildlife items cannot be required to come through specific designated ports. Therefore, they often escape undetected unless a sharp Customs inspector recognizes a declared item as coming from sea turtle or some other prohibited species.

To assist tourists and others in understanding the restrictions on wildlife importations, the Fish and Wildlife Service has conducted and will continue to conduct a public relations and education program. We have been quite successful during the past year in interesting numerous newspaper reporters and magazine writers in the problem of illegal wildlife commercialization. A number of major metropolitan daily newspapers and national magazines have printed articles on wildlife smuggling and the effect illegal trade has on wildlife populations. By encouraging reporters covering these stories, we have reached millions of Americans throughout the nation. We have also worked with television and radio. Two of the 3 major networks, ABC and NBC, did segments on wildlife smuggling on evening and weekend news earlier this year. Several members of our enforcement staff have participated in radio talk shows and were interviewed on local stations and National Public Radio.

Another valuable and extremely effective tool has been our series of widely used TV and radio spots. The 3 television spots were distributed to 450 television stations—or 60 percent of the U.S. television market—in early 1975 and were used by some stations as long as 4 years. We conservatively estimate that over 60 million people saw one of the spots the first year it was aired.

Another part of our public relations effort is the distribution of fact sheets and a brochure aimed primarily at tourists, called "Facts About Federal Wildlife Laws." The Fish and Wildlife Service has distributed about 35,000 copies of this brochure annually, and expects to distribute another 50,000 copies in 1980. We also distribute the brochure in bulk to U.S. Customs facilities at our major ports of entry, and to U.S. Embassies and Consulates abroad for direct distribution to tourists preparing to enter the United States.

The forensic identification of sea turtle parts and products presents another major problem. Often, turtles seized as evidence have been processed into frozen meat, turtle oil, and tortoiseshell products. At this point, the identification of the species-origin of the turtle product is by no means a trivial project. The forensic examiner not only has to determine the species of the turtle involved, but must also demonstrate to a scientific certainty that the meat or oil is of turtle origin and not of any other processed animal species. Clearly, the examiner testifying in such cases needs an extensive background in the identification of animal tissues in general as well as specific expertise in identifying the physiological characteristics that distinguish individual turtle species.

Today, the Fish and Wildlife Service is in a position to coordinate the diversity of wildlife identification expertise in the scientific community in order to prosecute federal wildlife violators. Our Forensic Science Branch is contacting experts in turtle-product identification for the purpose of unifying and coordinating our ability to identify commercial wildlife products. For those of you who have not been contacted yet, and who are interested in becoming involved in our efforts to coordinate and resolve some of the existing problems in forensic identification of turtle products, we would be most happy to work with you.

In summary, commercial trade most certainly has had a devastating effect on sea turtle populations. There continues to be great demand in the international marketplace for sea turtle products. It has been our experience that so long as the demand exists, an illicit supply will emerge to meet that demand. U.S. law enforcement agencies intend to enforce our import controls aggressively, and we expect our efforts to take U.S. nationals out of the marketplace and remove the U.S. dollar as an incentive to the commercialization of sea turtles. We also stand ready to cooperate to the best of our ability with other nations similarly interested in the future of sea turtles.

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Sea Turtles, Animals of Divisible Parts: International Trade in Sea Turtle Products

Introduction

Most parts of sea turtles are of potential commercial value; the shell can be used for jewelry and ornaments; the skin of the flippers and neck can be tanned and used for leather articles; the meat is consumed; the offal is used in soup; the oil is used as a cosmetic base.

There are 7 species of sea turtle, but only 3 are heavily exploited for trade: the green turtle, *Chelonia mydas*, the olive ridley turtle, *Lepidochelys olivacea*, and the hawksbill turtle, *Eretmochelys imbricata*. The green turtle is taken for its meat, and its calipee/calipash (belly cartilage), neck, and tail bones are used in manufacturing turtle soup. The olive ridley is captured mainly for its skin and secondarily for its meat and oil. Due to the thickness and color pattern of the scute, the hawksbill has the most valuable shell.

In this report, we present world trade data on sea turtle products and identify importing and exporting countries and trade routes. The impact of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) on trade is assessed. All sea turtles (except some Australian populations) were on Appendix I of CITES by February 1977, thus prohibiting commercial trade in their products by party states.

Most of the data in this paper have been obtained from trade records published by government statistical offices and from CITES annual reports compiled by party states. Unfortunately, many countries do not list the import-export of turtle products under separate tariff headings, and these were inferred whenever possible from other countries' trade statistics. For example, Cuba does not list export trade statistics for turtle shell by volume, but this can be deduced, in part, from the amount of shell that Japan reports importing from Cuba.

Some countries separate tortoiseshell into a number of categories; most commonly "tortoiseshell" (bekko in Japan) is listed separately from "claws and waste" of tortoiseshell. To simplify the data, all categories of raw tortoiseshell (BTN tariff heading 05.11 and SITC tariff heading 291.11), and all categories of worked tortoiseshell (BTN tariff heading 95.01 and SITC tariff heading 899.110) have been added together.

Government statistics are well known for being inaccurate, and many discrepancies exist between the volume and value of imports and exports recorded by pairs of countries. These are due to a number of factors, including variations in classification of commodities, methods of recording (e.g. imports may be recorded with country of "origin" or of "consignment"), methods of valuation and exchange conversion, time lags between departure and arrival at country of destination, transportation charges and import duties. Where discrepancies are large, there is good reason to believe that illegal transactions may be taking place (Bhagwati 1974).

International Import and Export: Trade Statistics and Routes

Tortoiseshell Trade

Most of the tortoiseshell trade is believed to be from the hawksbill sea turtle. Wild green and olive ridley turtle scute is approximately 0.5-mm thick, and, while too brittle for jewelry or ornaments, it can be used as delicate inlays and veneer on furniture (King, personal communication, 1979). The intricate design and distinct gradations in color make the carapace the choice part of the hawksbill shell. The edge of the shell (referred to as hooves or claws) is thick and irregular, and both this and the plastron are less valuable than the carapace.

Since 1976, 45 countries within the range of wild populations are known to have exported raw (unworked) tortoiseshell (Table 1). According to government statistics, the major exporters of raw tortoiseshell between 1976 and 1978 were Indonesia, Thailand, the Philippines, India, and Fiji (Table 1). Export statistics are available for few tropical countries, but the figures estimated from importing countries' data show that the Caribbean and Central America are important sources, as is, to a lesser extent, East Africa (Table 1).

The volume of raw tortoiseshell involved in international trade has increased dramatically since the early 1970s. Between 1967 and 1970 Indonesia exported less than 10,000 kg of raw tortoiseshell annually. In 1978, it exported 219,585 kg, more than double the exports in 1977. Over 95 percent of Indonesia's exports are destined for Hong Kong, Japan, and Singapore (Tables 2a and 2b), although Hong Kong and Japan record much lower figures for their imports from Indonesia. Thailand exported between 10,000 kg and 15,000 kg of raw tortoiseshell annually between 1973 and 1975, but by 1978, exports had increased to 53,618 kg, going mainly to Hong Kong and Taiwan (Tables 2a and 2b). Indian exports rose from under 3,000 kg annually prior to 1975 to 82,855 kg in 1977 and 11,918 kg in the first 2 months of 1979 (Tables 2a and 2b). During the 1960s, the Philippines exported less than 5,000 kg annually (JTSA, 1973), but exports have risen steadily since 1975, reaching 38,145 kg in 1978. Although in the past Philippine exports of raw tortoiseshell were destined mainly for Japan, they have increasingly gone to other countries as well, particularly to Taiwan (Tables 2a and 2b). Although no country records large imports of raw tortoiseshell from Fiji (Japan records imports of about 300 kg annually in 1978 and 1979 (Table 3)), Fijian statistics show exports of large quantities since the mid-1970s (except in 1977), most of which have been destined for Japan and Europe (Tables 2a and 2b). Ecuador exported large quantities of raw tortoiseshell in 1976 and 1977 at a very low export value. This was probably olive ridley shell, a secondary product from the skin and leather trade.

The main importers of raw tortoiseshell from 1976 to 1978 were Taiwan, Hong Kong, and Japan (Table 4). Imports into Taiwan and Hong Kong have increased considerably over these three years, mainly from Indonesia and Thailand. Imports into Japan increased in 1979 (Table 3), having remained stable since 1974. Japan's imports come mainly from Asia and the Caribbean. In Europe, the main importer is West Germany (Table 4), although imports into this country have decreased since 1974 when over 28,000 kg were imported. Unfortunately, in 1978, many European countries ceased listing tortoiseshell under a separate tariff heading in their trade statistics, which makes it very difficult to monitor their trade. In the past, there have been considerable discrepancies between customs figures and figures in annual CITES reports for some countries. For example, in its annual CITES report for 1976, the UK recorded no imports of raw tortoiseshell and re-exports of 850 kg. UK customs statistics for 1976 recorded the import of 320 kg and the export of 1,742 kg. The 1977 West Germany CITES report recorded imports of 55 kg of "turtle shell," whereas West German customs recorded the import of 8,281 kg of raw tortoiseshell.

Singapore, Malaysia, and Hong Kong are the main re-exporters of raw tortoiseshell (Table 5), and all have increased their re-exports over the last few years. Malaysian re-exports leave from Sabah and are almost certainly of Philippine origin; domestic exports from Malaysia leave from Peninsular Malaya.

