The Loggerhead River Turtle (*Caretta caretta*)

ALan F. Rees[#], Panagiota Theodorou, Dimitris Margaritoulis

ARCHELON, the Sea Turtle Protection Society of Greece, Athens, Greece (#alanfrees@gmail.com)

ARCHELON has been carrying out a capture-mark-recapture programme in Amvrakikos Gulf sea turtle foraging area since 2002. The gulf is in western Greece (39°N, 21°E), its northern part is formed from the deltas of two rivers (Louros in the west and Arachthos in the east), which includes extensive lagoon and salt marsh systems. For more details see Rees et al. (2013). In 2020 and 2021 we undertook a telemetry project to track several adult male turtles from the gulf. This article reports on the unusual behaviour and movements of one of the turtles.

The turtle in question, "Louros", who was named after one of the local rivers, had a Straight Carapace Length (notch to tip) of 77.5 cm and Tail Length (notch between supracaudal scutes to the dorsal tip of the extended tail) of 25 cm when captured for satellite tagging on 10 July 2021. Based on his carapace and tail lengths he was assumed to be adult. He was a known resident of the gulf having first been captured in 2017 and had been recaptured during ARCHELON's annual monitoring programme in 2019. "Louros" received a FastGPS Argos transmitter (lotek.com), which collects and transmits snapshots of GPS satellite data that are decoded remotely. The GPS snapshot provide locations with tens of metres accuracy, which outperforms standard Argos-derived location data that are generally in the order of hundreds of metres accuracy at best. Thus, we were able to examine his small-scale movements around the gulf.

The transmitter operated well for an initial 312 days and then went quiet on 18 May 2022 for 86 days. It started working again on 12 August 2022 and has continued to work until after the end of 31 January 2023 (cut off point for our analysis) for a total duration of over 571 days' operation.

We processed the gathered tracking data by removing all poor-quality Argos

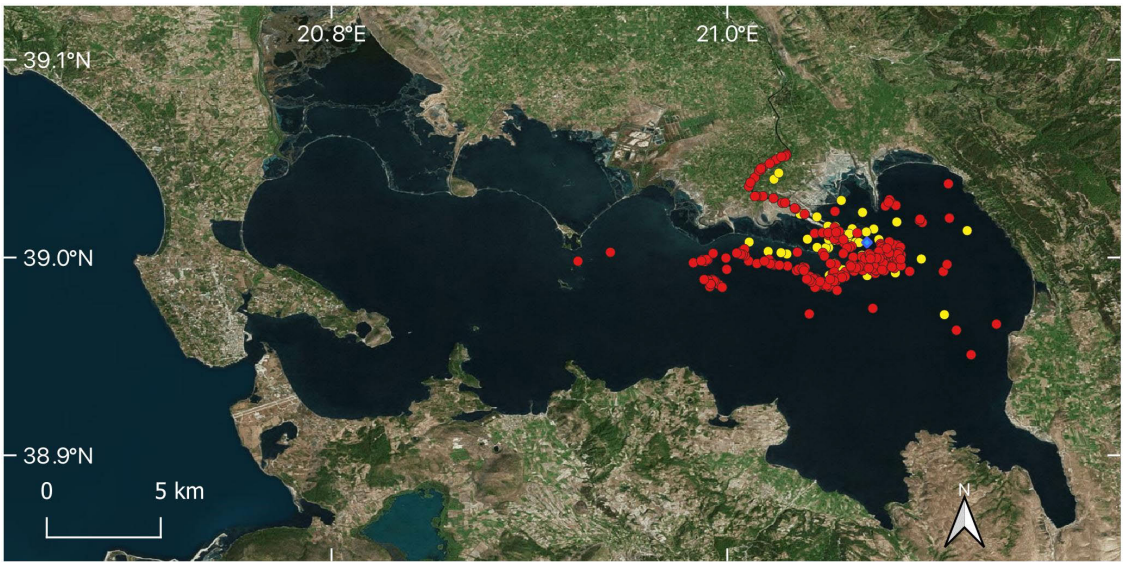

Figure 1. Amvrakikos Gulf and general locations for "Louros" during his ~18 months tag operation (to 31 January 2023). Argos locations are shown in yellow and GPS locations are shown in red. Locations are restricted to two per day to avoid over-representation of days with multiple locations. Note the turtle's upriver movement, along the river Arachthos, to the northwest of the main location cluster. Capture location shown as blue dot.

