



**AERIAL SURVEY ON SPAWNERS AGGREGATIONS
OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN
TUNA
(ICCAT-GBYP 03/2013)
SUB-AREAS C, D and F**



Final Report

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Summary

Within the ICCAT program GBYP, 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 carried out in four Mediterranean spawning areas, in 2013 the survey was extended to all the Mediterranean sea. This report is referring to the areas C, D and F, corresponding respectively to the Tyrrhenian Sea, the Adriatic and Ionian Sea and the Aegean Sea. In these areas, aerial surveys were performed and a series of sightings occurred. Data collected can contribute to the knowledge of the species in the area, and gather with other data at the same time collected for the whole Mediterranean in the framework of the general programme. A certain number of schools were spotted in the Subarea C (Tyrrhenian Sea), while no significant sighting took place in the other two subareas.

Keywords

Abundance, Geographical distribution, Migrations, Spawning grounds, Tuna fisheries, Statistical sampling, Bluefin tuna, Thunnus thynnus, Mediterranean, Aerial survey



1. BACKGROUND AND OBJECTIVES

The policy of Mediterranean Bluefin tuna conservation requires improved scientific knowledge regarding biology, reproductive behaviour and the broodstock status.

The programme “Aerial survey on spawners aggregations of the Atlantic-wide research programme on Bluefin tuna (GBYP)” was undertaken to develop fishery - independent indices of abundance to detect trends of the minimum spawning stock biomass. To detect these trends, surveys were planned to be performed for several years.

In 2010 and 2011, 4 Mediterranean spawning areas were identified, on the base of biological and traditional knowledge, and aerial surveys were carried out to detect spawners aggregations.

For 2013, the survey was extended in order to cover all the Mediterranean basin and more areas were identified.

The present report describes the activities and the results related to the subareas C, D and F, including the Tyrrhenian, Adriatic, Ionian and Aegean Sea.

2. MEANS AND METHODS

The methodology followed the terms of reference of the Call and the technical specifications annexed to the contract, with some adjustments forcedly adopted to overcome operative unforeseen constraints. The activities were carried out taking into account what foreseen by the ICCAT methodology and according to the behaviour of Bluefin tuna in respect to the season. The spawning behaviour 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 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.

According to what foreseen by ICCAT, a representative of the personnel involved in the survey participated to an “ad hoc” training course carried out in ICCAT headquarters (Madrid, 4th June 2013), during which “tuning” of the methodology and operative standards were adopted.

2.1 Aircrafts and equipment

In order to cover the three area in the available time, two P68 aircrafts were involved, both with upper wings, good forward visibility, bubble windows applied and capable of flying at a spotting altitude of 300 m and a speed of 100 nm, as foreseen by ICCAT.

One was a Partenavia P68 V, planned to be used to work in the areas C and D. Stickers with “ICCAT 8” on the right side and under the left wing were applied (Figure 1 to Figure 2). It has about 5 hours fly autonomy.

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



Figure 1 - The I-GNIT aircraft



Figure 2 - I-GNIT aircraft, the bubble windows

The second aircraft was a Partenavia P68 C-TC planned to be used to work in the area D. Stickers with “ICCAT 9” on the right side and under the left wing were applied (Figure 3 to Figure 4). It has about 6 hours fly autonomy.

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



Figure 3 - The I-AGSD aircraft



Figure 4 - The I-AGSD aircraft, the bubble windows



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);
- 2 GPS external antennas to be applied on the bubble window top in order to enhance the satellite signal reception
- 2 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); D3000 with 1600 ISO maximum sensitivity, equipped with *Nikkor*® 55-200 zoom lens f/5.6 VR, polarised filter (52mm gauge).
- *Manfrotto*® monopods.
- *Silva Sight Master*® clinometers

Onboard each aircraft there always were a professional tuna spotter and two scientific spotters. Effort and sightings were recorded on the specific forms and GPS recording of all flights and sighting positions was saved. During a survey, the GPS recorded every 3 seconds the exact position of the plane as well as all the waypoints entered by the spotters. After every landing, the information was saved into the computer.

The survey period was comprised between 18th June and 3th July.

Weather conditions were considered adverse when they could interfere with a reliable observation of tuna schools (winds over 3 on the Beaufort scale, clouds lower than 300 m high or heavy rain, according to the terms of reference of the contract).

For data mapping, ArcGIS software was used. For track designing, analysis, saving and editing, *Garmin BaseCamp*® and *Garmin MapSource*® were used.

2.2 Survey area and the Survey design

A general map of the study areas is reported in the Figure 5. The areas are represented in the Figure 6 to Figure 9. The study areas are described as follows.

Aerial surveys were designed by ICCAT using the "DISTANCE" program. In each block, a series of transects were created, based on the amount of the dimensions of the area, to achieve the approximate coverage indicated. Surveys are designed as equal spaced parallel lines. Parallel lines designs achieve equal coverage probability (Hammond P. et al, 2010).

The statistical design identified a survey for each of the Subareas C, D and F, each one with its specific characteristics.

Area C: including the Tyrrhenian Sea area comprised approximately between the Elba Island to the North and northern coast of Sicily to the South, the eastern coast of Sardinia to the West and the Italian mainland coast to the East. The Subarea C is divided in a wider area called "C



outside" and a smaller area named "C inside", the second one corresponding to the area surveyed in the former two campaigns. The importance of the area "C inside" for the concentration of Bluefin tuna spawners is well known (Arena, P. 1978, 1982): for this reason, constant activity of purse seine fishing has been carried out since the early Seventies (Arena, 1990).

Table 1 - Features of Subarea C "inside"

Total area (km ²)	54,177
On effort track (km)	2,854

Table 2 - Features of Subarea C "outside"

Total area (km ²)	179,121
On effort track (km)	1,734

Area D: including the Adriatic and Ionian Sea from Civitanova town and Dugi Otok island down through Lefkada island.

Table 3 - Features of Subarea D

Total area (km ²)	171,047
On effort track (km)	1,300

Area F: including the Aegean Sea from Zakynthos island to the west to Rhodes island to the east, with an approximate area of 296,961 km².