The data available for worked tortoiseshell in trade are more difficult to interpret; a number of countries record only values of exports and imports, and, where volumes are recorded, these may include the weights of materials such as metal and wood which go to make up the articles. However, the Far East (Indonesia, the Philippines, and Taiwan in particular) is clearly the

Table 1. Domestic exports of raw tortoiseshell (kg)

Country	*1976*	*1977*	*1978*
Asia			
Indonesia	71,373	85,577	219,585
Thailand	23,859	37,941	53,618
India	21,460	82,855	11,918[a]
Philippines	15,607	27,905	38,145
Malaysia	7,253	8,879	(9,311)[b]
Singapore	370	2,501	230
Pakistan	(745)	—	—
Maldives	(625)	(317)	(567)
Sri Lanka	2	—	—
Burma	—	(1,100)	(500)
Bangladesh	—	(4,960)	(4,150)
Vietnam	—	(1,854)	—
Laos	—	—	(781)
Indian Ocean	—	(68)	—
Total	141,294	253,957	338,805
Oceania/Pacific Islands			
Fiji	53,587	362	35,243
Solomon Isl.	(873)	(756)	(528)
Australia	(1,087)	(192)	—
Total	55,547	1,310	35,771
Central and South America			
Ecuador	12,323	37,423	—
Mexico	6,334	—	—
Panama	(5,885)	(4,450)	(6,505)
Nicaragua	(1,446)	(2,573)	(1,014)
Costa Rica	1,390	(260)	(47)
Belize	(12)	(40)	—
Honduras	—	(71)	(9)
Venezuela	(1,000)	—	—
Total	28,390	44,817	7,575
Africa			
Somalia	(5,099)	(236)	(30)
Tanzania	1,813	1,836	1,625
Kenya	1,661	872	761
Mozambique	(463)	(290)	—
Madagascar	(164)	—	—
Seychelles	(106)	(577)	(1,198)
Mauritius	(55)	—	—
Reunion	(377)	—	(46)
Cape Verde	(63)	—	—
Total	9,801	3,811	3,660
Caribbean			
Barbados	22	—	(23)
Cuba	(6,985)	(3,984)	(6,600)
Haiti	(1,219)	(1,173)	(1,004)
Cayman Isl.	(4,002)	(3,875)	(7,500)
Bahamas	(532)	(922)	(1,018)
Dominican Rep.	(367)	(1,000)	(62)

Table 1.

Country	*1976*	*1977*	*1978*
Jamaica	(343)	(1,136)	(128)
Puerto Rico	(262)	(264)	(25)
Fr. W. Indies	(152)	(236)	(276)
St. Vincent	(130)	(230)	(144)
Brit. Dominica	(126)	(507)	—
St. Lucia	—	(489)	(349)
Grenada	—	(59)	—
Total	14,140	13,875	17,129
World Total	249,172	317,770	402,940

Key
— Not available.
( ) Figures estimated from importing countries' data.
a. January and February only.
b. May include re-exports.
Source: Published government statistics.

Table 2. Exports and countries of destination for major raw tortoiseshell exporters (kg)

a. 1977

Country of destination	*Exporting country*					
	Indonesia	*India*	*Thailand*	*Philippines*	*Ecuador*	*Fiji*
Japan	55,442	6,000	—	26,259	17,038	—
Hong Kong	1,127	1,134	28,031	—	—	—
Singapore	27,920	—	5,000	—	—	—
Taiwan	—	—	4,910	1,269	—	—
Kuwait	—	50,050	—	—	—	—
Italy	95	1,699	—	25	19,861	—
Fed. Rep. Germany	—	20,816	—	—	—	—
United States	—	1,656	—	—	524	—
Other countries	993	1,500	—	352	—	362
Total	85,577	82,855	37,941	27,905	37,423	362

b. 1978

Country of destination	*Exporting country*				
	Indonesia	*India Jan–Feb*	*Thailand*	*Philippines*	*Fiji*
Japan	40,368	2,245	—	29,847	16,803
Hong Kong	125,008	—	26,990	—	—
Singapore	52,313	—	5,628	—	—
Taiwan	—	—	20,500	7,600	—
Italy	400	—	—	384	—
Fed. Rep. Germany	—	—	—	—	9,144
Spain	—	—	—	—	9,144
United States	—	9,673	—	164	—
Other countries	1,496	—	500	150	152
Total	219,585	11,918	53,618	38,145	35,343

— Not available.
Source: Published government statistics.

Table 3. Japanese imports of raw tortoiseshell (kg)

Country of origin	*1976*	*1977*	*1978*	*1979 Jan–Oct*
Asia				
Indonesia	6,464	10,114	5,735	19,068
Philippines	3,160	3,313	1,439	3,399
Singapore	3,129	4,080	1,844	2,413
Thailand	0	200	1,550	1,380
Maldives	485	317	567	1,470
Other countries	2,861	1,696	499	3,758
Subtotal	16,099	19,720	11,634	31,488
Africa				
Kenya	2,712	2,655	2,850	2,051
Tanzania	2,152	1,474	1,410	5,824
Seychelles	106	577	1,066	1,054
Other countries	777	0	46	67
Subtotal	5,747	4,706	5,372	8,996
Caribbean				
Cuba	6,985	3,984	6,600	4,475
Cayman Islands	4,002	3,863	7,500	6,312
Haiti	1,094	1,173	1,004	1,351
Bahamas	532	922	1,018	1,332
Jamaica	343	1,136	128	474
Other countries	796	1,785	879	615
Subtotal	13,752	12,863	17,129	14,559
The Americas				
Panama	5,885	4,450	6,505	4,589
Nicaragua	1,446	1,573	1,014	949
Other countries	182	371	122	412
Subtotal	7,513	6,394	7,641	5,950
Pacific				
Australia	1,087	192	6	0
Fiji	189	82	399	463
Solomon Is.	873	756	528	799
Other countries	0	0	42	0
Subtotal	2,149	1,030	975	1,262
European countries	800	1,105	1,288	3,040
Total	46,060	45,818	44,039	65,295

Source: Published government statistics.

main region exporting carved tortoiseshell (Table 6), and exports have increased from less than 24,000 kg in 1975 to over 92,000 kg in 1978. Although still destined mainly for Japan, Hong Kong, and Singapore, exports now also go directly to European countries (Table 7). Philippine exports of worked tortoiseshell reached a peak in 1976 (in 1974, only 425 pieces were exported), but they have declined slightly since then (Table 6). In the past, most went to Japan, but they are now going increasingly to European countries (Table 7), as are Taiwanese exports of worked tortoiseshell.

Japan, Italy, and West Germany have been the main importers of worked tortoiseshell since 1976 (Table 8). Japan imports primarily from Indonesia, Singapore, the Philippines, and Taiwan, although it also has its own traditional carving industry. Fiji appears to be a

Table 4. Imports of raw tortoiseshell (kg)

Country	*1976*	*1977*	*1978*
Asia			
Taiwan	52,427	37,704	128,846
Japan	46,060	45,818	44,039
Hong Kong	26,620	42,788	102,275
Malaysia	9,133	30,060	—
Singapore	4,140	21,002	18,469
South Korea	6,100	6,100	7,333
Mainland China	(3,911)	(3,381)	(3,827)
Vietnam	(2,700)	(647)	—
Thailand	1,238	2,231	2,622
Nepal	—	(1,699)	—
Kuwait	—	(50,000)	—
Total	152,329	241,430	307,411
Europe			
Federal Republic of Germany	3,937	8,281	(9,309)
Netherlands	3,000	3,000	—
Italy	2,500	3,000	(784)
Spain	1,531	824	1,080
France	1,000	1,000	(240)
Belgium	400	100	—
United Kingdom	320	26	—
Switzerland	126	39	—
Total	12,814	16,270	11,413
Americas and the Caribbean			
United States	(5,160)	(11,853)	(164)
Mexico	18,021	—	—
Canada	—	—	(50)
Barbados	—	(22)	—
Total	23,181	11,875	214
Pacific			
Fr. Pac. Isl.	(425)	(352)	(150)
New Hebrides	—	—	(102)
New Caledonia	—	(302)	—
Australia	(975)	(60)	—
Total	14,000	714	252
World total	202,324	270,289	319,290

— Not available.
( ) Figures estimated from exporting countries' data.
Source: Published government statistics.

major center for the worked tortoiseshell in the Pacific; imports have risen from US$6,605 in 1972 to US$62,718 in 1978, mainly from the Philippines and a smaller proportion from India. Fiji exports worked tortoiseshell to American Samoa, Western Samoa, and the United States.

From February 1977 until the ban on imports of farmed turtle products in June, 1979 (see later), imports of worked tortoiseshell into the United States have been limited to farmed green turtle shell from the Cayman Turtle Farm (CTF). However, a number of countries continued to report exports to the US (Table 7), and, although over this period U.S. customs officials seized approximately 1,000 hawksbill shell articles from tourists returning to the United States, this does not account for the figures recorded in other

Table 5. Re-exports of raw tortoiseshell (kg)

Country	*1976*	*1977*	*1978*
Asia			
Singapore	20,026	30,014	45,578
Malaysia	5,587	46,212	—
Hong Kong	7,497	6,471	10,128
Taiwan	2,376	338	2,233
Japan	24	274	2,258
Total	35,510	83,309	60,197
Europe			
Netherlands	64,000	2,000	—
United Kingdom	1,742	—	—
Portugal	400	200	—
Federal Republic of Germany	47	73	—
Italy	58	—	—
Total	66,247	2,273	—
World total	101,757	85,582	60,197

— Not available.
Source: Published government statistics.

countries' export statistics. Large quantities of worked tortoiseshell are sold as souvenirs in many countries; this trade goes unrecorded, and it is impossible to estimate its volume.

