AERIAL SURVEY FOR BLUEFIN SPAWNING AGGREGATION OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA ICCAT-GBYP Phase 7 CALL FOR TENDERS ICCAT/GBYP 02/2017-b - Circular #0426/2017, 20.3.2017 SUB-AREA C

Final Report

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Summary

Within the ICCAT GBYP program, aerial surveys were 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 the survey was extended to the whole Mediterranean Sea. The same choice was adopted for 2015 survey. In 2017, the surveys were limited to the 4 initial spawning areas, which this report is about. In the 2017 campaign, Unimar was awarded to carry out the survey in the Sub-area C, (South Tyrrhenian Sea) performing the 4 mandatory replicas. The survey took place from May 30th to June 14th, 2017. N. 16 BFT sightings were performed in the 13 survey days.

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, was decided to restrict the survey to the 4 initial areas:

A - Balears

C - South Tyrrhenian Sea

E - Sicily Channel

G - South Turkey, Cyprus.

This report describes the activities and the results related to the 2017 Unimar survey, covering the Sub-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 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 in the ICCAT headquarters (Madrid, 15th May 2017), 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, as foreseen by ICCAT GBYP. The model of both the aircrafts was "Partenavia P68", the same as the one used in the past campaigns.

In details, one model was a Partenavia P68 V (I-GNIT registration number), planned to work in the sub-area C. Stickers with “ICCAT 2” on the right side and under the left wing of the aircraft were attached. It had about 4-5 hours flight range.

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

The second aircraft model was a Partenavia P68 C-TC (I-AGSD registration number) planned to be used as a reserve aircraft. Stickers with “ICCAT 6” on the right side and under the left wing of the aircraft were attached. It has about 5-6 hours flight range.

- Brand: Partenavia
- Model: P68 C-TC
- Code: I-AGSD

The aircrafts and teams are shown in Figure 1 and Figure 2.

Figure 1 - I-AGSD (ICCAT 6) aircraft

Figure 2 - I-GNIT (ICCAT 2) aircraft

The equipment used by the spotters was the following:

- 2 GPS: *Garmin*® Map 60CSx and 62st, with the statistical survey design uploaded (the same route files were provided to the pilot);
- GPS external antenna which were applied on the aircraft dashboard under the front window in order to enhance the satellite signal reception
- A digital *Nikon*® photo camera: D3200 with 6400 ISO maximum sensitivity, equipped with Sigma® 70-200 zoom lens f/2.8 OS and 62st, polarised filter (77mm gauge) and 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 (who was also a professional spotter), 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 survey period was comprised between May 30th and June 14th, 2017.

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® and Garmin MapSource® were used for track designing, analysis, 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).

A general map of 2017 survey areas is provided in Figure 3.

The sub-area and replicas are represented in Figure 4 and are described as follows.

Sub-area C is the Central Mediterranean area located North of Sicily and West of Calabria. The importance of this area for the Bluefin tuna spawners 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).

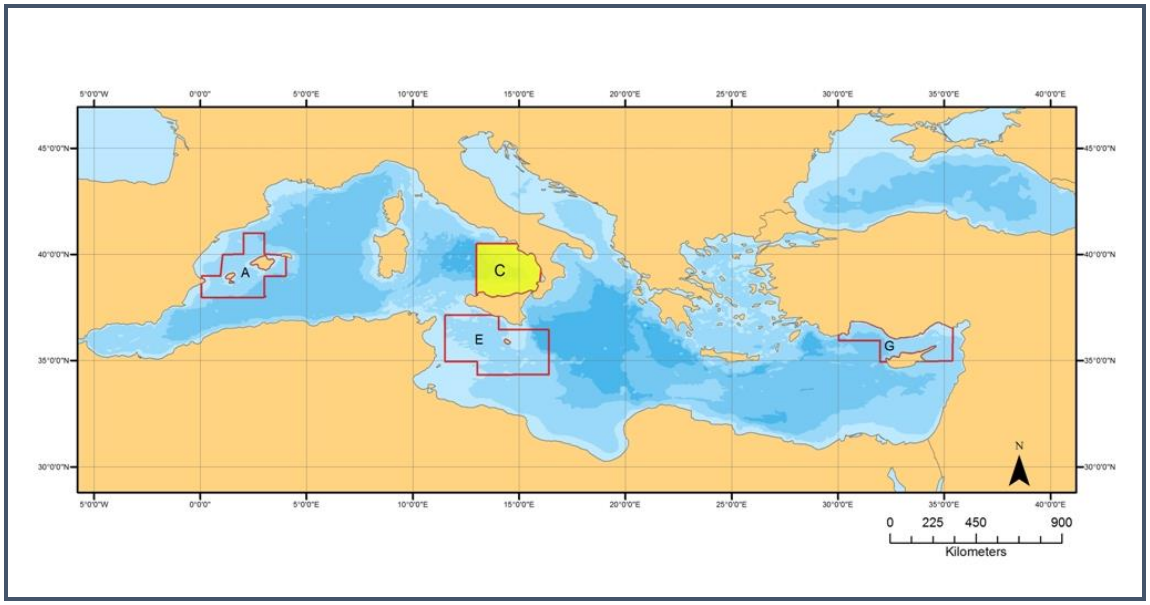

Figure 3 - 2017 Aerial Survey Sub-areas (UNIMAR area in yellow)

