Successful Rescue, Rehabilitation, Release and Remote Tracking: A Case Study of Zoë, a Loggerhead Turtle Found Near Naxos Island, Greece

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On 5 September 2018, an amateur fisher found, during a period of northerly winds, a loggerhead turtle floating, unable to dive, to the north of Naxos near Grotta beach (~37.112°N, 25.375°E). The fisher called Naxos Wildlife Protection (NWP; www.naxoswildlifeprotection.com), which is a non-profit environmental organization run by volunteers who operate a first aid station for wild fauna and has the facilities and knowledge to treat and take care of injured/sick sea turtles and created the "Network for the Protection of the Sea Turtles in the Cyclades" in cooperation with ARCHELON, and described the turtle's behaviour. It was apparent that she had buoyancy issues which could be a symptom of disease, so the fisherman was instructed how to collect and transfer the turtle safely back to Naxos port, where she could be picked up.

NWP volunteers transported the loggerhead turtle from the port to their station in the town of Naxos where she received first aid and a first examination. She showed accumulation of small and large barnacles on her carapace and plastron, as well as her head and flippers. Zoë, as the turtle was named, was administered fluids and parasites which had grown inside her eyelids and on her head were removed. The same day, an X-Ray made at the local veterinary centre revealed she had a lung infection. Consequently, the next day, Zoë was sent by ferry to ARCHELON's Rescue Centre at Glyfada, near Athens (Rees 2005), for further treatment and rehabilitation.

Zoë was administered with antibiotics to cure the lung infection, as well as with vitamins to restore her energy and strength. Throughout the rehabilitation period, she was offered a wide variety of food, such as different kinds of fish, squid, shrimp, and sea urchins. She started to eat two weeks after her arrival at the rescue centre, but she needed assistance because of her buoyancy issues. Her buoyancy control returned three months after her arrival, and she was able to eat without assistance. Zoe was moved in a bigger tank as soon as the weather and water temperatures were suitable; this was the final stage before her release. She was housed in the big tank for three weeks where she was able to swim, dive and forage more freely. During that time, daily observations were made to confirm Zoe's normal behaviour and diving ability to ensure her safe return into the wild.

After she was assessed as healthy, Zoë was equipped with a Wildlife Computers SPOT-375 Argos-linked satellite transmitter, using the manufacturers methods and attachment kit (www.widlifecomputers.com) to follow her subsequent movements. The transmitter was deployed on 29 May 2019 while Zoë was still at ARCHELON's Rescue Centre being prepared for the trip back to Naxos. On the morning of 30 May 2019, Zoë, with representatives of ARCHELON, travelled by ferry to Naxos, reaching the island in the early afternoon. She was immediately transferred to Agios Prokopios beach (37.0731°N, 25.3521°E) where she was released in the presence of residents of the island as well as visitors, schools and representatives of the local authorities and Cyclades Preservation Fund. Even the fisher who had rescued Zoë attended the release with his family.

Figure 1. Zoë heading back to the sea at Agios Prokopios beach on Naxos, 30 May 2019. The release was keenly watched by many locals, visitors, and officials.

Upon release (Fig. 1), Zoë's carapace measured 53.3 cm SCLn-t (Bolten 1999; 57.5 cm CCLn-t)) and she weighed 23.8 kg; up from 17.0 kg at admission.

Zoë's location data was automatically gathered and archived in the Wildlife Computers Data Portal (www.wildlifecomputers.com). For the needs of this paper, we carried out a very simple data filtering process. To reconstruct the turtle's movements, we used only Argos Location classes (LCs) 3, 2 and 1 which have the highest accuracy (www.argos-system.org/) we selected the best daily location (accuracy LC3 > LC2 >LC1) and in the case of multiple locations of the same LC in a day we selected the first occurrence. These locations were then mapped in QGIS (v3.26), with different activities (residence / movement) determined visually.

When we determined Zoë to be on the move, we also determined approximate daily distance travelled by calculating the straight-line distance between consecutive selected daily locations, ignoring any possible intervening land.

In total, Zoë's transmitter provided locations for a duration of 684 days and recorded her movements around the Aegean Sea (Fig. 2). After release, Zoë moved immediately westwards towards the island of Paros and then north, on to Mykonos arriving there on 1 June 2019. She remained in the vicinity of Mykonos until 30 May 2020 (364d). She then left the shallow waters around the island and completed several looping movements around the Aegean until 14 July 2020 (45d). During this trip Zoë travelled ~1064km averaging 24.8km/d (SD=13.2, range 1.0-51.0, N=43). Some days were spent foraging in limited areas with minimal movement as indicated by the days with low distances travelled (Figs 2, 3). After this trip she remained near Mykonos until her transmitter ceased functioning (13 April 2021; 273d).