Turtle Skin and Leather Trade

The recent growth of the turtle skin trade is a typical example of international trade's turning to a new species for a product when the traditional source is depleted through overexploitation. In this case, turtle skin became important when the leather trade found it increasingly difficult to obtain traditional reptiles (such as crocodiles) due to scarcity, bans, and better protection in the early 1960s and 1970s. Since very few countries record turtle skin or leather under a separate tariff heading, the extent of the trade may be larger and involve more countries than we have recorded.

At present, olive ridley turtles from Mexico and Ecuador are the main source of skins. In Mexico, sea turtles are captured by fishermen who are part of fishery cooperatives. Antonio Suarez purchases most of these at present and processes them at his 3 plants on the Pacific coast of Mexico. Table 9 provides the volume and number of olive ridley turtles captured by fishermen. Each year, there is a large discrepancy between the number of turtles captured as reported by the legal fishery cooperatives to the Mexican Department of fishery and the number of turtles caught as estimated by Antonio Suarez. According to Suarez's estimates, from 1966 to 1977, an average of 130,000 olive ridleys was taken annually in the states of Oaxaca, Michoacan, and Jalisco.

Since 1975, it has been illegal to export raw turtle skin from Mexico (Mârquez, in litt., 1979), and, as a result, most exports are now in the form of leather. In 1976, 22 kg of turtle skins were exported from Mexico, whereas exports of turtle leather rose from 10,041 kg in 1974 to 23,787 kg in 1976, with most of it destined for the United States and Japan. However, there appears to be a large scale illegal trade in raw skins, since Japan records imports of over 50,000 kg of raw turtle skins from Mexico since 1976 (Table 10).

The trade in olive ridley skins in Ecuador is discussed in detail in the paper by Green and Ortiz in this volume. Three companies are still exporting turtle skins, mainly to Japan and Italy. 161,070 kg of skins were exported in 1978, and 139,900 kg were exported in the first 6 months of 1979.

A third important source of skins is from the farmed green turtles from the Cayman Turtle Farm (CTF). Japan imported 23,514 kg of skin in 1978 and 6,988 kg of skin in the first 10 months of 1979 from CTF. The United States imported 14,000 pieces of skin from CTF in the first 5 months of 1979, before the ban on the import of farmed products came into force, and, in 1978, West Germany imported 2,603 skins from CTF, according to its CITES report.

Japan imports large quantities of skins from Asian countries, in particular, the Philippines, Singapore, Indonesia, and Pakistan; these may be from wild green or olive ridley turtles (Table 10). Japan has been recording imports of turtle skin and leather since 1976 (Tables 10 and 11) and is probably the largest consumer of skins in the world. From 1976 to 1978, Japan

Table 6. Exports of worked tortoiseshell (kg and US dollars)

Country	1976 Volume	1976 Value	1977 Volume	1977 Value	1978 Volume	1978 Value
Asia						
Indonesia	69,065	396,629	90,792	531,813	92,099	340,533
Philippines	24,330[a]	23,630	11,615[a]	64,306	7,835[a]	95,524
Taiwan	6,044	49,868	2,984	48,000	2,218	100,259
Japan	40	20,081	91	25,511	37	19,057
South Korea	62	13,027	85	9,138	—	—
Thailand	27	5,672	3	673	3	2,439
India	249	4,431	349	2,477	—	—
Singapore[b]	—	2,092	—	10,356	—	23,063
Malaysia[b]	—	39	—	2,033	—	—
Total	75,487	515,469	94,304	694,307	94,357	580,875
Europe						
Italy	700	41,363	1,400	30,382		
United Kingdom	1,725	26,555	525	7,475	—	—
Spain	1,000	4,977	1,000	4,265	—	—
Federal Republic of Germany	18	2,383	4,700	1,723	—	—
Belgium	500	11,579	0	0	—	—
Switzerland	54	1,440	7	1,004	—	—
Netherlands	0	0	—	1,630	—	—
France	1,157	11,507	1,071	27,069	—	—
Total	5,154	99,804	8,703	73,548	—	—
Other countries						
Mexico	76	1,763	—	—	—	—
Fiji[b]	—	4,711	—	9,498	—	8,052
Total	76	6,474	—	9,498	—	8,052
World total	80,717	621,747	103,007	777,353	94,357	588,927

— Not available.
a. Number of pieces (not included in totals).
b. Only values available for these countries.
Source: Published government statistics.

imported an average 10,061 kg of leather (98 percent from Mexico) and 92,198 kg of skins yearly (over 50 percent from Ecuador). In the first 10 months of 1979, Japan imported 159,728 kg of turtle skin and 19,274 kg of turtle leather, which is a considerable increase on previous years.

There is now a considerable market for turtle leather products in a number of European countries. Italy may be the main importer, importing large numbers of skins from Ecuador (see Green and Ortiz, this volume), and Spain and France may also be important centers for the turtle leather trade. West Germany imported CTF skins in 1978 and re-exported a number to Switzerland; turtle leather products are seen on sale in the United Kingdom.

The United States was a major consumer of skin and leather before CITES and U.S. legislation were introduced. From January to May 1977, the United States imported over 31,000 pieces of olive ridley skins and almost 3,000 turtle skin leather articles (shoes) from Mexico (Table 12). In May 1977, the United States banned the import of wild turtle products, but, in 1978, import permits show that 5,706 pieces of wild olive ridley skin from Mexico were illegally imported. The 1978 United States CITES report records the import of 2,000 olive ridley skins from Mexico. In 1979, imports were recorded only from CTF. Only a few shipments of wild turtle leather articles have been seized since 1977: 448 items in 10 shipments (Table 12).

Table 8. Imports of worked tortoiseshell (kg–US dollars)

Country	1976 Volume	1976 Value	1977 Volume	1977 Value	1978 Volume	1978 Value
Asia						
Japan	113,286	874,507	101,674	757,462	97,605	847,422
Singapore[a]	—	15,884	—	13,980	—	17,306
Malaysia[a]	—	5,793	—	8,024	—	—
South Korea	9	1,926	0	0	—	—
Thailand	905	1,796	0	0	2,100	3,603
Taiwan	0	0	0	0	15	486
Indonesia	0	0	11	50	0	0
India	—	—	801	2,104	—	—
Total	114,200	899,906	102,486	781,620	99,720	868,817
Europe						
Italy	109,300	19,135	50,200	20,169	—	—
France	8,125	197,715	2,963	93,418	—	—
Federal Republic of Germany	1,058	26,211	22,434	252,390	—	—
Belgium	3,100	24,997	500	7,729	—	—
United Kingdom	112	19,872	777	21,100	—	—
Spain	25	10,463	1,000	39,175	—	—
Switzerland	359	6,270	51	5,249	—	—
Netherlands	2,000	5,295	2,000	6,519	—	—
Malta[a]	—	614	—	1,334	—	—
Total	124,079	310,572	79,925	447,083	—	—
Other						
Fiji[a]	—	29,189	—	44,815	—	62,718
Mexico	2	257	—	—	—	—
Total	2	29,446	—	44,815	—	62,718
World total	238,281	1,239,924	182,411	1,273,518	99,720	931,535

— Not available.
a. Only values available.
Source: Published government statistics.

tortoiseshell souvenirs, most of this trade goes unrecorded.

There are also very few data available on trade in turtle oil. This is processed in Mexico and at CTF and may be exported to a number of countries for use in beauty creams. During the first quarter of 1979, U.S. Customs at New Orleans confiscated 107 turtle products from U.S. tourists; over half of the products confiscated were turtle creams mainly from Mexico.

Turtle Farming

Although turtle farming has been considered for many years as a practical method of harvesting turtles commercially, it was not until 1968 that the first carefully planned sea turtle farm was established by American and British interests under the name of Mariculture, Ltd., on Grand Cayman Island. As a "seed" stock, several thousand green turtles were imported and raised during the first year of operation (Rebel 1974).

Following their first year, Mariculture imported approximately 60,000 doomed eggs annually from the beaches of Surinam and hatched them in their facilities. These young turtles were either used to supplement the breeding stock or were killed and sold as turtle products.

In 1975, Mariculture, Ltd., was liquidated, sold to a consortium of British and West German industrialists and the Cayman Island government, and renamed the Cayman Turtle Farm (CTF). In March 1978, it ceased obtaining eggs or adults from the wild (Johnson, personal communication, 1979).

During the March 1979 CITES meeting in Costa Rica, the parties defined "farmed animals" as those

Table 7. Exports and countries of destination for major worked tortoiseshell exporting countries, 1978

Country of destination	Exporting countries: Indonesia kg	Philippines pieces	Taiwan kg	Fiji US dollars
Japan	47,150	6,344	515	—
Hong Kong	25,369	—	—	—
Singapore	16,575	—	—	—
Mainland China	2,200	—	—	—
Federal Republic of Germany	7	1,176	9	—
Italy	200	155	18	—
Spain	—	—	440	—
France	66	—	146	—
Belgium	269	—	—	—
Netherlands	30	—	—	—
United Kingdom	—	100	1	—
Australia	233	60	—	—
United States	—	—	337	477
American Samoa	—	—	—	7,386
Western Samoa	—	—	—	189
Other countries	—	—	752	—
Total	92,099	7,835	2,218	8,052

— Not available.
Source: Published government statistics of exporting countries.

