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## MIGRATIONS OF THE LOGGERHEAD SEA TURTLE (*CARETTA CARETTA*) INTO THE ADRIATIC SEA

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Data on migrations of sea turtles in the Adriatic Sea are extremely rare, presented, partially, only by Margaritoulis (1988) and Argano *et al.* (1992). In first 10 years of the implementation of tagging programs in the Mediterranean basin (1981/82-1992), 13 tagged loggerheads were recaptured in the Adriatic Sea (Margaritoulis, 1988: 6 specimens from 34 recaptured; Argano *et al.*, 1992: 7 specimens from 51 recaptured). From Croatian waters, only 4 tagged loggerheads have been reported.

Our results are based upon recoveries of tagged loggerheads along the Croatian coast of the Adriatic Sea, in the period between 1993 and 1996. The majority of the records were obtained from local inhabitants and fishermen, through the network of institutions along the Croatian coast, implemented in the Adriatic Marine Turtle Research and Conservation Program in Croatia. All data were gathered at the research center of the Program (Department of Zoology, Croatian Natural History Museum), and forwarded to the tagging institution.

During the four year period, 11 tagged loggerhead females were recovered in Croatian waters, which is almost three times more than in the last 10 years. All the recaptured specimens were tagged in Greece by STPS. However, it is possible that the number of recaptured specimens in Croatia was higher in the past, but due to the lack of a data collecting network and of public awareness, the majority of recaptures were never reported. From 11 tagged loggerhead recovered in Croatia between 1993 and 1996, two turtles were found dead, washed ashore in the northern Adriatic region, while 9 specimens were caught in fishing nets. Six loggerheads were captured in a gill net. Five of them were found dead, while only one specimen was recaptured alive and released. Three more loggerheads were recovered by trawling: one was found alive and released, while data on the condition of the other two recovered specimens were not available. No tagged specimens have been recaptured more than once. In total, only two loggerheads have been recovered alive and released. For

two specimens data on recapture-condition were not available, while the mortality rate seems to be even higher than the 60% described by Argano *et al.* (1992). The highest mortality is caused by the gill net, recognized as the most deadly fishing method by Argano *et al.* (1992), with a death-rate of about 75%.

All 11 recaptured tagged loggerheads come from nesting beaches on Zakynthos or on Peloponnesus in Greece. The longest migration, of about 1,200 km, was recorded for specimens recovered in the Northern Adriatic, along the eastern coast. The shortest period between last record on the nesting beach and recovery in Croatia was 43 days. The specimen migrated at least 750 km, which indicates an average speed of about 17.5 km/day. This speed is in the range of the results of Margaritoulis (1988). The 11 in-transit recoveries of migrants in Croatia presented in this paper, as well as data on recaptures by Argano *et al.* (1992) and Margaritoulis (1988), show that part of the Greek loggerhead nesting population migrates through the Adriatic Sea. Although migratory behavior is unknown, it is probable that the Adriatic represents their feeding and developmental area. According to Lazar and Tvrtkovi (1995), a yearly incidental catch of 2,500 specimens has been estimated for the eastern Adriatic region. The evidence of professional fishermen in Croatia is mostly related to "small", subadult turtles caught in the nets. It is interesting that Lazar and Tvrtkovi (1995) have presented data on three schools of mostly subadult marine turtles (probably *Caretta caretta*) observed in Croatian waters, while according to Dood (1988) group migrations are unknown in *Caretta*. Furthermore, according to a preliminary analysis of incidental catch in Croatian waters (Lazar, 1995), and due to the maximum peak of the incidental catch by bottom trawl-

ers during the winter months, it is not impossible that part of Greek nesting loggerhead population overwinters in the Adriatic as well.

Although we can not precisely reconstruct the migratory pathway of loggerheads in the Adriatic, it seems that migratory route leads along the eastern Adriatic coast, toward the north. This route overlaps with the current that enters the Adriatic along the eastern coast and surely have an influence on the direction of loggerhead migration. However, migration against the prevailing currents in the Adriatic can not be excluded, so the question about the active passage of loggerheads in the region is still without a proper answer.

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## USING MOLECULAR GENETICS AND BIOTELEMETRY TO STUDY LIFE HISTORY AND LONG DISTANCE MOVEMENT: A TALE OF TWO TURTLES

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Molecular genetics and biotelemetry are powerful tools that have been used to study sea turtle movements and life history (Bowen 1995) (Balazs 1994). Together they can provide empirical evidence for previously stated hypotheses, increase our understanding of habitat use, migration routes, and suggest further research lines on the interrelationships between nesting and feeding areas.

Loggerhead (*Caretta caretta*) and black turtles (*Chelonia mydas agassizii*) are thought to undertake long migrations from nesting beaches in Japan (Villanueva 1991; Ramirez Cruz *et al.*, 1991) and Michoacan, Mexico (Alvarado and Figueroa, 1992), respectively, to distinct feeding grounds along both coasts of Baja California, Mexico. Results from analysis of mtDNA control regions, from this study and presented elsewhere (Bowen *et al.*, 1995), and from our recent satellite telemetry studies confirm these nesting beach-feeding ground relationships and suggest vastly different patterns of use of Baja California waters by each species.

We have observed that eastern Pacific loggerheads primarily occupy offshore areas confirming the observations of Pitman (1990), make long pelagic forays, and feed predominantly on pelagic red crabs (*Pleuroncodes planipes*). In contrast, black turtles utilize primarily nearshore waters, lagoons and bays, migrate along the coast, and consume sea grasses and algae. Mortality due to incidental catch is common for both species in this region (pers. obs.).

These results reiterate the need for management and protection efforts on sea turtle feeding grounds in Baja California, the importance of a species by species approach to turtle conservation, and the utility of multi-faceted research programs. These studies have also led to an increase in intra- and inter-regional cooperation.

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