Table 4 - Features of Subarea F

Total area (km ²)	296,961
On effort track (km)	2,558

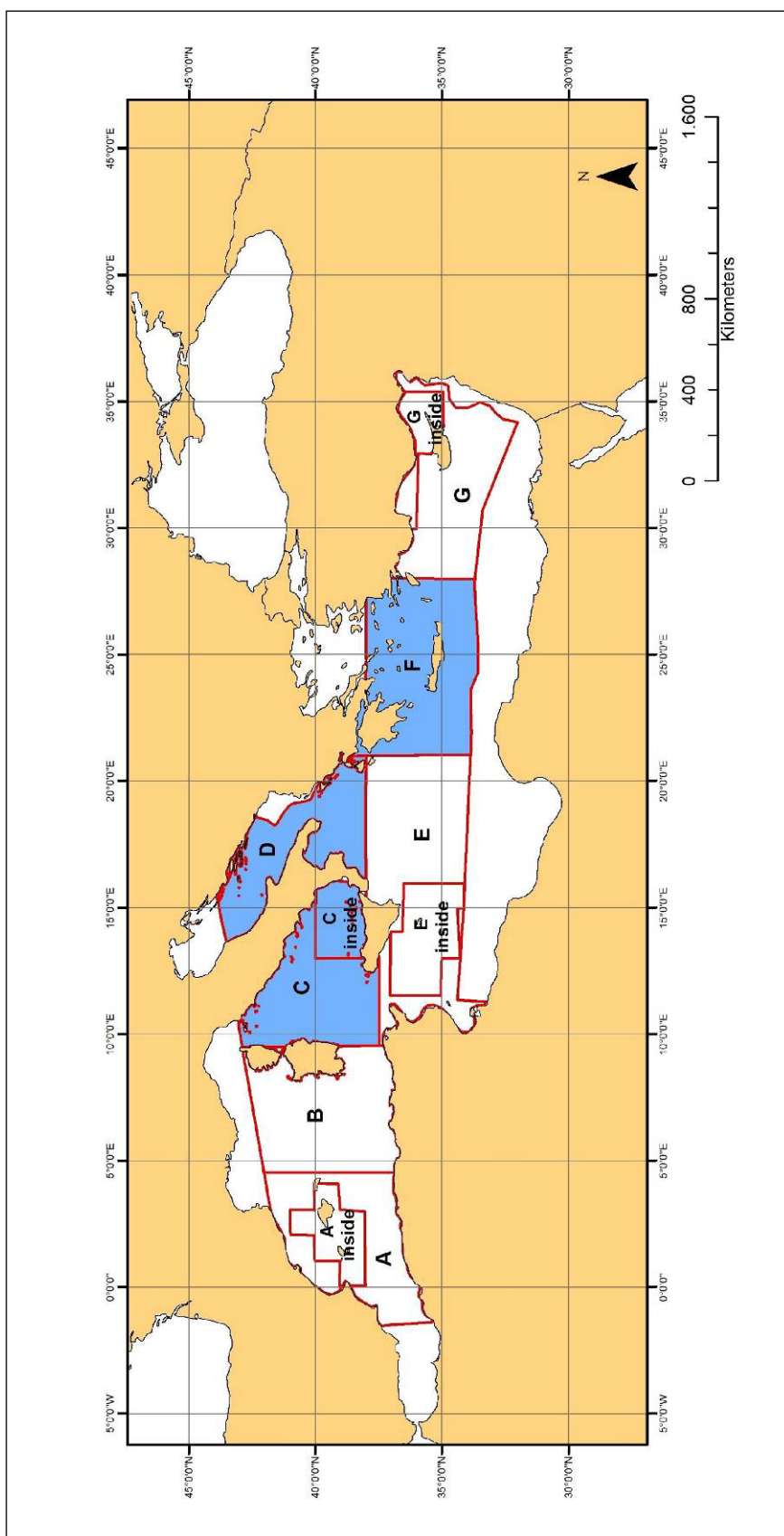


Figure 5 - Aerial Survey 2013: UNIMAR Subareas (blue)

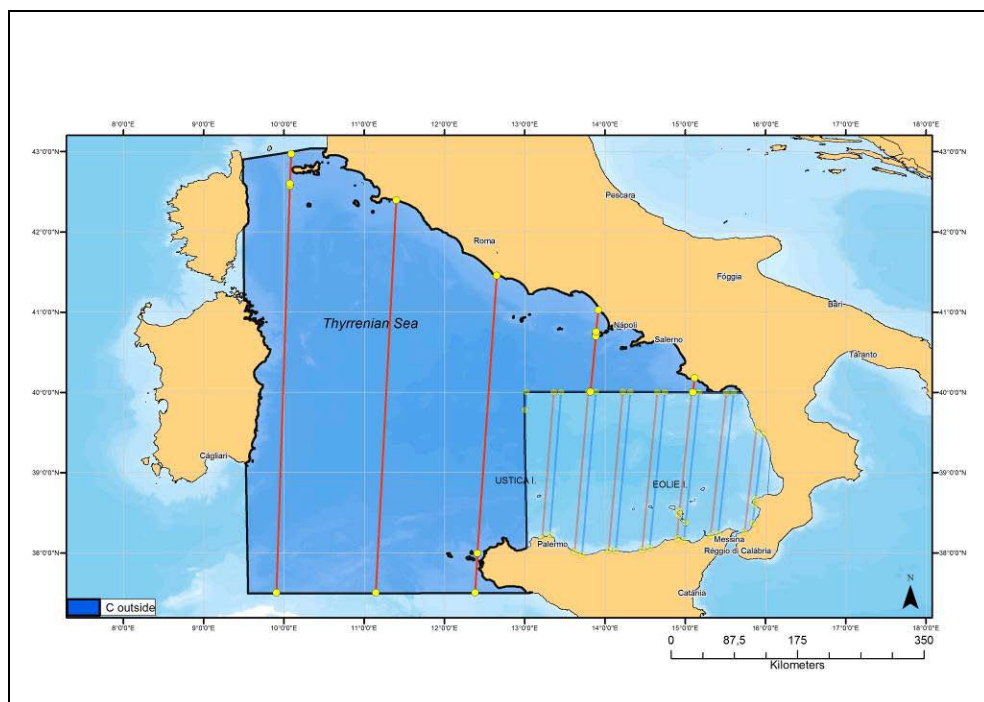


Figure 6 - Area and sampler routes: Subarea C "outside"

