AERIAL SURVEY FOR THE MONITORING OF BLUEFIN TUNA SPAWNING AGGREGATIONS IN THE MEDITERRANEAN SEA CALL FOR TENDERS 05/2022 (ICCAT/GBYP Phase 11) - Circular #0434/2022, 19.4.2022

AREA C

Final Report

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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 2022 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 11th to June 20th, 2022. 17 BFT sightings were performed through 13 total survey flights. Including other species, 94 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. In 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 2022 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 June 3rd, 2022, 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 seconds 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 11th and was completed on June 20th, 2022.

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 2022 survey area is shown in Figure 2.

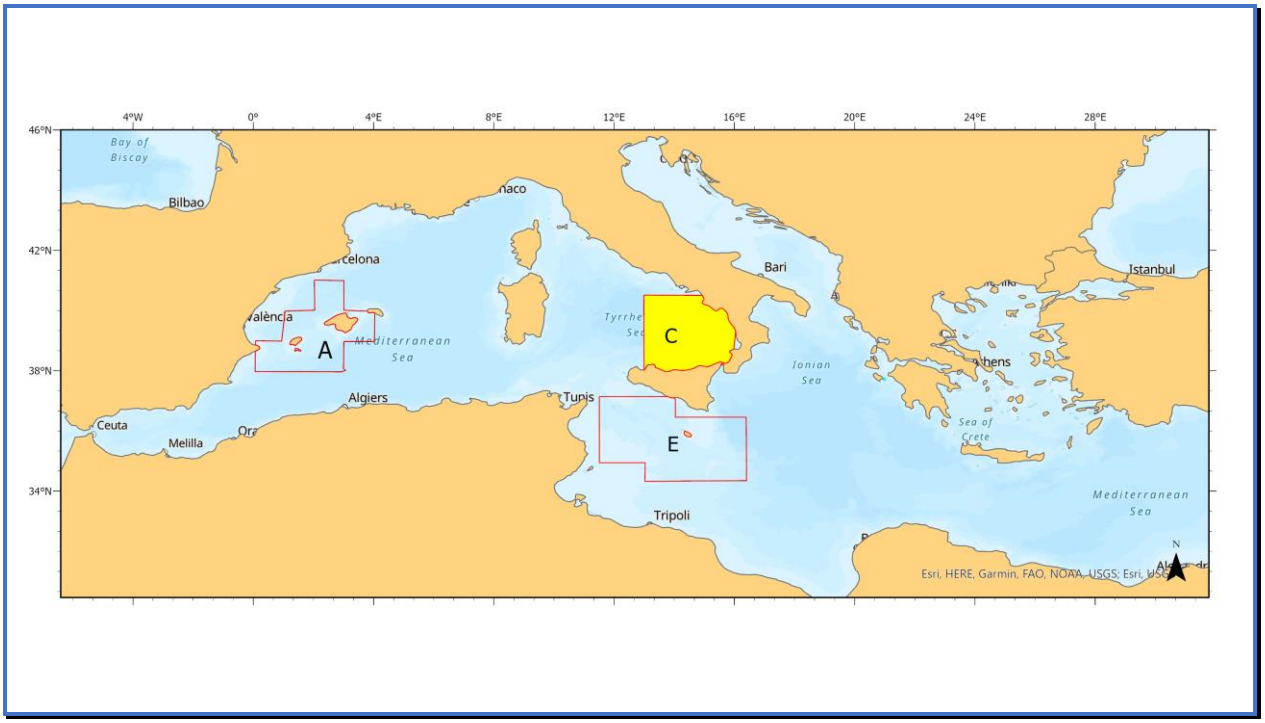

Figure 2 - 2022 Area C in yellow

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.

