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Endangered species

Pan-Atlantic leatherback turtle movements

The overall extent of habitat use by leatherback turtles in the North Atlantic, and hence their possible interactions with longline fisheries, is unknown. Here we use long-term satellite telemetry to reveal that leatherbacks range throughout the North Atlantic, indicating that closing limited areas to longline fisheries will probably have only partial success in reducing turtle bycatch. Although turtles dive very deeply on occasion (one descended to a maximum depth of 1,230 metres, which represents the deepest dive ever recorded for a reptile), they generally restrict their diving to less than 250 metres, which increases the chance that they will encounter longline hooks.

Leatherback turtles (*Dermochelys coriacea*) are critically endangered (www.redlist.org), and their incidental capture by pelagic fisheries is a major source of mortality[1]. The Atlantic is the last stronghold for leatherback turtles. Longline fishermen from the United States are mandatorily excluded from a large region of the western North Atlantic (the Northeast Distant reporting area), although other countries continue to operate there[2]. An estimated 1.4 million hooks are deployed daily throughout the rest of the Atlantic[3], an intensity of fishing that has had devastating effects on a variety of apex predators[4]. As well as trying to reduce the bycatch of leatherback turtles by using different fishing methods[2], it is important to track their movements to identify areas that are at high risk from fisheries.

Leatherbacks routinely travel long distances and are found in the North Atlantic, far from their tropical and subtropical nesting beaches[5]. This has been shown by long-term tracking of individuals in the Pacific and Indian Oceans[6,7] as well as by preliminary studies in the Atlantic[8]. We used satellite telemetry to record both the horizontal and vertical (diving) movements of leatherback turtles in the North Atlantic for up to one year (for methods, see supplementary information).

We found that turtles travelled extensively throughout the Atlantic, although individuals differed in the pattern of their movements (Fig. 1a). The two turtles tracked from the Caribbean in 2002 travelled mainly eastwards: one traversed the Atlantic to within 600 km of the west African coast before returning westwards (turtle A); the other reached an area about 1,000 km from the coast of South America and remained there for several months (turtle B). Turtles leaving the Caribbean in 2003 travelled to more northerly latitudes: two travelled northwest, arriving within a few hundred kilometres of Cape Cod and Nova Scotia before turning southwards (turtles C and D, respectively); the other five travelled northeast, reaching northerly latitudes between the Azores and the United Kingdom, when some turned south (turtles E, F, G, H and I). Six of the nine tracked turtles entered the Northeast Distant area and travelled extensively inside it.

The reasons for these broad individual differences in travel routes are unknown. Ocean currents seem to play little part in driving broad-scale movements, with turtles swimming against, across and with the major current systems in the North Atlantic. Periodic residence in specific areas is probably linked to locally enhanced prey availability, as both leatherbacks and other pelagic-feeding turtle species target frontal features and mesoscale eddies[6,9].

Normally, more than half an individual's time was spent diving to depths below 10 m (data obtained from 3,304 individual 6-hour periods; mean percentage of time spent diving in each 6-hour period, 59.0%, s.d. = 27.6). Dives were generally within the epipelagic (near-surface) zone and over 99% of all dives were shallower than 250 m (Fig. 1b). This pattern of epipelagic diving was maintained throughout the tracking of each individual. Turtles occasionally dived very deeply and we recorded a maximum dive depth of 1,230 m. However, very deep dives were sporadic and extremely rare (of 16,767 dive profiles, 55 dives reached a maximum depth of over 400 m, 15 reached over 600 m and 6 reached over 800 m).

Our results have important implications for conservation techniques. Although closing specific areas to fishermen will help to reduce the leatherback turtle bycatch, the wide-ranging movement of individuals means that future conservation measures need to operate across the basin to the ensure survival of the species. Leatherbacks sometimes dive deeply at their nesting areas[10] and deep diving should reduce their interaction with fishing gear, but our long-term telemetry

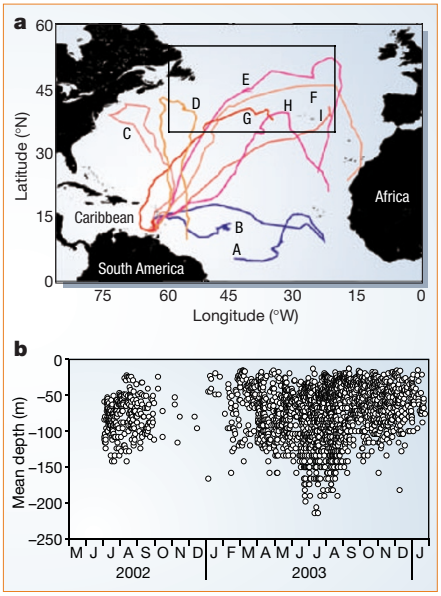

Figure 1 Movements and diving behaviour of nine leatherback turtles tracked after nesting in the Caribbean. **a,** Tracks of turtles A–I: A and B were tracked for 12 months from July 2002 until July 2003; turtles C–I were tracked for 6–8 months from May–July 2003 until January 2004. Black box outlines the Northeast Distant area, which is closed at present to longline fishing by the United States. **b,** Mean depth of dives during individual 6-hour periods, recorded from all nine turtles. For clarity, we include only those 6-hour periods during which at least 50% of the time was spent diving to over 10 metres (2,227 out of 3,304). Months indicated by initials.

results indicate that they spend most of their time diving in the epipelagic zone — which is exactly the depth-range targeted by longline fishermen[11].

Pan-oceanic movements and shallow diving are doubly disadvantageous, in that they both increase the interaction of leatherback turtles with longline fisheries. It is therefore crucial that new methodology and fishery management procedures be applied to reduce leatherback turtle bycatch.

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