CALL FOR TENDERS ICCAT GBYP 03/2023 – AERIAL SURVEY FOR THE MONITORING OF BLUEFIN TUNA SPAWNING AGGREGATIONS IN THE MEDITERRANEAN SEA (ICCAT GBYP – PHASE 13) - ICCAT GBYP CIRCULAR # G-0428/2023 AREA C

Final Report

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This project is co-funded by the European Union

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Summary

Within the ICCAT GBYP program, aerial surveys are carried out with the aim of providing fishery-independent indices to improve the knowledge of Bluefin tuna populations in the Mediterranean, particularly for what is concerning the spawners aggregations. After the 2010 and 2011 surveys, carried out in four Mediterranean spawning areas, in 2013 and 2015 the survey was extended to the whole Mediterranean Sea. In 2017, 2018 and 2019, the surveys were limited to the 4 initial spawning areas. In 2022, the area G was excluded by the ICCAT survey design. In the 2023 campaign, Unimar was awarded to carry out the survey in the Area C (Southern Tyrrhenian Sea) and performed the whole 4 replicas foreseen by the ICCAT sampling protocol. The survey was carried out from June 2nd to June 19th, 2023. 5 BFT sightings were performed through 13 total survey flights. Including other species, 57 sightings were performed.

Keywords

Abundance, Geographical distribution, Migrations, Spawning grounds, Tuna fisheries, Statistical sampling, Bluefin tuna, Thunnus thynnus, Mediterranean, Aerial survey

1. BACKGROUND AND OBJECTIVES

The improvement of knowledge of the Atlantic Bluefin tuna key biological and ecological processes is essential for developing management policy which can provide long term sustainable exploitation of this resource.

The comprehensive ICCAT Atlantic Wide Research Programme on Bluefin Tuna (GBYP) was initiated with the aim to improve basic data collection, the understanding of key biological and ecological processes, assessment models and management. Among the other activities, aerial surveys were planned to be performed for several years.

In 2010 and 2011, aerial surveys on spawning aggregations were carried on 4 areas in the Mediterranean Sea, which were, identified as spawning areas on the base of biological and traditional knowledge, as well as recent fishery data. In 2013 and 2015, following the GBYP Steering committee recommendation, the area of the survey was extended to the whole Mediterranean basin and therefore more sub-areas than in the previous years were identified.

In 2017, ICCAT decided to restrict the survey to the 4 initial areas and so was done in 2017, 2018 and 2019. From the 2022 campaign, ICCAT decided to exclude the Area G and cover only the following three ones:

A - Balears

C - Southern Tyrrhenian Sea

E - Sicily Channel

This report describes the activities and the results related to the 2023 Unimar-Aerial Banners survey, covering the Area C.

2. MEANS AND METHODS

The activities were carried out following the terms of reference of the ICCAT Call for Tenders and the Technical specifications annexed to the contract. The spawning behaviour of Bluefin tuna was reported in detail by Arena (Arena, P. 1979, 1982 a/b/c/d) for the Southern Tyrrhenian; the individuals tend to aggregate in bigger schools starting from late April, with maximum aggregation when water temperature exceed 20°C and while a thermocline forms and stabilises at a depth of 15 - 30 m, inducing Bluefin tuna schools to stay in the superficial layers.

Most of the personnel involved in the survey participated to the training course held online on May 31st, 2023, during which the details of the methodology and operative standards were explained, and previous field experiences were shared.

2.1 Aircrafts and equipment

One aircraft was used, with upper wings, good forward visibility, bubble windows on both sides and capable of flying at a spotting altitude of 300 m and a speed of 100 nm/h, as foreseen by ICCAT GBYP protocol. The aircraft is a Partenavia/Vulcanair P68 B model (I-GNIT registration number), already used in the past campaigns. It has about 5 hours flight range.

- Brand: Partenavia/Vulcanair
- Model: P68 B
- Code: I-GNIT

The aircraft and crews are shown in Figure 1.

Figure 1 - The crew and the aircraft

The equipment used by the spotters was the following:

A GPS *Garmin*® GPSMap 64st, with the statistical survey design uploaded (the same route files were provided to the pilot);

- A GPS external antenna, which were applied on the aircraft dashboard under the front window in order to enhance the satellite signal reception and avoid any signal loss
- A digital *Nikon*® D3200 photo camera, with 6400 ISO maximum sensitivity, equipped with Sigma® 70-200 zoom lens f/2.8 OS, polarised filter (77mm gauge) and Nikon 55-200 zoom lens f/5.6 VR, polarised filter (52mm gauge): after some trial, the panning and multiple shot mode was chosen as the best one to have the higher possibilities to capture clear images, as well as autofocus mode
- *Silva Sight Master*® clinometers

Onboard the aircraft there always were a pilot, a professional spotter and two scientific spotters. Effort and sightings were recorded on the data forms and the GPS recording of all the flights and sighting positions were saved. During the flights, the GPS recorded (with a 3 second recording frequency) the exact position of the aircraft as well as all the waypoints entered by the spotters in order to mark the significant events to be transcribed into the forms. After every landing, the information was saved into a laptop and sent to the central office. The altimeter of the spotters GPS device was daily calibrated with the known altitude of the airport. The pilot calibrated the aircraft altimeter and followed the actual altitude that matched with the one measured by the spotters GPS device.

