AERIAL SURVEY FOR THE MONITORING OF BLUEFIN TUNA SPAWNING AGGREGATIONS IN THE MEDITERRANEAN SEA CALL FOR TENDERS 04/2024 (ICCAT/GBYP Phase 14) - Circular #G-00262/2024

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. From 2017 the surveys were limited to the 4 initial spawning areas. From 2022, the area G was excluded from the ICCAT survey design. In the 2024 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 4th to July 6th, 2024. 3 BFT sightings were performed through 13 total survey flights. Including other species, 59 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 – Balearic Sea

C - Southern Tyrrhenian Sea

E - Sicily Channel

This report describes the activities and the results related to the 2024 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 30st, 2024, 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

Figure   The crews

Figure 2 - 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 4th and was completed on July 6th, 2024.

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.. 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). Survey design was provided by ICCAT GBYP

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 2024 survey area is shown in 3.
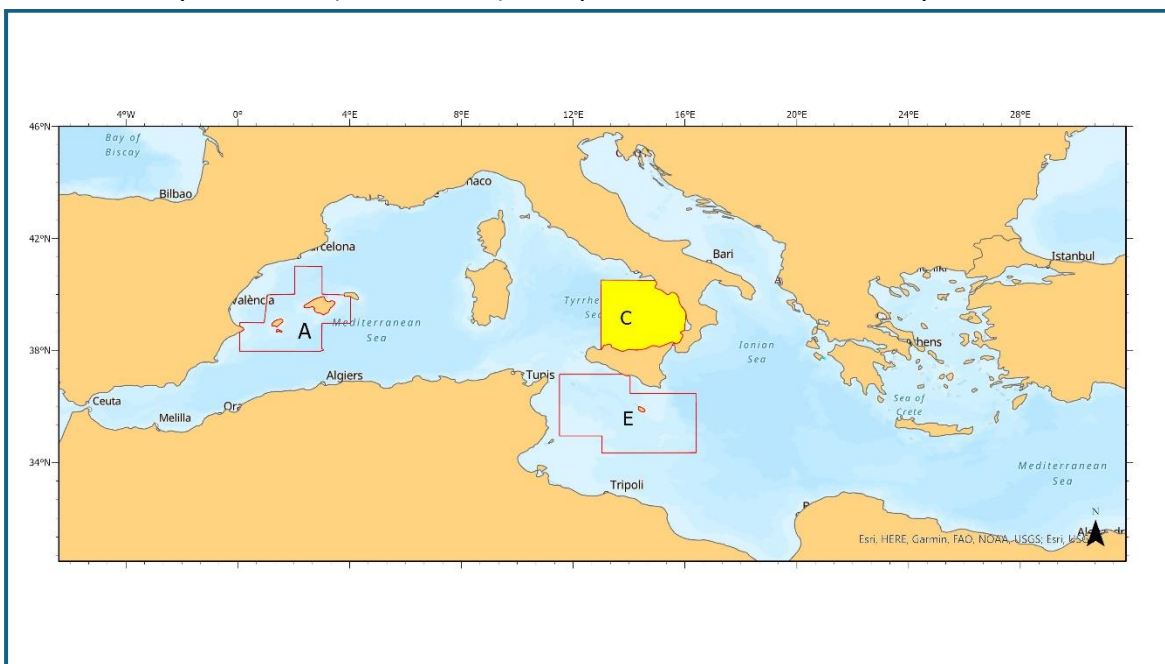
Figure 3 - 2024 Area C in yellow