Table 1 - Features of Sub-area C

Sub-area	C
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

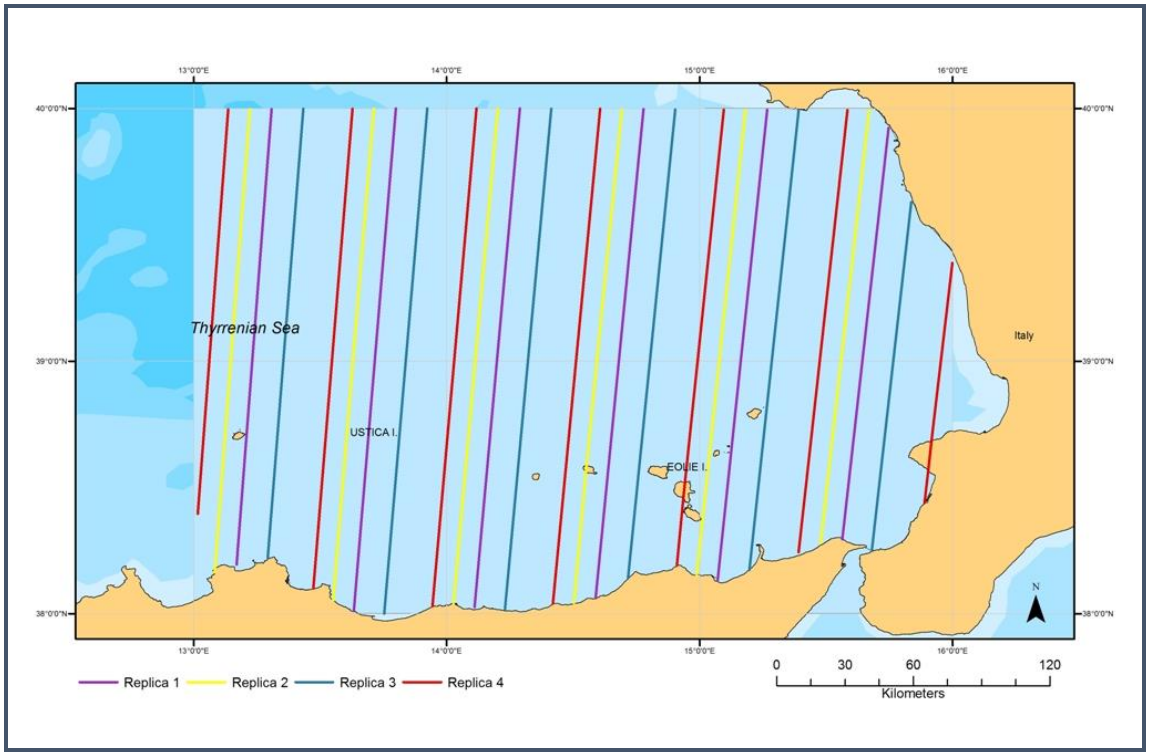

Figure 4 - Sub-area C detail and sampler routes (Transects-Legs)

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 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.

In addition to the ICCAT course in Madrid, some meetings were held 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 activities

According to ICCAT schedule and the meteorological conditions, the staff moved to the base airport on the first available day (May 29th, 2017) and started on May 30th. The survey ended on June 14th, 2017. The diary report of the surveys carried out is provided in Table 2. As in the past years, the operative base for both aircrafts was "Salerno - Costa d'Amalfi" airport, at Pontecagnano, south of Salerno.

Table 2 - Diary report of the surveys: Area C

Day #	Date	Survey #	Flight start time*	Flight end time*	Tot. time on duty	Area	Transects	Aircraft	Take off airport	Landing airport
1	30/05/2017	1	07:15	11:00	03:45	C	R1L2-R1L1	I-GNIT	Pontecagnano	Pontecagnano
2	31/05/2017	2	07:20	10:10	02:50	C	R4L1	I-GNIT	Pontecagnano	Pontecagnano
3	01/06/2017	standby				-	-	-	-	-
4	02/06/2017	3	08:05	11:33	03:28	C	R1L3-R1L4	I-AGSD	Pontecagnano	Pontecagnano
5	03/06/2017	4	07:43	12:06	04:23	C	R1L6-R1L5	I-AGSD	Pontecagnano	Pontecagnano
6	04/06/2017	5	07:37	11:41	04:04	C	R4L7-R4L6	I-AGSD	Pontecagnano	Pontecagnano
7	05/06/2017	6	07:36	11:17	03:41	C	R4L5-R4L4	I-AGSD	Pontecagnano	Pontecagnano
8	06/06/2017	7	07:20	11:10	03:50	C	R4L3-R4L2	I-GNIT	Pontecagnano	Pontecagnano
9	07/06/2017	standby				-	-	-	-	-
10	08/06/2017	standby				-	-	-	-	-
11	09/06/2017	8	07:10	10:45	03:35	C	R3L2-R3L1	I-GNIT	Pontecagnano	Pontecagnano
12	10/06/2017	9	07:05	10:40	03:35	C	R3L4-R3L3	I-GNIT	Pontecagnano	Pontecagnano
13	11/06/2017	10	07:05	11:05	04:00	C	R3L6-R3L5	I-GNIT	Pontecagnano	Pontecagnano
14	12/06/2017	11	07:10	11:20	04:10	C	R2L2-R2L1	I-GNIT	Pontecagnano	Pontecagnano
15	13/06/2017	12	07:15	11:05	03:50	C	R2L4-R2L3	I-GNIT	Pontecagnano	Pontecagnano
16	14/06/2017	13	07:15	11:35	04:20	C	R2L6-R2L5	I-GNIT	Pontecagnano	Pontecagnano

