Satellite tracking of loggerheads sea turtles (*Caretta caretta*) in the Gulf of Taranto (Northern Ionian Sea, Central Mediterranean Sea)

Fanizza C.[1], Colella R.[2], Crugliano R.[1], Cirelli G.[3], A. Colucci[3], Pisto A[3], Cipriano G.[4], Ricci P.[4], Maglietta R. [2], Carlucci R.[4]

[1] *Jonian Dolphin Conservation, Viale Virgilio 102, 74121 Taranto (TA) Italy,*
areaprogetti@joniandolphin.it

[2] *Institute of Intelligent Industrial Technologies and Systems for Advanced Manufacturing, National Research Council, Via Amendola 122/D-I, 70126, Bari (BA) Italy, rosalia.maglietta@cnr.it*
[3] *Sea Turtle Rescue Center WWF, Piazza Siris, 1, 75025 Policoro (MT) Italy, wwf.poli@gmail.com*
[4] *Department of Biology, University of Bari, Via E. Orabona 4, 70125 Bari (BA) Italy,*
roberto.carlucci@uniba.it

Abstract – **A detailed knowledge of sea turtle distribution in relation to anthropogenic threats is key to inform conservation measures. The movements of two Mediterranean loggerhead sea turtles (*Caretta caretta*) incidentally caught in the Gulf of Taranto, were tracked via satellite telemetry for between 8 and 118 days. With the caution due to the small sample size, results suggested that turtles might have very small home ranges in the area.**

Moreover, one of the two released loggerhead sea turtle, returning to the site where it has been accidentally captured. It has shown to have a remarkable fidelity to the site. Therefore, if confirmed and further detailed, information about sea turtle migration patterns and routes in the Gulf of Taranto will serve to plan effective conservation strategies for this species.

I.INTRODUCTION

The loggerhead sea turtle (*Caretta caretta)* is widely distributed in warm-temperate and subtropical oceans [1]. In the Mediterranean Sea, although its marine habitats extend throughout the basin, the reproductive habitats are concentrated prevalently in the eastern basin, with few registered nests in the western one [2]. Upon attaining sexual maturity, loggerhead sea turtles undertake breeding migrations between foraging grounds and nesting areas at remigration intervals from one to several years, with a mean interval of 2.5-3 years for females. The migration interval for males would be shorter [1]. According to the current criteria of the IUCN Red List,

the sub-population of *C. caretta* in the Mediterranean Sea is listed as Least Concern [1]. This assessment confirms the effectiveness of intense conservation programs in the Mediterranean basin, especially oriented to the conservation of its nesting sites to face human induced threats [1]. Therefore, understanding how *C. caretta* uses its habitat both in space and time is essential to effectively buffer its bio-ecology from exposition to anthropogenic threats. In this light, increase the knowledge about the migration patterns of *C. caretta* from local to a wider spatial scale is essential to develop strategies to ensure its conservation. Unfortunately, the lack of this information in the Mediterranean Sea often raised concerns about the possibility of an effective management of the species mostly in case of the increasing anthropic pressures on coastal and offshore areas.

In particular, concerning the Northern Ionian Sea, the knowledge about the spatio-temporal distribution of *C. caretta* is still scarce and fragmentary. To that regard, this study aims to provide new indications about the loggerhead sea turtle movement pattern in the investigated area, implementing current knowledge with modern technologies such as the use of satellite tracking devices. The use of such tools is a response to many of the concerns that have been raised and reviewed surrounding the biology and conservation of sea turtles [3]. This innovative tracking approach can be crucial to enable progress towards a global understanding of sea turtle ecology away from nesting beaches, and to indicate effective conservation and protection strategies.

II. MATERIALS AND METHODS

A. Study area

The Gulf of Taranto in the Northern Ionian Sea (Central Mediterranean Sea) covers an area of approximately 14.000 km^2 from Santa Maria di Leuca to Punta Alice. A narrow continental shelf with a steep slope and several channels characterize the western sector, while the eastern sector shows descending terraces toward the 'Taranto Valley', a NW–SE submarine canyon with no clear bathymetric connection to a major river system [4,5,6]. In addition, a transitional water system [7], the Mar Piccolo of Taranto, characterizes the northernmost part of the Gulf of Taranto. It covers a total surface of about 20.63 km^2 and consists in a system of two distinct inlets, called 'Primo' and 'Secondo Seno' (first and second inlet), the innermost of which receives an inflow from some small streams. The Mar Piccolo is characterized by low water turnover and water movement. Currents are moderate, anticyclonic, and more intense in the first inlet than in the second one, where they are more appreciable near the narrows, which connect the two inlets [8].

