AERIAL SURVEY FOR THE MONITORING OF BLUEFIN TUNA SPAWNING AGGREGATIONS IN THE MEDITERRANEAN SEA CALL FOR TENDERS 06/2022 (ICCAT/GBYP Phase 11) - Circular #0496/2022, 19.5.2022

AREA E

Final Report

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Index

Summary 4
1. BACKGROUND AND OBJECTIVES 5
2. MEANS AND METHODS.....5
2.1 Aircrafts and equipment.....5
2.2 The Survey design and the Survey area.....7
3. RESULTS.....9
3.1 Preparatory tasks 9
3.2 Field activity 10
3.3 Sightings overview.....14
3.4 Methodological remarks and discussion 18
4. REFERENCES.....20
5. ANNEXES.....21

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 2022 campaign, Unimar was awarded to carry out the survey in the Area E (Sicily Channel) and performed the 3 replicas foreseen by the ICCAT sampling protocol as the minimum acceptable. The survey was carried out from June 21th to July 4th, 2022. 10 BFT sightings were performed through 16 total surveys. Including other species, 76 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 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, 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 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 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

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 were 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 21th and ended on July 4th, 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, 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.

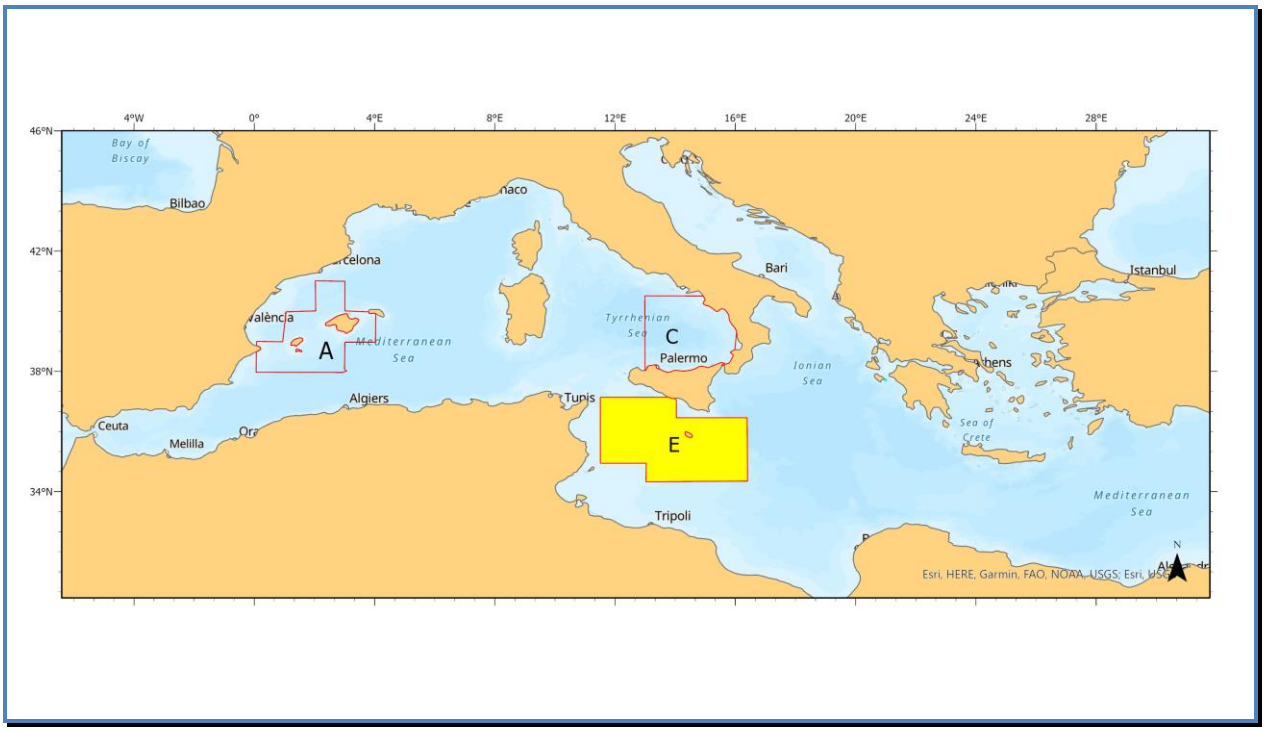

Figure 2 - 2022 Area E in yellow

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

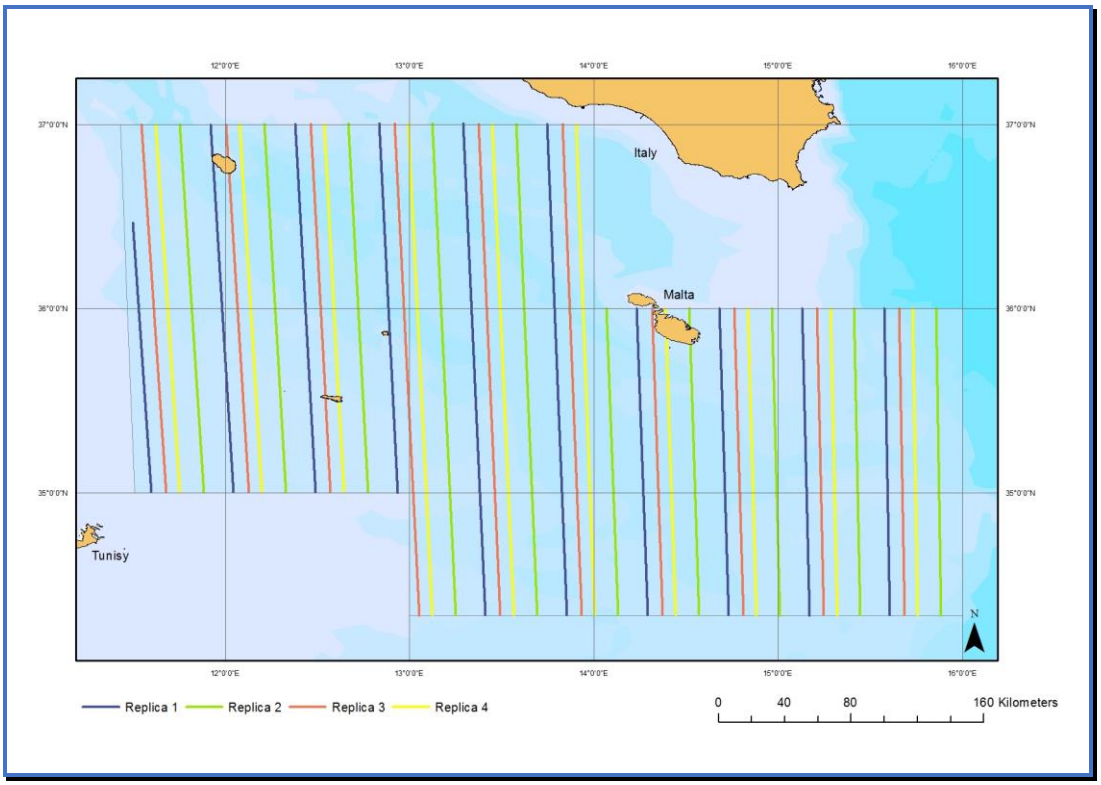

Figure 3 - Area E sampler routes (Transects-Legs)

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.