The survey period started on June 2nd and was completed on June 19th, 2023.

According to the contract terms of reference, weather conditions were considered adverse when they could interfere with a reliable observation of tuna schools: winds over 3 Beaufort scale, clouds lower than 300 m, heavy rain.

Esri ArcMap® GIS software was used for data mapping. Garmin BaseCamp® was used for track designing, analysis, checking, saving and editing.

2.2 The Survey design and the Survey areas

Aerial surveys were designed using the "DISTANCE" program and were provided by ICCAT GBYP. In each block, a series of transects were created, based on the dimensions of the area, in a manner to achieve the approximate statistical coverage. Surveys were designed as equal spaced parallel lines since it provides equal coverage probability (Hammond P. et al, 2010).

Area C is the Central Mediterranean area located North of Sicily and West of Calabria, around Ustica island as western limit and Marina di Camerota as northern limit.

The importance of these areas for Bluefin tuna spawning activities is well known (Arena, P. 1978, 1982): for this reason, constant activity of purse seine fishing has been carried out there

since the early Seventies (Arena, 1990). The position of the 2023 survey area is shown in Figure 2.

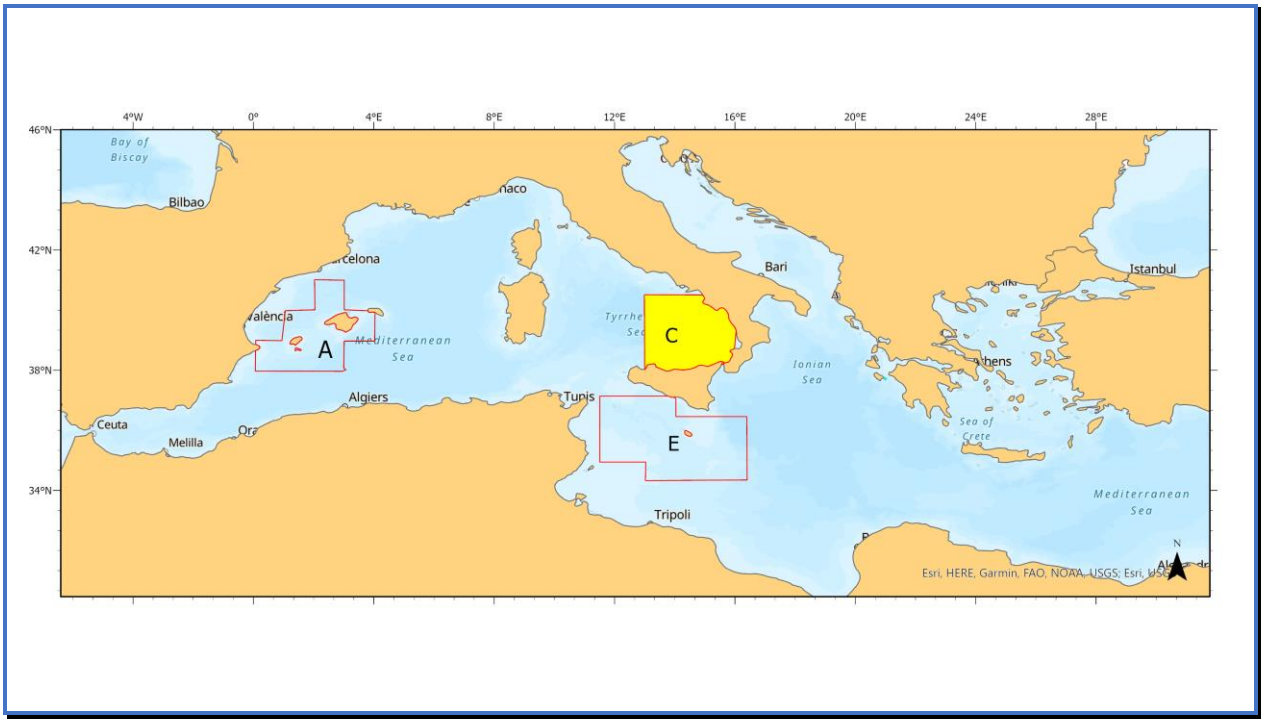

Figure 2 - 2022 Area C in yellow

The survey area features, from the ICCAT Survey Protocol, are described in Table 1.

Table 1 - Features of Area C

Area	
Area (km^2)	53,868
Proport. of total area	20.3
Expected proport. Length of Trackline on Effort	6,489
Expected proport. Length of Trackline on Effort (minus 10% for circling)	5,841
% coverage	18.7
Line spacing per replica	42.5
On effort track Replica 1	1,270
On effort track Replica 2	1,273
On effort track Replica 3	1,228
On effort track Replica 4	1,332
Total on effort track	5,103
Leftover effort	21.4

The sampler routes are shown in Figure 3.