B. Data collection

The movements of two loggerhead sea turtles (*C. caretta*) were monitored during January 2020 through May 2020. The sea turtles were incidentally caught in the set nets, typically deployed in neritic area where large turtles are supposed to spend most of their time [9]. They were kept in captivity at Sea Turtle Rescue Centre WWF Policoro for a maximum of one month prior to release.

Fig.1 Loggerhead sea turtle with SPOT-365 transmitter

Animal tracking is usually done using location trackers built for the particular application. In particular, while most of terrestrial animals can be tracked using Global Positioning System, this is not possible for marine animals due to the time required for a GPS receiver to acquire satellite signals and navigation data, and calculate a position solution (called a fix).

SPOT (Smart Position and Temperature) transmitting tags produced by Wildlife Computers well respond to the requirement of our application, as they exploit Argos satellite telemetry (https://argos-system.cls.fr/) a widely used method to relay data and track the movements of marine animals, which regularly spend time at the surface. These tags were provided in the framework of the SAT-CAL Project "Application of Satellite Transmitters on Sea Turtles in the Ionian Sea".

When the tag's antenna completely clears the surface of the water, wet/dry sensors activate the tracker and messages can be successfully transmitted the low-orbiting Argos satellites, and sent to earth-based receiving stations for location processing (using Doppler shift) and distribution. Collected data include time-at-temperature histograms and wet/dry percentage.

Wildlife tags offer many benefits, the most important are:

- Response time: it needs less than half a second, since the activation, for the first packet to be sent to the satellite.
- Long battery life: when submerged, the tracker goes in a low-consumption mode, maximizing the battery duration. Depending on the particular animal behavior and on the tag model, data can be collected for up to several hundreds of days.
- Data availability: data are made available on the Wildlife Computers Data Portal (https://my.wildlifecomputers.com/data/). Argos accounts are checked for new data every hour. If new Argos data are detected, the portal will begin checking every 15 minutes to ensure the new data are captured in a timely manner. If no new data are detected within a 24-hour period, the portal will resume checking for data every hour. Location data can be downloaded and displayed on a map and user can observe how position changes with time.
- Tags can be widely and easily configured, connecting them to a pc through the Wildlife Computers software (named Tag Agent) or offline, from the Wildlife Computers Data portal, Tags section, storing the settings to be updated later. Settings include the possibility of masking hours of the day to prevent uplink when no satellite passes are expected, reducing power consumption. Time-at-temperature histograms can also be customized.

Drawbacks are the lower accuracy of Argos data (250 m) with respect to GPS, that make them not suitable for small scale analysis and the not complete coverage of the whole daytime with satellite passes: a location-based

check of the satellite passes is made available on Argos site as a simulation and needs to be carried out before configuring the hourly mask of the tag.

Argos system algorithm analyzes location data and classifies them into six location classes (LC) of decreasing accuracy (LC 3-1: accuracy <1 km, LC 0, LC A, LC B) plus LC Z, which includes invalid, rejected locations. This allows researches easily filter out data that can be considered unreliable because of a too large error.

In order to attach the transmitter to the turtle's carapace, a custom plastic mount was designed and 3D printed. Then, it was fixed to the carapace with some water-resistant resin after the surface had been cleansed of grease and debris and slightly roughened, so that the resin got a better grip on it.

We used two SPOT-365 transmitters (57 x 48 x 24 mm, 57 g.) that are currently in use and will last for a maximum time of 340 days. Both of them have been configured so that transmission is enabled in the interval 6.00 am – 06.00 pm. The data coming from both of them can be visualized on movebank.org, a free online platform for sharing, managing and analyzing data.

III. RESULTS

The first female (ID 01POLI2020) named "Erasmus" was incidentally captured in the second inlet of the Mar Piccolo of Taranto. The turtle was released from Policoro on 31 January 2020 and is currently monitored. Since its release to May 26th, it first remained in an area of 3.5 km radius around the release point for 24 days, then it spent the next 13 days traveling toward Taranto where it was recorded in the second inlet of the Mar Piccolo and where it remained until 26 May 2020. The 275 location data points related to "Erasmus" have been filtered, keeping only the 59 points that belong to LC_0 -3 location classes.

Fig.2 Location points, filtered with respect to data quality, shows that the turtle named "Erasmus" traveled for 13 days from the release zone, where it remained for 23 days, to Mar Piccolo, where it currently is and where it was captured

The second female (ID 04POLI2020) named "Alessandra" was incidentally captured in the coastal area of Policoro. The turtle was released from Policoro on 19 May 2020 and is currently monitored. During these 7 days, the turtle remained in the coastal area of Policoro, moving not more than 3 km away from the release location.

The loggerhead turtles tracked, showed a CCL (Curved carapace length) ranging from 65 to 72 cm, resulting above the minimum size of nesting females in the Mediterranean [10]. Thus, it cannot be excluded that they were adults.