3.2 Field activity

The base airports were Pantelleria and Malta. According to ICCAT schedule, the team availability and the meteorological conditions, on the first available day (June 21th, 2022) the first spotters arrived to Pantelleria onboard the I-CCMC aircraft. The survey started on June 22nd. On June 22nd afternoon, I-GNIT aircraft and a second crew went to Pantelleria to start the survey on June 23rd. I-CCMC performed the last survey on June 25th. The last survey on the Area E was performed on July 4th, 2022 by I-GNIT aircraft. The diary report of the surveys carried out is provided in Table 2 and Table 3 split per each aircraft. The main problem this year was the very short availability of time, due to the delayed start of the campaign: so, in order to optimize the flight hours and reduce the transfer time, the team was forced to split the area E in two parts: the western one performed from Pantelleria airport and the eastern one performed from Malta airport. For the same reasons, only three replicas were performed. Once completed the western transects of the first three replicas (on June 25th), the I-GNIT aircraft and crew transferred to Malta, were the eastern transects of the first three replicas was completed. Once the whole three replicas were completed, the aircraft and crew went back to Pantelleria (on July 4th), from where the aircraft went back to Naples.

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

The survey was carried out through 16 survey flights. The main aircraft used in the campaign in the Area E was I-GNIT, performing 11 total survey flights. In the first survey days, the I-CCMC aircraft was used as a support in order to speed up the survey performing 5 surveys flights.

The general visibility conditions were rather good during the whole survey, both the wind/sea state and haze/clouds. This allowed to have high sighting chances especially for scientific spotters, despite the professional spotters are able to detect schools also in medium conditions.

The team

Pilots: Francesco Ruggiero, Fabio Peri

Professional spotters: Salvatore De Martino, Vincenzo Severino

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

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

Flight #	Date	Take-off*	Landing*	Area	Transects	Take off airport	Landing airport
1	22/06	10:29	13:10	E	E1L10-E1L9	Pantelleria	Pantelleria
2	22/06	14:55	18:05	E	E1L7-E1L8	Pantelleria	Pantelleria
3	23/06	9:07	12:50	E	E1L6	Pantelleria	Pantelleria
4	24/06	9:21	12:25	E	E2L10-E2L9	Pantelleria	Pantelleria
5	25/06	9:22	12:29	E	E3L10-E3L9	Pantelleria	Pantelleria

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

Flight #	Date	Take-off*	Landing*	Area	Transects	Take off airport	Landing airport
1	23/06	8:44	13:10	E	E1L5 - E2L6	Pantelleria	Pantelleria
2	24/06	9:17	13:10	E	E2L7 - E2L8	Pantelleria	Pantelleria
3	25/06	9:19	13:10	E	E3L7 - E3L8	Pantelleria	Pantelleria
transf.	25/06	14:47	16:03	E	Transfer flight	Pantelleria	Malta
4	26/06	7:50	10:15	E	E3L6 - E3L5**	Malta	Malta
5	27/06	8:27	11:25	E	E1L1 - E1L2	Malta	Malta
Standby	28/06	-	-	E	-	-	-
6	29/06	10:05	12:35	E	E1L3 - E1L4	Malta	Malta
7	30/06	9:25	12:20	E	E2L1 - E2L2	Malta	Malta
8	01/07	8:00	12:26	E	E2L3 - E2L4 - E2L5	Malta	Malta
9	02/07	9:43	12:23	E	E3L3 - E3L4	Malta	Malta
10	03/07	16:28	19:18	E	E3L1 - E3L2	Malta	Malta
11	04/07	12:41	15:32	E	E3L5 - E3L6**	Malta	Pantelleria

* local time

** a half of each transect was surveyed each time

The times are in GMT.

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 Figure 6 show the GPS tracks recorded onboard the aircrafts during the survey. Each colour corresponds to a different day.