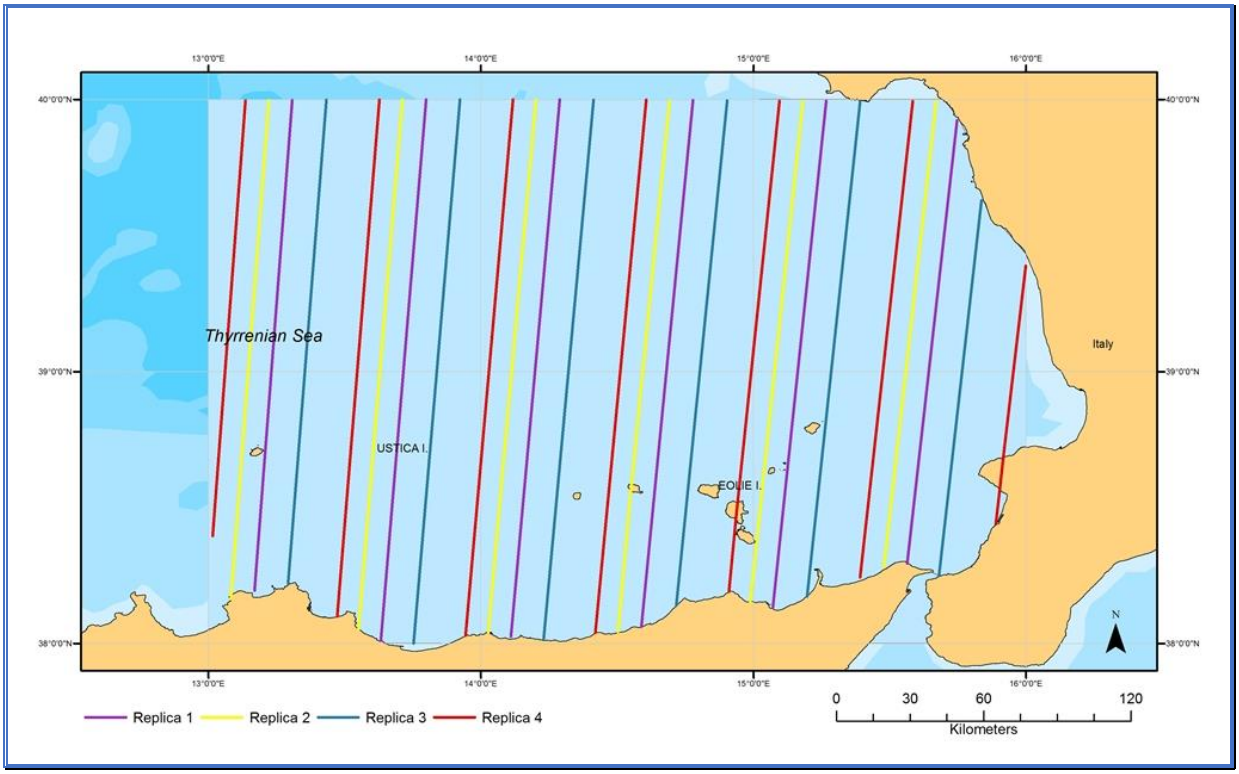

Figure 3 - Area C sampler routes (Transects-Legs)

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 on the basis of 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 10th) in order to perform the first flight on June 11th. Once the crew arrived on site, the weather forecast got worse and the beginning of the survey was delayed one day after what planned. The base airport for Area C was "Napoli - Capodichino" airport (ICAO code: LIRN), the civil and military main airport of Naples. The Salerno-Pontecagnano airport, used in the past campaigns, was not available for renovation works.

A flight per day was mainly performed, as planned in the technical Offer. In four days, two surveys per day were performed, in order to prevent any loss of time due to the delayed beginning of the surveys.

The survey was carried out in 9 on-duty days. Only one standby day was necessary because a foreseen strong wind on June 11th would have affected the spotting, as said before. The survey was completed on June 20th. 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 Poggi

The 2022 campaign was the eighth survey in the area “C”, already surveyed in 2010, 2011, 2013, 2015, 2017, 2018 and 2019. While in 2010 and 2011 about eleven transects per replica were followed, in 2013, 2015, 2017, 2018 and 2019 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 2022, the same sampling design of 2017, 2018 and 2019 was adopted.

