



BFT aerial survey 2019  
Area C

Aerial banners



Aerial banners

**AERIAL SURVEY FOR BLUEFIN SPAWNING AGGREGATION OF THE  
ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA  
ICCAT-GBYP Phase 9  
CALL FOR TENDERS ICCAT/GBYP 04/2019 - Circular #0279/2019,  
3.4.2019**

**AREA C**

Final Report

July 17th, 2019



### **Technical staff**

Adriano Mariani - coordinator and scientific spotter  
Simone Serra - field coordinator and scientific spotter  
Andrea Fusari - scientific spotter  
Andrea Poggi - scientific spotter  
Salvatore De Martino - professional spotter  
Mario Piscino - professional spotter  
Vincenzo Severino - professional spotter  
Claudia Camolese - data analyst



## Index

Summary.....	4
1. BACKGROUND AND OBJECTIVES.....	5
2. MEANS AND METHODS.....	5
2.1 Aircrafts and equipment.....	6
2.2 The Survey design and the Survey areas.....	7
3. RESULTS.....	9
3.1 Preparatory tasks.....	9
3.2 Field activity.....	10
3.3 Sightings overview.....	15
3.4 Methodological remarks and discussion.....	18
4. REFERENCES.....	19
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 and 2018, the surveys were limited to the 4 initial spawning areas and the same was done in 2019. In the 2019 campaign, Unimar was awarded to carry out the survey in the Area C (Southern Tyrrhenian Sea) performing the 4 mandatory replicas. The survey was carried out from June 3rd to June 16th 2019. Total 4 BFT sightings were performed in 13 total survey days. Including other species, total 115 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 2018 and 2019:

- A - Balears
- C - South Tyrrhenian Sea
- E - Sicily Channel
- G - South Turkey, Cyprus.

This report describes the activities and the results related to the 2019 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 in the ICCAT headquarters (Madrid, May 22th, 2019), 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, as foreseen by ICCAT GBYP protocol. The aircraft is a "Partenavia P68 V" model (I-GNIT registration number), already used in the past campaigns. Stickers with "ICCAT 2" on the right side and under the left wing of the aircraft were attached. It has about 5 hours flight range.

- Brand: Partenavia
- Model: P68 V
- Code: I-GNIT

The aircraft and crews are shown in Figure 1.



Figure 1 - The spotters, pilots and aircraft



The equipment used by the spotters was the following:

A GPS *Garmin*<sup>®</sup> GPSMap 62st, 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*<sup>®</sup> D3200 photo camera, with 6400 ISO maximum sensitivity, equipped with *Sigma*<sup>®</sup> 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*<sup>®</sup> 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 3<sup>rd</sup> and was completed on June 16<sup>th</sup>, 2019.

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*<sup>®</sup> GIS software was used for data mapping. *Garmin BaseCamp*<sup>®</sup> and *Garmin MapSource*<sup>®</sup> were 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). A general map of 2019 survey areas is provided in Figure 2.