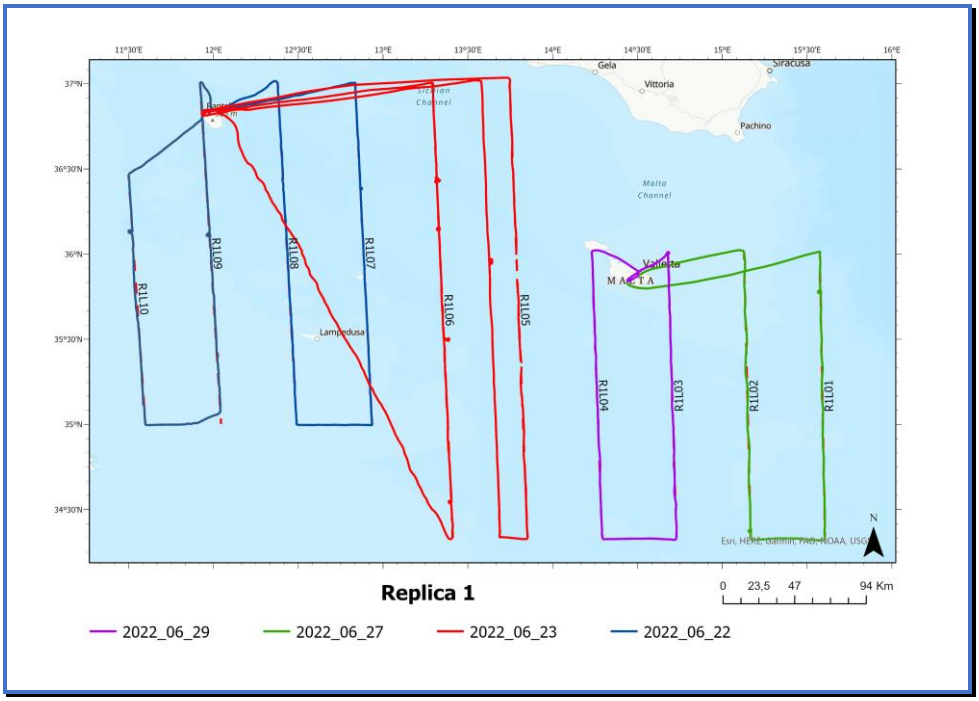

Figure 4 - Recorded GPS tracks: Area E, Replica 1

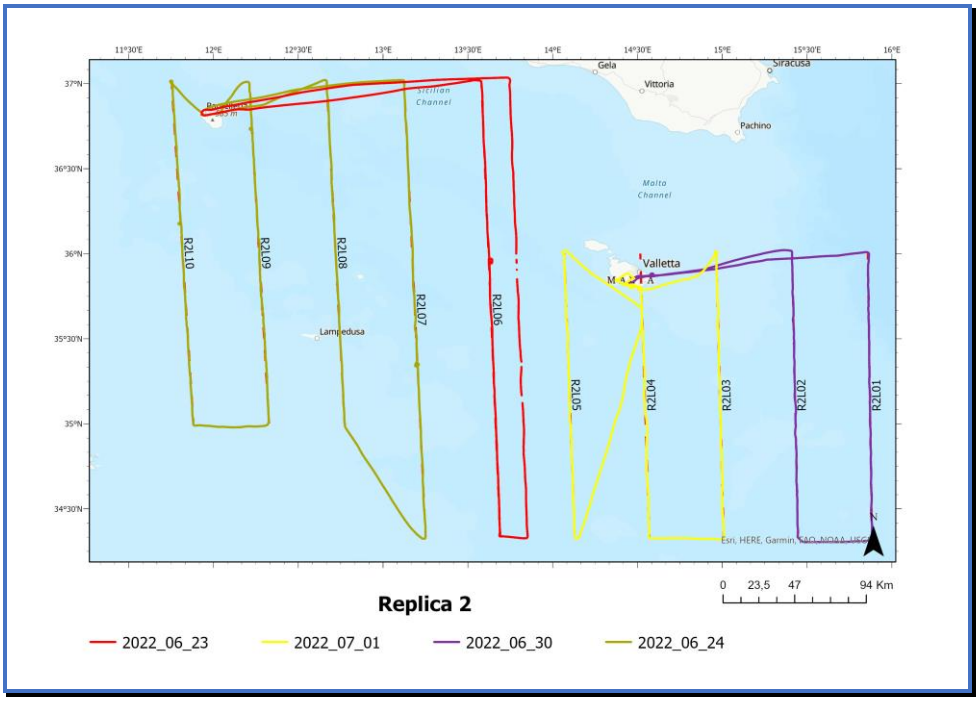

Figure 5 - Recorded GPS tracks: Area E, Replica 2

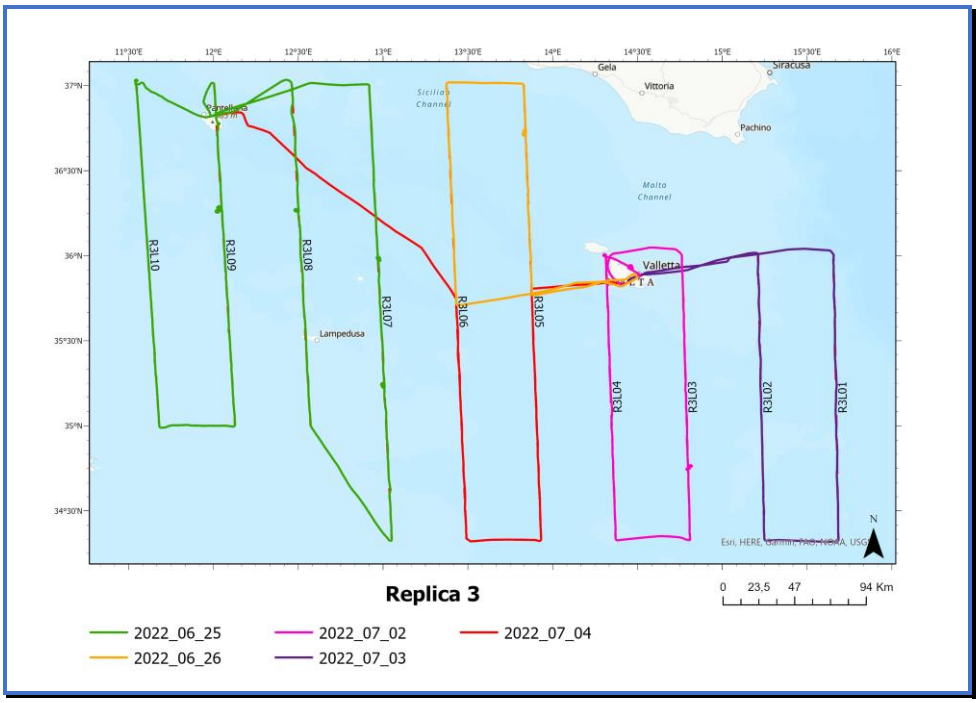

Figure 6 - Recorded GPS tracks: Area E, Replica 3

3.3 Sightings overview

Figure 7 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 8 shows the distribution of the sightings of other species.

76 sightings were performed from the two involved aircrafts: 10 on BFT and 66 on other species. 8 out of 10 spotted schools were composed by small individuals, and they were in any case in feeding activity. The other 2 were composed both by small and medium fishes. Most of the schools were seen under the surface rather near to the aircraft.

The 2022 survey was performed later than the last aerial survey campaign in Area E in 2018 (30/5 - 23/6). The number of BFT sightings was about the same than in the 2018 campaign (11). As observed in every campaign, a huge number of loggerhead turtles and undefined dolphins were sighted. Some swordfishes were seen. A group of three sperm whales, 4 swordfish sightings, 2 sharks and some mantas were detected in Area E.