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

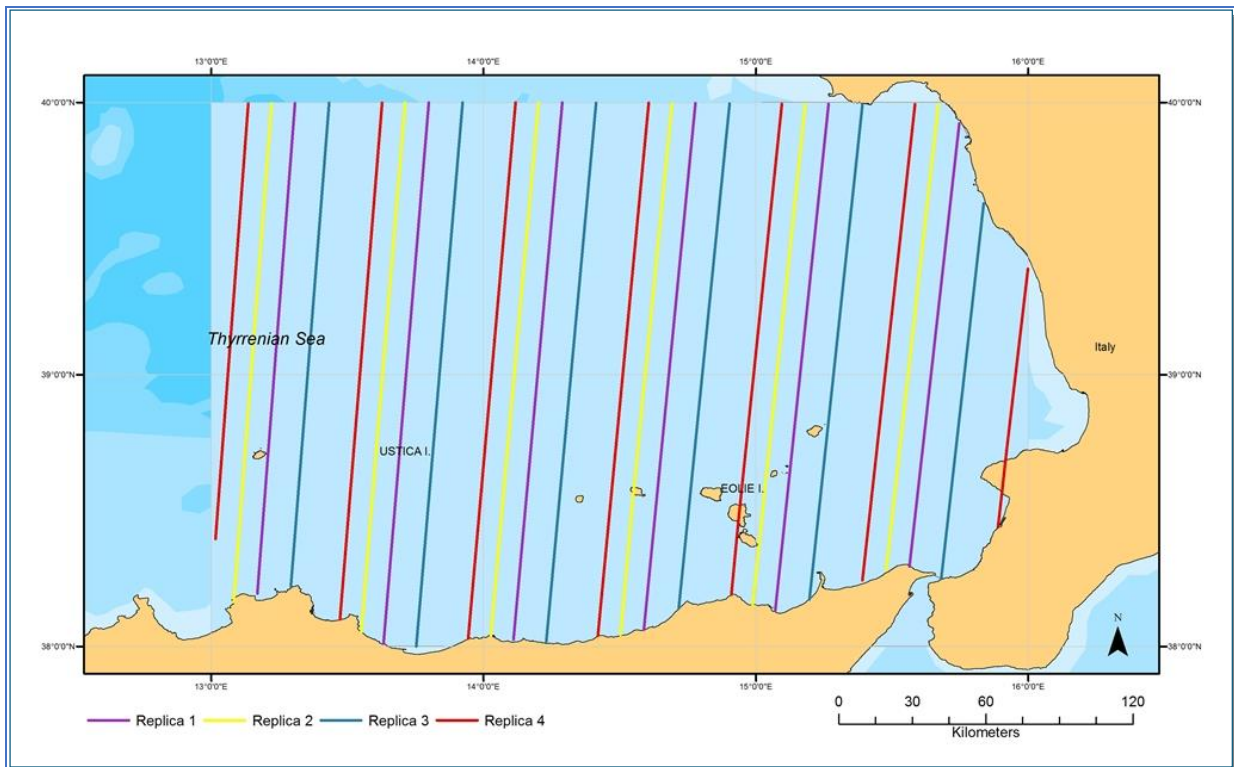The sampler routes are shown in Figure 4.

Figure 4 - 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 aircraft 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 4th) in order to perform the first flight on the same day, June 4th. 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 (or two in some cases to speed up the survey) was performed, as planned in the technical Offer.

The survey was carried out in 13 on-duty days. There were 3 standby days due to unfavourable weather conditions. The survey was completed on July 6th. The daily report of the surveys is provided in Table 2.

The team
Pilot: Francesco Ruggiero
Professional spotter: Salvatore De Martino and Vincenzo Severino
Scientific spotters: Adriano Mariani, Andrea Fusari, Andrea Poggi, Lorenzo De Santis, Sandro Cerasi

The 2024 campaign was the tenth survey in the area "C", already surveyed in 2010, 2011, 2013, 2015, 2017, 2018, 2019, 2022 and 2023. While in 2010 and 2011 about eleven transects per replica were followed, in 2013, 2015, 2017, 2018, 2019, 2022 and 2023 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 2024, the same sampling design of 2017, 2018, 2019, 2022 and 2023 was adopted.

The field activities started on the first day with acceptable conditions: (June 4th). 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.

Considering the general unstable meteorological conditions it has been planned to perform the minimum requested number of replicas. At the end of the survey, after the conclusion of the Area E survey, a "window" of good weather permitted to perform the 4th replica of the area C as well.