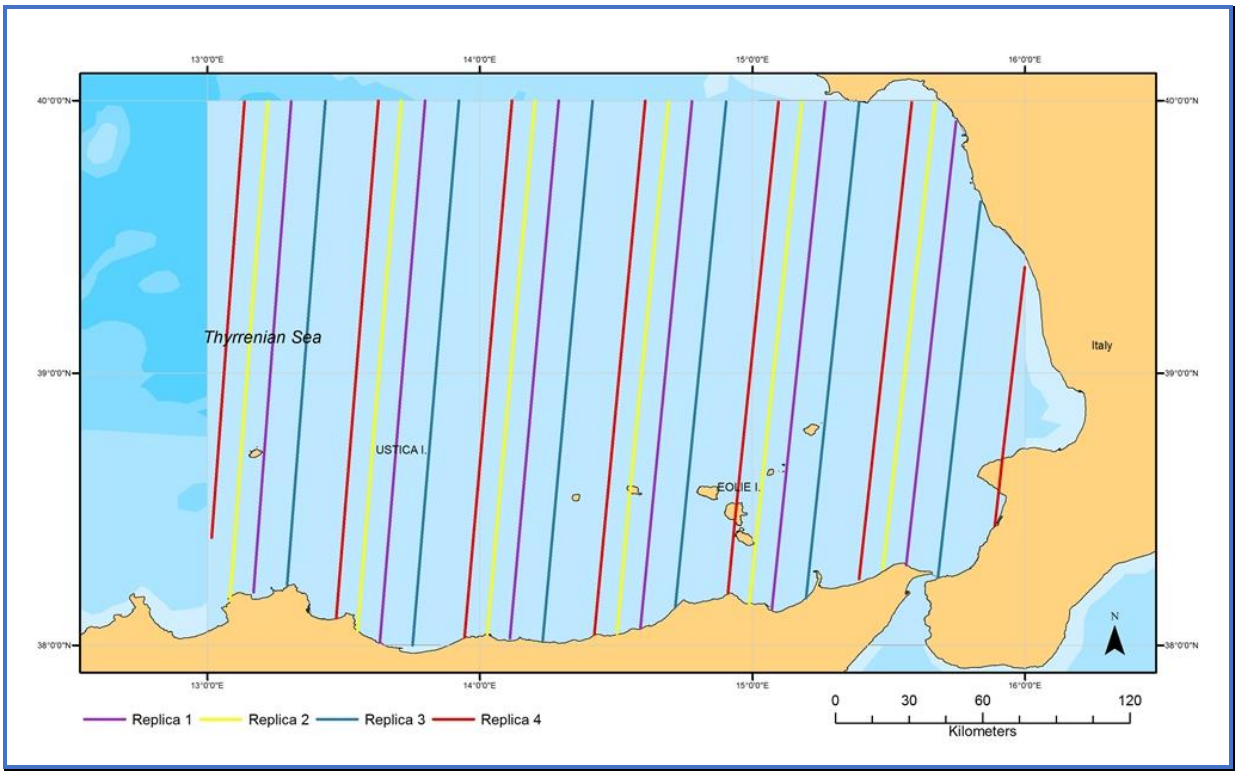

Figure 3 - Area C sampler routes (Transects-Legs)

3. RESULTS

3.1 Preparatory tasks

First of all, the team was set up. The Unimar coordination staff contacted the spotters and managed the preliminary activities with Aerial Banners, the partner company providing the aircrafts and the pilots. The spotters were chosen based on the expertise requested for the aerial survey: years of experience in aerial tuna spotting for the professional spotters, years of experience in tuna fisheries and biology, aerial surveys and/or census of marine populations for the scientific spotters, past participation in the BFT aerial spotting or aerial survey campaigns for the pilots. A data analyst with experience in data mapping was involved as well. All scientific observers were already involved in all or some of the previous aerial survey campaigns.

Several meetings were organised at Unimar headquarters in order to share the methodology among the scientific spotters and to organise the field activities. Other meetings with the pilots were organised before and during the surveys.

3.2 Field activity

According to ICCAT schedule and meteorological conditions, the Area C staff moved to the base airport on the first available day (June 2nd) in order to perform the first flight on the same day, June 2nd. The base airport for Area C was "Napoli - Capodichino" airport (ICAO code: LIRN), the civil and military main airport of Naples. The same airport used in the past campaign.

A flight per day was performed, as planned in the technical Offer.

The survey was carried out in 13 on-duty days. There were 3 days of stop, 14,15,16 of June due to sudden and unpredictable events, and the subsequent needs to reorganize the activities, and 2 more days, 17 and 18 of June, because of the mandatory maintenance operations of the aircraft. The survey was completed on June 19th. The daily report of the surveys is provided in Table 2.

The team

Pilot: Francesco Ruggiero

Professional spotter: Salvatore De Martino

Scientific spotters: Adriano Mariani, Simone Serra, Andrea Fusari, Andrea Poggi

The 2023 campaign was the ninth survey in the area “C”, already surveyed in 2010, 2011, 2013, 2015, 2017, 2018, 2019 and 2022. While in 2010 and 2011 about eleven transects per replica were followed, in 2013, 2015, 2017, 2018, 2019 and 2022 the transects number per replica was fewer: 6 in the 1-3 replicas and 7 in replica 4, so the distance between the lines was higher. In 2023, the same sampling design of 2017, 2018, 2019 and 2022 was adopted.