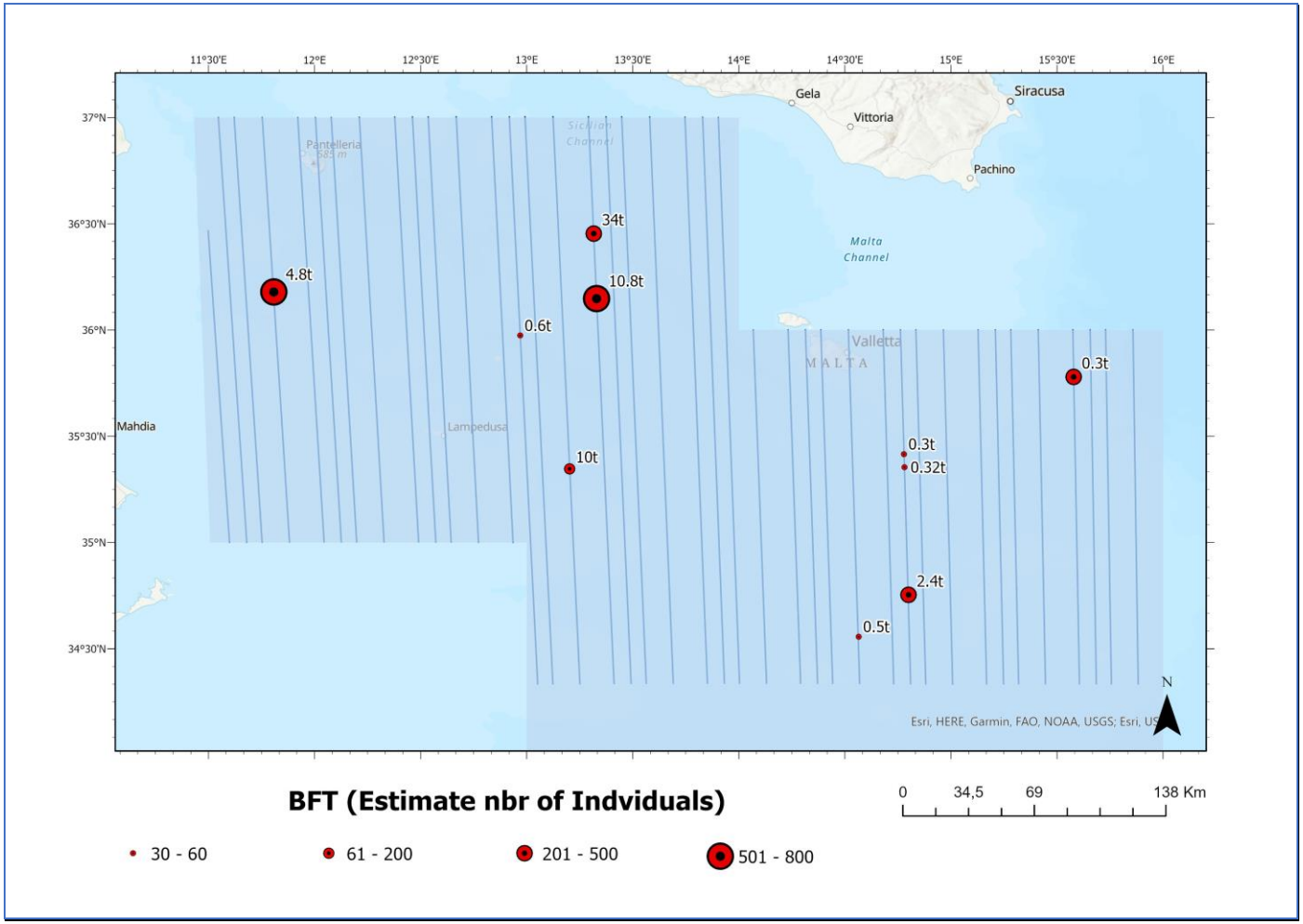

Figure 7 - Map of the BFT sightings (number of individuals and weight)