Table 2 - Daily report of the surveys

Flight#	Date	Aircraft	Take off time	Landing time	AREA	Transects
1	04/06/2024	I-GNIT	10:10-10:19	14:06-14:09	C	C1L01-C1L02
2	05/06/2024	I-GNIT	09:16-09:24	17:49-17:52	C	C1L3-C1L4
3	05/06/2024	I-GNIT	14:02-14:25	17:58-18:02	C	C1L6-C1L5
4	06/06/2024	I-GNIT	09:59-10:30	14:10-14:13	C	C2L1-C2L2
5	07/06/2024	I-GNIT	08:49-09:02	12:39-12:44	C	C2L3-C2L4
6	07/06/2024	I-GNIT	14:00-14:26	18:10-18:13	C	C2L6-C2L5
7	08/06/2024	I-GNIT	08:55-09:06	12:41-12:45	C	C3L1-C3L2
8	08/06/2024	I-GNIT	13:51-14:19	17:59-18:01	C	C3L4-C3L3
9	09/06/2024	I-GNIT	10:18 - 10:27	13:54 - 13:57	C	C3L6-C3L5
10	02/07/2024	I-GNIT	09:43-09:53	13:25-13:26	C	C4L2-C4L1
11	05/07/2024	I-GNIT	09:58-10:14	13:38-13:40	C	C4L4-C4L3
12	05/07/2024	I-GNIT	14:41-15:01	17:55-17:57	C	C4L5
13	06/07/2024	I-GNIT	09:53-10:00	13:35-13:38	C	C4L7-C4L6

* 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.

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 5 to 8 show the GPS tracks recorded onboard the aircrafts during the survey. Each colour corresponds to a different day.
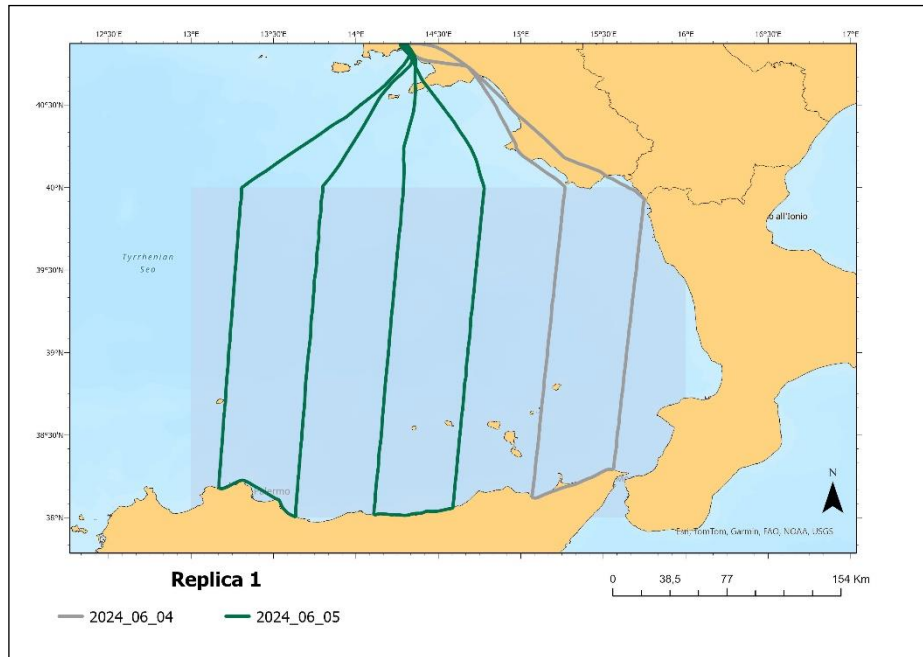

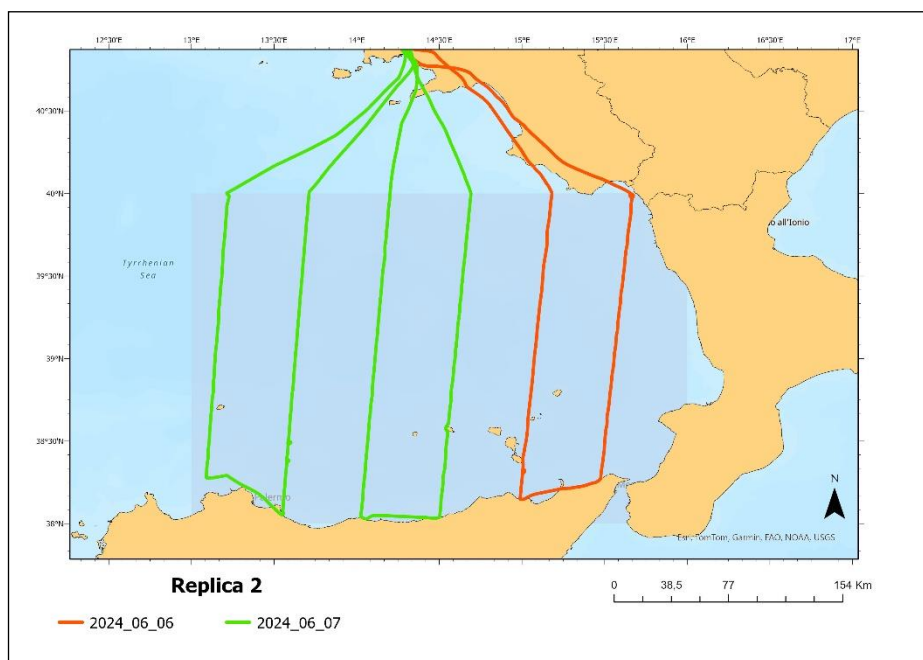
Figure 5 - Recorded GPS tracks: Area C, Replica 1