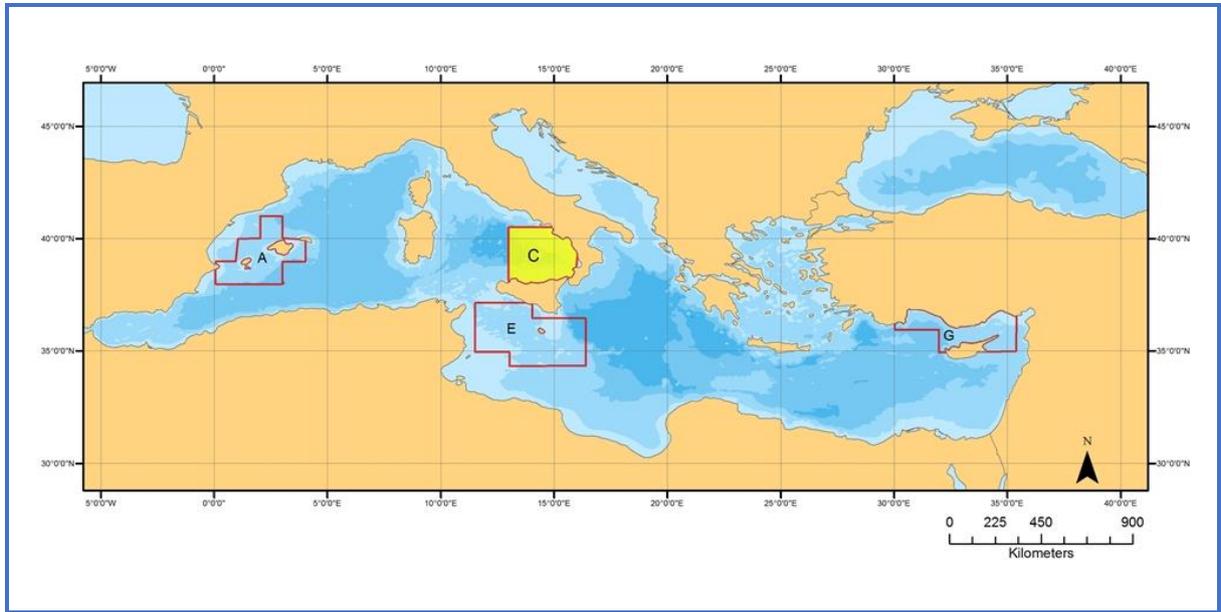


Figure 2 - 2019 Aerial Survey Areas (Unimar-Aerial Banners area is in yellow)

The survey area features are described in Table 1.

Table 1 - Features of Area C

Area	
Area (km <sup>2</sup> )	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.

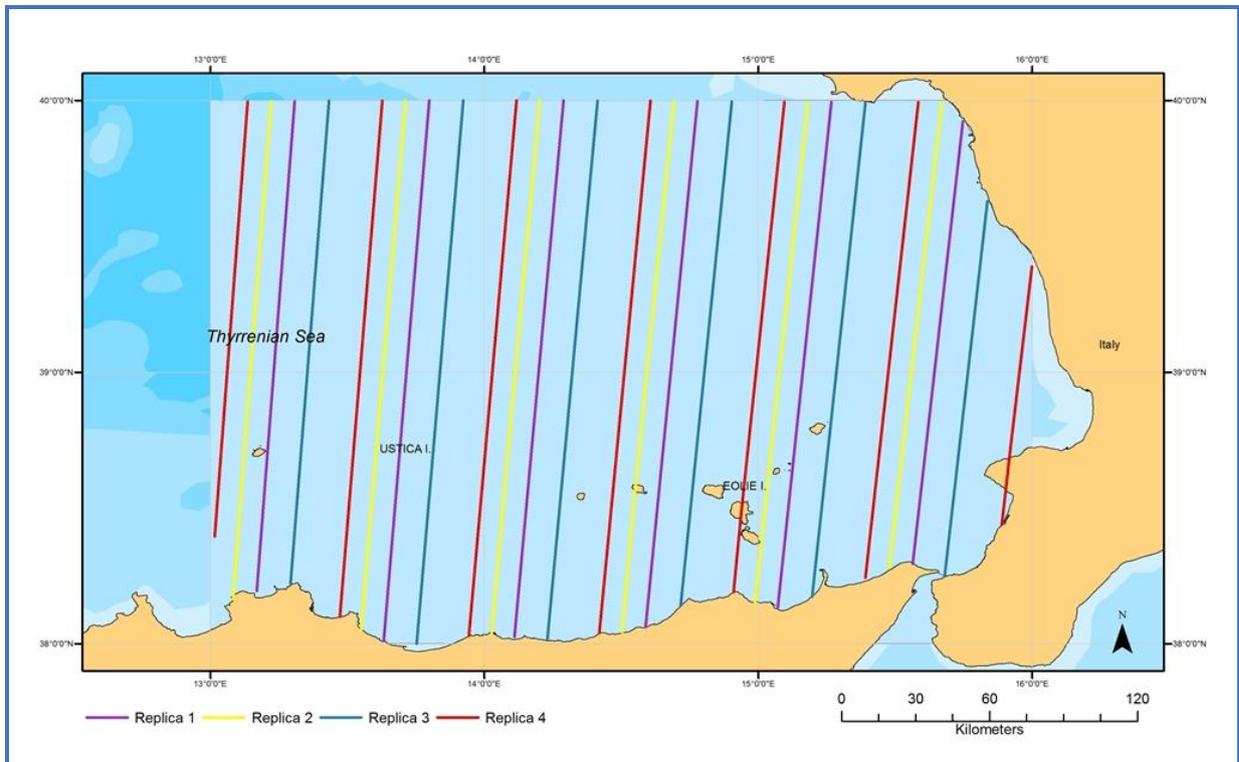


Figure 3 - Area C details and sampler routes (Transects-Legs)

### 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 2<sup>nd</sup>) in order to perform the first flight on June 3<sup>rd</sup>. No way to start the survey before was possible, because the weather conditions were beyond the allowed limits for many days. The survey was completed on June 16<sup>th</sup>. The diary report of the surveys carried out is provided in Table 2. The base airport for Area C was "Salerno - Costa d'Amalfi" airport (LIRI), at Pontecagnano, south of Salerno. A flight per day was performed, as planned in the technical Offer.