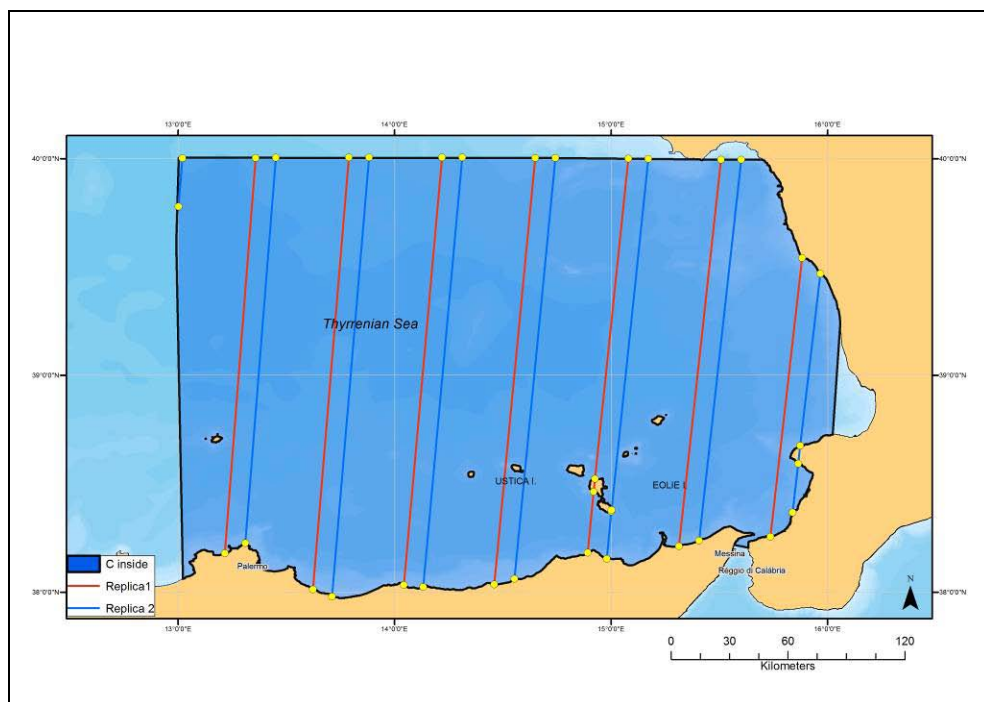


Figure 7 - Area and sampler routes: Subarea C "inside"

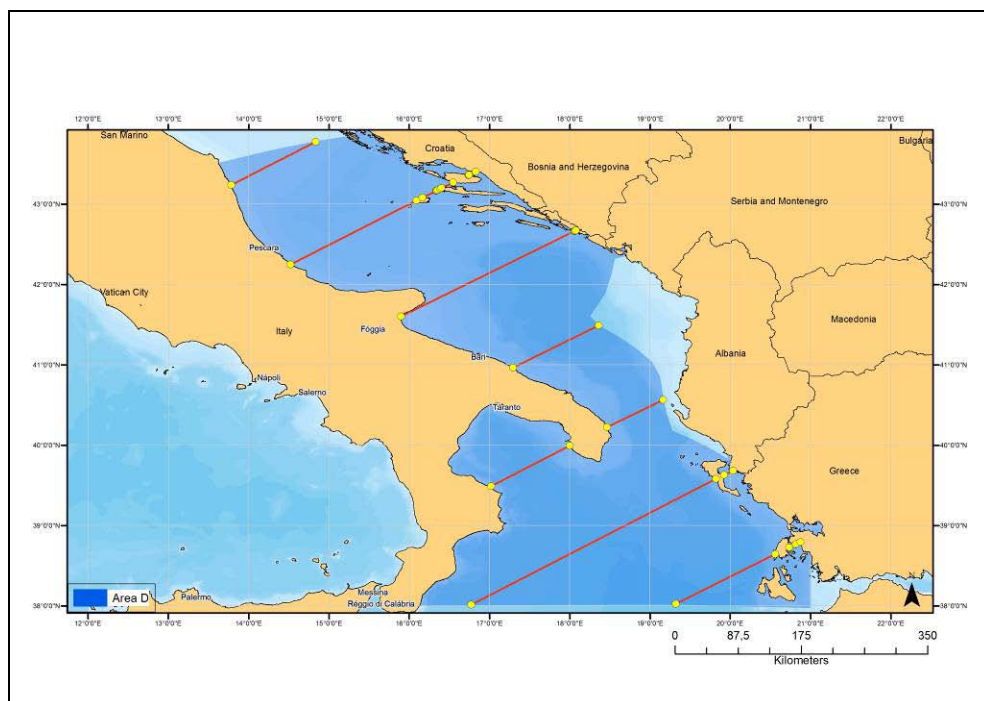


Figure 8 - Area and sampler routes: Subarea D

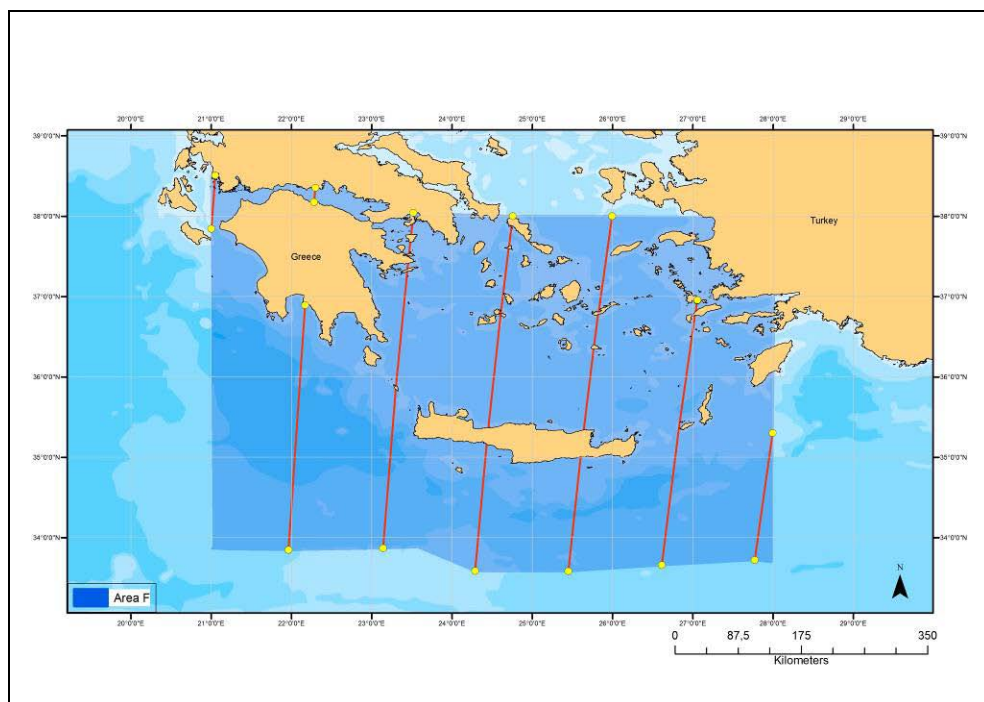


Figure 9 - Area and sampler routes: Subarea F

3. RESULTS

3.1 Preparatory tasks

First of all, the team was set up. The coordination staff made contact with the subcontractors and the spotters, 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 GIS mapping was involved as well.