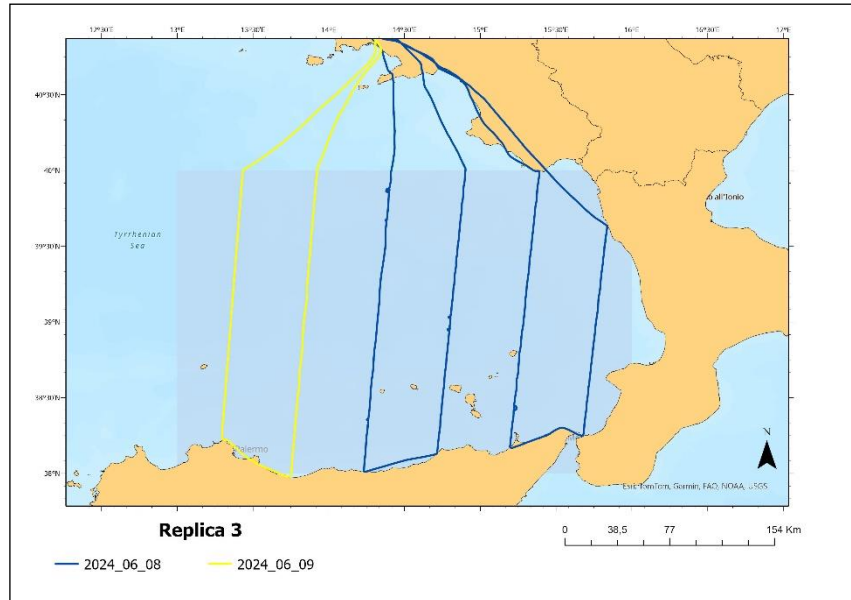Figure 6 - Recorded GPS tracks: Area C, Replica 2

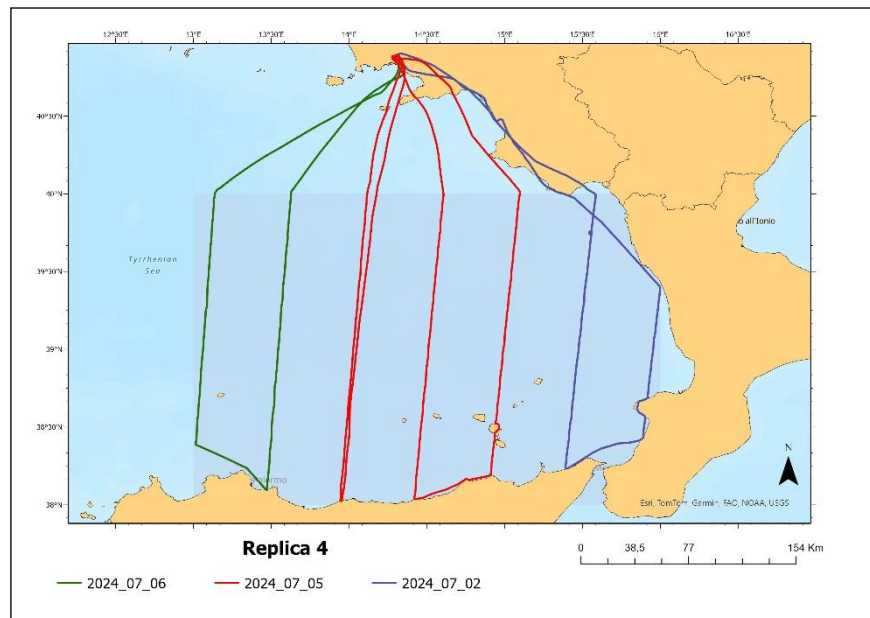Figure 7 - Recorded GPS tracks: Area C, Replica 3

Figure 8 - Recorded GPS tracks: Area C, Replica 4

3.3 Sightings overview

Figure 9 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 10 shows the distribution of the other species sightings.

