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 E

Final Report

July 21th, 2023

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, which were 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 E (Sicily Channel) and performed the 4 replicas foreseen by the ICCAT sampling protocol only for the West part, Pantelleria based. Due to problems in the release of the flight permission, the Est part of the area couldn't be spotted. The survey was carried out from June 20th to July 5th, 2023. 11 BFT sightings were performed on a total of 57 sightings.

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 the 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 and in the 2023, 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 E.

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 South 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 31, 2023), during which the details of the methodology and operative standards were explained, and previous field experiences were shared.

2.1 Aircrafts and equipment

Two aircrafts were involved, both 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. Both the aircrafts were a "Partenavia P68" model, already used in the past campaigns.

In details, one model was a Partenavia/Vulcanair P68 B (I-GNIT registration number). It has about 4-5 hours flight range.

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

The second aircraft model was a Partenavia/Vulcanair P68 B, as well (I-CCMC registration number). It has about 4-5 hours flight range.

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

Figure 1 - Aircrafts I-GNIT and I-CCMC and the crews

The equipment used by the spotters was the following:

- 2 GPS: *Garmin*® GPSMap 62st and GPSMap 64s, with the statistical survey design uploaded (the same route files were provided to the pilot);
- 2 GPS external antennas, which were applied on the aircraft dashboard under the front window in order to enhance the satellite signal reception
- 2 digital *Nikon*® photo cameras: D3000 and D3200, with 6400 ISO maximum sensitivity, equipped with Sigma® 70-200 zoom lens f/2.8 OS and 62st, 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
- *Silva Sight Master*® clinometers

Onboard the aircraft there were always a pilot, a professional tuna spotter and two scientific spotters. Effort and sightings were recorded on the specific forms and the GPS recording of all the flights and sighting positions were saved. During the flights, the GPS recorded (with a 3 seconds 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 to the forms. After every landing, the information was saved into the laptop and sent to the central office as soon as possible. The altimeter of the spotters GPS device and the aircraft one was daily calibrated with the known altitude of the airport. During the survey, the pilot followed the actual altitude that matched with the one measured by the spotters GPS device, that recorded the tracks.

The survey period started on June 20th and ended on July 5th, 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, high or heavy rain).

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

2.2 The Survey design and the Survey area

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 E is the Central Mediterranean area comprised between Sicily, Tunisia and Libya, included within the Rome and Malta FIR.

The importance of these area for the 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.