Location Classes and those that were visually erroneous (i.e., falling well outside the coast of Amvrakikos Gulf). We then identified the first best location before and after midday on each day of the tracking by ordering the location data in terms of expected accuracy. The filtered dataset comprised 305 from the original 1779 received locations which were plotted in QGIS 3.28.3 (qgis.org).

"Louros" the turtle remained resident in the north-eastern part of Amvrakikos Gulf, generally close to capture site near the mouth of the Arachthos river (Fig. 1), but with trails of locations heading to the west and to the northwest. The trail of locations to leading northwest revealed the turtle had journeyed upstream in the Arachthos river and closer inspection of the data identified two distinct periods the turtle had resided at different distances up the river (Fig. 2). The first period the turtle spent upriver started on 29 July 2021 and lasted until 2 August 2021 (4 days) but may have extended another day as no good quality location data was acquired on 3 August 2021. The turtle was located out of the river again on 4 August 2021. This first four- or five-day sojourn took the turtle a maximum of 5.3 km upriver to where the river width was 80-100 m. The second period lasted longer but precise duration cannot be determined due to the protracted periods when no location data were received. When the transmitter resumed functioning on 13 August 2022 the turtle was already upriver. The next two locations, received at the end of September 2022, also placed the turtle upriver. Then from 7 to 16 November regular locations placed the turtle upriver. After an eight-day data gap, locations resumed and placed the turtle once more outside the river. During this second sojourn up the river which may have lasted 95 days or more, if the turtle did not return to the gulf during periods with no transmissions, the turtle resided between 5.3 and 8.6 km from the river mouth in areas where the river width was as narrow as 50 m.

Since the 1920s loggerheads of the Mediterranean have occasionally been reported in brackish river waters and on two occasions from a freshwater lake (Keller 2005 and references therein; Cerritelli et al. 2022). However, this is the first report of a loggerhead in a river from Greece, and notably present in freshwater conditions.

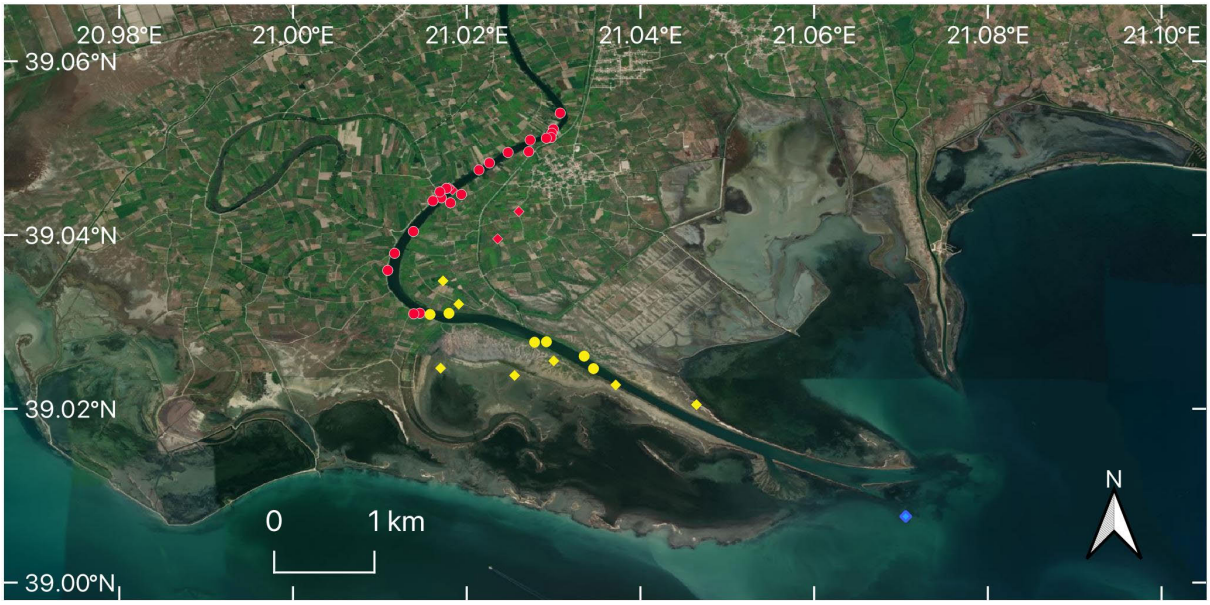

Figure 2. Close up of the two trips the turtle made up the river Arachthos. Summer 2021 (yellow) and late 2022 (red). All LC0-3 (diamonds) and GPS locations (circles) for the days up the river are plotted to show that even less accurate locations placed the turtle near the river. Capture location shown as blue dot.