The field activities started on the first day with stable conditions: June 12th. 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.

It’s worth to remark that the surface water temperature was exceptionally high for this season (around 25 °C): it is possible that these conditions could have an effect on the visibility of Bluefin tuna schools. We spotted more schools than ever, despite some were observed below the surface.

Table 2 - Daily report of the surveys

Survey #	Date	Aircraft	Take off*	Landing*	Area	Transects	Take off airport	Landing airport
standby	11/6	I-GNIT	-	-	-	-	-	-
1	12/6	I-GNIT	11:00	14:38	C	C1L6-C1L5	Naples	Naples
2	13/6	I-GNIT	10:45	14:22	C	C1L4-C1L3	Naples	Naples
3	14/6	I-GNIT	9:42	13:22	C	C1L2-C1L1	Naples	Naples
4	14/6	I-GNIT	14:43	20:51**	C	C2L6-C2L5	Naples	Naples
5	15/6	I-GNIT	14:25	17:56	C	C2L4-C2L3	Naples	Naples
6	16/6	I-GNIT	10:25	14:30	C	C2L2-C2L1	Naples	Naples
7	17/6	I-GNIT	10:00	13:39	C	C3L1-C3L2	Naples	Naples
8	17/6	I-GNIT	14:40	18:21	C	C3L6-C3L5	Naples	Naples
9	18/6	I-GNIT	10:25	14:56	C	C3L4-C3L3	Naples	Naples
10	18/6	I-GNIT	15:10	18:54	C	C4L1-C4L2	Naples	Naples
11	19/6	I-GNIT	10:28	13:51	C	C4L7-C4L6	Naples	Naples
12	20/6	I-GNIT	10:19	14:00	C	C4L5-C4L4	Naples	Naples
13	20/6	I-GNIT	15-32	18:39	C	C4L3	Naples	Naples

* local time (GMT+2)

**During the Survey #4, the crew decided to land at Palermo-Boccadifalco airport in order to check a suspected technical problem for an onboard instrument. Once verified everything was safe, the return flight to Naples was possible.

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.

In order to enhance the visibility of fishes, we edited the .jpg files adjusting contrast and light with a simple photo editing program (MS Office Picture Manager). Enhancing the contrast and the dark components of the image, in many cases the fishes have become more visible than in the unmodified photo.

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 many 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.

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.