The field activities started on the first day with stable conditions: June 2nd. The general visibility conditions were within the limits during the whole survey, both the wind/sea state and haze/clouds. In very few cases, it was necessary to change the transect sequence in order to be sure to fly with the best spotting conditions, according to the weather forecasts and human evaluations.

Table 2 - Daily report of the surveys

Survey #	Date	Aircraft	Take off*	Landing*	Area	Transects	Take off airport	Landing airport
1	02-giu	I-GNIT	10:25	14:28	C	C1L4-C1L3	-	-
2	03-giu	I-GNIT	09:50	13:25	C	C1L1-C1L2	Naples	Naples
3	04-giu	I-GNIT	09:56	13:21	C	C1L6-C1L5	Naples	Naples
4	05-giu	I-GNIT	10:18	13:42	C	C2L4-C2L3	Naples	Naples
5	06-giu	I-GNIT	09:50	13:25	C	C2L2 - C2L1	Naples	Naples
6	07-giu	I-GNIT	09:48	13:35	C	C2L6 - C2L5	Naples	Naples
7	08-giu	I-GNIT	09:41	13:16	C	C3L6 - C3L5	Naples	Naples
8	09-giu	I-GNIT	09:47	13:28	C	C3L6 - C3L5	Naples	Naples
9	10-giu	I-GNIT	09:50	13:45	C	C3L4 - C3L3	Naples	Naples
10	11-giu	I-GNIT	09:44	13:25	C	C3L1 - C3L2	Naples	Naples
11	12-giu	I-GNIT	11:22	15:17	C	C4L3-C4L2	Naples	Naples
12	13-giu	I-GNIT	09:31	13:14	C	C4L7-C4L6	Naples	Naples
13	19-giu	I-GNIT	10:34	12:38	C	C4L1	Naples	Reggio Calabria

* local time (GMT+2)

Although the flights were generally performed at the altitude and speed requested (300 m, 100 nm/h), occasional slight differences and fluctuations due to environmental and technical factors were registered.

For all the performed flights, the tracks were registered by the observers' GPS (the .gpx files of the tracks and the Excel format tables of the same tracks are sent as Annexes).

The effort and sightings forms can be found in the Annexes, as well.

The photos can be identified according to the number shown in the file name. A complete set of the photos taken during the surveys can be find in the Annexes in both .JPG and .NEF (RAW) format.

The photos were taken following the methodologies tested in the previous campaigns. In order to overcome the problems in photography, especially the ones linked to aircraft bouncing and vibrations, high shutter speeds (around 1/800-1/1000) and a medium zoom (around 70-80) were used, but in most cases, this wasn't enough for getting sharp and clear photos. Despite many trials and changes were performed, the presence of the windows, the short time available, the difficulties with autofocus and the general shooting conditions unavoidably affected the sharpness of the photos and therefore their usefulness.

Maps of recorded GPS tracks

Figure 4 to Figure 7 show the GPS tracks recorded onboard the aircrafts during the survey. Each colour corresponds to a different day.