In addition to the ICCAT course in Madrid, a training meeting was held at Unimar headquarters aimed to share the methodology with the scientific spotters and organise the field activity. Other meetings with the scientific spotters were organised in the days before the surveys. A meeting was held at Pontecagnano airport before the start of the survey with all the scientific and professional spotters and the pilots.

Four countries were contacted in order to avoid any problem in flying on the foreign airspaces: Croatia, Turkey, Greece, Tunisia. All the effort was supported by ICCAT representatives, who gave a strong aid in obtaining the permits.

The greater problems were encountered with Croatian authorities, because of their strict national rules regarding especially the aerial photography regulation. A general authorisation was issued by the Croatian Civil Aviation Agency on the 19th June, but no permits for taking photographs was obtained before the end of the surveys. In order to avoid problems deriving from that, ICCAT suggested to stop the surveys 3 nm before Croatian land, but anyway no sighting occurred in Croatian airspace.

Some problem came initially from Turkey, that issued a ministerial authorisation on the 4th June, as the result of the contacts with Italian Embassy at Ankara (Dr. Varriale) and the strong support of ICCAT. Along with the permit, Turkey requested the constant presence of a Turkish observer onboard during the surveys in the Turkish airspace: so Unimar agreed with ICCAT to avoid flying in the Turkish FIR in order to overcome possible problems deriving from that. The segment of survey included in the Turkish FIR foreseen in the Survey Design was about 63 nm long (1 hour flight) comprised between Kalymnos island and the Turkish coast south of Izmir: in order to cover this segment, it should have been necessary to fly to the nearest available Turkish airport to pick up the Turkish observer, disembarking an Italian scientific observer for weight and security reasons, then go back to the fly on the transect and come back to pick up the Italian spotter and disembark the Turkish one: these additional transfer flights would have caused additional flight costs and possible additional costs for the Turkish flight permits. So was agreed with ICCAT to cover this track involving the French team, working in the adjacent Subarea G and already authorised by the Turkish authorities. In this way was avoided the need to have the Turkish permit, because the flights never trespass the Turkish FIR boundaries.



After contacts with the Greek Civil Aviation Authority and Italian Embassy in Athens (Col. Venanzi), Greece assured that no special permit was needed to flight in the Greek FIR. Only flight plans were submitted every day to the Civil Aviation prior to the flights.

Tunisia had no problems in granting the permit, thanks to the direct intervention of ICCAT representatives.

During the flight planning, it was noticed that 6 out of 7 transects in the Area F provided in the Survey Design trespassed the Libya and Egypt FIR boundaries, so it was agreed with ICCAT to avoid entering there and interrupt the transect on the boundary intersections. This reduced the survey of about 140 nm total. For this reason, it was initially agreed with ICCAT to do some repetition on some segment in the Area F transect.

3.2 Field activities

The surveys started the first day after the draft contract receiving, according to the meteorological conditions. The first day suitable for the aerial survey was the 18th of June and the surveys went on until the 3th of July, the initial deadline fixed by ICCAT. The diary reports of the surveys carried out is described in the Table 5 to Table 7. The starting operative base for both the aircrafts was the "Salerno - Costa d'Amalfi" airport, south of Salerno. As shown in the annexed tables and in the maps, other airports were also used as further bases both in the Tyrrhenian and Adriatic Sea and in the Aegean and Ionian Seas.

Table 5 - Diary report of the surveys: Area C

Date	Mission start	Mission end	Tot. time on effort	Tot. time off effort	Tot. time on duty	Area	Tracks	Scient. spotters	Prof. spotter	Aircraft
18/6	9:35	13:20	1:33	2:12	3:45	C in	Rep 2 - Tr 1, 2	Fusari, Lombardo	Giordano	I-GNIT
18/6	14:34	18:10	2:10	1:26	3:36	C in	Rep 2 - Tr 3, 4	Fusari, Lombardo	Giordano	I-GNIT
19/6	10:07	13:48	2:25	1:16	3:41	C in	Rep 2 - Tr 5, 6	Fusari, Lombardo	Giordano	I-GNIT
19/6	15:09	19:10	1:07	2:54	4:01	C in	Rep 2 - Tr 7, 8	Fusari, Lombardo	Giordano	I-GNIT
20/6	9:37	12:52	1:03	2:12	3:15	C in	Rep 1 - Tr 1, 2	Fusari, Lombardo	Giordano	I-GNIT
20/6	14:10	17:55	2:16	1:29	3:45	C in C out	Rep 1 - Tr 3, 4 1	Fusari, Lombardo	Giordano	I-GNIT
21/6	9:36	13:44	2:13	1:55	4:08	C in	Rep 1 - Tr 5, 7	Fusari, Lombardo	Cirillo	I-GNIT
22/6	10:17	13:37	1:15	2:05	3:20	C out	4	Fusari, Lombardo	Cirillo	I-GNIT
22/6	14:38	17:55	2:17	1:00	3:17	C out	5	Fusari, Lombardo	Cirillo	I-GNIT
23/6	8:33	12:24	1:49	2:02	3:51	C out	5, 4	Fusari, Lombardo	Cirillo	I-GNIT
23/6	13:54	16:50	0:42	2:14	2:56	C out	4	Fusari, Lombardo	Cirillo	I-GNIT
27/6	9:41	13:20	1:27	2:12	3:39	C out	3, 2	Fusari, Lombardo	Giordano	I-GNIT
28/6	9:07	12:18	1:21	1:50	3:11	C out	3	Fusari, Lombardo	Giordano	I-GNIT
28/6	12:53	14:55	1:07	0:55	2:02	C in	Rep 1 - Tr 6	Fusari, Lombardo	Giordano	I-GNIT



Table 6 - Diary report of the surveys: Area D

Date	Mission start	Mission end	Tot. time on effort	Tot. Time off effort	Tot. time on duty	Area	Tracks	Scient. spotters	Prof. spotter	Aircraft
27/6	08:52	12:28	1:38	1:58	3:36	D	7, 6	Serra, Poggi	De Martino	I-AGSD
27/6	14:02	17:38	0:21	3:15	3:36	D	6	Serra, Poggi	De Martino	I-AGSD
1/7	10:42	14:18	1:19	2:17	3:36	D	1	Fusari, Lombardo	Cirillo	I-GNIT
1/7	15:32	16:35	0:00	1:03	1:03	D	2	Fusari, Lombardo	Cirillo	I-GNIT
2/7	9:38	13:35	1:37	2:20	3:57	D	3, 4	Fusari, Lombardo	Cirillo	I-GNIT
3/7	9:52	13:33	1:25	2:16	3:41	D	5, 6	Fusari, Lombardo	Giordano	I-GNIT
3/7	14:46	18:05	0:24	2:55	3:19	D	7	Fusari, Lombardo	Giordano	I-GNIT