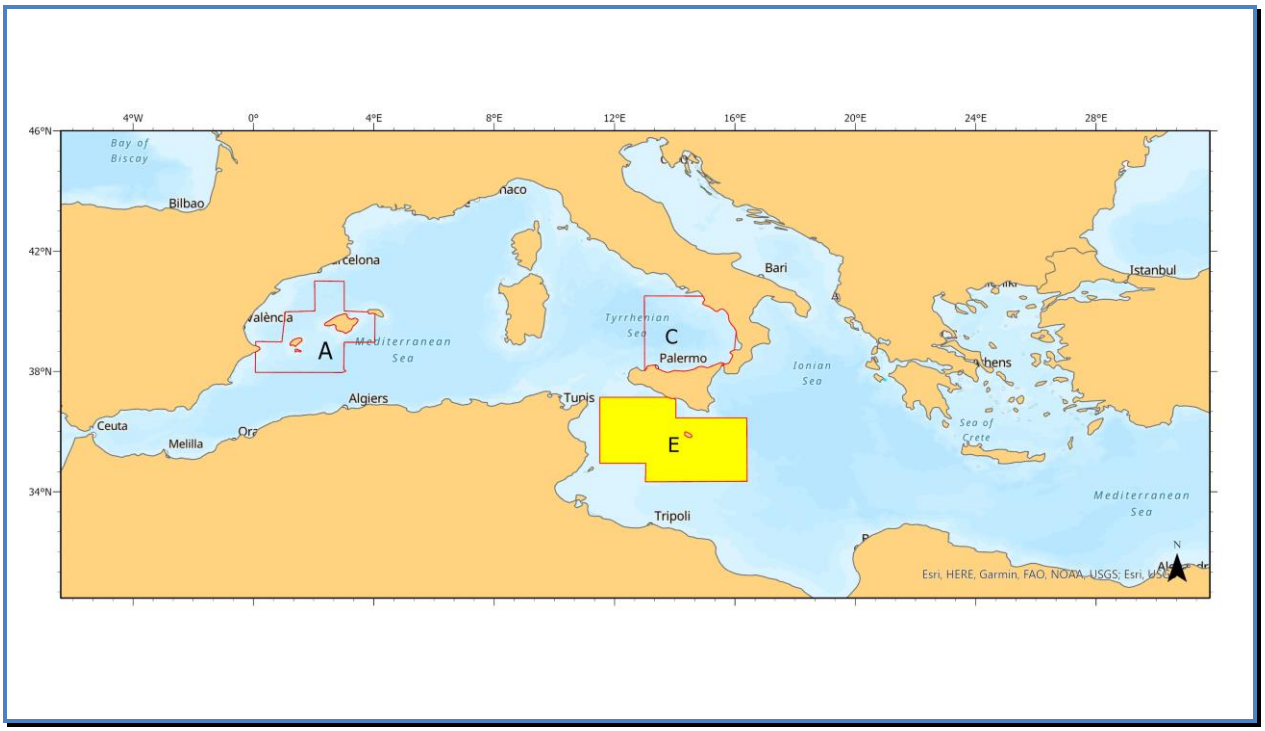

Figure 2 - 2022 Area E in yellow

The features of the survey area are described in Table 1.
The replicas to be performed in each area are shown in Figure 3.

Table 1 - Features of Areas E

Area	**E**
Area (km^2)	93,614
Proport. of total area	35.2
Expected proport. Length of Trackline on Effort	11,278
Expected proport. Length of Trackline on Effort (minus 10% for circling)	10,150
% coverage	19.3
Line spacing per replica	41.3
On effort track Replica 1	1,431
On effort track Replica 2	1,410
On effort track Replica 3	1,404
On effort track Replica 4	1,455
Total on effort track	5,700
Leftover effort	15.8

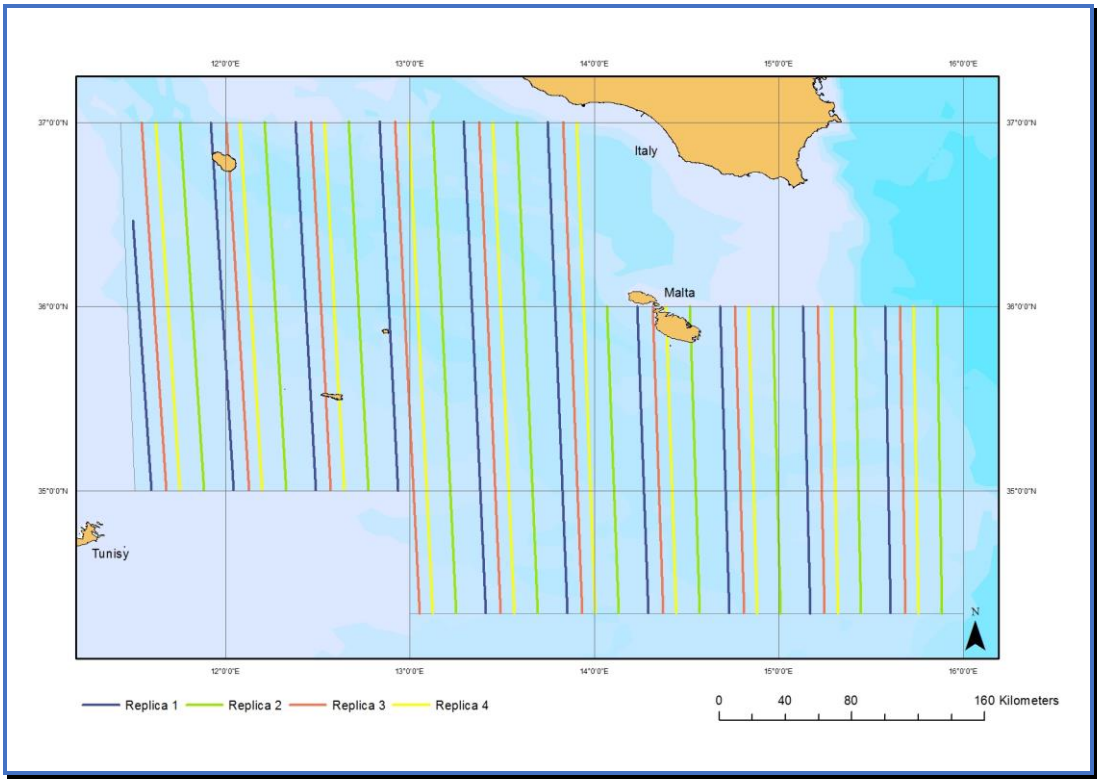

Figure 3 - Area E sampler routes (Transects-Legs)

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 aerial tuna 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 one or more campaigns in the previous years.