Sea Turtle Meat Trade

Most green turtles that are taken for their meat are consumed locally, and, where they are exploited for international trade, the use of their meat may be secondary only to the use of their skin. In the past, calipee was the main export product since it could be dried and easily transported. Many New World countries killed turtles for meat in the early 1970s (Rebel 1974), and Nicaragua, Mexico, Ecuador, and Costa Rica were the largest exporters according to U.S. import statistics (Table 13). Both Nicaragua and Costa Rica have since curbed or stopped this trade, and Mexico and Ecuador have few buyers for their meat, although illegal shipments and smuggling of Mexican and Ecuadorian meat are known to occur. Crates of olive ridley meat have been labelled as green turtle for export from Ecuador (Ortiz, personal communication); further information on the Ecuadorian meat trade is to be found in the paper by Green and Ortiz in this volume.

Today, CTF is probably the largest exporter of green turtle meat in the world, since many countries are now restricted to imports of "farmed" turtle meat due to CITES regulations on the trade of wild sea turtle products. Prior to the U.S. ban on the import of farmed turtle products, all CTF meat was exported via the United States through the port of Miami. Large quantities were imported for domestic consumption as well as for re-export (Table 14). However, considerable discrepancies exist between the available figures for imports up to the time of the ban (Table 15). The reasons for these discrepancies have not yet been ascertained, but they emphasize the problems of obtaining reliable information in order to monitor the wildlife trade.

Since the U.S. ban on farmed products, West Germany and the United Kingdom have become the main importers of turtle meat, calipee/calipash, etc., from CTF. A number of firms in Europe manufacture turtle soup, and turtle steak is seen increasingly on restaurant menus. The 1977 West German CITES report recorded the import of 31,819 kg of turtle meat from CTF and 18,568 kg from Somalia. The latter import was prior to April 1977, when green turtles (other than farmed ones) were added to CITES Appendix I; the 1978 report recorded the import of 2,370 kg of meat from CTF and the re-export of over 17,000 kg to the United Kingdom and smaller quantities to Denmark and France. The 1977, U.K. CITES report records the import of 3,072 kg of tail and neck bone and 907 kg of calipee from CTF; in 1978, 1,088 kg of tail and neck bone were imported. Between January and November 1979, U.K. licenses had been taken up for the import of 375 kg of steak, 4,082 kg of neck and tail bone, 6,019 kg of calipee/calipash, and 2,718 kg of skinned flipper. This is a considerable increase from the 1978 imports. Switzerland imports meat and calipash from West Germany and, in 1978, re-exported 318 cartons of soup to Canada. Japan may also be a major consumer of turtle meat, but no data are available.

Other Turtle Products

Although turtle eggs are collected in huge numbers for food in many countries, they do not play a large role in international trade. The only data available are for Malaysia: Sarawak imported 334,600 eggs in 1976 and 99,800 eggs in 1977 from Indonesia (species not specified), and Sabah imported 80,800 eggs from the Philippines in 1976. Malaysia also re-exports eggs to Brunei. Turtle egg trade in Central America is discussed by Cornelius in this volume.

Stuffed turtles have become a very important product for the tourist souvenir trade. Large numbers of adult and juvenile hawksbills and green turtles are stuffed or freeze-dried in countries such as Indonesia, the Philippines, the Maldives, the Seychelles, Thailand, Madagascar, and Panama. Japan is probably the main consumer, but tourists from European countries such as the United Kingdom continue to buy them. As with

Table 8. Imports of worked tortoiseshell (kg–US dollars)

Country	1976 Volume	1976 Value	1977 Volume	1977 Value	1978 Volume	1978 Value
Asia						
Japan	113,286	874,507	101,674	757,462	97,605	847,422
Singapore[a]	—	15,884	—	13,980	—	17,306
Malaysia[a]	—	5,793	—	8,024	—	—
South Korea	9	1,926	0	0	—	—
Thailand	905	1,796	0	0	2,100	3,603
Taiwan	0	0	0	0	15	486
Indonesia	0	0	11	50	0	0
India	—	—	801	2,104	—	—
Total	114,200	899,906	102,486	781,620	99,720	868,817
Europe						
Italy	109,300	19,135	50,200	20,169	—	—
France	8,125	197,715	2,963	93,418	—	—
Federal Republic of Germany	1,058	26,211	22,434	252,390	—	—
Belgium	3,100	24,997	500	7,729	—	—
United Kingdom	112	19,872	777	21,100	—	—
Spain	25	10,463	1,000	39,175	—	—
Switzerland	359	6,270	51	5,249	—	—
Netherlands	2,000	5,295	2,000	6,519	—	—
Malta[a]	—	614	—	1,334	—	—
Total	124,079	310,572	79,925	447,083	—	—
Other						
Fiji[a]	—	29,189	—	44,815	—	62,718
Mexico	2	257	—	—	—	—
Total	2	29,446	—	44,815	—	62,718
World total	238,281	1,239,924	182,411	1,273,518	99,720	931,535

— Not available.
a. Only values available.
Source: Published government statistics.

tortoiseshell souvenirs, most of this trade goes unrecorded.

There are also very few data available on trade in turtle oil. This is processed in Mexico and at CTF and may be exported to a number of countries for use in beauty creams. During the first quarter of 1979, U.S. Customs at New Orleans confiscated 107 turtle products from U.S. tourists; over half of the products confiscated were turtle creams mainly from Mexico.

Turtle Farming

Although turtle farming has been considered for many years as a practical method of harvesting turtles commercially, it was not until 1968 that the first carefully planned sea turtle farm was established by American and British interests under the name of Mariculture, Ltd., on Grand Cayman Island. As a "seed" stock, several thousand green turtles were imported and raised during the first year of operation (Rebel 1974).

Following their first year, Mariculture imported approximately 60,000 doomed eggs annually from the beaches of Surinam and hatched them in their facilities. These young turtles were either used to supplement the breeding stock or were killed and sold as turtle products.

In 1975, Mariculture, Ltd., was liquidated, sold to a consortium of British and West German industrialists and the Cayman Island government, and renamed the Cayman Turtle Farm (CTF). In March 1978, it ceased obtaining eggs or adults from the wild (Johnson, personal communication, 1979).

During the March 1979 CITES meeting in Costa Rica, the parties defined "farmed animals" as those

Table 9. Olive ridley turtles captured in Mexico by fishery cooperatives

Year	*Take reported to government by cooperatives*		*Total take*[a]	
	Number of turtles	*Thousands of kg*	*Number of turtles*	*Thousands of kg*
Oaxaca				
1966	2,737	104	60,000	2,280
1967	84,368	3,206	120,000	4,560
1968	9,053	344	65,000	2,470
1969	53,131	2,019	60,000	2,280
1970	41,053	1,560	50,000	1,900
1971	—	—	25,000	950
1972	—	—	30,000	1,140
1973	53,046	2,015.74	90,000	3,420
1974	25,493	968.73	60,000	2,280
1975	58,575	2,225.84	70,000	2,660
1976	40,407	1,535.46	55,000	2,090
1977	56,706	2,154.85	75,000	2,850
Total	424,569	16,133.62	760,000	28,880
Av/yr	35,381	1,344.47	63,333	2,406.67
Michoacan				
1965	447	17	15,000	570
1966	26	1	15,000	570
1967	1,447	55	25,000	950
1968	1,526	58	30,000	1,140
1969	684	26	5,000	190
1970	474	18	5,000	190
1971	—	—	15,000	570
1972	—	—	10,000	380
1973	—	—	15,000	570
1974	987	37.5	10,000	380
1975	889	33.79	10,000	380
1976	1,819	69.11	5,000	190
1977	575	21.86	5,000	190
Total	8,874	337.26	165,000	6,270
Av/yr	683	25.941	12,692	482.3
Jalisco				
1968	16,687	634.11	150,000	5,700
1969	1,037	39.42	10,000	380
1970	1,055	40.08	20,000	760
1971	—	—	40,000	1,520
1972	—	—	40,000	1,520
1973	16,947	643.97	100,000	3,800
1974	19,830	753.54	40,000	1,520
1975	10,896	414.05	40,000	1,520
1976	20,057	762.16	40,000	1,520
Total	86,509	3,287.33	480,000	18,240
Av/yr	9,612	365.26	53,333	2,206.67

Note: The conversion factor from volume to number of turtles is 38kg/1 turtle.
— Not available.
a. Report by Antonio Suarez to Departamiento de Pesca, Mexico.

Table 10. Japan: Imports of turtle skin

Country	*1976 (kg)*	*1977 (kg)*	*1978 (kg)*	*1979 (Jan–Oct) (kg)*
Ecuador	40,275	62,073	40,807	120,599
Mexico	35,231	5,244	1,061	9,075
Cayman Is.	—	36	23,514	6,988
Nicaragua	883	2,322	640	—
Panama	—	—	2,546	—
United States	1,676	—	—	—
Philippines	18,610	6,408	3,857	3,600
Singapore	—	—	9,673	12,261
Indonesia	—	145	6,261	3,477
Pakistan	4,648	1,016	5,360	3,248
Taiwan	—	—	726	—
Belgium	3,283	—	—	—
France	—	—	—	480
Total	104,606	77,244	94,445	159,728

— Not available.
Source: Published government statistics.

