Marine Turtle Newsletter

Number 71 October 1995

TEACHING CRITICAL CONCEPTS FOR THE CONSERVATION OF SEA TURTLES

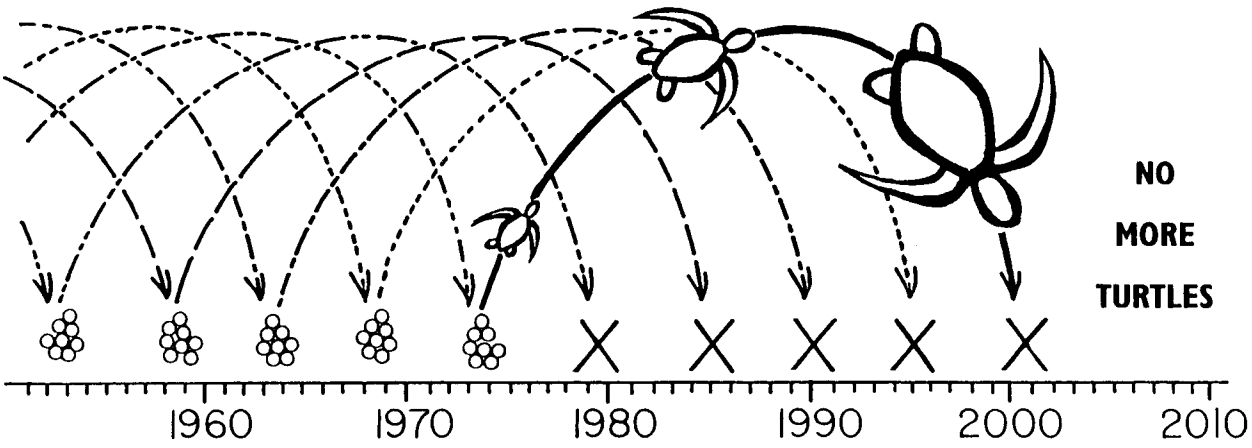
I am here presenting two visual aids (in a format that can easily be photocopied and distributed as hand-outs) that have proved helpful in explaining complicated aspects of the life history of sea turtles. An understanding of these concepts is critical to the design and public acceptance of effective sea turtle management plans. The singular difficulty in understanding these concepts stems from the long delay between the cause and the visible effect of certain devastating practices.

Scientific studies clearly demonstrate that, under natural conditions, most sea turtles are long-lived animals with delayed sexual maturity and high survivorship of adults. Unfortunately, these life history traits prevent a turtle population from showing early symptoms of over-harvest that are visible to the casual observer. They also limit the ability of populations to recover after having suffered extended over-exploitation (Congdon et al., 1993).

Over-harvest of eggs or of nesting females can continue for decades before it manifests itself at the nesting beach as a decrease in numbers of nesting females. In the interim, there may be no visible signs of population decline on the nesting beach, and so the general public often remains oblivious to the fact that over-exploitation is occurring. By the time the nesting population crashes, it may be too late to save the population at large from extinction.

These population dynamics are complicated, abstract, and difficult to explain to the general public, especially through words and mathematical equations alone. I have found, however, that people are very receptive to diagrammatic representation of these concepts, and the two presented here have proven to be effective educational tools.

Figure 1. Over-harvest of Nesting Females (modified from Mortimer, 1984). This figure represents a hypothetical case in which people slaughter 100% of the breeding females on the nesting beach before they can lay their eggs. (This was the situation for nesting hawksbill turtles on certain islands in the Seychelles during the early 1980's, and is still the case in many parts of the world today.)



Depending on the species, gravid (=egg-bearing) females average 2-7 clutches of eggs per nesting season, returning to the beach at regular intervals to deposit each clutch in turn. The circles at the ends of the arrows represent these clutches of eggs and the successful nesting by female turtles prior to 1975. (I arbitrarily chose the year 1975 simply for illustration.) The Xs indicate that, after 1975, people killed the female turtles before they laid their eggs. The arrows represent that after hatching from the egg, hatchlings depart from the nesting beach and do not return until they reach reproductive maturity decades later, at which time a new generation of adult females comes ashore to lay eggs in the sand. For illustration, I have used the span of 25 years to maturity, although the actual age to maturity is variable.