IV. DISCUSSION AND CONCLUSIONS

The present study contributes to the current knowledge of loggerhead sea turtle movements in the Northern Ionian Sea (Central Mediterranean Sea). Particularly interesting is the behavior of the turtle called "Erasmus" who after being released in the coastal waters of Policoro returned to the transitional water in the Mar Piccolo of Taranto. Results suggest that "Erasmus" may have a very small home range. This condition seems to be associated to the local environmental conditions, such as the occurrence of shallow waters with good availability of benthic preys and mostly of extended mussel farms.

"Alessandra" remained in the coastal area of Policoro during the tracking period. This suggests the occurrence of optimal trophic conditions even in the open waters. A longer monitoring period would be needed to identify possible ecological drivers favoring loggerhead turtles.

Present results suggest that turtle occurrence may be higher in shallow waters along the coast, and further investigation may inform conservation actions aimed at reducing the impact of fishing [11]. The use of satellite tracking technology on nesting females can lead us to identify new nesting areas in the Gulf of Taranto. This information could be applied to the conservation and management of the species in order to reduce the interactions between fishermen and sea turtles.

V. ACKNOWLEDGMENTS

VI. REFERENCES

1. P.Casale, "*Caretta caretta* (Mediterranean subpopulation)", The IUCN Red List of Threatened Species, 2015: e.T83644804A83646294. http://dx.doi.org/10.2305/IUCN.UK.2015 4.RLTS.T83644804A83646294.en.

2. P.Casale, G.Simone, "Seasonal residency of loggerhead turtles *Caretta caretta* tracked from the Gulf of Manfredonia, south Adriatic", Mediterr. Mar. Sci., vol.18, No.1, 2017, pp.4-10. doi:https://doi.org/10.12681/mms.1663.

3. F.Bentivegna, "Intra-Mediterranean migrations of loggerhead sea turtles (*Caretta caretta*) monitored by satellite telemetry", Mar. Biol., vol.141, 2002, pp. 795–800. DOI 10.1007/s00227-002-0856-z

4. R.Carlucci, C.Fanizza, G.Cipriano, C.Paoli, T.Russo, P.Vassallo, "Modeling the spatial distribution of the striped dolphin (*Stenella coeruleoalba*) and common bottlenose dolphin (*Tursiops truncatus*) in the Gulf of Taranto (Northern Ionian Sea, Central-Eastern Mediterranean Sea)", Ecol. Indic. vol.69, 2016, pp.707–721.

5. R.Carlucci, V.Bandelj, F.Capezzuto, L.Sion, P.Maiorano, A.Tursi, C.Solidoro, S.Libralato, "Exploring spatio-temporal changes in the demersal and benthopelagic assemblages of the northwestern Ionian Sea (central Mediterranean Sea)", Mar. Ecol. Prog. Ser., vol.598, 2018, pp.1-19.

6. P.Ricci, S.Libralato, F.Capezzuto, G.D'Onghia, P.Maiorano, L.Sion, A.Tursi, C.Solidoro, R.Carlucci, "Ecosystem functioning of two marine food webs in the North−Western Ionian Sea (Central Mediterranean Sea)", Ecol. and Evol., vol.9, 2019, pp.10198-10212.

7. E.Cecere, G.Alabiso, R.Carlucci, A.Petrocelli, M.Verlaque, "Fate of two invasive or potentially invasive alien seaweeds in a central Mediterranean transitional water system: failure and success" Botanica Marina, vol.59, 2016, pp.451-462.

8. D. Malcangio, M.Mossa, "Tidal current computation in the Mar Piccolo (Taranto)", G.H.Jirka, W.S.J Uijttewaal, Shallow Flows, (Eds.). The Netherlands, A.A. Balkema, 2004, pp.217-223.

9. P. Casale, "Sea turtle bycatch in the Mediterranean", Fish and Fisheries, vol.12, 2011, pp.299-316.

10. D.Margaritoulis, R.Argano, I.Baran, F.Bentivegna, M.N.Bradai, J.A.Camiñas, P.Casale, G.De Metrio, A.Demetropoulos, G.Gerosa, B.J.Godley, D.A.Haddoud, J.Houghton, L.Laurent, B.Lazar, "Loggerhead turtles in the Mediterranean Sea: present knowledge and conservation perspectives", in: A.B.Bolten (Eds). Loggerhead Sea Turtles, Smithsonian Institution Press, Washington D.C.

11. P.Casale, M.Affronte, D.Scaravelli, B.Lazar, C.Vallini, P.Luschi, "Foraging grounds, movement patterns and habitat connectivity of juvenile loggerhead turtles (*Caretta caretta*) tracked from the Adriatic Sea", Mar. Biol., vol.159, 2012, pp. 1527-1535.