(* GMT)

The times are calculated on the time the engines are switched on.

The time reference is GMT.

Although the flights were generally performed at the altitude and speed requested (300 m, 100 nm/h); there are some differences and fluctuations due to environmental and technical factors.

For all 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 in the Annexes).

The effort and sightings forms can be find in the Annexes, as well.

The photos can be identified according to the frame numbers.. A complete set of the photos taken during the surveys can be find in the Annexes in .NEF (RAW) format. Two SD cards were used and so two different series IDs are to be considered: the photos are provided in two separated directories, corresponding to each card.

In order to enhance the visibility of tunas and other species, we suggest to adjust contrast and light with a photo editing programs able to read .RAW (.NEF, in this case) format, such as Picasa. Using Picasa, we found that an efficient function for highlighting the animals is the automatic editing command "*I'm feeling lucky*".

The photos were taken following the methodologies tested in the previous campaigns, trying to improve the resolution, the exposure time and the focus system. In order to overcome the problems in photography, especially the ones linked to aircraft bouncing, high shutter speeds were used, but in many cases this wasn't enough for getting sharp photos. Despite all the precautions adopted, the presence of the windows unavoidably affected the sharpness of all the photos.

Description of the survey

On May 29th, 2017, the spotters arrived at Pontecagnano and a briefing at the airport was organised.

The survey was carried out in 16 days: 9 days with I-GNIT (ICCAT 2) and 4 days with I-AGSD (ICCAT 6). 3 standby days were necessary for technical and weather conditions.

The team

Pilots: Francesco Orrico, Daniele Mercurio, Francesco Ruggiero

Professional spotters: Salvatore De Martino Mario Piscino, Vincenzo Severino

Scientific spotters: Adriano Mariani, Simone Serra, Andrea Fusari

The 2017 campaign was the fifth survey in the "C" area, already surveyed in 2010, 2011, 2013 and 2015. While in 2010 and 2011 about eleven transects per replica were followed, in 2013 and 2015 the transects number per replica was 7, so the distance between the lines was higher. In 2017, 3 replicas had 6 transects and 1 replica had 7 transect.

Flight history and relevant remarks

The base for all flight was "Salerno-Costa D'Amalfi" airport (Pontecagnano) and were performed one per day.

Day 1 - 30/5/2017

Survey # 1

Replica 1, Leg 2 downward, Leg 1 upward.

During the flight, an anomaly in the communication between the fuel tanks convinced the pilot to check the aircraft. Despite the risk of serious problems was not very high, the pilot preferred to test the aircraft on the shortest and nearer flight of all the survey in the next day. So it was decided to do the Leg 1 of Replica 4.

Day 2 - 31/5/2017

Survey # 2

Replica 4, Leg 1 downward.

During the flight, the tanks problem was confirmed and so it was decided to use the reserve aircraft for the next days while the main aircraft was checked and the problem fixed. This entailed a standby day while waiting the availability of I-AGSD, not already in Pontecagnano airport.

Day 3 - 1/6/2017

Standby for technical reasons.

Day 4 - 2/6/2017
Survey # 3
Replica 1, Leg 3 downward, Leg 4 upward.
With I-AGSD aircraft, the survey went on to complete Replica 1. No problems encountered.

Day 5 - 3/6/2017
Survey # 4
Replica 1, Leg 6 downward, Leg 5 upward.

Day 6 - 4/6/2017
Survey # 5
Replica 4, Leg 7 downward, Leg 6 upward.

Day 7 - 5/6/2017
Survey # 6
Replica 4, Leg 5 downward, Leg 4 upward.

Day 8 - 6/6/2017
Survey # 7
Replica 4, Leg 3 downward, Leg 2 upward.
Two replicas were completed. The adverse wind and wave forecast forced to suspend the survey.

Day 9 - 7/6/2017
Standby for adverse wind and sea state forecast.

Day 10 - 8/6/2017
Standby for adverse wind and sea state forecast.