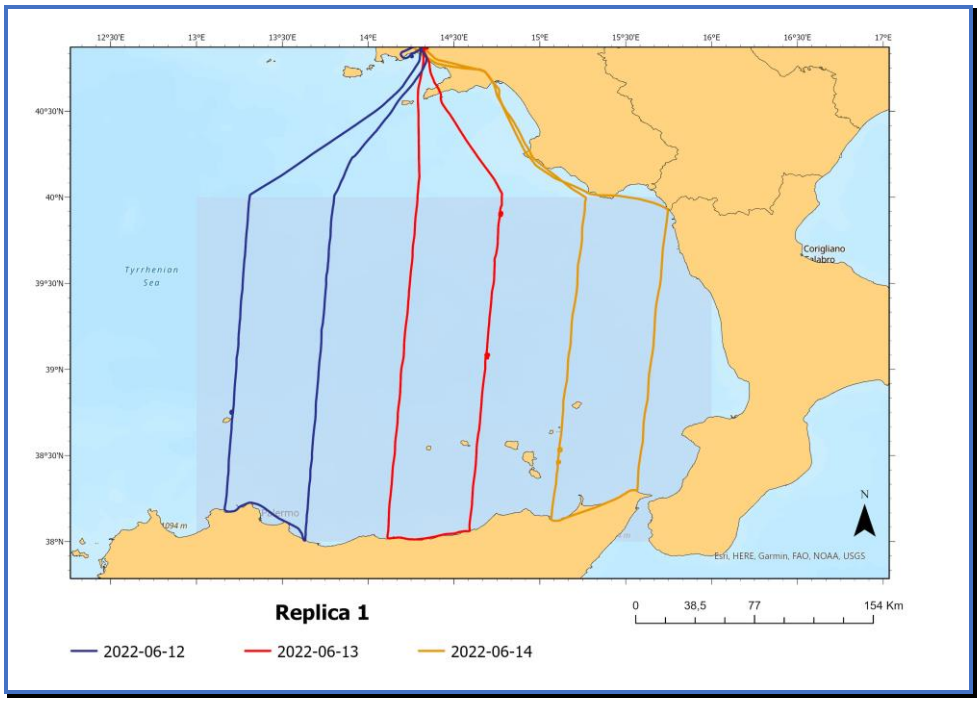

Figure 4 - Recorded GPS tracks: Area C, Replica 1

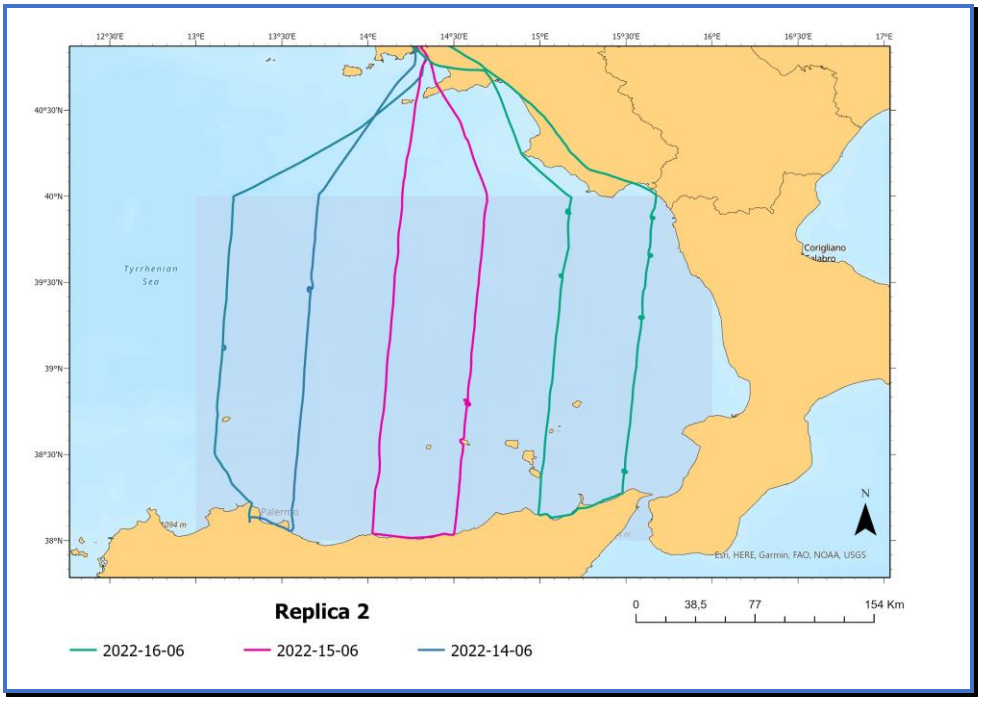

Figure 5 - Recorded GPS tracks: Area C, Replica 2

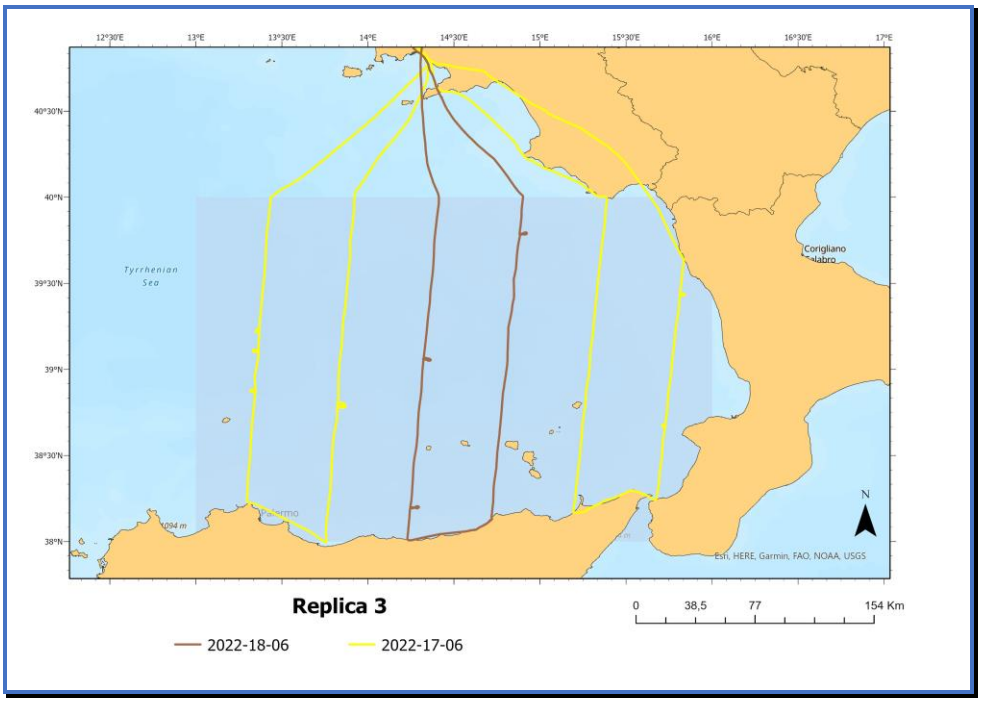

Figure 6 - Recorded GPS tracks: Area C, Replica 3

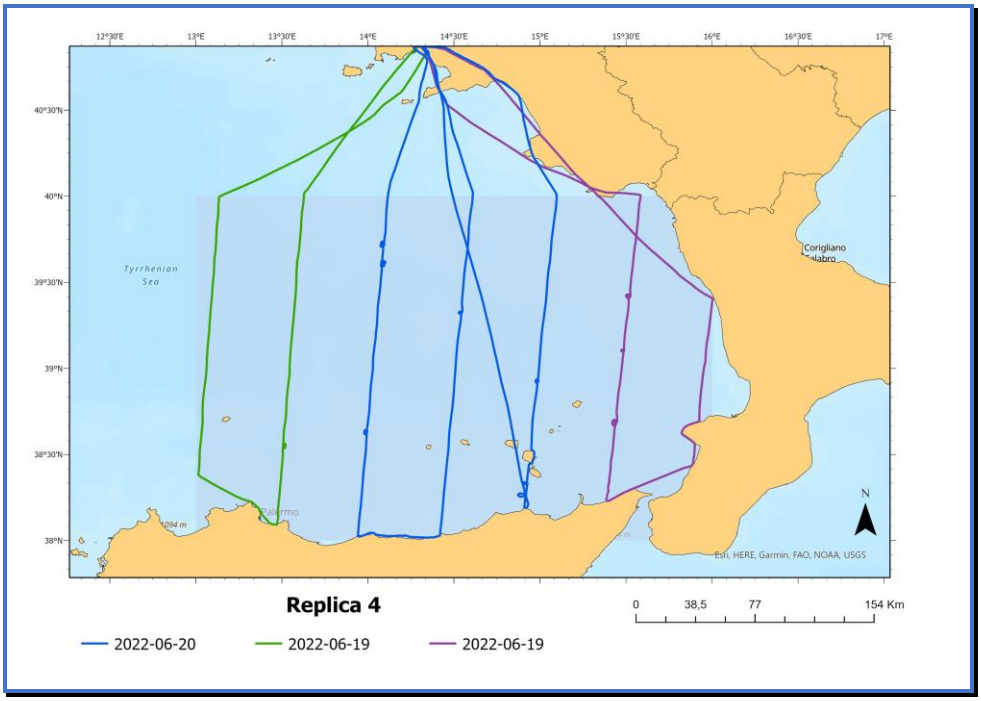

Figure 7 - Recorded GPS tracks: Area C, Replica 4

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.

94 sightings were performed: 17 BFT and 77 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 2022 survey was performed later than the last four campaigns (2015, 2017, 2018 and 2019), but earlier than 2013 (started on June 18th). The BFT sightings occurred almost over the whole period. The same regarding other species sightings: a high number of loggerhead turtles, swordfishes and dolphin-like cetaceans (including pilot whales and Risso's dolphins) were sighted all along the survey. Two sperm whales and a juvenile were detected during the first survey in the western part of the area. Two sharks and three mantas were spotted as well.