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.

In the meantime, all the procedures for the request of flight authorizations over Malta started.

3.2 Field activity

The base airports were Pantelleria and Malta. According to ICCAT schedule, the team availability and the meteorological conditions, the flights started on June 20th from Pantelleria onboard the I-GNIT aircraft. While waiting for the release of the permissions, to optimize the time, even this year the area was split in two parts, performing before the west part, Pantelleria based. After one day (June 23 th) of standby because of bad weather conditions, the activities were stopped for some days due to the protracted adverse meteorological forecast. In annex 4 the screenshots of the meteo forecast are reported. The flights started again on June 28th with the aircraft I-CCMC until July 5 th, with 2 more standby days (1-2 July).

After that date, due to the protracted impossibility to obtain the permissions from Malta Authorities the campaign was terminated. In Annex 5 a detailed chronological sequence of the written exchanges with Malta Authorities and Iccat- GBYP coordinator is reported.

In order to avoid bad wind and sea conditions, the transects order were adapted day by day. For the same reason, in some case, two short flights per day were performed.

The team

Pilots: Francesco Ruggiero, Alessandro Razzolini

Professional spotters: Salvatore De Martino

Scientific spotters: Adriano Mariani, Andrea Poggi, Sergio Lombardo, Sergio Bizzarri

Table 2 - Daily report of the surveys - I-GNIT aircraft

Flight	Date	Aircraft	Take off*	Landing*	Area	Transects	Take off airport	Landing airport
1	20-giu	I-GNIT	15:29	18:52	E	E1L6 (1/2) - E1L5 (1/2)	Pantelleria	Pantelleria
2	21-giu	I-GNIT	08:43	11:26	E	E1L9 - E1L10	Pantelleria	Pantelleria
3	21-giu	I-GNIT	13:37	16:54	E	E1L7 - E1L8	Pantelleria	Pantelleria
4	22-giu	I-GNIT	09:13	12:59	E	E1L6 (1/2) - E2L5 (1/2)	Pantelleria	Pantelleria
5	22-giu	I-GNIT	14:27	17:29	E	E2L10 - E2L9	Pantelleria	Pantelleria
Standby	23-giu	bad weather conditions			E			
Stop	24-giu	bad weather conditions			E			
Stop	25-giu	bad weather conditions			E			
Stop	26-giu	bad weather conditions			E			
Stop	27-giu	bad weather conditions			E			

Table 3 - Daily report of the surveys - I-CCMC aircraft

Flight	Date	Aircraft	Take off*	Landing*	Area	Transects	Take off airport	Landing airport
6	28-giu	I-CCMC	09:35	13:08	E	E2L7 (1/2) - E2L8	Pantelleria	Pantelleria
7	29-giu	I-CCMC	09:15	13:49	E	E2L6 - E2L7 (1/2)	Pantelleria	Pantelleria
8	30-giu	I-CCMC	08:50	12:20	E	E3L7 (1/2) - E3L8	Pantelleria	Pantelleria
9	30-giu	I-CCMC	15:18	18:37	E	E3L10 - E3L9	Pantelleria	Pantelleria
Standby	01-lug	bad weather conditions			E			
Standby	02-lug	bad weather conditions			E			
10	03-lug	I-CCMC	09:05	13:02	E	E3L7 (1/2) - E3L6	Pantelleria	Pantelleria
11	04-lug	I-CCMC	08:53	13:15	E	E4L6 - E4L7 (1/2)	Pantelleria	Pantelleria
12	04-lug	I-CCMC	15:51	19:22	E	E4L7 (1/2) - E4L8 (2/3)	Pantelleria	Pantelleria
13	05-lug	I-CCMC	10:00	14:12	E	E4L8 (1/3) -E4L9 - E4L10	Pantelleria	Pantelleria

* local time

The times are in 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 observed.

For all the performed flights, the tracks were registered by the observers' GPS device (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.