Table 11. Japan: Imports of turtle leather

Country	*1976 (kg)*	*1977 (kg)*	*1978 (kg)*	*1979 (Jan–Oct) (kg)*
Mexico	11,065	6,835	11,646	18,256
Singapore	186	145	154	143
Belgium	—	—	—	875
Federal Republic of Germany	120	—	—	—
Netherlands	—	28	—	—
Italy	—	—	3	—
Total	11,371	7,008	11,803	19,274

— Not available.
Source: Published government statistics.

born (hatched) from parents which had mated in a captive environment. Under this definition, many sea turtle products presently sold by the Cayman Turtle Farm are not farmed, since the eggs were taken from wild populations and only hatched in their facilities; however, West Germany, the United Kingdom, and Switzerland, all CITES members, still import green turtle products originating from CTF for their luxury soup industry, in the belief that CTF will eventually become self-supporting. The United States is the only country so far to have banned the import of farmed products.

The large investment involved in raising captive turtles to a size suitable for export means that the retail products are going to be expensive; hence, they are restricted to a luxury market. At present, the main criticism of turtle farms is that they encourage and maintain a market for turtle products and, in some cases, cause wild turtle products to be sold under the guise of farmed ones at a time when many populations are seriously threatened by commercial exploitation.

Numbers of Turtles Involved in Trade

Given the inaccuracy of trade statistics and the fact that in many countries turtle products such as tortoiseshell may be stored for long periods before being exported, it is not possible to estimate actual catch numbers from trade data. However, the statistics presented in this paper point to an ever increasing quantity of turtle products on the world market at the same time as

Table 12. United States: Imports and seizures of turtle skins and leather from major ports of entry

Port of entry	1977			1978			1979 (Jan–May)		
		Seizures			Seizures			Seizures	
	Imports	No.	Quan.	Imports	No.	Quan.	Imports	No.	Quan
Miami	—	—	—	—	—	—	8,000 pc (CTF) 1 ar (CTF)	1	18 ar
Los Angeles	—	2	88 ar	—	2	2 ar	—	1	1 ar
New York	—	1	132 ar	—	1	188 ar	—	1	18 ar
SW Region (Brownsville, Laredo and El Paso)	21,732 pc* (Mexico) 10,150 sq* (Mexico) 2,987 ar (Mexico)	1	1 ar	5,706 pc* (Mexico) 4,000 pc (CTF)	—	—	6,000 pc (CTF)	—	—
Total	21,732 pc 10,150 sq	4	221 ar	9,706 pc	3	190 ar	14,000 pc 1 ar	3	37 ar

Key: * = from olive ridley turtles; pc = pieces; ar = articles; sq = squares; CTF = Cayman Turtle Farm (country of origin).
Source: 3–177 Declaration of Import Permits, courtesy of Law Enforcement Division, Fish and Wildlife Service, U.S. Department of the Interior.

Table 13. United States: Imports of turtle products by country of origin, 1966–76 (thousands of kg)

Country of origin	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976
Mexico	7.0	4.6	—	4.8	13.2	11.2	2.5	10.0	6.9	6.3	—
Nicaragua	38.3	35.5	—	—	—	—	84.4	72.2	135.9	76.5	1.2
Costa Rica	11.0	—	4.7	42.7	2.0	—	12.3	—	—	—	13.6
Ecuador	—	—	—	1.3	—	—	—	12.3	28.3	22.0	19.1
Grand Cayman	—	—	—	—	—	—	—	—	—	9.0	17.6
West Indies	—	—	—	—	—	—	.3	1.4	—	3.6	—
Jamaica	—	—	—	—	—	—	.1	5.8	—	—	—
Bahamas	—	—	—	—	—	—	.4	1.9	—	—	—
Colombia	—	—	—	3.2	—	.9	—	—	—	—	—
Guatemala	—	—	—	—	—	—	3.2	—	—	—	—
Honduras	—	—	—	—	—	13.6	—	—	—	—	—
Dominican Rep.	—	—	—	—	—	—	—	.2	—	—	—
Venezuela	—	—	—	—	—	—	—	.6	—	—	—
Yemen	—	—	—	—	—	—	—	—	10.9	—	—
The Netherlands	2.0	—	—	—	—	—	—	—	—	—	—
Total	58.3	40.1	4.7	52.0	15.2	25.7	103.2	104.4	182.0	117.4	51.5

— Not available.
Source: Derived from the National Marine Fisheries Service, NOAA, Unpublished Statistics. From Peter Pritchard with permission (in Cato, Prochaska and Pritchard, Unpublished Report, December, 1978).

scientists report ever declining numbers in most turtle populations. This suggests that the turtle catch is, in fact, increasing in many areas, although, as discussed below, the increase in volume on the world market may be due to dealers' getting rid of stocks or stockpiling in anticipation of protective legislation.

Table 14. United States: Imports of turtle meat from major ports of entry

Port of entry	1977 Quantity	1977 Country of origin	1978 Quantity	1978 Country of origin	1979 (Jan–May) Quantity	1979 (Jan–May) Country of origin
Miami	6,609 kg	CTF	8,909 kg	CTF	65,498 kg	CTF
	2,230 ct[1] (50,682 kg)		1,765 ct[1] (40,114 kg)		150 ct[1] (3,409 kg)	
	18,800 kg	Ecuador				
	1,783 ct[2] (32,418–40,523 kg)					
	1,477 kg	Costa Rica				
	400 ct[2] (7,273–9,091 kg)	Fr. W. Ind.				
West Palm Beach	21,560 kg	CTF[3]				
	114 ct[2] (2,073–3,182 kg)	Ecuador				
Total	140,892–151,924 kg		49,023 kg		68,907 kg[3]	

Note: New York, Los Angeles and the Southwest Region (Brownsville, Laredo, El Paso) did not report turtle meat imports during these years.
1. A carton (ct) of meat from CTF (Cayman Turtle Farm) contains 50 lbs. (22.7 kg).
2. A carton (ct) of meat from Ecuador and the French West Indies was estimated to contain between 40 and 50 lbs. (18.2–22.7 kg).
3. Of this total, 9,318 kg was re-exported to West Germany and 4,546 kg was re-exported to the United Kingdom.
Source: 3–177 Declaration of Import Permits, courtesy of Law Enforcement Division, Fish and Wildlife Service, U.S. Department of the Interior.

Table 15. Imports of CTF meat into the United States according to different sources

Source of data	1978	1979 (Jan–May)
U.S. Customs statistics	120,874 kg	106,157 kg
U.S. Declaration of Import Permits	49,023 kg	69,361 kg
National Marine Fisheries Service	84,950 kg	44,100 kg
U.S. CITES Report	4 kg (stew)	—

— Not available.
Sources: U.S. Customs statistics compiled by Bureau of Census, Department of Commerce. U.S. Declaration of Import Permits, Fish and Wildlife Service, Department of the Interior. National Marine Fisheries Service, Department of Commerce. U.S. CITES Report compiled by the Wildlife Permit Office, Fish and Wildlife Service, Department of the Interior.

Hawksbill Turtles

There is increasing evidence that species other than hawksbill may now be used in the tortoiseshell trade. CTF exports polished green turtle shell, and Ecuador may be exporting shell from olive ridleys. Philippine tortoiseshell exports inlcude a large number of green turtle carapaces and scutes (Alvarez, in litt., 1979). However, most tortoiseshell exports are probably still hawksbill, and the following calculation of the numbers represented by the world trade is based on this assumption.

There is considerable variation in the estimates available for the yield of tortoiseshell from a hawksbill. A further complication is that the tariff heading for raw tortoiseshell, which in many countries covers only the scutes, also covers whole carapaces in some countries (e.g. Thailand and the Philippines). The following estimates have been obtained:

Average Weight of Scutes	*Weight of Carapace*
.68 kg (JTSA 1973)	3.64 kg (Rebel 1974) (maximum commercial yield)
.91 kg (Uchida 1977)	
1.6 kg (Parsons 1972)	

These maximum and minimum estimates were used to calculate the numbers of hawksbills involved in the world trade (Table 16). These numbers must be interpreted with great care. *They are not estimates of annual catches.* Exports from a number of countries such as India, Indonesia, and the Philippines may well be tortoiseshell that has been stored. The figures in Table

Table 16. Number of hawksbills involved in world trade

Year	*Weight of raw tortoiseshell exported (excluding CTF and Ecuador)–Table 1*	*Numbers of turtles using maximum and minimum scute weight*	*Numbers of turtles using carapace weight*
1976	249,172	155,000–367,000	68,000
1977	317,770	198,000–468,000	87,000
1978	402,940	251,000–593,000	111,000

16 may possibly be overestimated, since re-exported tortoiseshell may be included in the total if a country does not list it separately from domestic exports of tortoiseshell.

The tortoiseshell export figures for many countries have been calculated from other countries' import data, and, therefore, the size of the export figure is to some extent dependent on the number of countries for which import figures were available. At the time of writing, 1978 statistics for a few countries were still not available, and, as mentioned earlier, some European countries did not record tortoiseshell separately in their trade statistics in 1978. As a result, the 1978 total may actually be underestimated. The number of hawksbills involved in trade may be even larger if worked tortoiseshell and stuffed turtles for the souvenir trade are taken into account.