Table 7 - Diary report of the surveys: Area F

Date	Mission start	Mission end	Tot. time on effort	Tot. Time off effort	Tot. time on duty	Area	Tracks	Scient. spotters	Prof. spotter	Aircraft
18/6	12:18	14:36	0:00	2:17	2:18	F	-	Serra, Poggi	De Martino	I-AGSD
19/6	10:40	13:47	0:00	3:02	3:07	F	-	Serra, Poggi	De Martino	I-AGSD
22/6	09:52	14:47	2:16	2:39	4:55	F	4, 3, 2	Serra, Poggi	De Martino	I-AGSD
23/6	08:53	13:48	1:28	3:27	4:55	F	6	Serra, Poggi	De Martino	I-AGSD
24/6	06:46	11:30	1:47	2:57	4:44	F	5	Serra, Poggi	De Martino	I-AGSD
24/6	13:05	17:55	3:21	1:29	4:50	F	1, 2	Serra, Poggi	De Martino	I-AGSD
25/6	08:10	11:57	1:32	2:15	3:47	F	5, 4	Serra, Poggi	De Martino	I-AGSD
25/6	12:30	16:43	2:32	1:41	4:13	F	3, 4	Serra, Poggi	De Martino	I-AGSD
26/6	08:37	12:07	0:05	3:25	3:30	F	6	Serra, Poggi	De Martino	I-AGSD
26/6	14:39	17:03	0:20	2:04	2:24	F	7	Serra, Poggi	De Martino	I-AGSD

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

For uniformity reasons, all the time considered in the program is in Italian Local Time/Greek Solar Time (GMT+2).

Flights were generally performed at the altitude and speed requested (300 m, 100 nm/h); any difference and fluctuation due to environmental and technical factors was registered as well.

For all the performed flights, the tracks get by the GPS were registered and checked with the aircraft GPS as well (the .gpx files of the tracks including the waypoints relevant to the sightings are sent in the Annexes). The forms about effort and sightings were filled in (they can be find in the Annexes). Whereas taken, the pictures were identified according to the frame numbers. A complete set of the relevant photos taken during the surveys can be find in the Annexes. The photos were taken following the methodologies tested in the previous campaigns. In order to overcome the problems for photography, especially linked to aircraft bouncing, some trick was adopted: use a monopod positioned on the chair, that in some case could help the camera stability; try to avoid the use of a focal length higher than 100 mm; set the camera on "shutter



speed priority" mode and use a very high shutter speed (from 1/600 up to 1/2000); in order to raise the shutter speed, increase the ISO sensitivity but not too much in order to avoid blur problems; increase the exposure compensation by some spot.

All the photos (Annex 3) are provided in non compressed RAW (.NEF) formats: the more relevant ones were adjusted with photo editing programs (Photoshop, Picasa) in order to enhance the visibility of the images: in particular, the Picasa automatic tool "I feel lucky" was seen as the best one to highlight the tuna fish shapes. The adjusted photos were saved in compressed high quality format (.jpg).

Description of the surveys

On 17/6, the spotters arrived at Pontecagnano and a briefing at the airport was organised.

Subarea C

Entirely surveyed with I-GNIT aircraft (Aerial Banners Srl)

Staff

Pilots: Francesco Orrico, Francesco Ruggiero

Professional spotters: Michelangelo Cirillo, Raffaele Giordano

Scientific spotters: Andrea Fusari, Sergio Lombardo

The 2013 campaign was the third survey of this area, already surveyed in 2010 and 2011. While in 2010 and 2011 about eleven transect per replica were followed, in 2013 the transect number per replica was about 7, so the distance between the lines was higher.

Flight history

Day 1 - 18/6

N. 2 Pontecagnano-Pontecagnano flights. Morning: **C inside Replica 2, Transect 1 and 2.**
Afternoon: **C inside Replica 2, Transect 3 and 4.**

5 BFT adult schools on effort sightings were done + 1 off effort estimated.

Day 2 - 19/6

N. 2 Pontecagnano-Pontecagnano flights. Morning: **C inside Replica 2, Transect 5 and 6.**
Afternoon: **C inside Replica 2, Transect 7 and 8.**

3 BFT adult schools on effort sightings were done + 2 off effort estimated + 2 off effort non estimated.



Day 3 - 20/6

N. 2 Pontecagnano-Pontecagnano flights. Morning: **C inside Replica 1, Transect 1 and 2.**
Afternoon: **Replica 1, Transect 3 and 4; C outside, Transect 1.**
2 BFT adult schools on effort sightings were done.

Day 4 - 21/6

N. 1 Pontecagnano-Pontecagnano flight. Morning: **C inside Replica 1, Transect 5 and 7.**
Afternoon: stop due to the starter of one engine.
3 BFT adult schools on effort sightings were done + 2 off effort non estimated.

Day 5 - 22/6

N. 1 Pontecagnano-Elba flight in the morning: **C outside, Transect 4 (northern part).**
N. 1 Elba-Cagliari flight in the afternoon: **C outside, Transect 5 (northern part)**
1 BFT off effort estimated.

Day 6 - 23/6

N. 1 Cagliari-Cagliari flight in the morning: **C outside, Transect 4 and 5 (southern part).**
N. 1 Cagliari- Pontecagnano flight in the afternoon: **C outside, Transect 4 (mid part).**
No BFT sightings.

Day 7, 8, 9 - 24, 25, 26/6

Standby due to adverse weather conditions.

Day 10 - 27/6

N. 1 Pontecagnano-Pontecagnano flight: **C outside, the whole Transect 2 and the northern part of Transect 3.**
No BFT sightings.

Day 11 - 28/6

N. 1 Pontecagnano-Palermo flight: **C outside, the southern part of Transect 3.**
N. 1 Palermo-Pontecagnano flight: **C inside Replica 1, Transect 6.**
1 off effort non estimated sighting.



Subarea D

Surveyed with I-GNIT aircraft (Aerial Banners Srl) and I-AGSD aircraft (Aviopesca Srl).

I-GNIT Staff

Pilot: Francesco Orrico, Francesco Ruggiero

Professional spotters: Michelangelo Cirillo, Raffaele Giordano

Scientific spotters: Andrea Fusari, Sergio Lombardo

I-AGSD staff

Pilot: Stefano Kirchmayr

Professional spotter: Salvatore De Martino

Scientific spotters: Simone Serra, Andrea Poggi

Flight history

Day 1 - 27/6 (I-AGSD aircraft and staff)

In order to avoid one more transfer flights from Pontecagnano and so to reduce the total flight time, the "Area F" team was allowed by the "Area C-D" team to do the Transect D6 (from Corfu to Calabria) and D7 (near to Lefkada Island) of area D, because they were the farthest ones from Pontecagnano, while "Area F" aircraft was already in the Ionian islands zone. On the 10th day of the Aegean mission with I-AGSD aircraft, while staying in Corfu before going back to Pontecagnano, the forecasts were within the limits and so we decided to go to the **Transect D7**: the eastern half of the transect had good sea conditions, but going to the west the wind increased and the wave height were in some moment slightly over the limits allowed for the sightings. On the way back to Corfu we decided to try to do the eastern half of **Transect D6**, where good conditions were expected: once on the transect we observed in most part a wave height slightly over the limits.