The survey was carried out in 13 on-duty days. Only one standby day was necessary because a foreseen strong wind from South-East on June 12<sup>th</sup> would have affected the spotting.

#### *The team*

Pilots: Francesco Orrico, Francesco Ruggiero

Professional spotters: Salvatore De Martino, Mario Piscino, Vincenzo Severino

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

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

In the first available week - May 28<sup>th</sup> to June 2<sup>nd</sup> - the global and local bad weather conditions and forecasts didn't allowed to start the survey. The field activities started on the first day with more stable conditions: June 3<sup>rd</sup>. The general visibility conditions were within the limits during the whole survey, both the wind/sea state and haze/clouds. When a lack of visibility was expected or observed, the survey was interrupted: only one day before the end of the survey was necessary to stop due to the bad wind forecast. 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.

Despite the visibility conditions were good all over the period, it could be useful to remark that in the first survey week - until June 8<sup>th</sup> included - the water temperature was exceptionally low for this season: these conditions could have seriously affected the Bluefin tuna spotting because they were supposed to stay below the surface. The sightings occurred in the second week seem to confirm this: only occasionally the fishes were observed close to the surface.



Table 2 - Daily report of the surveys

Flight #	Date	Mission start*	Mission end*	Area	Transects	Take off airport	Landing airport
1	3/6	08:30	09:57	C	R1L1 – R1L2	Pontecagnano	Pontecagnano
2	4/6	08:07	09:39	C	R1L3 - R1L4	Pontecagnano	Pontecagnano
3	5/6	09:48	12:05	C	R1L5 - R1L6	Pontecagnano	Pontecagnano
4	6/6	07:38	09:03	C	R2L1 - R2L2	Pontecagnano	Pontecagnano
5	7/6	07:15	08:51	C	R2L4 - R2L3	Pontecagnano	Pontecagnano
6	8/6	07:16	09:29	C	R2L6 - R2L5	Pontecagnano	Pontecagnano
7	9/6	09:30	11:10	C	R3L1 - R3L2	Pontecagnano	Pontecagnano
8	10/6	09:28	11:03	C	R3L3 - R3L4	Pontecagnano	Pontecagnano
9	11/6	09:31	11:06	C	R3L5 - R3L6	Pontecagnano	Pontecagnano
standby	12/6	-	-	-	-		
10	13/6	09:17	10:34	C	R4L7	Pontecagnano	Pontecagnano
11	14/6	09:50	11:13	C	R4L1 - R4L2	Pontecagnano	Pontecagnano
12	15/6	10:03	11:20	C	R4L3 - R4L4	Pontecagnano	Pontecagnano
13	16/6	09:37	11:20	C	R4L5 - R4L6	Pontecagnano	Pontecagnano

\* GMT



The times are in GMT and are calculated on the time the engines were switched on/off.

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 in .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 and a medium zoom (around 70-100) were used, but in many cases this wasn't enough for getting sharp and clear photos. Despite all the precautions adopted, the presence of the windows unavoidably affected the sharpness of the photos. We tried as well to shot through the small circular window besides the front seats, but no significant improvement in the photo quality was observed, despite in this way there was no plexiglas between the camera and the subject. On the base of what observed on field, we suppose that the photo quality in this campaign was strongly affected by the deeper position of fishes compared to the previous years.

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.