Olive Ridley Turtles

From 1970 to 1977, an estimated one million ridleys were taken on the eastern Pacific coast by Mexico and Ecuador to supply the skin and leather trade (Table 9; Green and Ortiz, this volume). Skins from an estimated 85,000 ridleys were exported in 1978 by Ecuador (Green and Ortiz, this volume), and, during the same year, Mexico captured 50,000 ridley turtles (mainly gravid females) in the state of Oaxaca alone (Cliffton, in litt., 1979).

Green Turtles

In addition to the large number of olive ridleys captured in Mexico, green turtles are also taken; in 1978, fishermen in Mexico took 5,000 of them, mainly males (Cliffton, in litt., 1979).

According to Japan's import data, a number of Southeast Asian countries export turtle skins (Table 10). These skins are likely to be from green turtles, since imports of skins from most of these countries have a much lower value than Ecuadorian and Mexican ridley skins and an even lower value than the farmed green turtle skins from CTF. A wild turtle skin weighs 3.0 kg to 3.4 kg (Hirth and Hollingworth, 1973); using this estimate, between 13,833 and 15,677 green turtles were killed in Southeast Asia (excluding Singapore) between 1976 and 1978, and the skins were imported by Japan. As mentioned earlier, skin may be the secondary product of the green turtle; the turtles may be killed primarily for meat which is consumed locally.

According to a representative of CTF at the World Conference on Sea Turtle Conservation, 12,000 green turtles are being killed yearly at CTF. This could account for the volume of meat, leather, and shell from CTF observed in trade in 1978. The highest figure for the import of CTF meat into the United States in 1978 is that provided by U.S. Customs: 120,874 kg. Since an average of 16.8 kg of meat, calipee, and steak is obtained from a CTF turtle (Rebel 1974), a minimum of 4,510 turtles (depending on whether all meat and calipee is exported from one turtle) were killed for the U.S. meat trade in 1978. Japan imported 23,514 kg of turtle skin from CTF in 1978; Japan's imports represent 9,406 turtles since raw skin of a CTF turtle weighs approximately 2.5 kg (Johnson, personal communication). Of the 7,500 kg of raw tortoiseshell imported into Japan from CTF in 1978, 6,321 kg were bekko (probably scutes), and 1,179 kg were claws and waste. Since a CTF turtle yields .45 kg of scute (Johnson, personal communication), the bekko imports represent 14,047 turtles.

The Effect of CITES on Sea Turtle Trade

The Convention on International Trade of Endangered Species of Wild Fauna and Flora (CITES) came into force on 1 July 1975. By the end of the first meeting of parties in Berne, Switzerland, in 1976, all marine turtles (except the flatback, *Chelonia depressa*, and the Australian population of green turtles) were listed on Appendix I of the convention. These amendments came into effect on 2 February 1977, thus prohibiting commercial export and import of sea turtle products (except products from farmed stocks) by party states.

By 1 January 1980, 59 countries had ratified CITES. Currently, France has a reservation on the green and hawksbill turtles, and Italy has one on the green turtle. However, none of the exporting countries which are parties to CITES has reservations.

At least 23 CITES party states have recently been involved in trade in sea turtle products. Many countries have legislation covering marine turtles (see Navid, this volume), but data from official trade statistics and other sources show that domestic or CITES regulations are being enforced in very few countries. This is partly due to the fact that even though a country may be party to CITES, its own legislation may not necessarily fulfill the requirements of the convention, or that some of its trade is being justified on the grounds that the stocks are "pre-convention."

A number of nonparty countries heavily involved in the trade have recently ratified (for example Indonesia, Kenya, Italy, and Tanzania) or shown their intention to ratify CITES. This may cause panic buying and selling before legislation comes into effect and could account for the big increase in tortoiseshell on the world market in the last 2 years, as shown in our analysis of official statistics. While some countries have curbed their exports or imports since ratifying the convention, other countries have not.

Laxity in Enforcement?

There is evidence that some of the following parties may not be effectively enforcing CITES. Parentheses refer to date that CITES came into force:

INDONESIA (March 1979)

Indonesia's ratification in December 1978 may have accounted for the huge exports that year as traders unloaded their stocks of raw tortoiseshell before CITES came into force (Table 1). However, Japan imported 4,911 kg of raw shell and 459 kg of turtle skin from Indonesia between July and October 1979 (Tables 3 and 10).

MALAYSIA (January 1978)

Singapore and Hong Kong reported imports of over 9,000 kg of raw tortoiseshell from Malaysia in 1978.

PAKISTAN (July 1976)

Japan imported over 3,000 kg of turtle skin from Pakistan in the first 10 months of 1979; it is not known which species is involved (Table 10).

INDIA (October 1976)

In 1977, 82,855 kg of raw tortoiseshell were recorded in India's export figures, and, in January and February 1978, 11,918 kg were exported (Table 1), in spite of the fact that exports of tortoiseshell have been banned since 1975 (Karand Bhaskar, this volume).

KENYA (March 1979)

It is still too early to tell if the convention is being effectively enforced in Kenya. Prior to 1979, Japan imported approximately 2,500 kg of tortoiseshell annually from this country; between July and October 1979, Japan imported 896 kg from Kenya (Table 3).

TANZANIA (February 1980)

Japan's imports of raw tortoiseshell from Tanzania increased dramatically in 1979, probably in anticipation of the ratification in November 1979 (Table 3).

SEYCHELLES (May 1977)

Japan has increased imports of tortoiseshell from the Seychelles since 1976 and, in 1979, had already imported over 1,000 kg by October (Table 3).

BAHAMAS (September 1979)

Japan doubled the amount of raw tortoiseshell it imported from the Bahamas between 1976 and 1978; imports rose again in the first 9 months of 1979 to 1,332 kg (Table 3). This increased export to Japan may be the result of unloading stocks before CITES legislation came into force.

PANAMA (November 1978)

Panama has been a regular supplier of raw tortoiseshell to Japan in the past; in 1978, Japan imported 6,505 kg of raw shell from this country. In 1979, tortoiseshell continued to be exported, however, and Japan imported 4,589 kg between January and October (Table 3).

ECUADOR (July 1975)

Ecuador is the world's largest exporter of olive ridley skins. In the first half of 1979, about 140,000 kg of skins were exported (Green and Ortiz, this volume). Sea turtles are classified as fish in Ecuador and come under the jurisdiction of the Fishery Department. This Department does not feel bound by the rules of the Convention (Ortiz and Cantos 1978; 1978 Ecuador CITES Report). The CITES Management Authority in Ecuador is currently working to solve this problem.

NICARAGUA (November 1977)

Between January 1978 and October 1979, Japan imported about 2,000 kg of raw shell and over 600 kg of turtle skins from Nicaragua (Table 3).

WEST GERMANY (June 1976)

According to customs statistics, West Germany imported over 8,000 kg of raw tortoiseshell in 1977, although this was not recorded in the 1977 annual CITES Report (Table 4). India recorded exports of over 20,000 kg to West Germany in 1977 (Table 2a). In 1978, Fiji recorded exports of over 9,000 kg to West Germany, which was also not recorded in the annual West German CITES Report (Table 2a). As mentioned above, West Germany still imports large quantities of meat from CTF.

UNITED KINGDOM (October 1976)

The U.K. ratification of CITES affected a number of dependent territories including Hong Kong and Belize, both of which are involved in the turtle product trade. Between January and October 1979, Japan imported 314 kg of raw tortoiseshell from Belize. In 1978, Hong Kong was the second largest importer of raw tortoiseshell, importing over 100,000 kg that year (Table 4). Between January and October 1979, Japan imported 1,976 kg of raw shell from Hong Kong. As mentioned above, the United Kingdom imports large quantities of meat from CTF.

FRANCE (August 1978)

Prior to its ratification, France was a major importer of worked tortoiseshell and regularly imported raw shell (Table 4). To ensure that this trade could continue, France placed a reservation on both green and hawksbill turtles. There are reports from Mexico that turtle leather is still exported to France; these skins are probably from olive ridleys, a species on which France did not place a reservation.

ITALY (December 1979)

Italy is a major center for the worked tortoiseshell trade and regularly imports raw tortoiseshell (Tables 4 and 6). Italy is also the European center of the turtle skin and leather trade, most of which is imported from Ecuador. Italy ratified CITES with a reservation on the green turtle but they import skins mainly from the olive ridley and tortoiseshell from the hawksbill.

UNITED STATES (July 1975)

The United States has been trying to control imports of tortoiseshell since 1970, when the hawksbill turtle was placed on the U.S. Endangered Species List, but it appears that some products are still getting into the country. India exported almost 3,000 kg of raw tortoiseshell to the United States in 1976, 1,656 kg in 1977, and 9,673 kg in January and February 1978 (Tables 2a and 2b). Taiwan exported worked tortoiseshell to the United States in both 1977 and 1978. Several shipments of turtle shell products were seized during these years, but the amounts do not appear sufficient to account for the above volume.

Other Possible Infringements

Over the last 3 years, other parties (Costa Rica, Brazil, Canada, Sri Lanka, Madagascar, Australia, and Papua New Guinea) have either exported or imported small quantities of raw or worked tortoiseshell. In general, these amounts are insignificant compared to the volume of the international tortoiseshell trade. Thailand and the Peoples' Republic of China have recently expressed their intention to ratify CITES. Thailand is one of the major exporters of raw tortoiseshell; if it ratifies, much pressure could be removed from the hawksbill turtles of Southeast Asia, especially if Indonesia and India, both CITES members, were to fully enforce CITES also. Mainland China is involved primarily in the worked tortoiseshell trade, although it regularly supplies Japan with small quantities of raw tortoiseshell.