In the afternoon, during the transfer flight from Corfu to Pontecagnano, the western part of **Transect D6**, protected from the northern wind by the Italy mainland, was done because the sea state was good.

Landing in Pontecagnano in the afternoon.

Due to the weather difficulties, it was later decided to do again the two segments of the two transects done with uncertain sea conditions with the "Area C-D" aircraft, once the rest of Area D was done and we were sure to have enough time to finish the job by the deadline.

Day 2 - 1/7 (I-GNIT aircraft and staff)

N. 1 Pontecagnano-Pescara flight: **Transect D1**.

N. 1 Pescara-Pontecagnano flight: **Transect D2**.

No BFT sightings.



Day 3 - 2/7 (I-GNIT aircraft and staff)

N. 1 Pontecagnano-Pontecagnano flight: **Transect D3** and **D4**.

1 BFT on effort sightings (small individuals) + 1 off effort non estimated.

Day 4 - 3/7 (I-GNIT aircraft and staff)

N. 1 Pontecagnano-Corfu flight: the whole **Transect D5** and **D6** part to be redone.

N. 1 Corfu- Pontecagnano flight: **Transect D7** part to be redone.

No BFT sightings.

Subarea F

Entirely surveyed with I-AGSD aircraft (Aviopesca Srl)

Staff

Pilot: Stefano Kirchmayr

Professional spotter: Salvatore De Martino

Scientific spotters: Simone Serra, Andrea Poggi

Beyond the said problems linked to the international coverage of the survey, other issues had to be considered in the Area F, differently than in the past Unimar experiences in the Tyrrhenian Sea.

One is due to the flight permissions "on flight": despite no special authorisation was necessary to fly in Greek (UE) airspace and despite flight plans were regularly registered prior to every flight, different problems occurred sometimes with radio contacts because some transects passed through inaccessible military zones (the detailed effects of this are described below in the flight history). In almost all the cases, the pilot was able to be allowed to proceed with the regular flight. In two areas (between the islands south of Athens - 10 nm total - and south of Crete, 9 nm) it was absolutely impossible to fly.

The second problem was the presence onboard of the crew luggage, that increased the total weight of about 100 kg and caused security risks and then some limitations in managing the flight schedule.

The third problem was the availability of the airports: despite there are a lot of airports in the Aegean islands, almost all have scarce availability of fuel. Some have only small quantities for touristic flights and other ones don't have it at all because they have mostly civilian traffic and large aircrafts with their own fuel sufficient for a return flight.

Both these last two problems forced the pilot to plan a flight schedule concentrated on the smallest number of airports as possible. Corfu airport was used as a refuelling step for the transfer flight from Italy to Crete and as the base for the Ionian transects. Heraklion (Crete) was chosen as the base for all the transects in the Aegean Sea. If this option allowed the crew to



leave the luggage for all the period in order to fly with less weight and safer conditions, at the same time it caused an increase of the total flight time, because some transects were far from the airport. A two days transfer flight was necessary to reach Heraklion from Pontecagnano, stopping at Corfu overnight. The same, on the way back at the end of the survey.

Due to the deeply unstable wind conditions in the Aegean Sea, the team was forced to plan the flights day by day, constantly checking the forecasts more than one time a day and try to avoid bad sea conditions. During the survey period, the wind direction and strength both changed drastically from a day to another and also from the morning to the afternoon. Several websites (see in the references) were accurately checked in order to be more certain as possible of avoiding vain flights and to waste hours. Despite this, to know precisely the actual conditions along all the flight was impossible, especially in the case of the transects far away from the airport: in many cases the conditions could deeply change during the transfer from the airport to the transect and also along the transect. At the same time, the team had to deal with the amount of work and standby days available, the deadline of the surveys, and the upcoming stable bad wind conditions shown by the forecasts. Despite all this problems, only one time was necessary to go back to the transect in a further flight (see Area F description of flight history).

Flight history

Day 1 - 18/6

Transfer flight Pontecagnano - Corfu. Planned for the morning, the leaving was delayed to the afternoon because of bureaucratic problems in Pontecagnano airport at the moment of boarding, unpredictable and never happened in the past campaigns.

Day 2 - 19/6

Transfer flight Corfu - Heraklion. Planned to cover some transect during the transfer, but two problems occurred: the weight due to the luggage; the transponder breakdown during the flight, pointed out by the control towers. For these two reasons, the aircraft was forced to go straight to Heraklion.

Day 3 and 4 - 20, 21/6 (standby)

Two days were necessary to have a new transponder, personally taken at Rome by the aircraft owner, because there were no possibility to find the same model in Crete.

Day 5 - 22/6

Replacement of the transponder and first survey flight.

The southern half of the **Transect F2, F3** and **F4** were performed.

Day 6 - 23/6



After the forecasts check, was decided to give priority to the western transects because a strong wind front coming from the West was foreseen for the next days. The whole **Transect F6** were performed (except the 10 nm segment included in the Gulf of Corinth, done on Day 9).

Day 7 - 24/6

For the same weather reasons, it was decided to go on **Transect F5** and so finish the western part. Once arrived to the starting point of the transect, the sea was totally calm, but a diffused presence of low clouds on about a 70 nm long southern segment, unpredictable before arriving there, was observed. Once finished the clouds part, the transect was completed through the northern end, where the only on effort BFT sighting of the whole area F happened (juveniles).

The bad weather, upcoming for the next days, forced us to perform two flights per day, so in the afternoon we covered **Transect F1** and the northern part of **Transect F2**, from Karpathos island to the North.

Day 8 - 25/6

In the last day with acceptable forecasts in the western part of the Aegean Sea, was decided to go back to cover the southern part of **Transect 5**, that in the day before was covered by low clouds. So, arriving there in the morning, the clouds were completely disappeared but wave height was increased even if below the limit allowed for the sightings. In any case, the segment was done before strong wind from the West arrived in the afternoon and remain stable for days. Once finished to fly on that part (about 70 nm), we went off track and go to fly on the central part of **Transect F4**, from Milos island to Crete, and then go back to Heraklion.