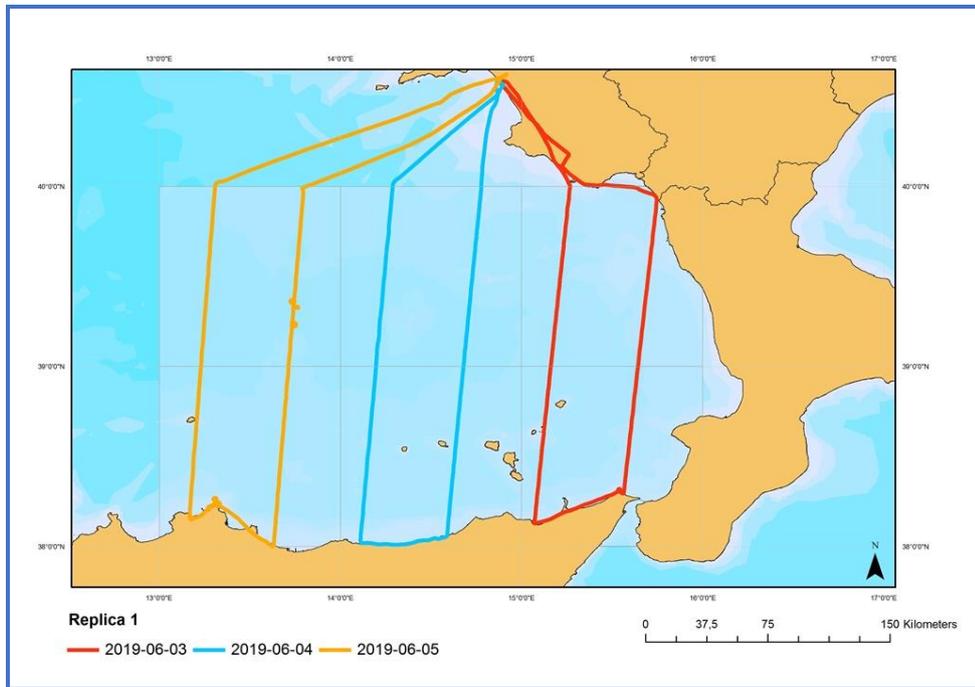


Figure 4 - Recorded GPS tracks: Area C, Replica 1

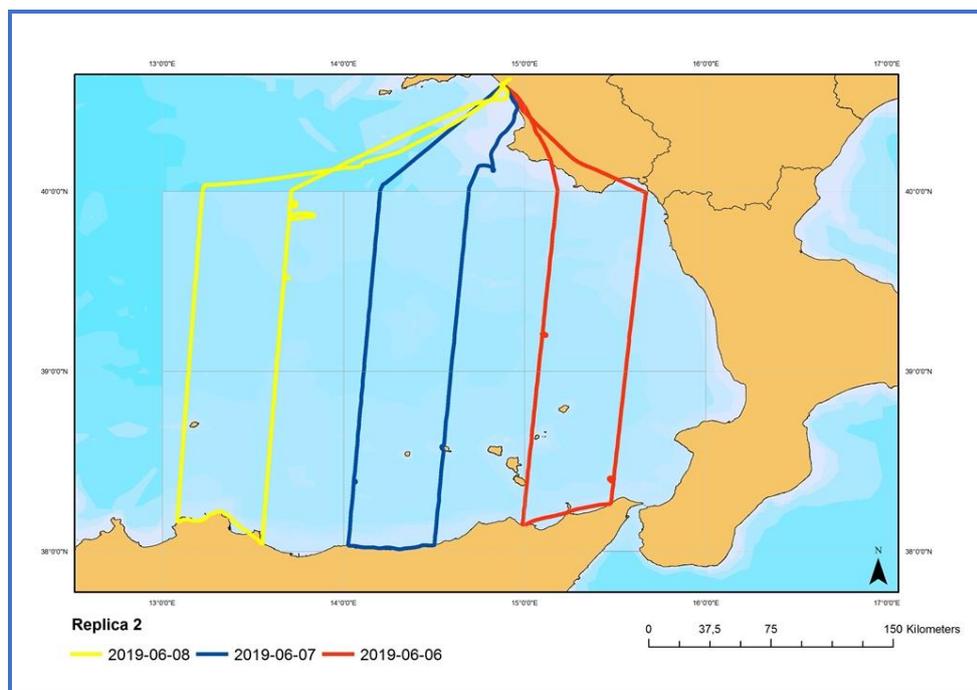


Figure 5 - Recorded GPS tracks: Area C, Replica 2

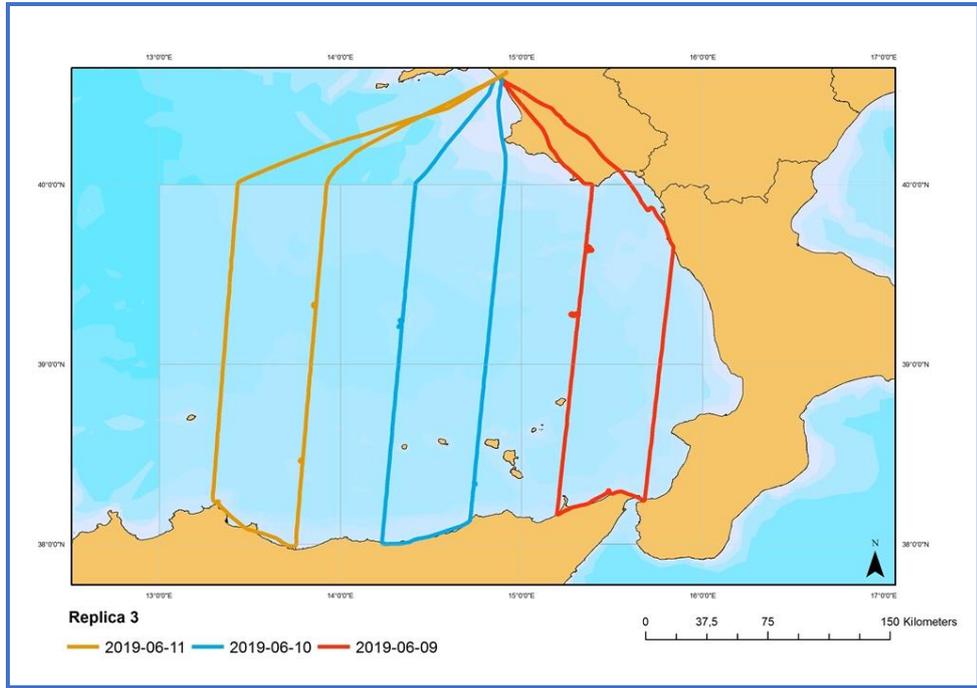


Figure 6 - Recorded GPS tracks: Area C, Replica 3

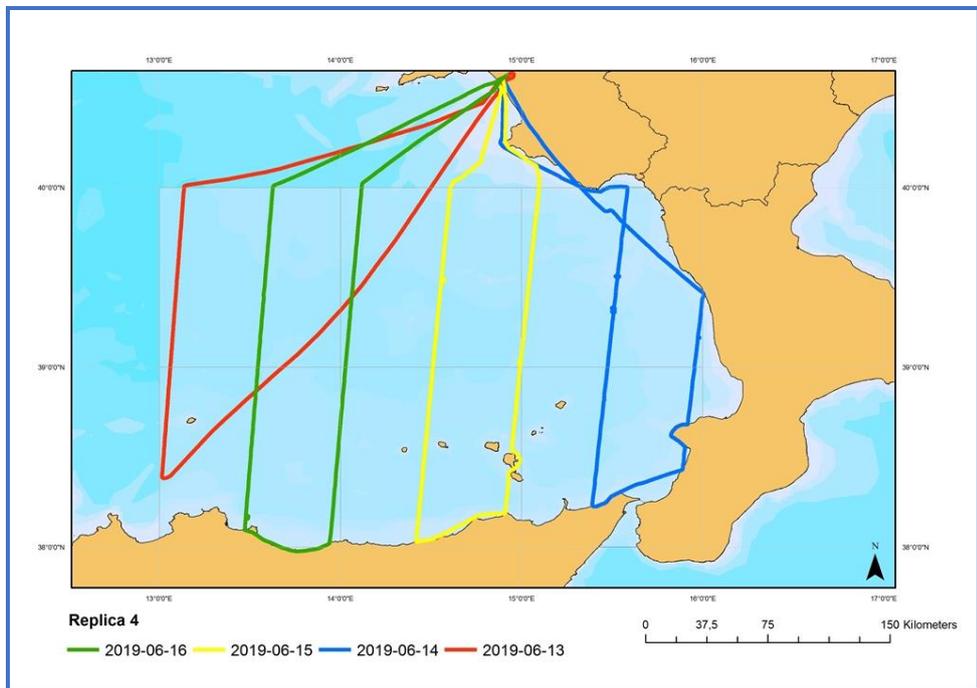


Figure 7 - Recorded GPS tracks: Area C, Replica 4



### **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.

115 sightings were performed: 4 of BFT and 111 of other species. Several photos of BFT sightings are provided, as well as of other species. According to the professional spotters' opinions, some of the BFT schools could be deeper and less visible, but professional spotters could estimate them according to their experience. Most of the schools were seen under the surface rather near to the aircraft.