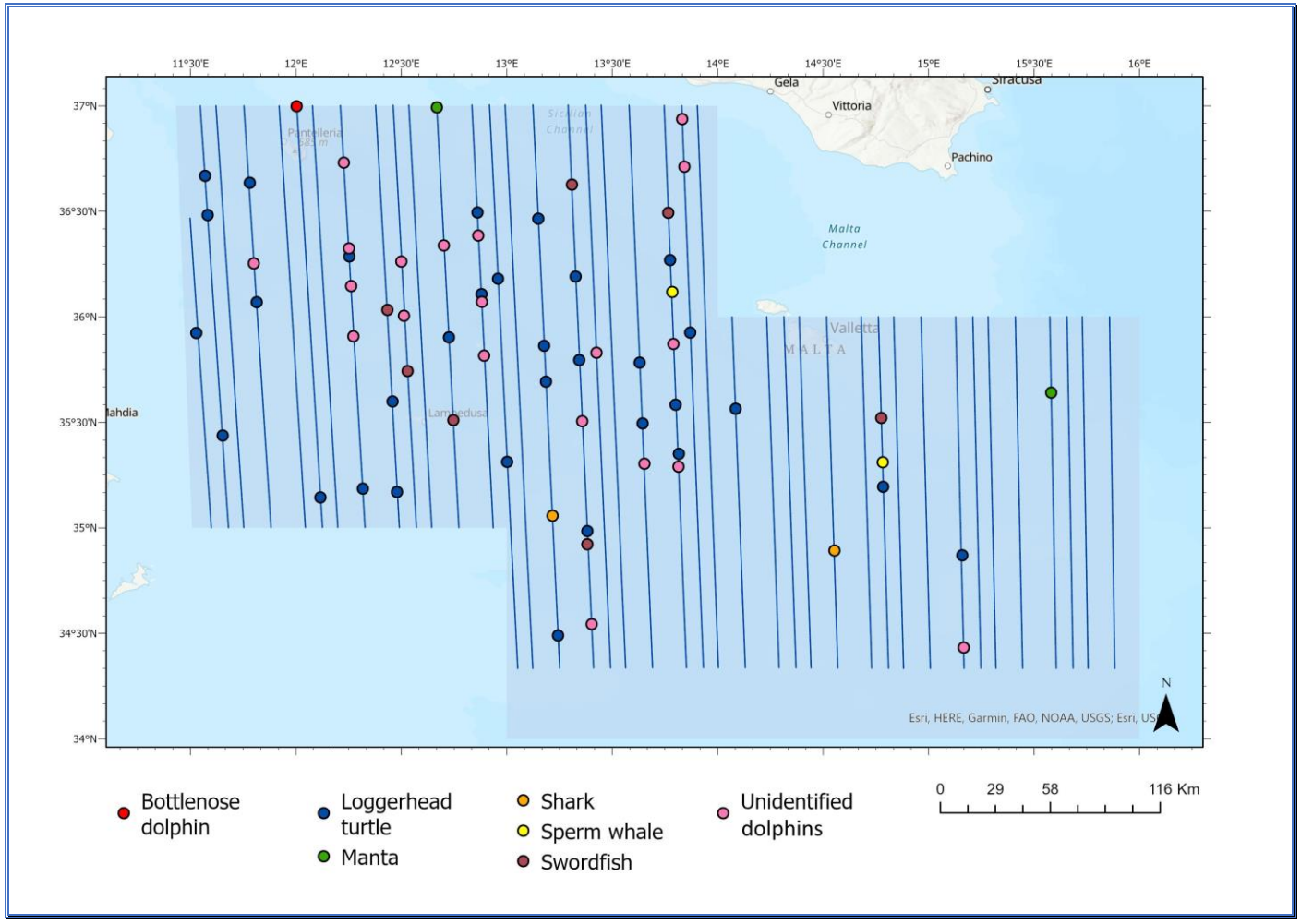

Figure 8 - Map of the other species sightings

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

AREA	ID	Date	Time abeam	Lat abeam	Lon abeam	Abeam?	Angle abeam	Altitude	Tot est. number	Tot est. weight (ton)	% small	% med	% large
E	15	24/06	08:37:48	35.34651	13.20240	Y	48	300	200	10		100	
E	23	25/06	08:16:30	35.97464	12.96941	Y	60	315	60	0,6	100		
E	33	27/06	07:03:13	35.77935	15.57833	Y	64	290	500	0,3	100		
E	38	01/07	07:31:27	34.55658	14.56512	Y	59	306	50	0,5	100		
E	42	02/07	08:21:25	35.41590	14.77835	Y	45	277	30	0,3	100		
E	43	02/07	08:23:22	35.35436	14.78077	Y	70	279	40	0,3	100		
E	46	02/07	08:42:14	34.75383	14.79988	Y	52	268	400	2,4	100		

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

AREA	ID	Date	Time abeam	Lat abeam	Lon abeam	Abeam?	Angle abeam	Altitude	Tot est. number	Tot est. weight (ton)	% small	% med	% large
E	13	23/06	08:05:44	36.44827	13.31644	Y	32	314	500	34	40	60	
E	15	23/06	08:23:14	36.14792	13.32952	Y	40	324	600	10,8	67	33	
E	23	24/06	08:06:13	36.17935	11.80797	Y	43	328	800	4,8	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.

The campaign was carried out without special problems in the Area E: only one day stop was necessary.

Regarding the Area E, as in the past campaigns, many difficulties were related to weather conditions, while other difficulties (logistics and administrative) were limited through a careful planning. Bad sea conditions and wind forecasts forced 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. The worst difficulty was linked to the high variability of the forecasts from a day to another: for this reason, during the stop the crew didn't move from Malta to be ready to perform the flights on the first good day, rather than go back home and waist time, especially because the survey deadline was approaching.

One more difficulty was related, as usual, to the many administrative and beaurocratic difficulties made by Malta Authorities, even after producing all the requested documents and duties. An average of 2 or 3 hours were also spent daily before the take off and after the landing, to clear the requested procedures.

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, sometimes the photographs were "blurry" or distorted: this seems to be the result of the window interference.