Much could be done to reduce the commercial exploitation of marine turtles by improving the enforcement of legislation in countries which are parties to CITES. In 1977, 6 party states or governed territories (India, Ecuador, Australia, Costa Rica, Belize, and Puerto Rico), where CITES had already come into force, exported an estimated 121,034 kg or 38 percent of world exports of raw tortoiseshell (Table 1). Seven party states or governed territories (Hong Kong, the United States, West Germany, Nepal, Australia, Switzerland, and the United Kingdom) imported an estimated 64,746 kg or 24 percent of world imports of raw tortoiseshell (Table 4). Data for fewer countries are available for 1978, but at least 6 party states (India, Seychelles, Nicaragua, Malaysia, Costa Rica, and Puerto Rico) exported over 22,000 kg of raw tortoiseshell. In the first 10 months of 1979, at least 13 percent (8,989 kg) of Japanese imports of raw tortoiseshell came from CITES parties, and over 70 percent of Japanese raw turtle skins were from CITES countries (Ecuador and Pakistan).

Conclusions

The present size of the international tortoiseshell trade gives considerable cause for alarm. Although European countries may still play an important role in the worked tortoiseshell trade, the Far Eastern countries, particularly Japan, Hong Kong, and Taiwan, are the main consumers. The Japan Tortoise Shell Association (JTSA) concluded in its report (1973) that if Japan reduced its volume of imports, exporting countries would automatically lower their catch of hawksbills. Unfortunately, no attention has been paid to this recommendation. The status of nesting populations of hawksbills in Southeastern Asia is virtually unknown (Ross 1979), but, in 1973, the JTSA reported that people involved in the trade claimed signs of hawksbill depletion.

The hawksbill has probably never maintained a high density, and few large populations are known (Ross 1979). Ross lists a number of priority areas for this species, many of which correspond to the regions of greatest exploitation: India, Thailand, the Philippines, the Seychelles, and the Caribbean. The large exports of tortoiseshell from Fiji suggest that the Pacific should also be made a priority region. In 1972, Bustard reported that hawksbills were already depleted in Fiji.

Data in this paper further stress the importance of the recommendations made by Ross (1979) for the hawksbill: "An effective ban on the international trade in this species is an absolute necessity for its survival. Immediate surveys and rescue programs are needed for the areas of major exploitation."

A second major threat to the hawksbill is the flourishing souvenir trade in many tropical regions. More effort should be made to inform tourists from developed countries of the detrimental effects of buying sea turtle articles. Controls on the import of such souvenirs should be strictly enforced.

Olive ridleys are seriously threatened throughout their range. The main pressures from trade are on the eastern Pacific populations on the west coast of Central America. Their habit of nesting in huge concentrations means that they are particularly vulnerable to intense commercial exploitation.

Mexico has the largest populations of olive ridleys—an estimated 485,000 adults in 1978 (Márquez, Villanueva, and Peñaflores 1976)—but, due to exploitation for commercial trade, the population is decreasing at an alarming rate. It has been estimated that, if this take continues unabated, the olive ridley rookery would cease to exist on the Pacific coast of Mexico by 1985 (Felger and Cliffton 1978).

In Ecuador, the CITES Management Authority is at odds with the Fisheries Department which controls legislation relating to sea turtles. The companies processing turtles feel that the ridleys are a migratory species, and, if they do not utilize their products, other neighboring countries will (Green and Ortiz, this volume). While most of the world's attention is focused on Mexico and their large-scale killing of olive ridleys, Ecuador actually currently takes more than twice as many.

The major pressure on green turtles may be the take of adults and eggs for local consumption. Although little data are available on international trade in green turtles products, the exploitation of this species in Mexico gives cause for concern. If the commercial take continues unabated, the green turtle rookery nesting on the Pacific coast of Mexico is likely to be extinct by 1980 (Felger and Cliffton, 1978). In Southeast Asia, green turtles may be threatened by the market in Japan for skin and possibly for meat. If other areas exporting green turtle products were to close as a result of stronger controls and new legislation, Southeast Asia could become a more important supplier for this trade.

Acknowledgments

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Copies of original data deposited in offices of IUCN Wildlife Trade Monitoring Unit, Cambridge, U.K.
A more detailed, 84 page sea turtle trade report is available from TRAFFIC(U.S.A.).

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Sea Turtle Conservation Strategy, Action Plan, and Action Projects

Sea Turtle Conservation Strategy

The first draft of the Conservation Strategy *was written by David Ehrenfeld. The draft was revised during the Conference to the version presented here.*

Situation and Objectives

Few groups of animals are more valuable and magnificent and at the same time more misused than sea turtles. Able to serve as a source of protein for coastal peoples in the tropics, they have been overexploited most frequently to feed, clothe and adorn the wealthy in Europe, North America, and eastern Asia. Populations are being lost through land development that destroys nesting beaches, through reef destruction, through the accidental drowning of turtles in trawl nets, and through the failure of states to join together to protect species that migrate from areas under one coastal jurisdiction to others. Even states intent on managing the resource wisely have destroyed sea turtle populations by developing management plans that ignored the biological needs of the species. Very few populations of sea turtles remain undiminished. The majority are depleted. Many are extinct. Six of the seven species are endangered.

The objective of this strategy is to develop conservation action based on the biology of the species that will return sea turtles to former abundance while allowing controlled exploitation for the benefit of generations of humans yet to come.

The Problem

The fate of sea turtles in the modern world is being determined by the interaction of many factors. These include: 1) the use of sea turtles as food by peoples who live where sea turtles are found; 2) the use of sea turtle products in local commerce (for example, sea turtle eggs sent to local markets); 3) the international trade in sea turtle products; 4) the differing attitudes toward conservation in different countries; 5) the incidental destruction of sea turtles that occurs during the fishing of other species; 6) the effects of nesting beach alteration or destruction; 7) the effects of marine and land-based pollution; and 8) the natural recovery rates of the various sea turtle populations under different conditions of exploitation and incidental stress. The biological constraint (8) is in turn determined by such variables as growth rate, food resources, migratory habits, the fixity of nesting behaviors (including preference for certain nesting sites) and others.

Of these eight factors (there may be more) that determine the fate of sea turtles, only one, the biological factor, is non-negotiable in a conservation strategy. Sea turtles, even the most resilient of the species, are neither shrimp nor herring. They mature very slowly compared with most commercially important species, and when mature their reproduction is vulnerable to disruption by many kinds of human activity in addition to ordinary turtle fishing. Among other widely exploited marine species, only the great whales, and possibly the sturgeons, show similar biological constraints on exploitation. In determining a conservation strategy, this ultimate limitation must be kept constantly in mind.

Sea Turtle Conservation Policy

This document sets forth, in outline format, policy considerations for the conservation of sea turtles.

I. *Habitat Protection*

Habitat conservation can be achieved through a variety of management techniques. These may include the creation of protected areas such as national parks or reserves, management efforts, or simple limitation of access or activities in specific areas at specific times. Management techniques need to be carefully evaluated for particular areas so the measures selected are most appropriate. Habitats that should be protected are:

- A. Terrestrial Habitats
  - 1. concentrated nesting beaches
  - 2. diffuse nesting beaches
  - 3. basking sites
- B. Aquatic Habitats
  - 1. internesting areas
  - 2. migration routes
  - 3. feeding grounds
  - 4. hibernacula

II. *Management* [Considerations under Eggs, Hatchlings, Adults and Subadults listed in order of priority or preference.]

- A. Eggs[1]
  - 1. No intervention other than protection.
  - 2. Criteria for intervention—intervention is justifiable when hatching rate is reduced by
    - a. heavy predation
    - b. heavy human exploitation
    - c. physical damage to nesting beach
  - 3. Types of intervention—the least manipulative techniques should be used.
    - a. protect eggs *in situ*, control of predation
    - b. transplant to adjacent hatch sites
    - c. remove to hatcheries
- B. Hatchlings[1]
  - 1. Protection of *in situ* nests—limit beach traffic and disturbance at vulnerable preemergence and emergence stage
  - 2. Immediate release of hatchery hatchlings
  - 3. Retention of hatchlings for headstarting
  - 4. Removal to safe habitat (e.g., airlifting beyond oil spills)
- C. Adults and Subadults
  - 1. Complete protection and prevention of interference with reproductive activities on nesting beaches, and in internesting habitats (see also sections VI. Conservation Education and VII. Legislation, below)
  - 2. Prevention, reduction and control of exploitation[2] in
    - a. migratory routes
    - b. feeding grounds
    - c. hibernacula

III. *Control of Exploitation*

One goal of conservation is the rational sustained use of wildlife for the greatest benefit of humans now and in the future. Since overexploitation is responsible for the endangerment and extinction of many populations of marine turtles, maximum control of exploitation is mandated.

- A. Commercial
  - 1. As long as sea turtles remain endangered, the ending of commercial exploitation of all sea turtle products is a long-range goal or ideal of the conservation strategy. We do not anticipate,

1. Although they may be of great value, the more manipulative techniques (removal of eggs or hatchlings, colony transplantation, headstarting) are unproven techniques and should not be applied to a substantial portion of the eggs and hatchlings of a given colony. Tests of the success of manipulative efforts should be a part of every operation. In all manipulations, efforts should be made to keep conditions as natural as possible (e.g., natural temperature regimes for eggs, exposure of newly emerged hatchlings to natural sensory imprints from the beach).