Day 11 - 9/6/2017
Survey # 8
Replica 3, Leg 2 downward, Leg 1 upward.
During the past days the tanks problem on I-GNIT aircraft was fixed and so it was used to complete the campaign to the end. It was decided to start with Replica 3.

Day 12 - 10/6/2017
Survey # 9
Replica 3, Leg 4 downward, Leg 3 upward.

Day 13 - 11/6/2017
Survey # 10
Replica 3, Leg 6 downward, Leg 5 upward.
Replica 3 was completed.

Day 14 - 12/6/2017
Survey # 11
Replica 2, Leg 2 downward, Leg 1 upward.
Replica 3 was started.

Day 15 - 13/6/2017
Survey # 12
Replica 2, Leg 4 downward, Leg 3 upward.

Day 16 - 14/6/2017
Survey # 13
Replica 2, Leg 6 downward, Leg 5 upward.
The survey campaign was completed.

The general visibility conditions were almost perfect 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.

Maps of recorded GPS tracks

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

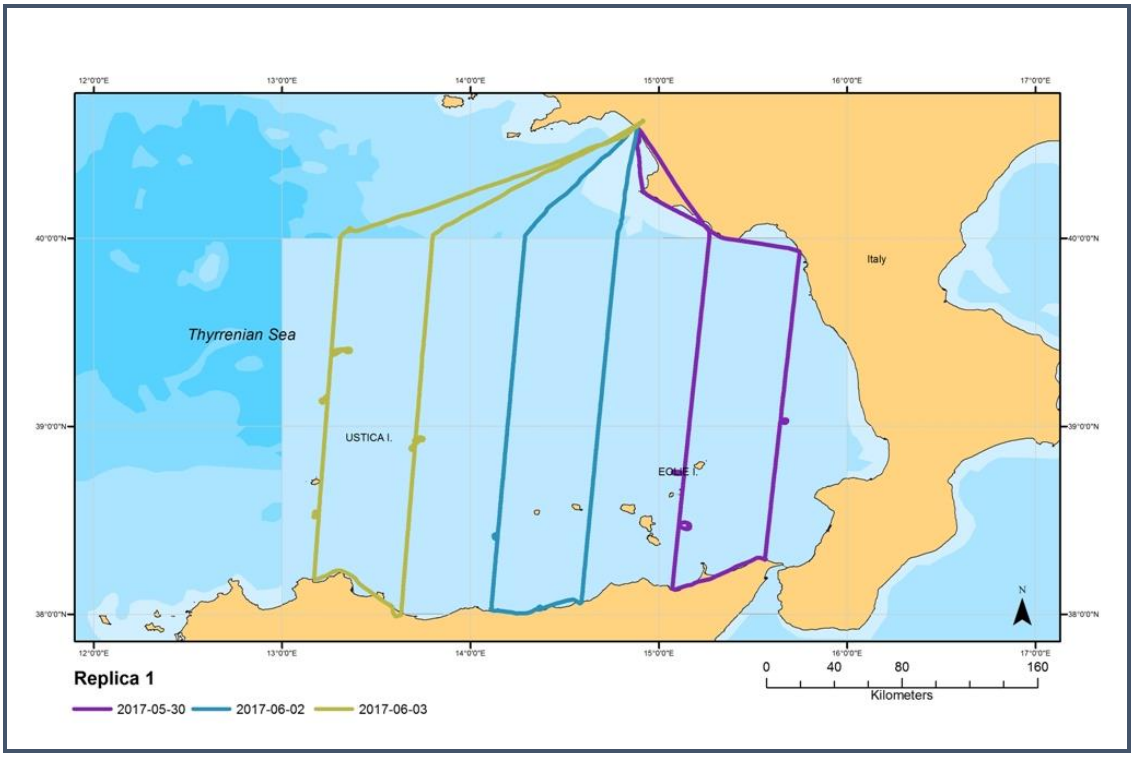

Figure 5 - Recorded GPS tracks: Replica 1

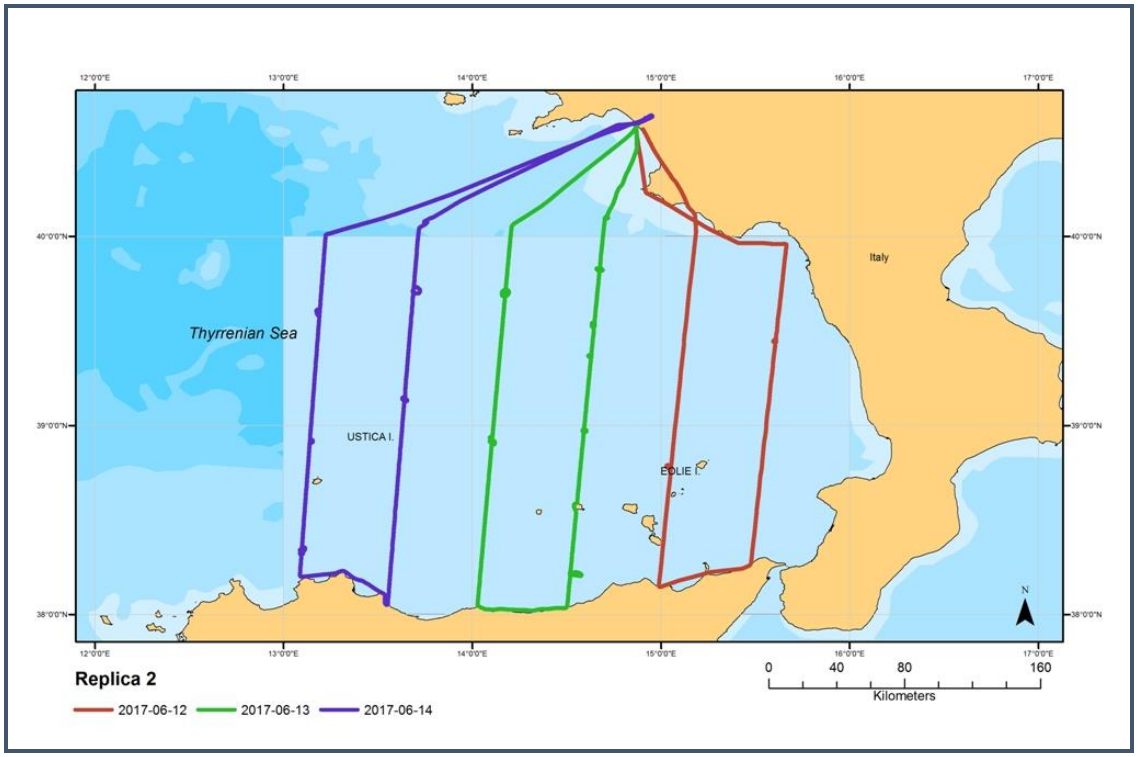

Figure 6 - Recorded GPS tracks: Replica 2

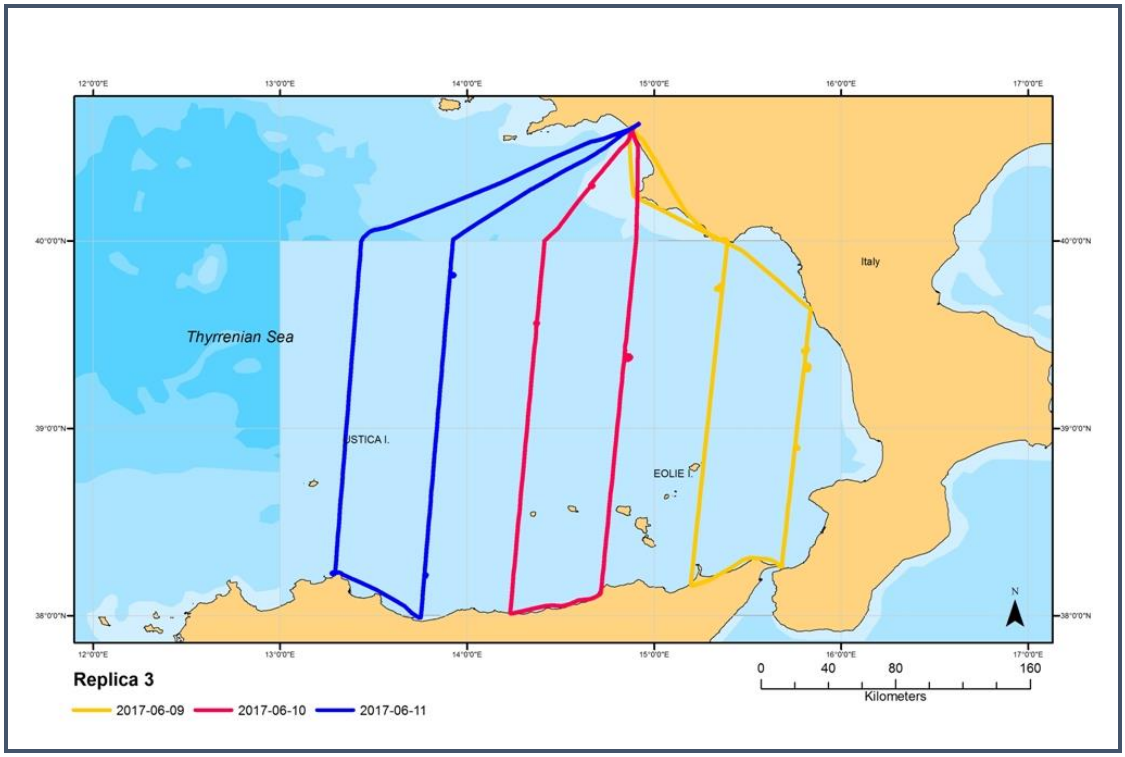

Figure 7 - Recorded GPS tracks: Replica 3

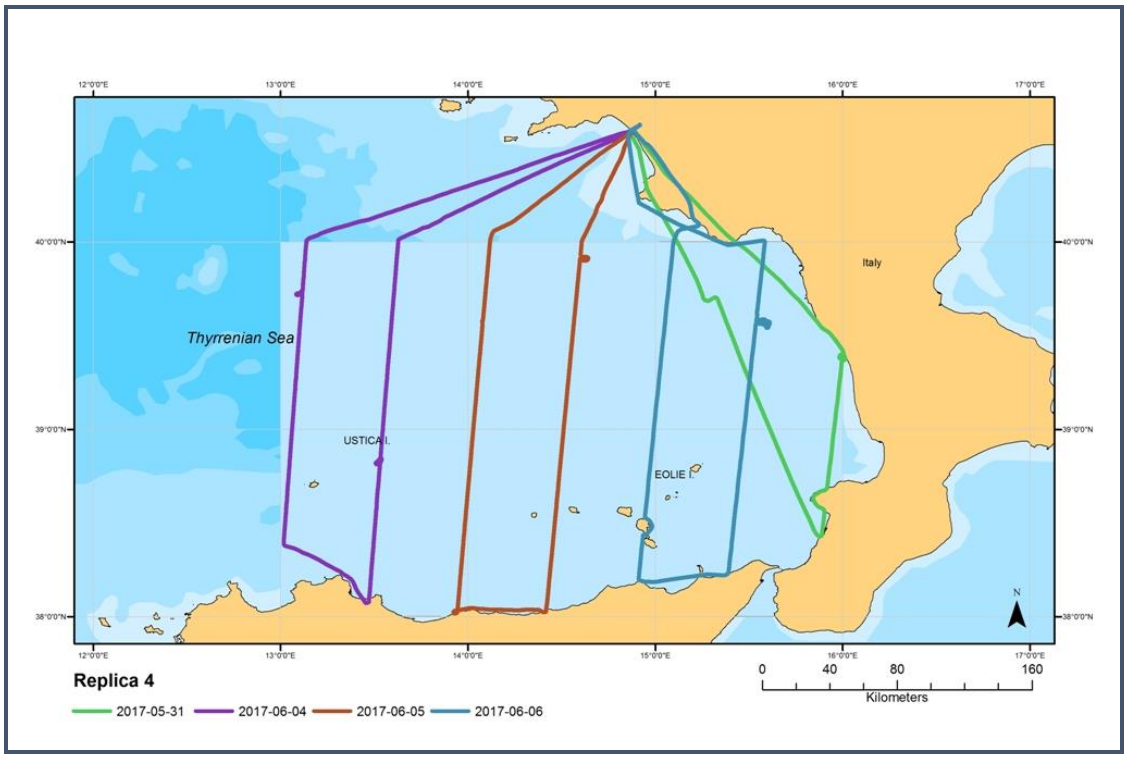

Figure 8 - Recorded GPS tracks: Replica 4

3.3 Sightings overview

The maps representing the sightings of Bluefin tuna are shown in Figure 9. The maps representing the sightings of other species are shown in Figure 10. The maps show the distribution of the sightings 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.

70 sightings were performed: 16 of BFT and 54 of other species. Several photos of BFT sightings are provided, as well as cetacean ones. According to the professional spotters' opinions, it is probable that some of the BFT schools were deeper and less visible, but professional spotters could estimate them according to their experience.

With respect to the 2013 campaign, the 2017 survey started earlier (in 2013, the survey started on the June 18th), but exactly in the same period of 2015 (started on June 1st). In the first days, more schools of small individuals were detected, while in the further days bigger fishes were sighted. In some schools, some big or giant fishes were sighted, particularly around the schools or quite separated from school core made of smaller ones. As usual, a certain number of loggerhead turtles and undefined dolphins were sighted. Some swordfishes were seen in the northern part of the area. 3 sperm whales were seen in the area North of western Aeolian islands (Filicudi) and 1 Northwest of Ustica.