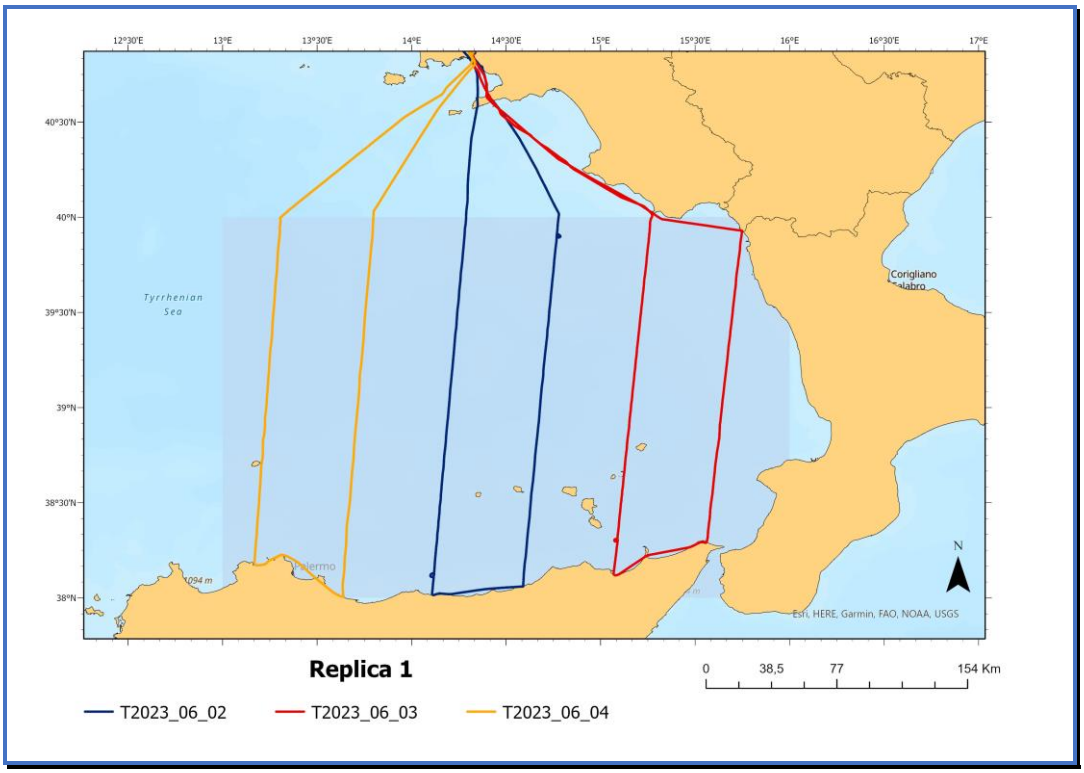

Figure 4 - Recorded GPS tracks: Area C, Replica 1

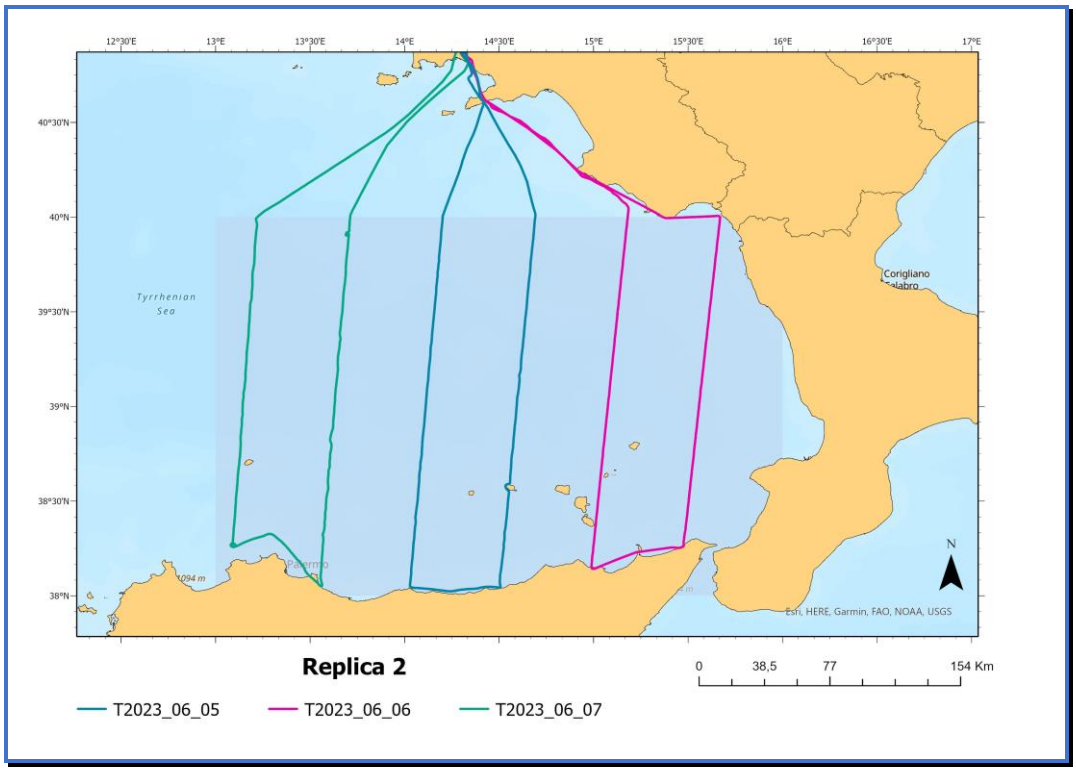

Figure 5 - Recorded GPS tracks: Area C, Replica 2

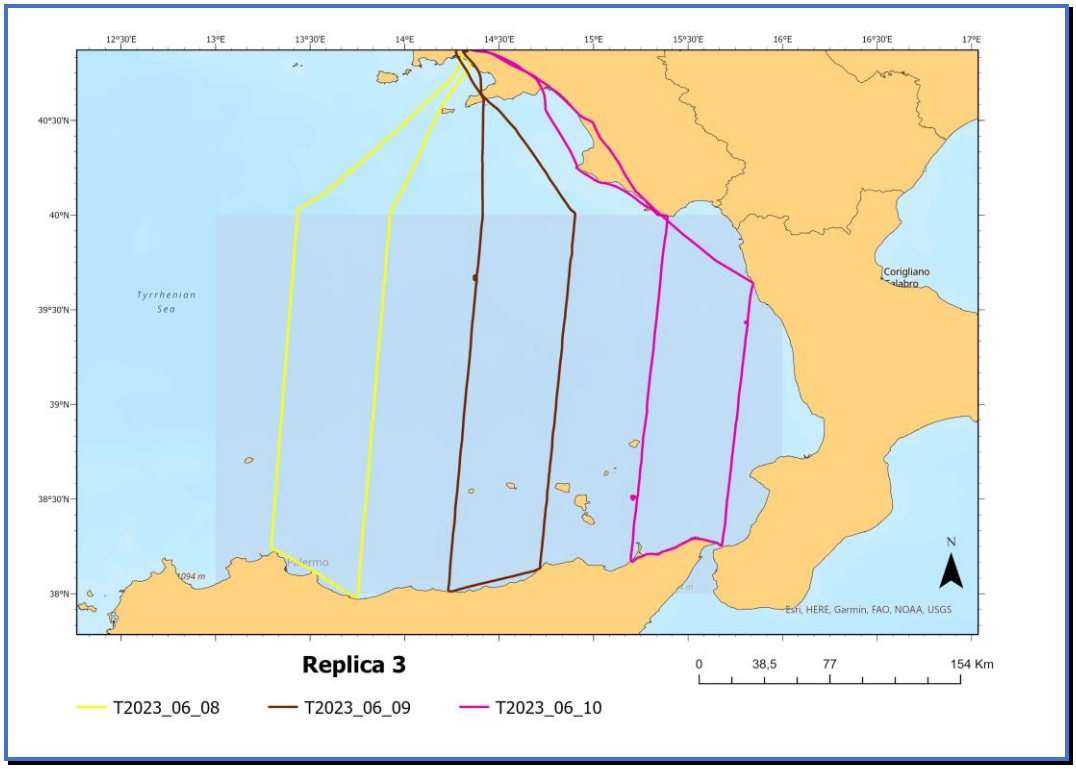

Figure 6 - Recorded GPS tracks: Area C, Replica 3

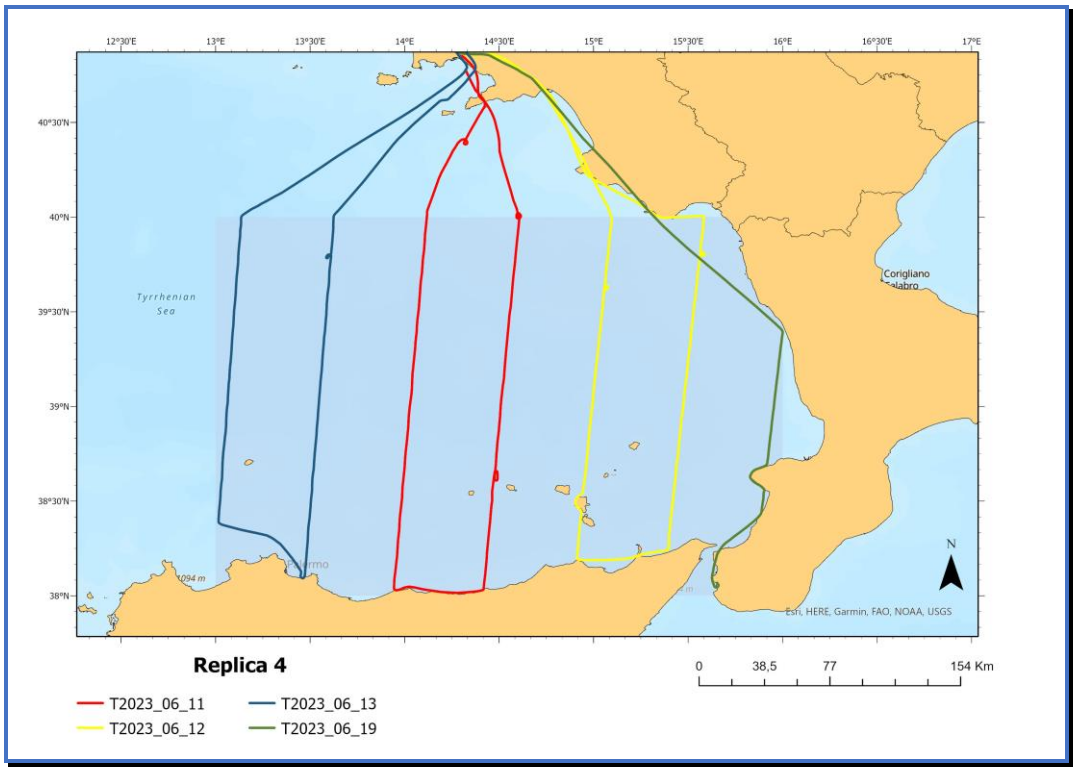

Figure 7 - Recorded GPS tracks: Area C, Replica 4

3.3 Sightings overview

Figure 8 shows the positions of the sightings of BFT and the related values in terms of number of individuals and weight. All the details are available in Table 3 and in the annexed forms.

Figure 9 shows the distribution of the other species sightings.

57 sightings were performed: 5 BFT and 52 other species. Several photos of BFT sightings are provided. According to the professional spotters' opinions, part of the BFT schools could be deeper and less visible, but professional spotters could estimate them according to their experience.

The 2023 survey was performed earlier than the last 2022 (started on June 11). Less BFT sightings occurred almost over the whole period. The same regarding other species sightings: less loggerhead turtles, swordfishes and dolphin-like cetaceans (including pilot whales and Risso's dolphins) were sighted all along the survey. Last years were spotted also some Sharks and mantas in contrast to this year where their presence are not recorded.