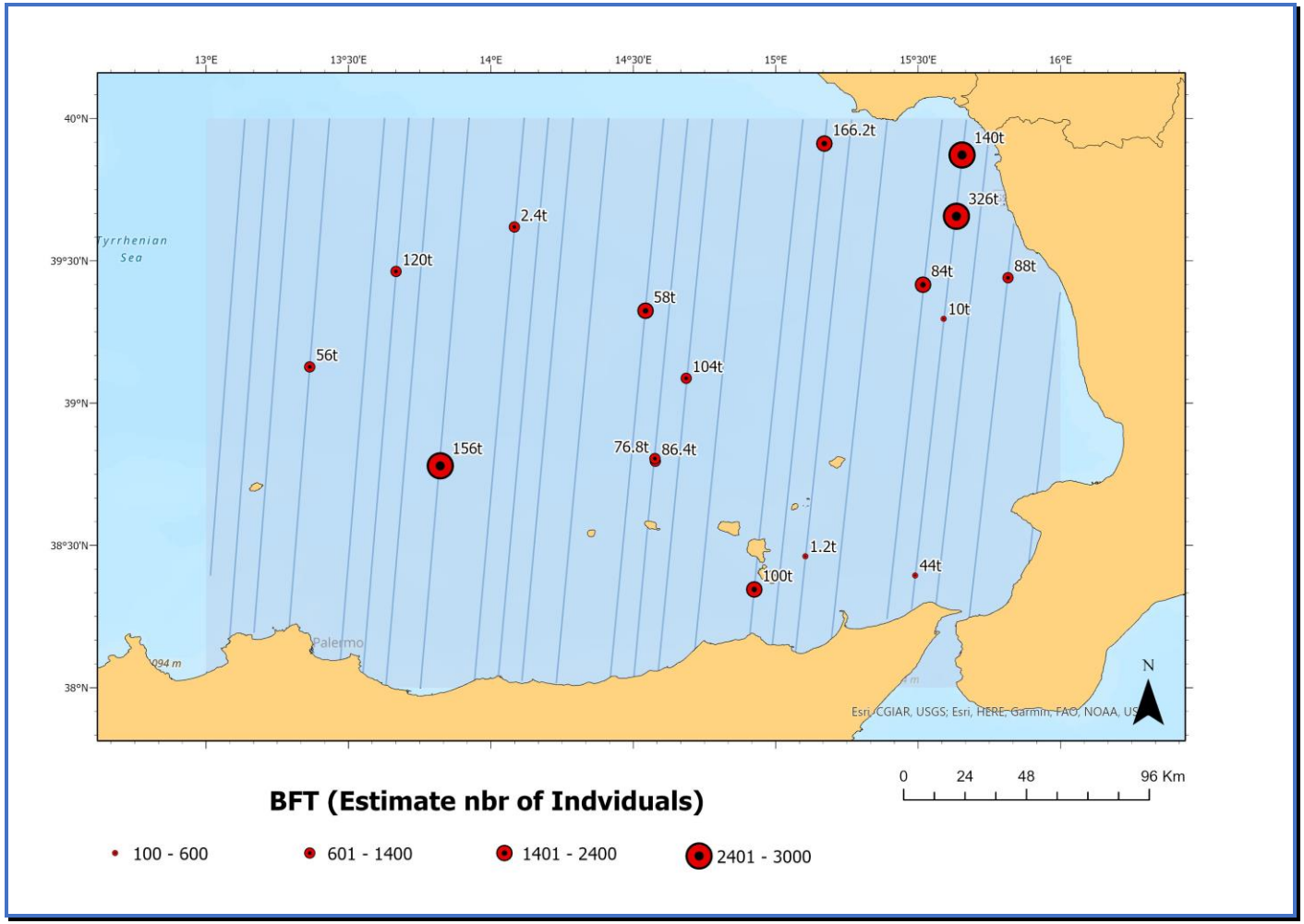

Figure 8 - Map of the BFT sightings (number of individuals and weight)