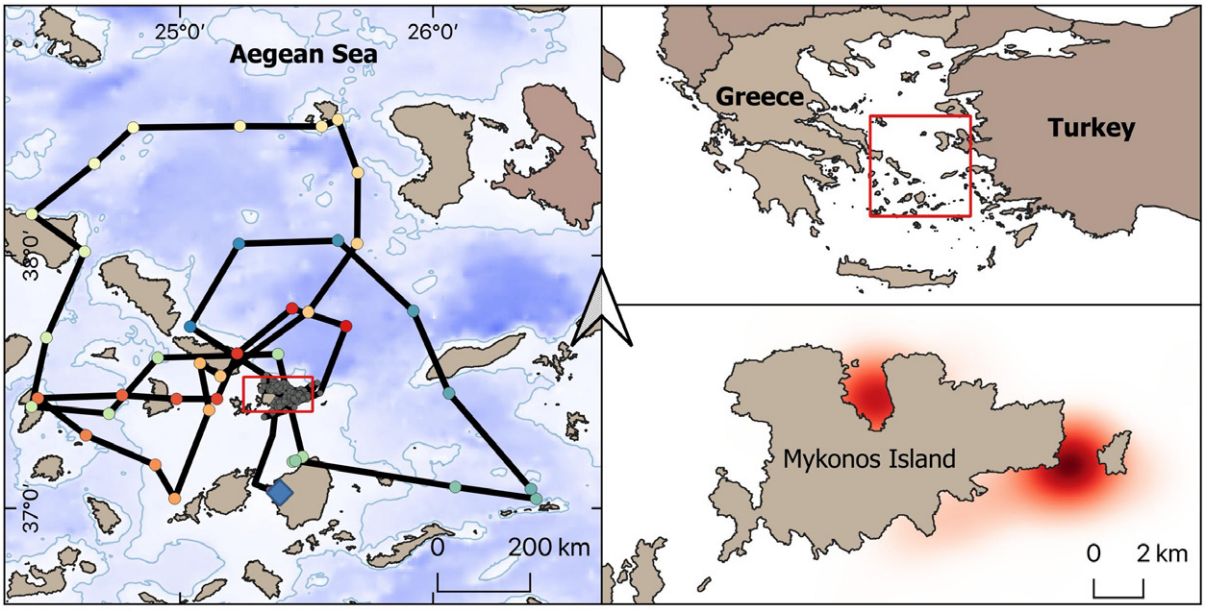

Figure 2. Aspects of Zoë's tracking. Left panel – best daily locations with large-scale circling movement indicated using colour from red at start of the movement to blue at the end. Sea depth is indicated with darkening blue at greater depths and the 200m isobath is shown with a blue line. Release location is indicated with a blue diamond. Bottom right panel – hotspot map from best daily locations when Zoë was resident in the waters around Mykonos. Hotspots created using the hotspot symbology function in QGIS.

During her period near the Island of Mykonos (637d) Zoë inhabited two focal hot spots, separated by approximately 13km. One was to the north of the island within the large Panormos Bay and the other to the east, between Mykonos and the nearby Island of Tragonissi (Fig 2).

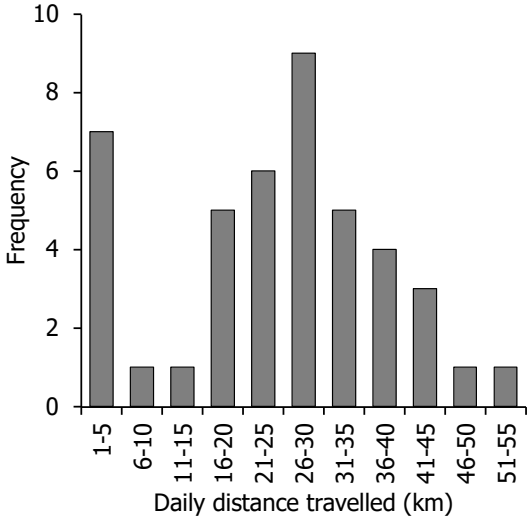

Figure 3. Approximate daily distance travelled by Zoë during her looping trip (see Fig. 2). No location data were obtained for five days during the trip. The resulting two-day distances were halved and allocated to both days.

From this extended tracking we conclude that Zoë was successfully rehabilitated after she was found floating with a lung infection. The >680d duration showed she had survived for that period and was behaving normally, able to change between localised foraging and protracted directed movements. Satellite tracking has previously been used to infer survivorship after rehabilitation (Cardona et al. 2012; Robinson et al. 2020, 2021; Cutajar et al. 2022) thus our record adds to the growing literature on the utility of this tool to assess rehabilitation outcomes.

We note that Zoë established long term residency near a different island to which she was found. This may result from her floating south to Naxos carried along by the northerly winds that prevailed at the time of her initial observation, or that she simply exhibited a change in preferred foraging location. Zoë's long-term residency near the Island of Mykonos is like that recorded for a loggerhead turtle that nested at Rethymno on Crete (Margaritoulis & Rees 2011), however the two hotspots selected by Zoë were different to the one chosen by the Cretan

turtle (ARCHELON, Unpub. Data) suggesting much of the waters around Mykonos may be favoured foraging sites for loggerheads within the Aegean.

In terms of turtle monitoring, the fact Zoë was resident at two separate locations around Mykonos Island during different periods has implications for at sea turtle surveying. If surveys were to be carried out at different locations around the island during different periods, then Zoë might have been double counted or not counted at all, thus illustrating that the research question and survey design need to be precisely aligned to gather the correct data.

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