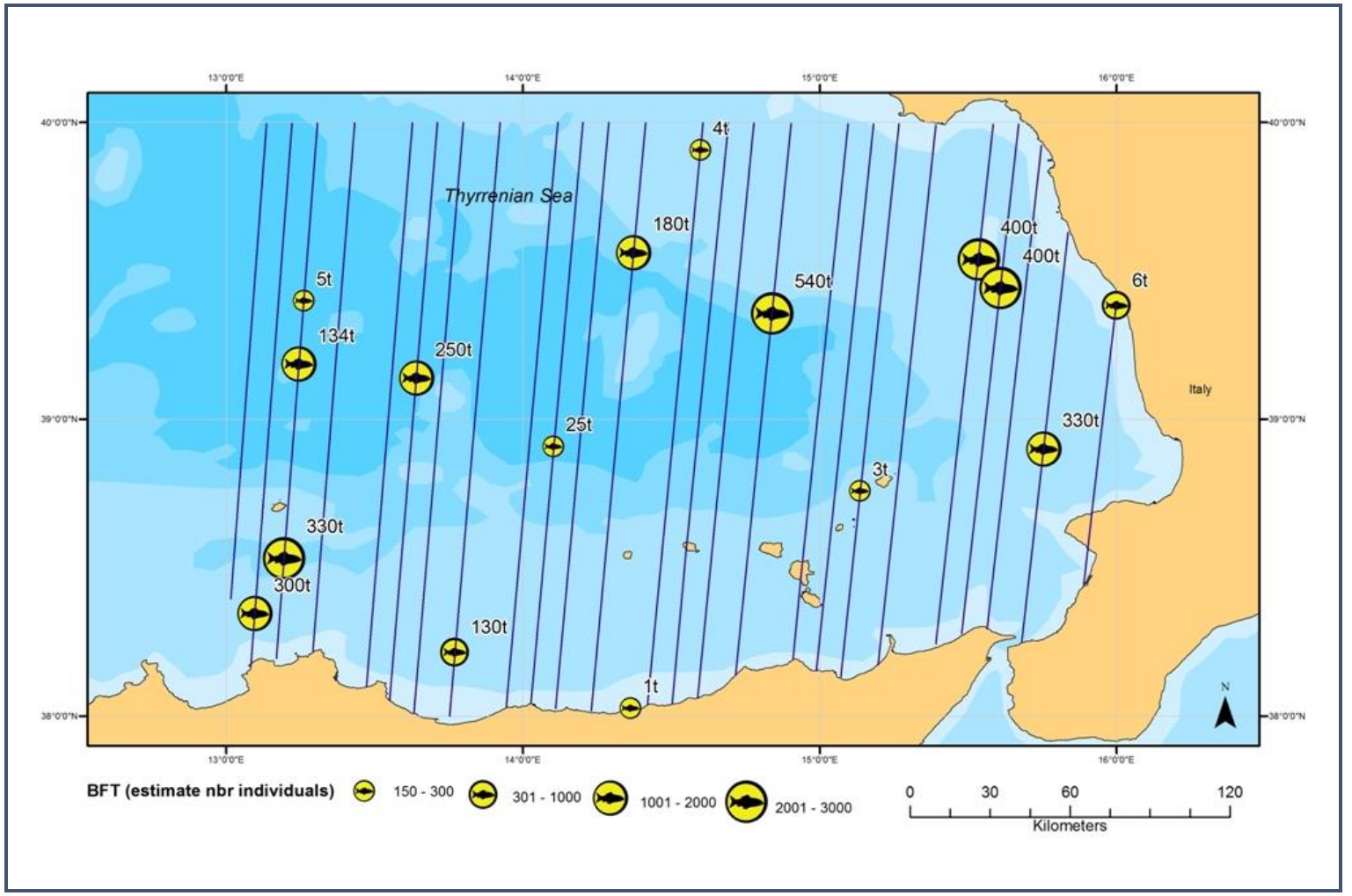

Figure 9 - Map of the BFT sightings (number of individuals and total weight)