Maps of recorded GPS tracks

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

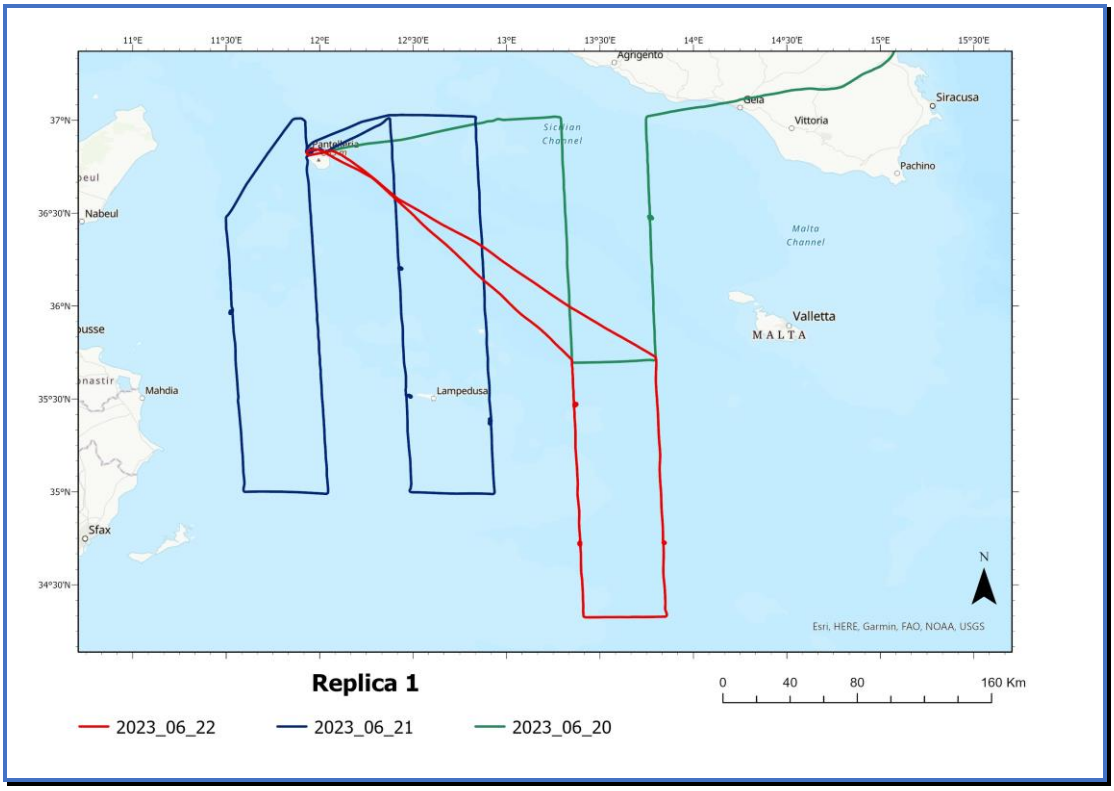

Figure 4 - Recorded GPS tracks: Area E, Replica 1

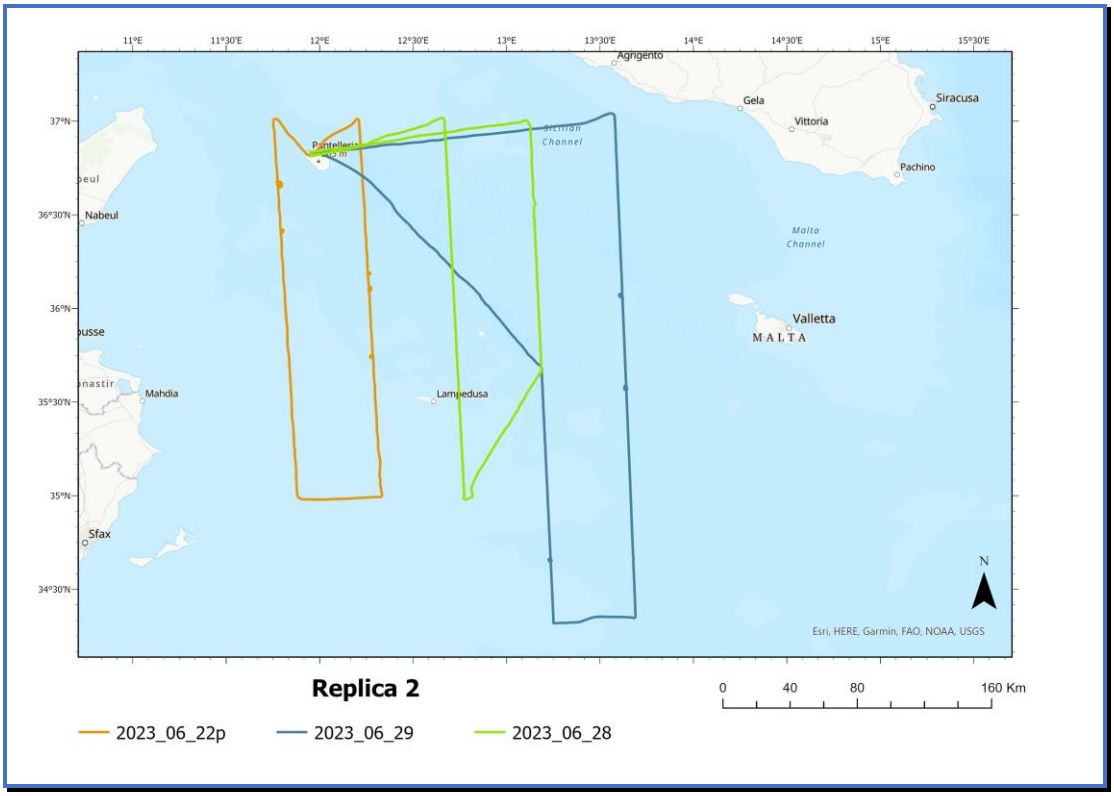

Figure 5 - Recorded GPS tracks: Area E, Replica 2

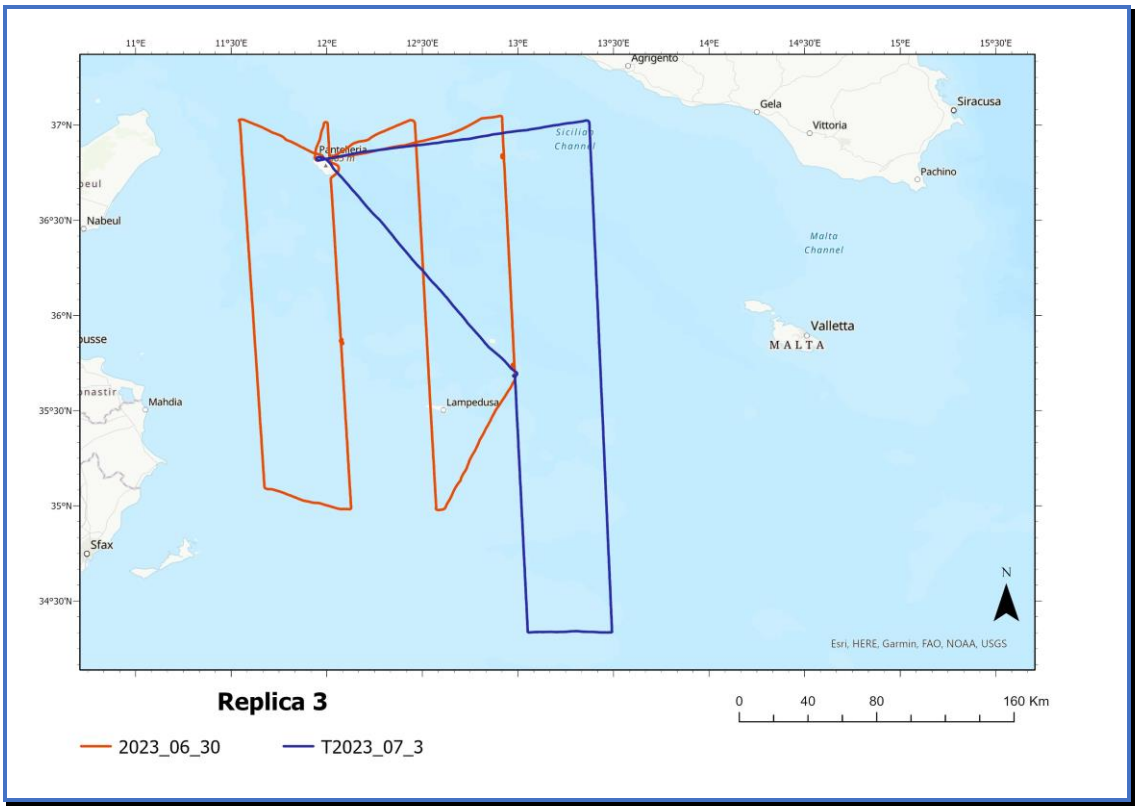

Figure 6 - Recorded GPS tracks: Area E, Replica 3

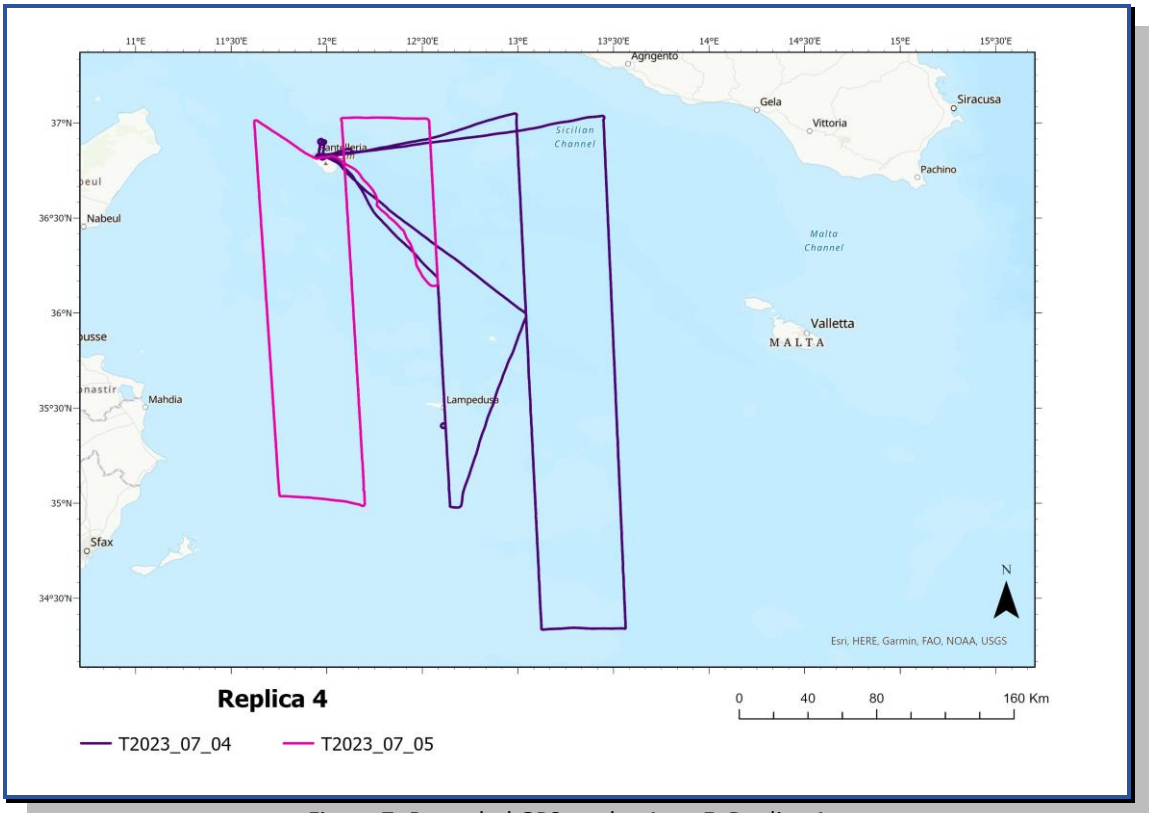

Figure 7- Recorded GPS tracks: Area E, Replica 4

3.3 Sightings overview

Figure 8 shows the positions of the sightings of Bluefin tuna in area E and the related values in terms of number of individuals and weight. All the details are available in Table 4 and in the annexed forms. Figure 9 shows the distribution of the sightings of other species.

57 sightings were performed from the two involved aircrafts: 11 on BFT and 46 on other species.

Respect to the 2022 campaign, even with only a part of the area spotted, more sightings of BFT were recorded, and with bigger percentage of medium and large fishes respect to 2022.

It is worth to note that 2022 survey was performed later than the 2023 campaign.

As observed in every campaign, a huge number of loggerhead turtles and undefined dolphins were sighted as well as 5 swordfishes.