2. Endangered and declining populations deserve complete protection through prevention of exploitation in all habitats.

however, that this goal will be achieved quickly. An end to international trade in all sea turtles and their products was mandated by placement of the species (with the exception of some Australian-Papua New Guinea populations) on Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1973 and 1976. But because many of the principal international trading nations are not Party to the Treaty or even though they are Party to it, have taken reservations for sea turtles, or do not adequately implement it, the Convention has had only limited effect. At the moment, the highest priority should be given to ending:

a. The leather trade. This is a new industry whose demise would not have any major undesirable cultural or economic side effects. The present leather trade constitutes an intolerable drain on the sea turtle populations, especially those of *Lepidochelys olivacea* and *Chelonia mydas*. Current world trade should be terminated and all measures taken to achieve this end.

b. The trade in tortoiseshell. The trade in tortoiseshell should cease in those countries where it has no special traditional cultural significance. Those countries where tortoiseshell has a cultural value (e.g., in marriage ceremonies) should be encouraged to preserve and recycle antique supplies, to promote the use of synthetic substances, and with all dispatch to phase out the importation of new material.

c. Eggs collected for sale in distant markets. Eggs should be collected only for noncommerical consumption—and then only in those cases where a program is in effect to ensure that the great majority of eggs from that beach will be left to hatch, and that hatching will be under conditions as natural as possible. Conservation Education (see VI, below) should be used to counter the myths about special properties of eggs, in those countries where these superstitions are a cause of high commercial demand.

d. Trade in stuffed juvenile sea turtles. This totally unnecessary luxury trade is having a serious impact on populations of *Eretmochelys imbricata*. It should cease and all measures should be taken to achieve this end.

After the demonstrated recovery of abundance of sea turtles, some level of exploitation may be possible. However, any exploitation program must be based on the best available biological information and must be in accordance with national and international law.

B. Noncommercial Hunting

1. Noncommercial hunting is defined as a traditional way of obtaining food practiced by aboriginal peoples who are not yet part of a cash economy or technological society. In this context, noncommercial hunting can be a valid activity, especially when it is carried out so as to have a minimum impact on turtle populations. Nevertheless, there are some turtle populations that are endangered even by legitimate noncommercial hunting, and in those cases techniques of self-regulation and biologically sound conservation practices should be encouraged (see I. Habitat Protection, II. Management, and V. Research and Population Assessment sections). Where the noncommercial hunting of sea turtles is valid, subsistence users have first right to the resource.

C. Farming

In addition to the prime objective of marketing sea turtles raised under artificial and/or semiartificial conditions, farming has been claimed by some to provide incidental conservation benefit by relieving the commercial pressure on wild animals. Others feel that such operations create the risk of increasing pressures on wild populations.

1. Before the benefits and risks of commercial turtle culture can be fully evaluated, more data are needed, as follows:
   a. The feasibility of complete, closed-cycle farming, with no dependence on wild populations (either eggs or adult breeders) should be studied. "Feasibility" refers to both biological and economic factors.
   b. The considerations that determine the minimum (and possibly maximum) sized operation that is commercially feasible ought to be ascertained.
   c. The impact of commercial turtle culture (farming and ranching) on prices of turtle products, on the creation of

new markets, on the capture of turtles from wild populations, and on the trade in products derived from wild-caught sea turtles should be evaluated.

2. In the absence of definitive answers from the above inquiries, the following cautions are necessary:
    a. Commercial mariculture must be in conformity with all applicable conservation regulations and laws, whether local, national, regional or international.
    b. Care should be taken that special legal provisions and exemptions for farmed products are not misused by importers and exporters of wild turtle products.
    c. Any effort by commercial mariculture interests to develop markets for new turtle products or to create demand for turtle products where it did not previously exist is insupportable.
    d. The establishment of new commercial turtle "farms" must be discouraged until it is certain that such operations will not cause, directly or indirectly, a further decline in turtle populations.

IV. *Incidental Catch*

Incidental catch is a major threat to many sea turtle populations and must be eliminated or reduced to very low levels.

A. All countries should be prepared to establish restricted fishing zones in areas of high turtle concentration (as has been done by Mexico, near Rancho Nuevo, and by the United States, near Cape Canaveral).

B. The development of fishing techniques and equipment that preclude the incidental take of sea turtles should be given high priority. This technology should be made freely available to all states.

C. Information concerning the magnitude of the incidental catch of sea turtles is sorely needed. The industries involved in this incidental catch should be encouraged to assist in the gathering of information.

D. International fisheries commissions should address the problem of incidental catch in the framing of their regulations. If necessary, amendments should be promoted for international fishery conventions to give specific jurisdiction to fishery commissions over nontarget species.

E. Turtles which remain alive after being incidentally captured in fishing nets should be resuscitated and released.

F. The deliberate mutilation and killing of sea turtles during commercial fishing for other species must be ended.

V. *Research and Population Assessment*

A. Data on the location, and estimated or census-determined sizes of all populations of sea turtles is needed. Except in the case of *Lepidochelys kempi*, which exists as a single population, it is not obvious that there is any value in devoting time to estimating the population sizes of entire species.

B. Information on all aspects of the basic biology of sea turtles is needed. Of special relevance to conservation is information about growth rates, complete life histories, population dynamics (reproductive rate, mortality rate, and age at sexual maturity), phylogenetic and taxonomic relationships of different populations, and effective tagging methods.

C. Important issues of management techniques include testing the biological effectiveness of restocking, transplanting, and headstarting programs, and studying the effects of incubation temperatures and other environmental conditions on sex determination.

VI. *Conservation Education*

Conservation education in different countries will be enhanced through cooperation of local conservation organizations and agencies. Provisions should be made to supply them with information about sea turtles so that they can:

A. Organize their own political action and educational campaigns

B. Perform market surveys and gather information about trade in sea turtle products as well as local consumption of these products

C. Organize tagging programs and make surveys of activity at nesting beaches

D. Educate coastal people to identify the different kinds of sea turtles and to aid in the gathering of information about them

E. Develop recommendations for children's books (including parts of school texts), comic strips, and posters in various languages, on the subject of the plight of local sea turtles, and the value of a wildlife heritage

F. Develop survey teams that would census and salvage turtles that had washed up on the beach and, when possible, determine the cause of death

G. Maintain records about sea turtle populations and trade in sea turtle products, which would facilitate year-to-year comparisons

VII. *Legislation*

A. National

1. A worldwide systematic inventory of turtle conservation laws is needed to determine where gaps in coverage exist and what the priorities for action should be.
2. Where gaps exist, comprehensive conservation legislation (dealing with exploitation and habitat protection) should be enacted and implemented.
3. Effective mechanisms for enforcement of legislation should be developed. These should emphasize the development of strong enforcement techniques, and the training of effective conservation officers, drawn from the people among whom they would work. To facilitate control of international commerce, points of entry for such commerce into a country should be limited to those which can be staffed with trained officers.
4. Attention should be given to the strengthening of penalties for the breach of national legislation to reflect the severity of violations.

B. International

1. All states that have not already done so should become Party to the Convention on the International Trade in Endangered Species of Wild Fauna and Flora (CITES) without reservation. States Party to CITES which have taken reservations for sea turtles should withdraw those reservations. All Parties to CITES should fully implement their obligations with vigor.
2. All states under whose jurisdiction sea turtles pass any part of their life cycle and any states that exploit sea turtles on the high seas should enter into cooperative conservation programs for turtles, and in particular those states should become party to regional or umbrella conventions as the framework for development of necessary international cooperation. The Convention for the Conservation of Migratory Species of Wild Animals represents a useful effort to develop an umbrella convention applicable to sea turtles.
3. Existing regional conservation conventions should be strengthened and implemented (e.g., Western Hemisphere, African, South Pacific Conventions).

VIII. *Cooperative Efforts*

The exchange of information and the development of joint conservation programs among the many disparate and often isolated organizations and states (e.g., governmental agencies and nongovernmental organizations and adjacent range states) should occur.

Implementation of the Strategy

A Standing Committee should be established to monitor and facilitate the further development and the implementation of the Sea Turtle Conservation Strategy.

This Committee should be associated with the Marine Turtle Specialist Group of the Survival Service Commission of the International Union for Conservation of Nature and Natural Resources (IUCN), and should include representatives from the various regions of the world. The IUCN and the World Wildlife Fund are requested to accept responsibility for the overall coordination of this Standing Committee and the active cooperation of the various elements of the IUCN, including the Traffic Specialist Group, the Commission on National Parks and Protected Areas, and the Commission on Environmental Policy, Law, and Adminstration is essential.

International and national nongovernmental organizations should assist with implementing the Strategy, as appropriate, and especially with public information and education and with the promotion of necessary governmental action.

Participation in the Action Plan by governmental agencies, and particularly those involved with marine turtle research and conservation, is requested, because such participation is essential to the successful implementation of the Action Plan. The United Nations Environment Program and the United Nations Food and Agriculture Organization are encouraged to provide financial and programmatic support to this global conservation program.

For the purpose of preparing a report assessing the progress made in implementing the Strategy, the Standing Committee should meet with the IUCN Survival Service Commission at its meeting immediately prior to the 3rd Conference of the Parties to CITES, in the first quarter of 1981.