In the afternoon, the last two segment of the Aegean Sea were covered: the northern parts of **Transect F3** and **F4**, around and inside the Cyclades islands, with a very glassy sea. Coming back to Heraklion, a small segment of Transect 4 yet done was repeated, because it was on the way.

Day 9 - 26/6

During the transfer flight from Heraklion to Corfu, the short segment of **Transect F6**, inside the Gulf of Corinth, was performed (about 5 minutes on effort).

In the afternoon, a flight Corfu-Corfu allowed us to fly the **Transect F7** and complete the Area F.

Day 10 - 27/6

See Area D, Day 1.

In all the flights, the scientific spotters periodically exchange their position, as recommended by ICCAT.

Figure 10 to Figure 14 show the GPS tracks of the surveys in the three areas. Each colour corresponds to a different day. The green and thick line is a track that partially overlaps with another one. In the areas C "outside", D and F, the primary replica was performed. In the subarea "C inside", the two primary replicas were performed.

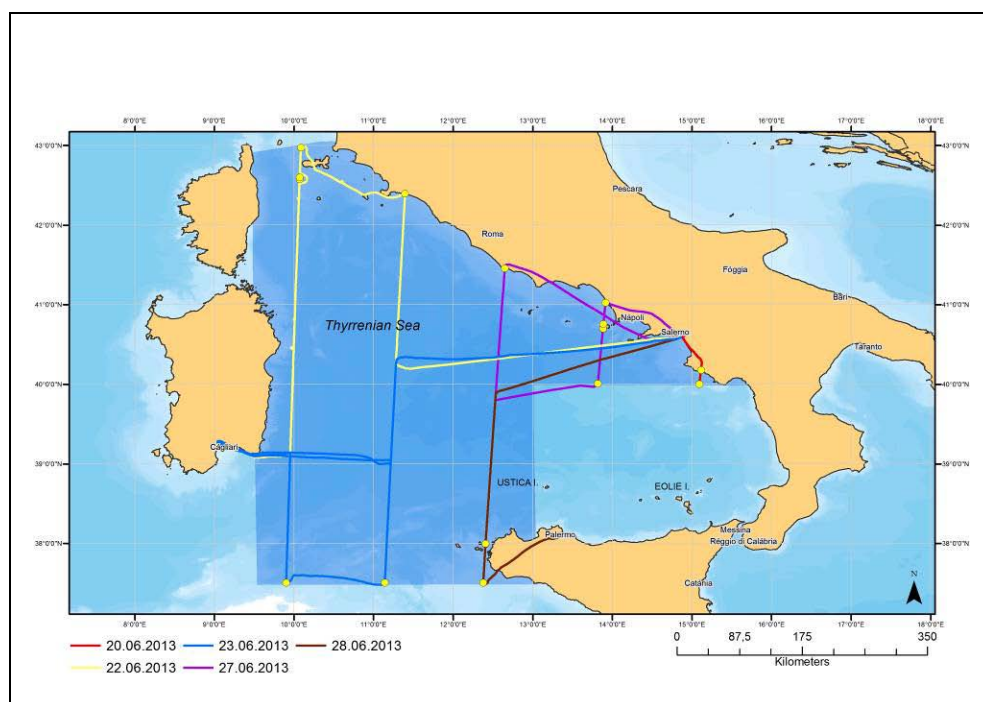


Figure 10 - GPS tracks: Area C "outside"