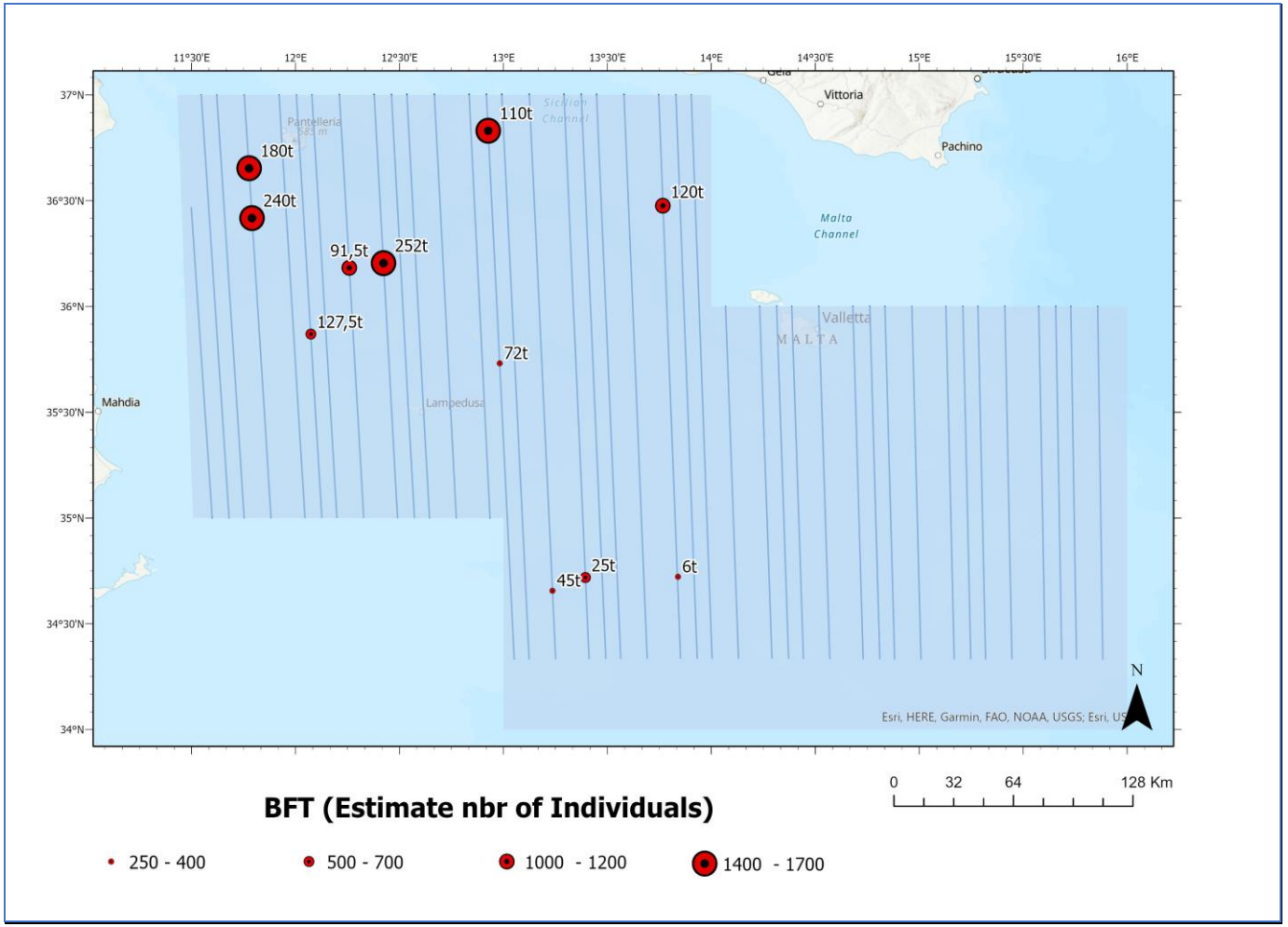

Figure 8 - Map of the BFT sightings (number of individuals and weight)