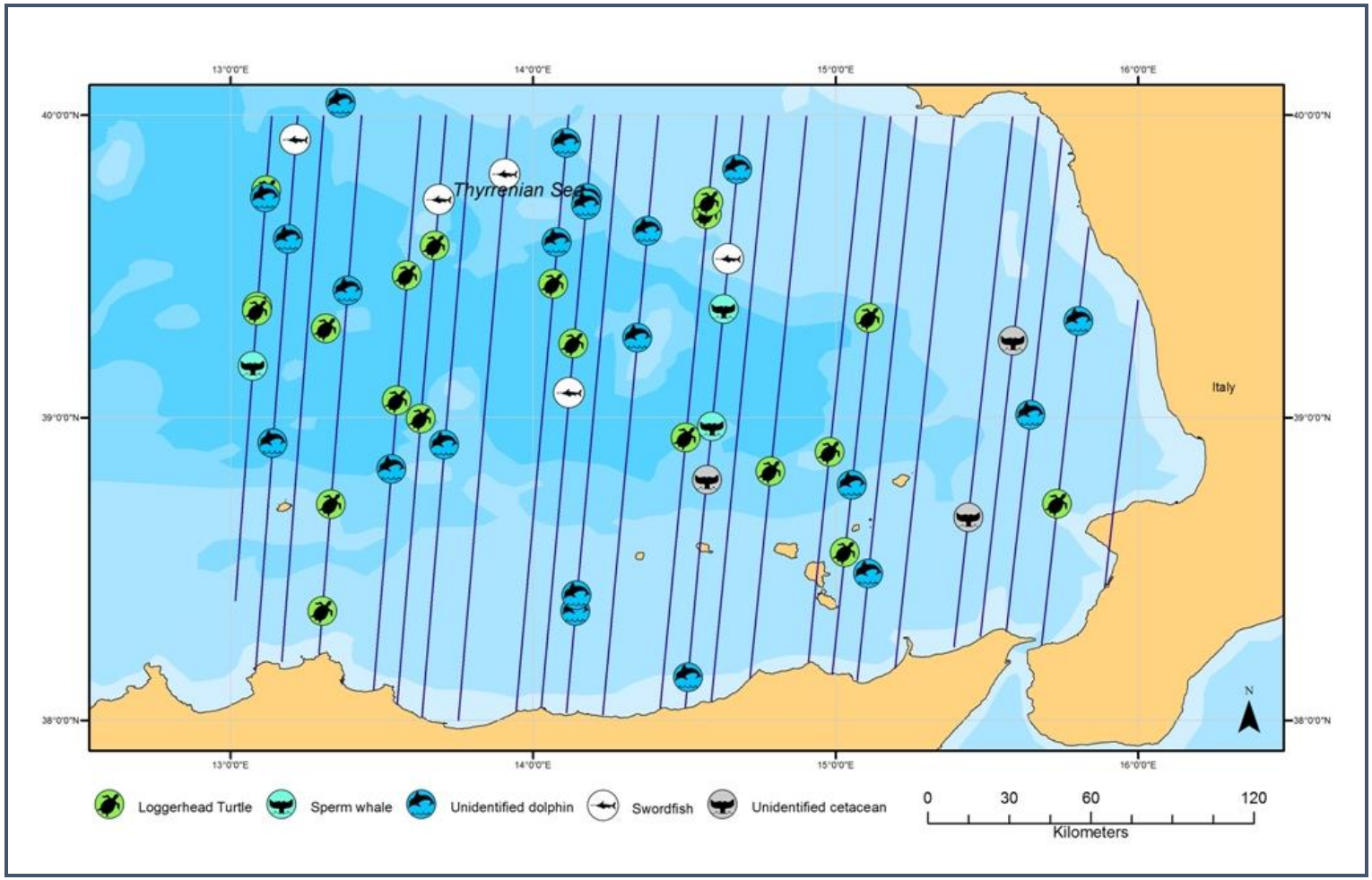

Figure 10 - Map of the other species sightings

Table 3 - Overview of the BFT sightings

ID	Date	Time of first sighting	Time abeam	Decl. angle	Lat first sighting	Lon first sighting	Cue	Spotter	School size	Est. weight (t)	% small	% med	% large	% giant
1	30/5	8:30	8:30	6	38.75856	15.13497	Underwater	PS	300	3000	100			
4	31/5	8:11	8:11	25	39.38299	15.99837	Underwater	PS	1000	6000	100			
5	2/6	9:44	9:44	17	38.02728	14.36146	Ripples	PS	200	1000	100			
9	3/6	8:52	8:52	2	39.39937	13.26143	Ripples	PS	250	5000	100			
10	3/6	9:06	9:08	6	39.18574	13.24386	Ripples	PS	1900	134000		65	35	
11	3/6	9:35	9:35	9	38.53091	13.19383	Ripples	PS	2300	330000		57	43	
27	5/6	10:38	10:38	7	39.90762	14.59763	Ripples	PS	200	4000	100			
30	6/6	10:01	10:02	4	39.53836	15.53345	Ripples	PS	3000	400000		66	34	
34	9/6	9:22	9:22	18	38.89993	15.75230	Shining	SS	2000	330000		35	65	
38	10/6	7:52	7:52	65	39.56118	14.37123	Surface	SS	1400	180000		72	28	
41	10/6	9:47	9:48	8	39.35634	14.83829	Ripples	PS	3000	540000		28	66	6
45	11/6	9:12	9:12	28	38.21466	13.77005	Ripples	PS	800	130000		37	63	
51	12/6	8:39	8:39	50	39.44216	15.60663	Surface	SS	2500	400000		40	60	
56	13/6	8:28	8:28	88	38.90850	14.10272	Surface	SS	150	25000		40	60	
66	14/6	9:14	9:14	48	38.34476	13.09552	Splash	SS	1500	300000			100	
68	14/6	10:18	10:18	42	39.13830	13.64006	Splash	P	1500	250000		30	70	

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, both in terms of weather and technical ones. Just a standby day was due to the need of a technical check of the main aircraft for safety reasons and two standby days for wind over the limits.

It is confirmed that the bubble windows are comfortable for vertical 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 or on the upper part of the front window in order to overcome some GPS signal reception problem, already noticed in the former campaigns, especially during circling.

Sunglasses with polarised lenses are useful for see clearly under the sea surface, but we noted that through the bubble windows they increase the sun reflection on the glass and disturb the long distance spotting.

Regarding the surveys results, more bluefin tuna school sightings occurred in the area compared to the past campaigns, despite the period began earlier than the past years. Furthermore, a suitable thermocline was available later in the season. Anyway, the importance of southern Tyrrhenian Sea as a bluefin tuna spawning area has been confirmed, with 16 sightings of adult spawners aggregations.

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Weather forecast websites

Mediterranean Wave Forecast	http://israмar.ocean.org.il
Aeronautica Militare Italiana	http://www.meteoam.it
Consorzio Lamma	http://www.lamma.rete.toscana.it
Windfinder	http://it.windfinder.com

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5. ANNEXES

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