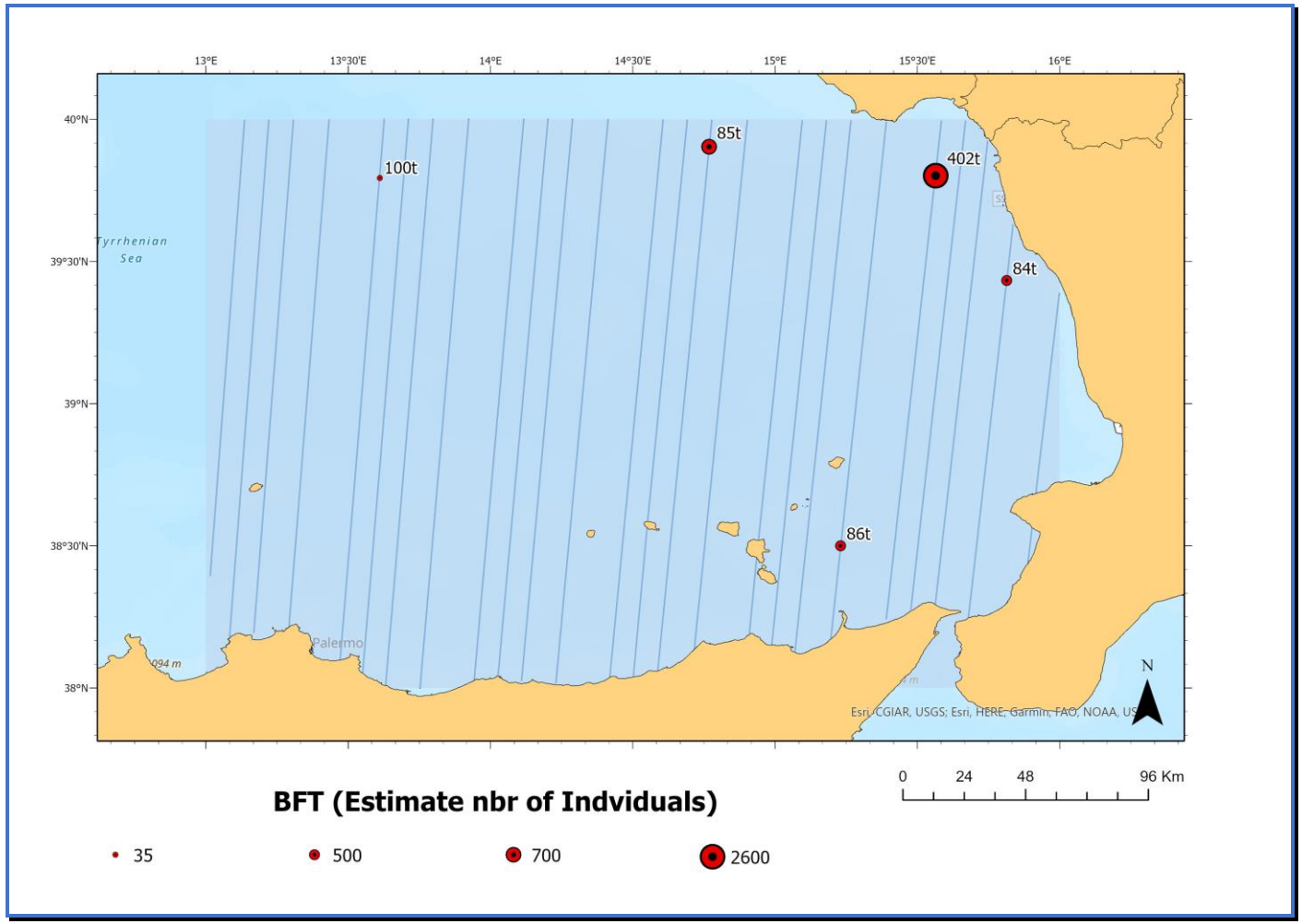

Figure 8 - Map of the BFT sightings (number of individuals and weight)