59 sightings were performed: 3 BFT and 56 other species. 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 2024 survey was carried out in the same period as the previous year (started on 2 June 2023). For bluefin tuna sightings, 2024 saw a decline in sightings both in number (5 in 2023 - 3 in 2024) and in estimated tonnage (673 tonnes in 2023 - 461 tonnes in 2024).

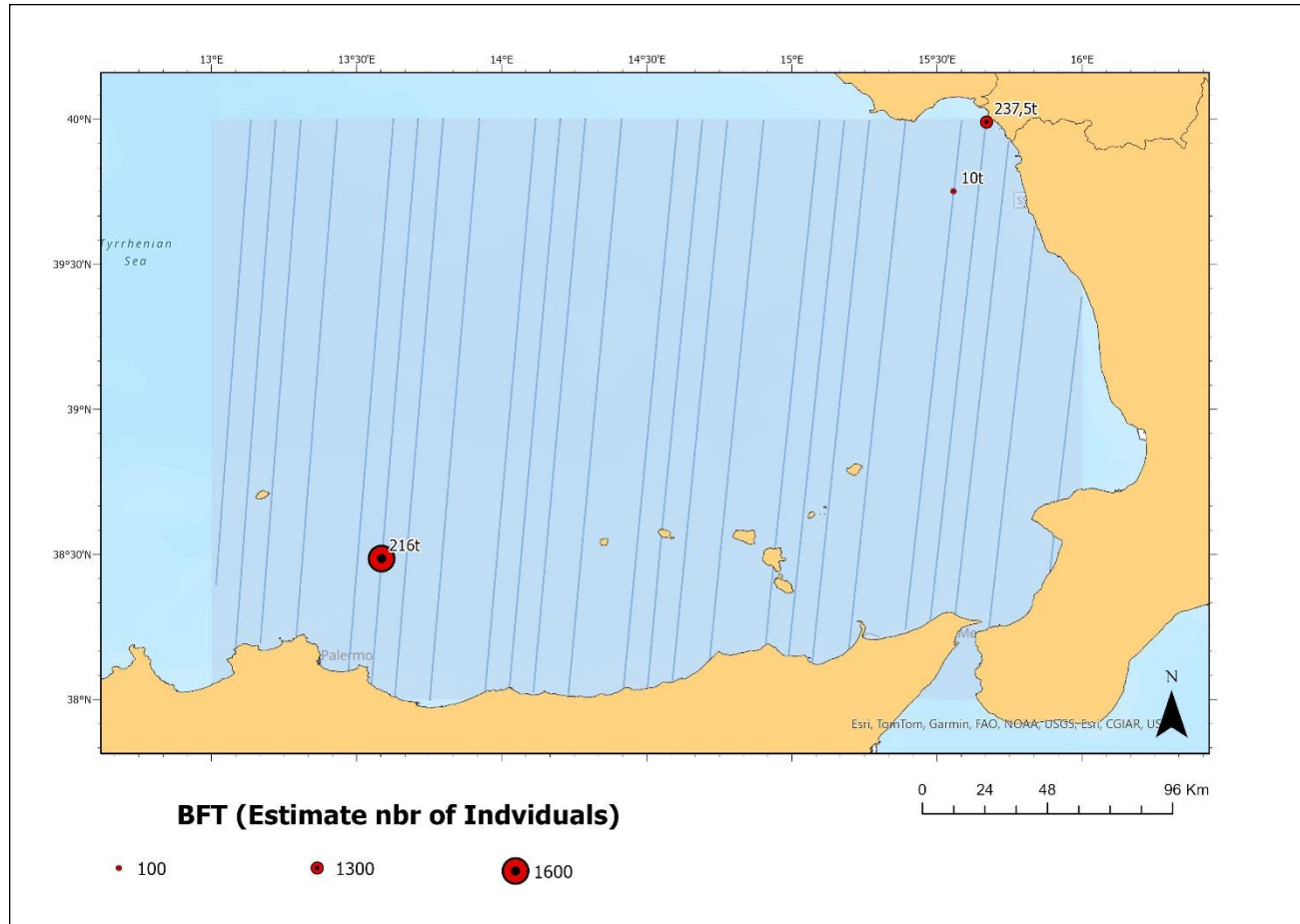For the other species, sightings between 2023 and 2024 are of similar magnitude.