If, beginning in 1975, people killed every nesting female before she laid her eggs, the number of females arriving to nest would not decline drastically until the year 2000. Why? Because hatchlings produced before 1975 safely left the beach, matured at distant foraging grounds, and then returned (in this scenario, after a period of 25 years) to the nesting beach to breed. We can see that those that reached adulthood ***before*** 1975 were able to successfully reproduce for a minimum of one season. In contrast, those that attained adulthood ***after*** 1975 were killed prior to laying any eggs. To the casual observer standing on the nesting beach, there might seem plenty of nesting turtles available for slaughter year after year.

This seeming unending supply of adult turtles results from the fact that eggs laid in 1950 matured into adults to be slaughtered in 1975. Eggs laid in 1951 matured into the adults to be slaughtered in 1976. And so on. When the hatchlings that emerged from the last egg clutches laid in 1975 finally attain maturity in the year 2000, the population will be on the brink of extinction. This is because, after 1975, the turtles would not have produced any new offspring to replace the females that were slaughtered each year. With no surviving adult females, and no eggs laid for the period of one generation, the population collapses in the year 2001. Of course this is an idealized portrayal, but the fact that in reality turtles are maturing at ages that may vary from 20 to 50 years of age does not change the qualitative result.

Figure 2. Over-harvest of Eggs (Mortimer, 1991a, 1991b). This figure represents the destruction of a green turtle nesting population through over-harvest of eggs — as is occurring in many parts of south-east Asia and elsewhere. For this model, females are assumed to take 20 to 50 years to reach adulthood (National Research Council, 1990) and then to remain reproductively active for about 20 years (Carr et al., 1978). The diagram illustrates how harvesting 100% of the eggs would destroy the population "from the bottom up" because no new hatchlings would enter the population. This stands in contrast to the scenario depicted in Figure 1 where the population is destroyed "from the top down."

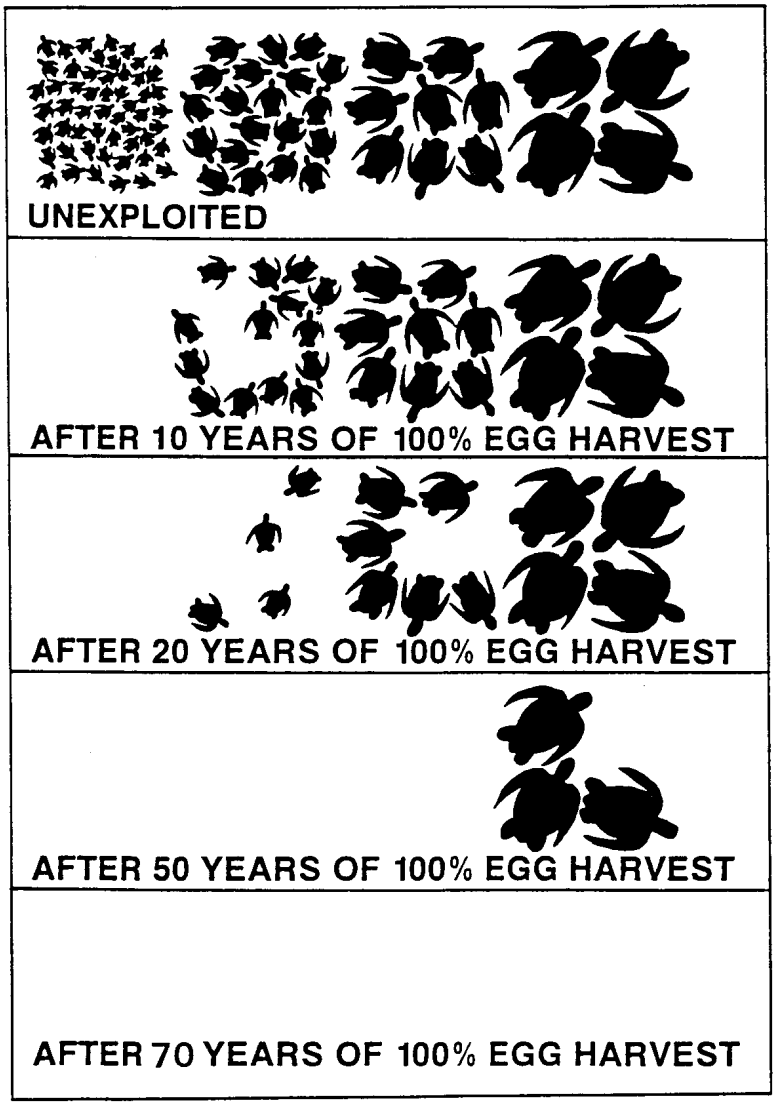
The top panel is a diagrammatic representation of an unexploited green turtle population, with four life stages indicated. Moving from left to right: the smallest turtles are hatchlings, next are juveniles, then subadults, and breeding adults. Each succeeding panel represents the same turtle population after 10 years, 20 years, 50 years, and 70 years of 100% egg harvest:

a) After 10 years of 100% egg harvest, no hatchling turtles will remain in the population, and the number of juvenile turtles will be reduced. However, the numbers of subadults and breeding adults will be the same as in the unexploited population. [N.B. Of course, hatchlings will be eliminated from the population after only ***one*** year of 100% egg harvest.]

b) After 20 years of 100% egg harvest, there will be no hatchlings, and fewer juveniles and subadults than were in the population after 10 years of 100% harvest. However, the numbers of breeding adults will remain the same as in the unexploited population.

c) After 50 years of 100% egg harvest, there will be no hatchlings, no juveniles and no subadults remaining in the population. The numbers of breeding adults that come to the nesting beach will have ***begun*** to decline. ***Only at this point will it be apparent to the general public that the population is in decline.*** By now, however, the population is on the verge of extinction. All the females remaining in the population are at least 50 years old.

d) After 70 years of 100% egg harvest, the turtle population will be extinct by the 71st year.



The model depicted in Figure 2 is conservative. Even in populations where some proportion of females require as long as 50 years to reach maturity, this is not likely to be the case for the majority of individuals. If we assume, for example, that the modal age at maturity is 35 years, with an expected reproductive period of 20 years, then the population described in the model will be virtually extinct in 55 years (55 years being a sufficient span of time to allow the majority of individuals to have matured and laid eggs for two decades). The younger the expected age to maturity (holding constant the reproductive period) the sooner the population would be expected to collapse.

For the sake of simplicity, both Figures 1 and 2 represent 100% harvest of previously unexploited populations. Real world situations are, of course, more complicated. At most sites, rates of exploitation are generally less than 100% (which would slow the rate of extinction), but are directed at more than one life stage (which would speed the rate of extinction). Another complication is that, in today's world, most turtle populations have already been in decline for decades, if not centuries, in response to a combination of factors. These may include purposeful harvest of turtles and eggs, accidental capture of juveniles and adults in fishing gear, habitat destruction, and pollution. Therefore, most sea turtle populations are, in reality, even ***more*** vulnerable to extinction than the hypothetical populations depicted in my figures.

Despite these complications and qualifications, the diagrams effectively depict the mechanisms leading to the extinction of turtle populations and the insidious nature of the processes involved. An understanding of these concepts must be communicated to resource managers and decision makers before they can be expected to take the measures necessary to prevent extinction of sea turtle populations. These diagrams have proven effective in public awareness campaigns I have conducted, and I invite anyone who wishes to use them to do so.

Carr, A. F., Jr., M. H. Carr and A. B. Meylan. 1978. The ecology and migrations of sea turtles. VII. The West Caribbean green turtle colony. Bull. Amer. Museum of Natural History 162:1-46.

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

Mortimer, J. A. 1984. Marine turtles in the Republic of Seychelles: status and management. International Union for the Conservation of Nature and Natural Resources (IUCN) Publication Services, Gland, Switzerland. vii + 80 pp., 4 pls. ISBN 2-88032-901-9.

Mortimer, J. A. 1991a. Recommendations for the management of the marine turtle populations of Pulau Sipadan, Sabah. Report to WWF-Malaysia (WWF Project No. 3868). 36 pp.

Mortimer, J. A. 1991b. Marine turtle populations of Pulau Redang: their status and recommendations for their management. A report submitted to the Turtle Sanctuary Advisory Council of Terengganu, Malaysia. Produced under WWF Project No. 3868. September 1991. 31 pp.

National Research Council. 1990. Decline of the Sea Turtles: Causes and Prevention. National Academy Press, Washington, D.C.

JEANNE A. MORTIMER, Caribbean Conservation Corporation, Gainesville, Florida. ***Mailing address:*** Department of Zoology, Bartram Hall, University of Florida, Gainesville, Florida 32611-8525 USA.