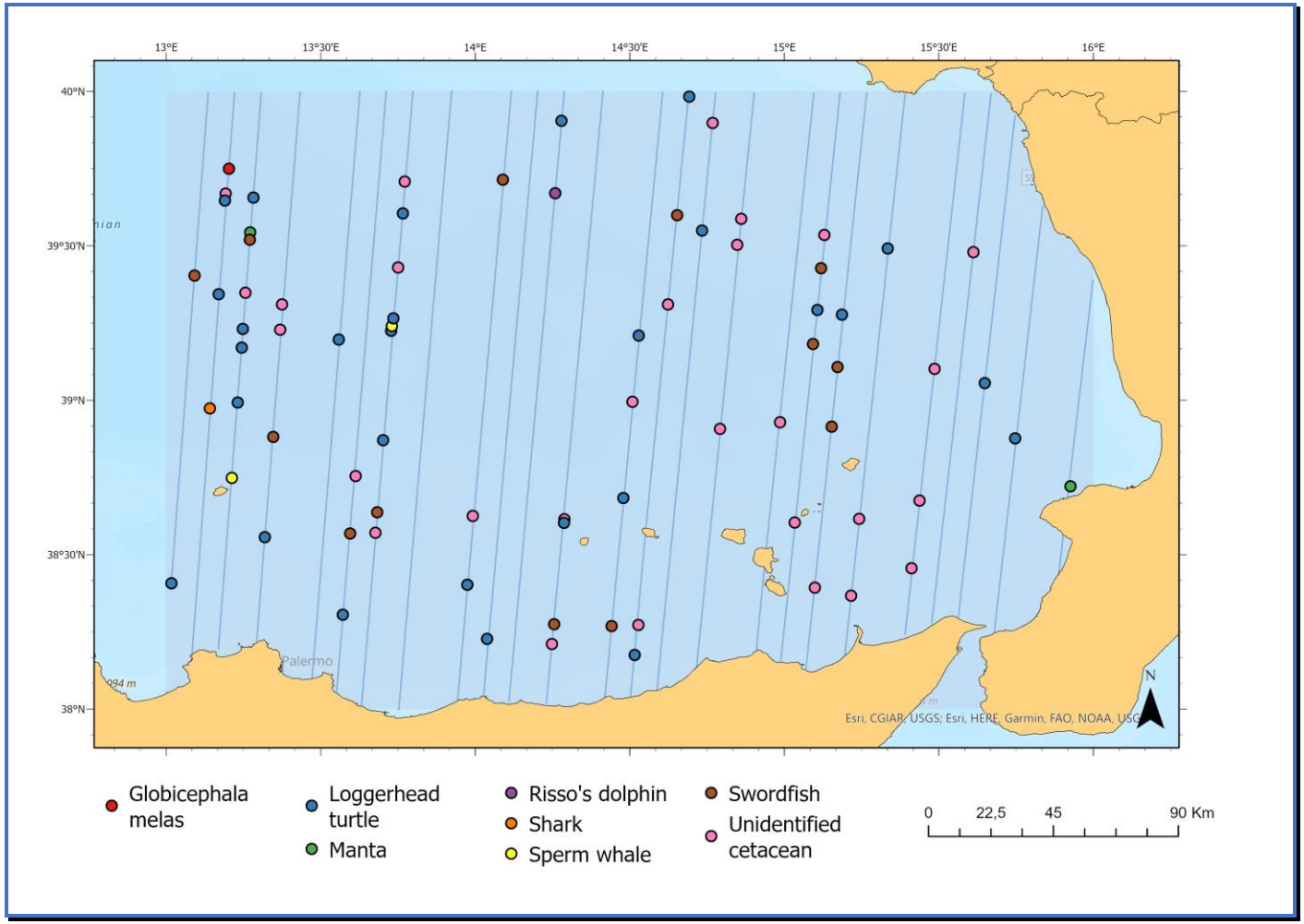

Figure 9 - Map of the other species sightings

Table 3 - Overview of the BFT sightings

ID	Date	Time abeam	Lat abeam	Lon abeam	Angle abeam	School size PS	Weight PS (ton)	% small	% med	% large
20	13/06/2022	10:59:37	39.08721	14.68583	46	1000	104		100	
27	14/06/2022	09:11:25	38.46181	15.10425	55	100	1,2	100		
39	14/06/2022	18:02:40	39.46264	13.66710	62	1000	120		100	
43	15/06/2022	14:35:16	38.79586	14.57740	53	1200	86,4	42	58	
44	15/06/2022	14:39:32	38.80504	14.57599	54	1000	76,8	40	60	
48	16/06/2022	09:03:12	39.90656	15.17032	60	2400	166,2	38	62	
54	16/06/2022	10:31:53	38.40038	15.49050	57	600	44	33	66	
55	16/06/2022	11:09:35	39.29630	15.58961	63	500	10	100		
57	16/06/2022	11:26:42	39.65652	15.63452	38	2800	326	46		54
58	16/06/2022	11:39:33	39.87190	15.65422	64	3000	140	66	33	
59	17/06/2022	08:59:30	39.44058	15.81552	10	1400	88	55	45	
68	17/06/2022	13:45:40	39.11307	13.36346	10	1200	56	66	33	
71	17/06/2022	14:58:56	38.80277	13.82352	6	3000	156	60	40	
85	18/06/2022	15:36:38	39.41600	15.51718	36	1800	84	66	33	
91	20/06/2022	09:04:02	39.61878	14.08254	21	800	2,4	100		
98	20/06/2022	10:59:44	39.32452	14.54300	44	1700	58	82	18	
100	20/06/2022	15:02:55	38.34109	14.92431	16	2200	100	68	32	

3.4 Methodological remarks and discussion

Regarding the methodological aspects of the sightings, no significant difference from the past campaigns is worthy of notice. The campaign was carried out without special problems: only one day stop was decided, for weather reasons.

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, sometimes 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 in order 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. A lot of BFT schools were observed (17) compared with the past campaigns. Many individuals or whole schools were observed some meters under the surface, mainly during the first survey days.

Regarding the other species sightings, as in the past years we observed that, particularly because of the high number of turtles, the BFT spotting effort is often interrupted for some seconds by marking, angle measuring and writing on the forms. In order to overcome or limit this problem and reduce the risk of affecting the BFT spotting, it could be useful for future campaigns to study a solution aimed to further simplify the procedure of registration of other species data.

4. REFERENCES

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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

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