As for the Mediterranean, reports of loggerhead turtles being found in rivers have been made in NW Atlantic since at least the 1920s (p385 in Carr 1952) and Carr (1952) affirms loggerheads are often found in streams "until the water freshens". Other recent reports show a loggerhead as inhabiting estuarine conditions in NE Australia (Perez et al. 2022), and they are well known in such habitats in the NW Atlantic (Carr & Caldwell 1956; Mendonça & Ehrhart 1982; Ehrhart et al. 2003; McNeill et al. 2020). These are marine or brackish water habitats, again implying fresh or low salinity water is a limiting factor in loggerhead distribution, which makes our study turtle in freshwater more unusual.

The reason for loggerheads to venture upstream is not certain, however they are not the only sea turtle species known to inhabit river estuaries. Green turtles (*Chelonia mydas*) are frequently recorded over 1 km upstream of the San Gabriel River mouth (NE Pacific), although in this instance they are selecting the area due to warm water effluent discharged into the river, which acts as a thermal refuge (Massey et al. 2023).

It is not likely that riverine habitats will ever be regular foraging sites for loggerhead turtles in Greece or the Mediterranean, making their observation in these locations more intriguing. We do not know what impacts this behaviour has on the metabolism and on the osmoregulation of the individual turtles, but from the most recent tracking data of this study turtle presenting normal behaviour it can be assumed no lasting harm is done.

Acknowledgements

This study was funded by MAVA foundation as part of the project "Conservation of Marine Turtles in the Mediterranean Region" (medmarineturtles.org). Thanks to ARCHELON's field teams who helped with all aspects of the fieldwork for this project.

Literature cited

Carr A (1952) Handbook of Turtles: The Turtles of the United States, Canada and Baja California. Cornell University Press, Ithaca

Carr A, Caldwell DK (1956) The ecology and migrations of sea turtles, 1: Results of field work in Florida, 1955. American Museum Novitates 1793: 23pp

Cerritelli G, Casale P, Sözbilen D, Hochscheid S, Luschi P, Kaska Y (2022) Multidirectional migrations from a major nesting area in Turkey support the widespread distribution of foraging sites for loggerhead turtles in the Mediterranean. Marine Ecology Progress Series 683:169-177

Ehrhart LM, Bagley DA, Redfoot WE (2003) Loggerhead turtles in the Atlantic Ocean: geographic distribution, abundance, and population status. In: Bolten AB, Witherington BE (eds) Loggerhead Sea Turtles. Smithsonian Books, Washington, DC. pp157–174

Keller M (2005) Loggerhead turtles in the Dalyan River, Mulğa [sic] Province, Turkey, 2004. Marine Turtle Newsletter 108:14-15

Massey LM, Penna S, Zahn E, Lawson D, Davis CM (2023) Monitoring green sea turtles in the San Gabriel River of Southern California. Animals 13:434

McNeill JB, Avens L, Hall AG, Fujisaki I, Iverson AR (2020) Foraging and overwintering behavior of loggerhead sea turtles *Caretta caretta* in the western North Atlantic. Marine Ecology Progress Series 641:209–225

Mendonça MT, Ehrhart LM (1982) Activity, population size and structure of immature *Chelonia mydas* and *Caretta caretta* in Mosquito Lagoon, Florida. Copeia 1982(1):161-167

Perez MA, Limpus CJ, Hofmeister K, Shimada T, Strydom A, Webster E, Hamann M (2022) Satellite tagging and flipper tag recoveries reveal migration patterns and foraging distribution of loggerhead sea turtles (*Caretta caretta*) from eastern Australia. Marine Biology 169:80

Rees AF, Margaritoulis D, Newman R, Riggall TE, Tsaros P, Zbinden JA, Godley BJ (2013) Ecology of loggerhead marine turtles *Caretta caretta* in a neritic foraging habitat: movements, sex ratios and growth rates. Marine Biology 160:519–529