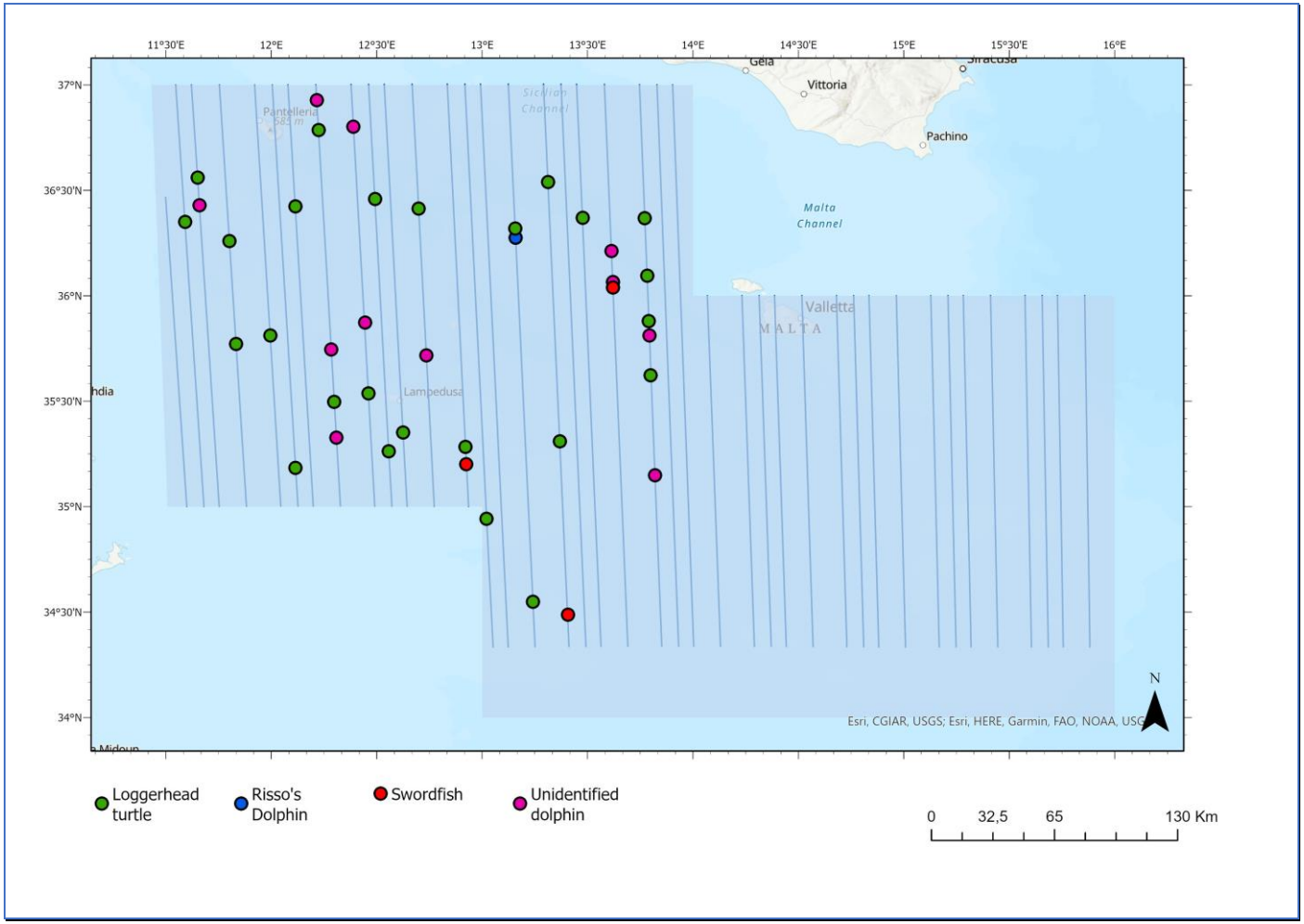

Figure 9 - Map of the other species sightings

Table 4 - Overview of the BFT sightings - I-GNIT aircraft

Date	Time abeam	Lat abeam	Lon abeam	Angle abeam	School size PS	Weight PS (ton)	% small	% med	% large
20/06/2023	14:56:50	36.47648	13.76659	46	1000	120	0	80	20
21/06/2023	14:11:48	36.20509	12.42307	60	1700	252		47	53
22/06/2023	08:46:12	34.71881	13.39428	35	500	25		100	
22/06/2023	09:28:14	34.72244	13.83939	17	300	6	100		
22/06/2023	12:56:34	36.65370	11.77665	36	1400	180		71	29
22/06/2023	13:11:02	36.41794	11.79058	40	1500	240		40	60
22/06/2023	14:48:53	36.18304	12.25859	32	1200	92		25	75

Table 5 - Overview of the BFT sightings - I-CCMC aircraft

Date	Time abeam	Lat abeam	Lon abeam	Angle abeam	School size PS	Weight PS (ton)	% small	% med	% large
29/06/2023	10:09:30	34.65626	13.23573	30	250	45	100		
30/06/2023	07:30:14	36.83090	12.92678	60	1700	110		100	
30/06/2023	08:13:43	35.73127	12.98205	48	400	72	100		
30/06/2023	15:36:59	35.86967	12.07375	60	700	128	42	58	

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 main problem was of course the impossibility to perform the campaign in the whole area, as previously reported.

As in the past campaigns, difficulties were related as well to uncertain and variable weather conditions, forcing the crew to continuously modify the flight plans in order to avoid strong wind areas, as well as to speed up the surveys performing more than one flight per day in some cases.

It is confirmed that the bubble windows are very useful for vertical and near spotting, but at the same time they create some disturbance for taking photographs because of the strong light reflection and light distortion. Even if the camera was set with the highest shutter speeds, most of the photographs were "blurry" or distorted: this seems to be the result of the window interference and resulted in the absence of clear pictures.

As in the past campaigns, an external antenna was installed and connected to the GPS. We suggest to fix it over the aircraft instrument panel in order to overcome some GPS signal reception problem, already noticed in the former campaigns, especially during circling.

As for the sightings of other species, particularly 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.

We also stress again the opportunity to shorten as much as possible the very long transects between Lampedusa and Malta. Toward the south side they arrive to areas very far from eventual emergency landing possibilities, and they also almost touch, or arrive to, Libyan aerial space, that is very often a problematic area.

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. Complete 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.