The 2019 survey was performed about in the same period of the last three campaigns (2015, 2017 and 2018), but earlier than 2013 (started on June 18th). The BFT sightings were concentrated in 3 days, while a high number of loggerhead turtles, swordfishes and dolphin-like cetaceans were sighted all along the survey. Two sperm whales were detected in a few minutes in the western part of the area, as well as sharks, mantas and a sunfish (*Mola mola*).

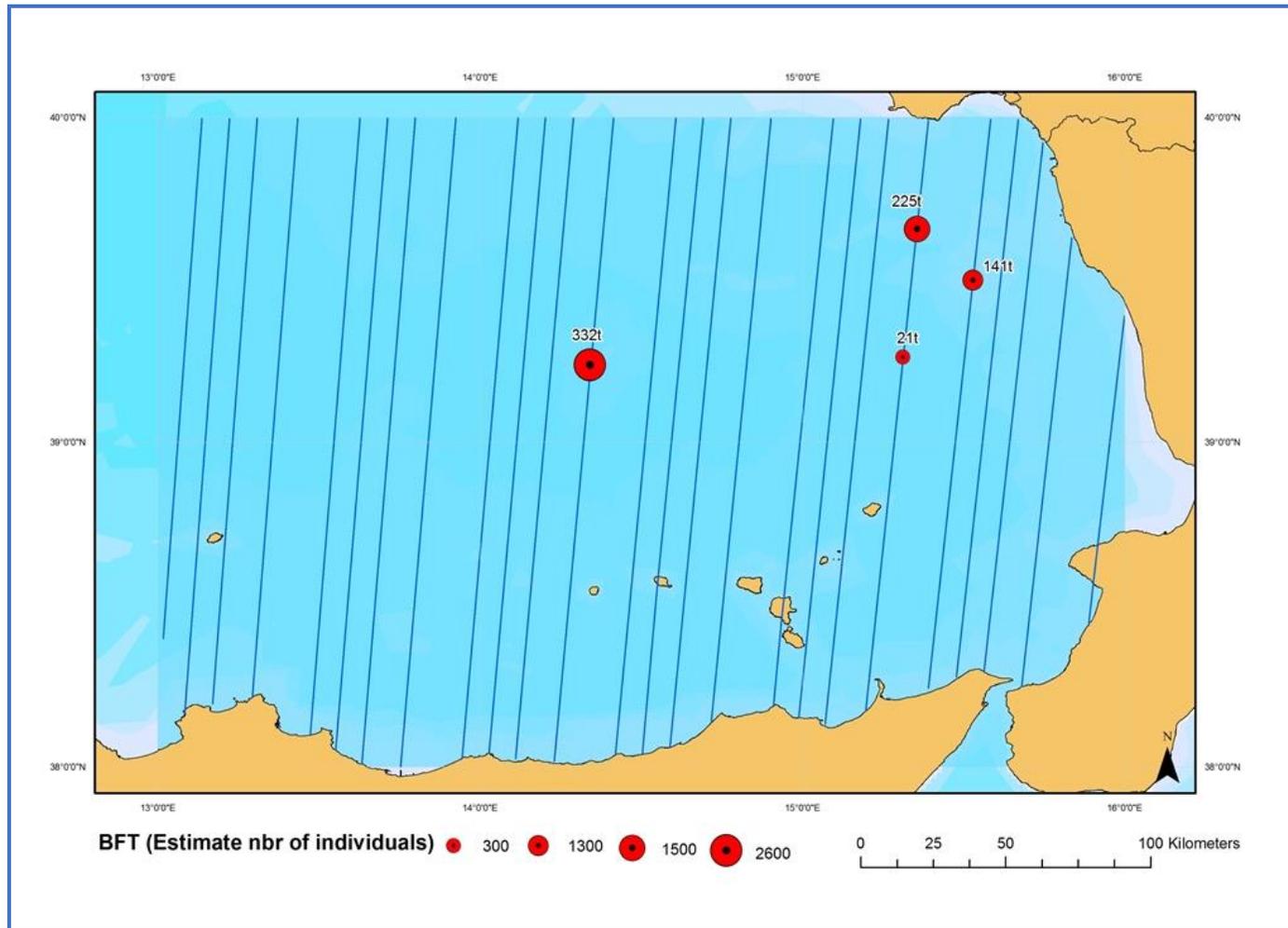


Figure 8 - Map of the BFT sightings (number of individuals and weight)