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, since during the survey it was stressed to register them in a systematic way, and it happened to have long periods with only a few sightings followed by strong concentrations of sightings, we suggest to modify the way of registration. It could be much more practical to register them in a separate sheet, where only the position and time of the sighting is requested (it is enough to mark a point in the GPS). Since these species are not the main focus of the survey, it is probably not important to have information about abeam or not and type of cue or to have two different (F and A) waypoints (they are sighted almost always under the aircraft, with the animal swimming at the surface): this modality would permit to sign them without affecting the main target of the survey even in the cases when a big number of sightings occur.

As a further note, we recommend to try 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.

Regarding the BFT spotting results, the importance of southern Tyrrhenian Sea and of Sicily Channel as bluefin tuna spawning areas is confirmed. Among the 10 BFT schools observed, most of them were composed of small individuals and were detected lower under the surface. In some cases they were seen closer to the surface.

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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

Index of tables

Table 1 - Features of Areas E 8
Table 2 - Daily report of the surveys - I-CCMC aircraft 11
Table 3 - Daily report of the surveys - I-GNIT aircraft 11
Table 4 - Overview of the BFT sightings - I-GNIT aircraft 17
Table 5 - Overview of the BFT sightings - I-CCMC aircraft 17

Index of figures

Figure 1 - Aircrafts I-GNIT and I-CCMC and the crews 6
Figure 2 - 2022 Area E in yellow 8
Figure 3 - Area E sampler routes (Transects-Legs) 9
Figure 4 - Recorded GPS tracks: Area E, Replica 1 12
Figure 5 - Recorded GPS tracks: Area E, Replica 2 13
Figure 6 - Recorded GPS tracks: Area E, Replica 3 13
Figure 7 - Map of the BFT sightings (number of individuals and weight) 15
Figure 8 - Map of the other species sightings 16

5. ANNEXES

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

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