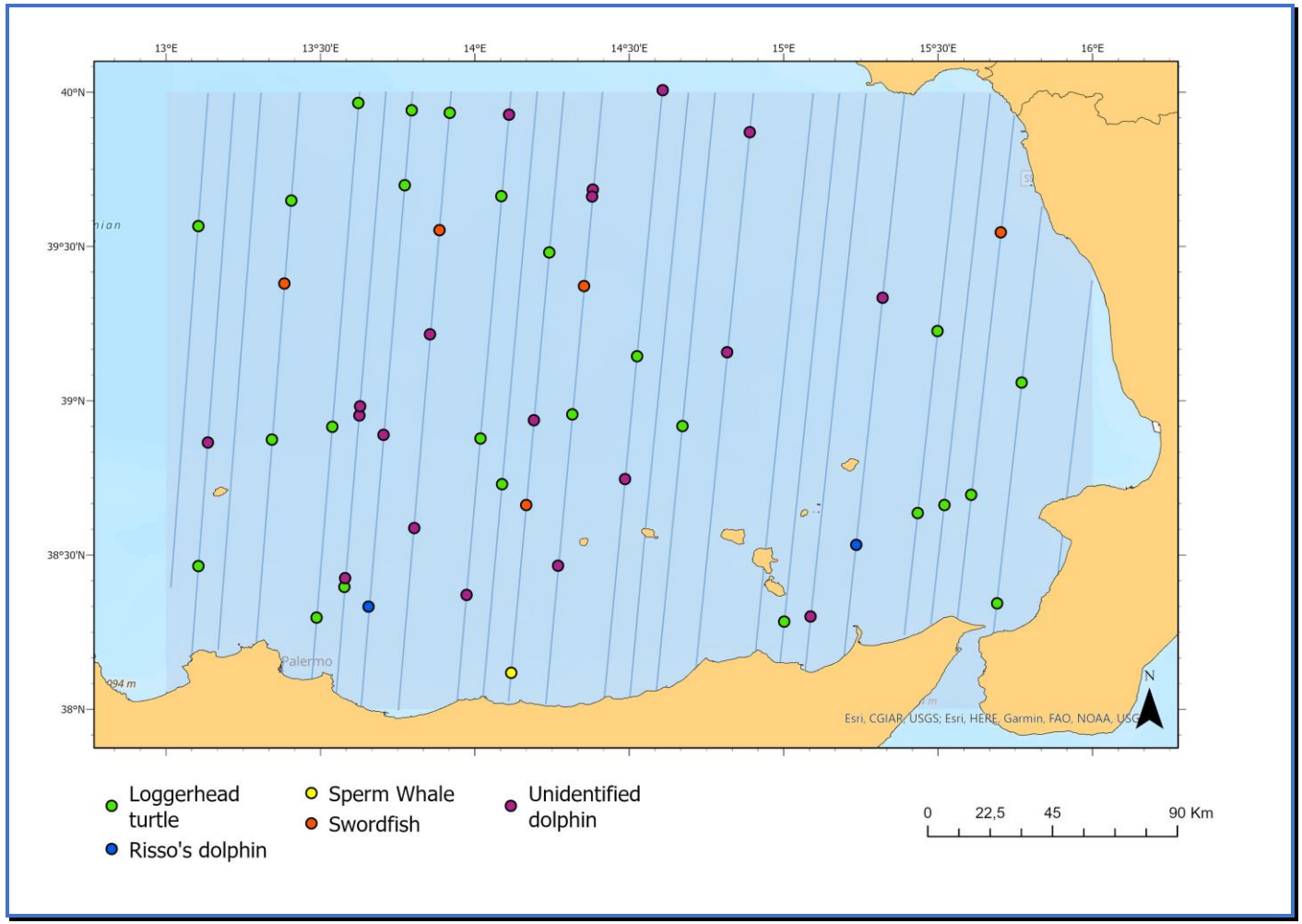

Figure 9 - Map of the other species sightings

Table 3 - Overview of the BFT sightings

Date	Time abeam	Lat abeam	Lon abeam	Angle abeam	School size PS	Weight PS (ton)	% small	% med	% large
02/06/2023	11:43:41	N39.90356°	E14.76813°	20	700	85	14	50	36
10/06/2023	08:55:11	N39.43317°	E15.81393°	26	500	84	20	20	60
10/06/2023	10:02:57	N38.49999°	E15.23019°	10	500	85,6		24	76
12/06/2023	12:14:53	N39.80170°	E15.56449°	24	2600	402	4	58	38
13/06/2023	10:27:58	N39.79366°	E13.61132°	20	7000	35	100		

3.4 Methodological remarks and discussion

Regarding the methodological aspects of the sightings, no significant difference from the past campaigns is worthy of notice.

It is confirmed that the bubble windows are very useful for vertical and near spotting. Regarding the photos, even if the camera was set with the highest shutter speeds, often the photographs were "blurry" or distorted: this seems to be the result both of the window interference and of the aircraft movements.

As in the past campaigns, an external antenna was installed and connected to the GPS to overcome some GPS signal loss especially during circling. We recommend to fix it over the aircraft instruments panel.

Regarding the BFT spotting, the importance of southern Tyrrhenian Sea as Bluefin tuna spawning areas is confirmed, even if the number of BFT schools spotted were much lower than the previous year.

Regarding the other species sightings, the usual species commonly found were spotted: in the case of the turtles, we followed the suggestions to remark in some cases the cumulated sightings, to avoid the many interruptions of the spotting where a high number of them were found in very short part of the transect.

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Weather forecast websites

Passageweather	www.passageweather.com
Windy	www.windy.com (and smartphone app)
Windfinder	http://it.windfinder.com
Mediterranean Wave Forecast	http://isramar.ocean.org.il
Aeronautica Militare Italiana	http://www.meteoam.it
Consorzio Lamma	http://www.lamma.rete.toscana.it

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5. ANNEXES

1. Effort and Sighting forms
2. GPS tracks (gpx file and Excel track log)
3. Photos
4. Power Point presentation

This work has been carried out under the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP), which is funded by the European Union, several ICCAT CPCs, the ICCAT Secretariat, and other entities (see https://www.iccat.int/gbyp/en/overview.asp). The content of this paper does not necessarily reflect ICCAT's point of view or that of any of the other sponsors, who carry no responsibility. In addition, it does not indicate the Commission's future policy in this area.