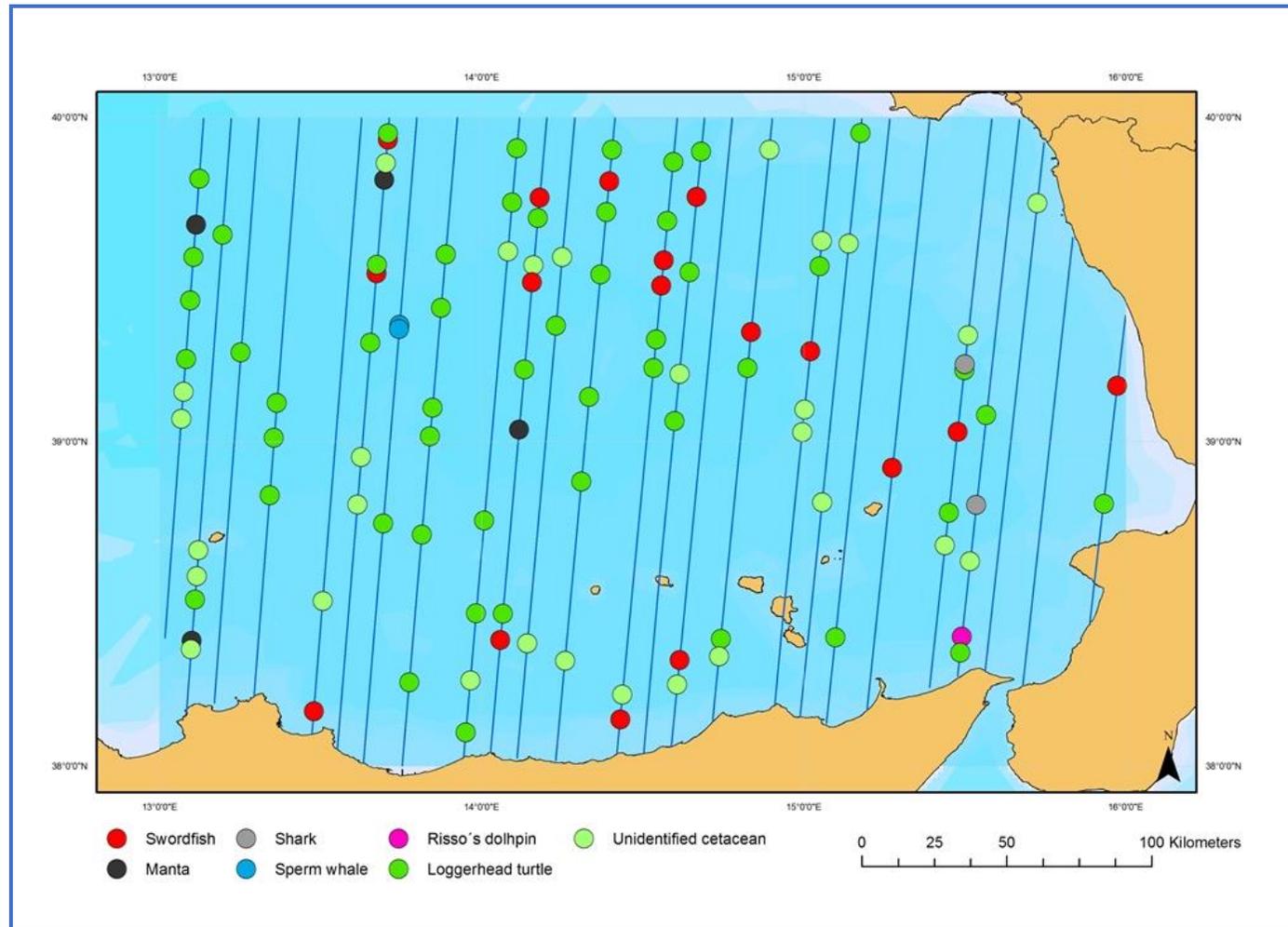


Figure 9 - Map of the other species sightings



Table 3 - Overview of the BFT sightings

ID	Date	Time abeam	Lat abeam	Lon abeam	Angle abeam	Tot PS est. number	Tot PS est. weight (t)	% small	% med	% large
51	9/6	09:59:17	39,27713	15,31241	15	300	21000	100		
52	9/6	10:23:20	39,65694	15,35626	80	1500	225000	30	60	10
62	10/6	10:08:54	39,24353	14,34134	44	2600	332800	60	35	5
93	14/6	10:20:46	39,50532	15,53019	40	1300	141700	85	14	1