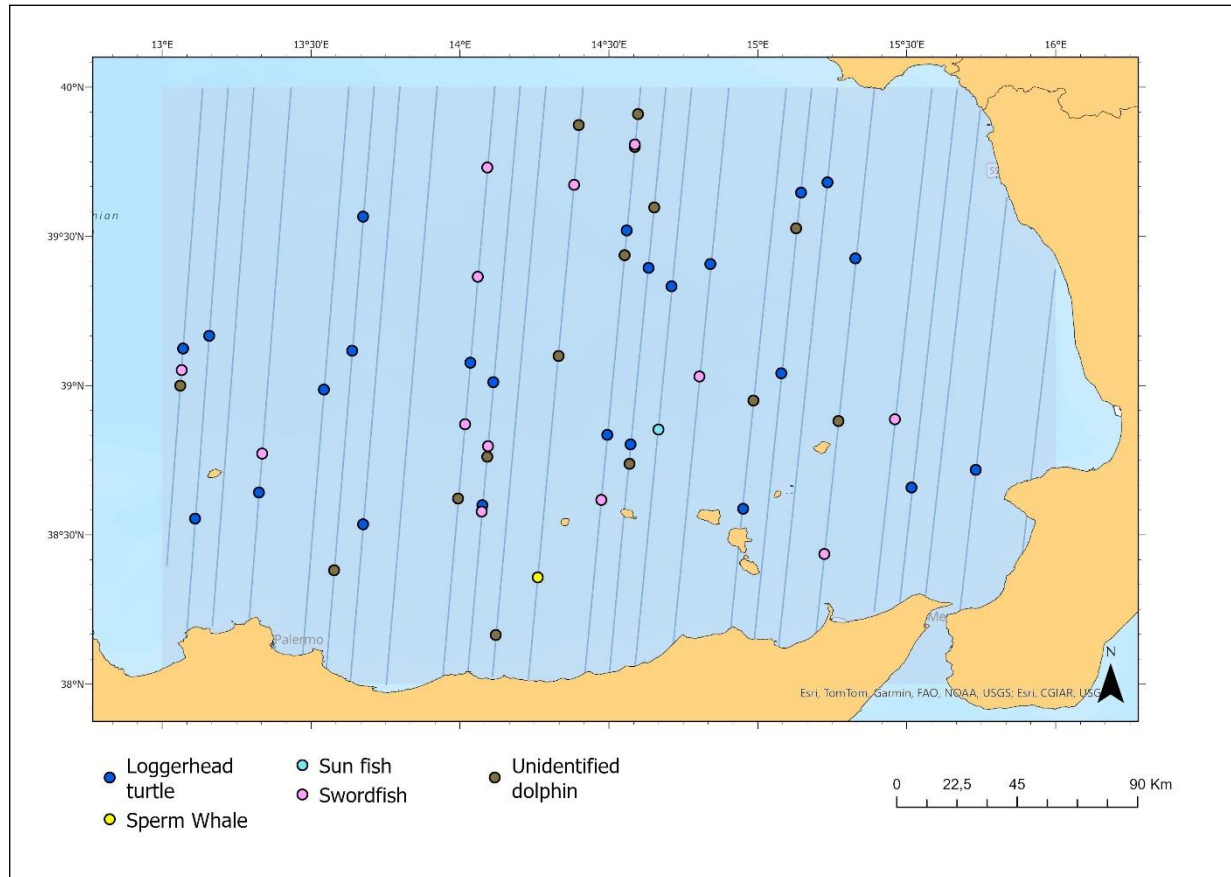Figure 9 - Map of the BFT sightings (number of individuals and weight)

Figure 10 - 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
06-giu-24	09:13:46	39,98735	15,67143	56	1300	237,5	0	16	84
07-giu-24	14:40:48	38,48522	13,58909	57	1600	216	0	16	84
02-lug-24	08:42:04	39,74903	15,55620	62	100	10	0	100	0

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: three days stop was decided, for bad 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.

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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- Philip Hammond, Ana Cañadas, José Antonio Vázquez (2010). Atlantic-wide research programme on bluefin tuna (GBYP - 2010). Design for aerial line transect survey in the Mediterranean Sea. Final Report.

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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