### **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 instrument panel.

Regarding the BFT spotting, the importance of southern Tyrrhenian Sea as Bluefin tuna spawning areas is confirmed, but we observed a clear influence of the temperature on the aerial spotting, since we didn't see tunas while it was cold in the first 6 survey days. The 4 spotted BFT schools observed on June 9<sup>th</sup>, 10<sup>th</sup> and 14<sup>th</sup> were swimming low under the surface, while spawning, with occasional splashes.

Regarding other species sightings, we observed, as in the past years, that 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, it could be useful for future campaigns to study a solution aimed to further simplify the procedure of registration of turtles data.



#### 4. REFERENCES

- Arena P., 1982a, Biologia, ecologia e pesca del tonno (*Thunnus thynnus* L.) osservati in un quinquennio nel Tirreno meridionale. Atti Conv. UU.OO: sottop. Ris.Biol.Inq.Marino, Roma: 381-405.
- Arena P., 1982b, Caratteristiche delle reti a circuizione per tonno e loro efficienza in relazione alle condizioni ambientali ed ai comportamenti della specie pescata. Atti Conv. UU.OO. sottop. Ris.Biol.Inq.Marino, Roma: 407-424.
- Arena P., 1982c, Composizione demografica dei branchi di tonno (*Thunnus thynnus*, L.) durante il periodo genetico, con indicazioni utili alla individuazione dello stock di riproduttori che affluiscono nel Mar Tirreno. Atti Conv. UU.OO. sottop. Ris. Biol. Inq. Marino, Roma.
- Arena P., 1982d, La pêche a la senne tournante du thon rouge, *Thunnus thynnus* (L.), dans les bassins maritimes occidentaux italiens. Collect. Vol. Sci. Pap. ICCAT, 17(2): 281-292.
- Arena P., 1990c, Catch and effort of the bluefin tuna purse seine fishing in the South Tyrrhenian Sea. Collect. Vol. Sci. Pap. ICCAT, 33: 117-118.
- Arena, P. 1978 Le thon rouge en Méditerranée. Biologie et aquaculture. Sète, 9-12 May 1978. Act.coll.CNEXO, 8; 53-57
- Jean-Marc Fromentin, Henri Farrugio, Michele Deflorio, Gregorio De Metrio (2003). Preliminary results of aerial surveys of bluefin tuna in the Western Mediterranean sea. Col. Vol. Sci. Pap. ICCAT, 55(3): 1019-1027 (2003)
- 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.
- Final reports of the ICCAT Aerial Surveys on spawners aggregations 2010, 2011, 2013, 2015, 2017 and 2018

#### *Weather forecast websites*

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



**Index of tables**

Table 1 - Features of Area C ..... 8  
Table 2 - Daily report of the surveys ..... 11  
Table 3 - Overview of the BFT sightings ..... 18

**Index of figures**

Figure 1 - The spotters, pilots and aircraft ..... 6  
Figure 2 - 2019 Aerial Survey Areas (Unimar-Aerial Banners area is in yellow) ..... 8  
Figure 3 - Area C details and sampler routes (Transects-Legs) ..... 9  
Figure 4 - Recorded GPS tracks: Area C, Replica 1 ..... 13  
Figure 5 - Recorded GPS tracks: Area C, Replica 2 ..... 13  
Figure 6 - Recorded GPS tracks: Area C, Replica 3 ..... 14  
Figure 7 - Recorded GPS tracks: Area C, Replica 4 ..... 14  
Figure 8 - Map of the BFT sightings (number of individuals and weight) ..... 16  
Figure 9 - Map of the other species sightings ..... 17



## 5. ANNEXES

1. Complete Effort and Sighting forms
2. GPS tracks and tables
3. Photos
4. Power Point presentation