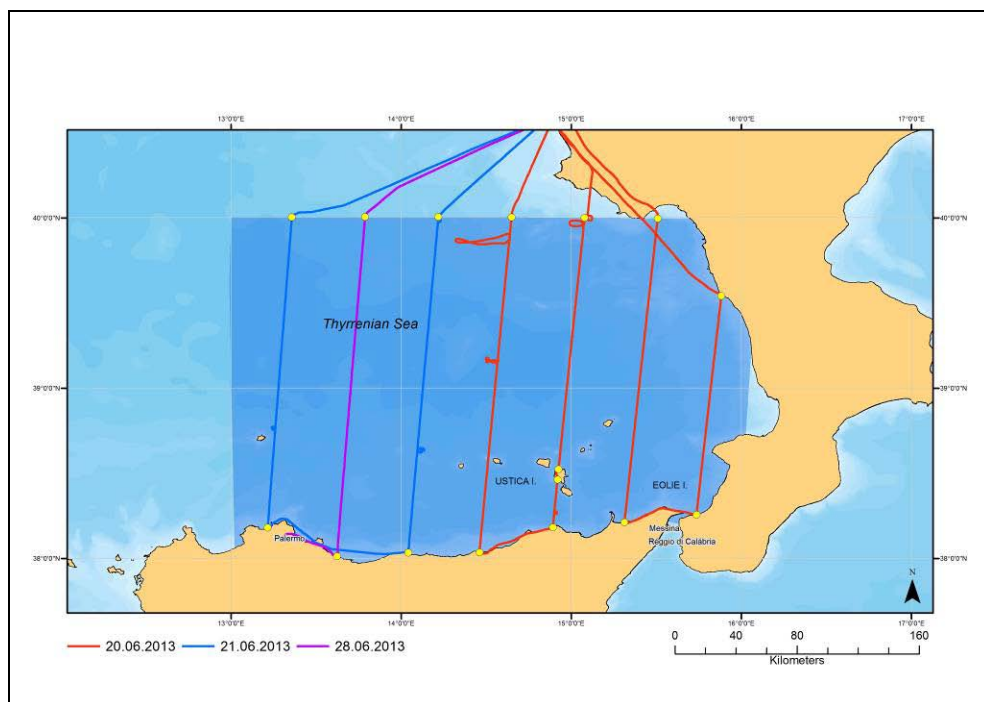


Figure 11 - GPS tracks: Area C "inside", replica 1

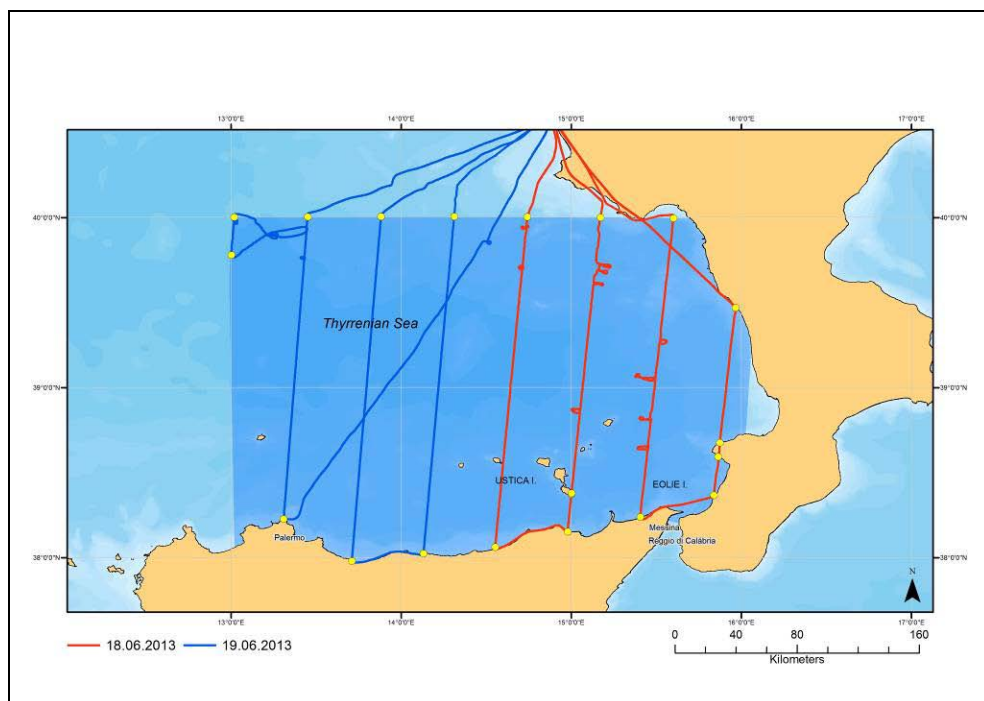
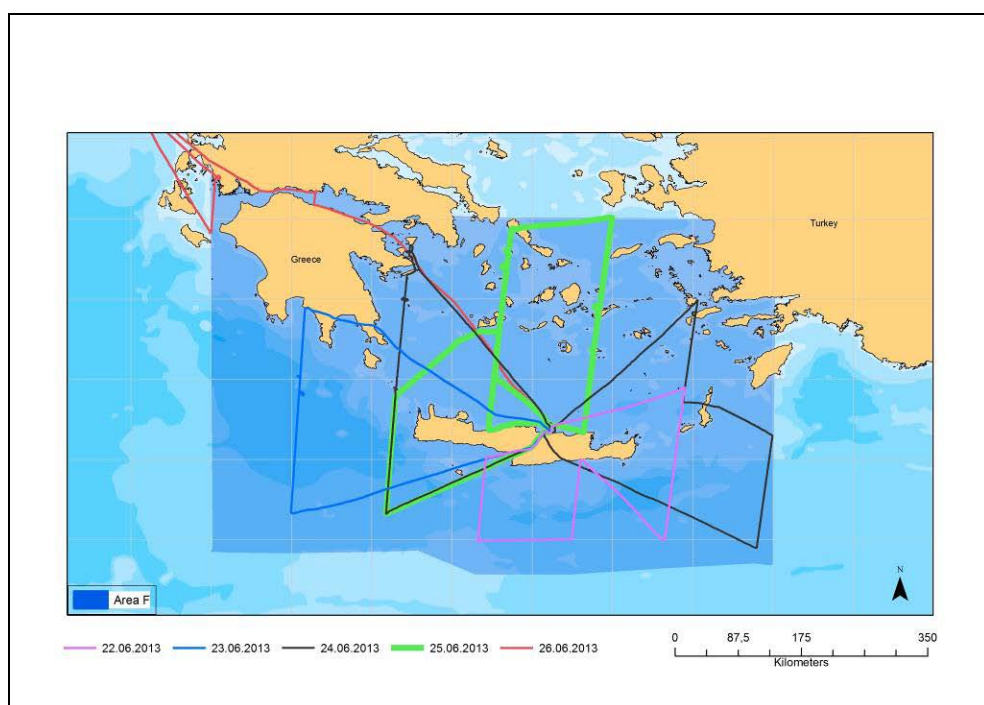
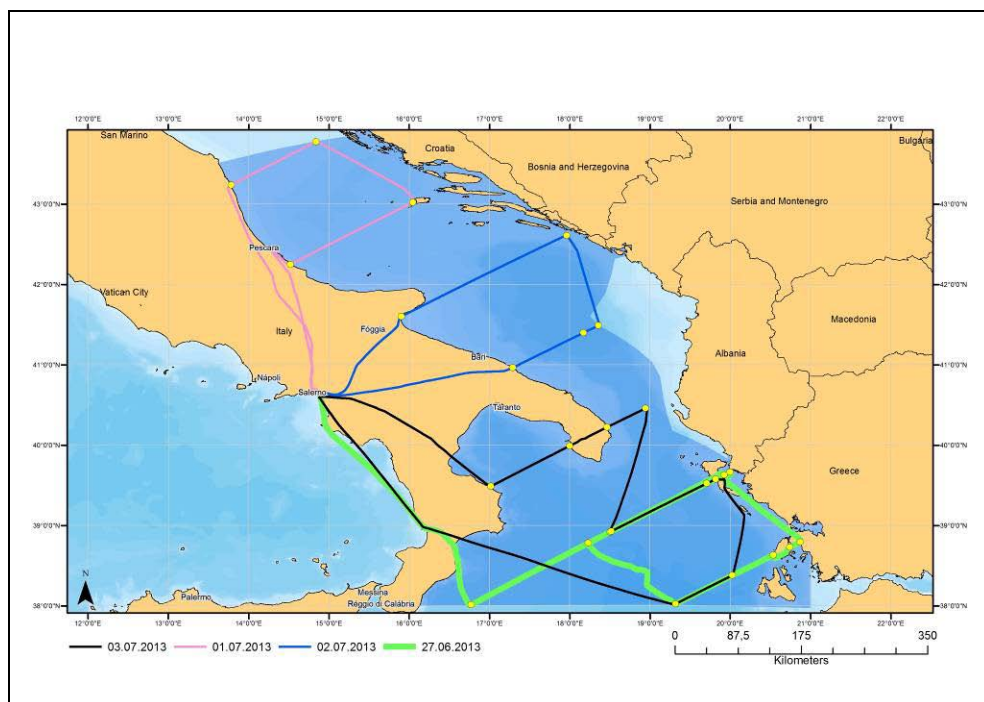


Figure 12 - GPS tracks: Area C "inside", replica 2





3.3 Sightings overview

The maps representing the sightings of Bluefin tuna are shown in Figure 15 to Figure 17. 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 the Table 8 and in the annexed forms.

Almost all the sightings occurred in the Area C and in particular "C inside": 13 schools on effort and 4 off effort that were estimated. In the Area D one on effort sighting of small individual and one off effort estimated. In the Area F only one school of small individuals was spotted on effort. Like in the past campaigns, no clear pictures of small individuals are available: only some splash is visible in the images. On the contrary, a good number of adult picture taken in the area C is clearer.

In the Area C there are 13 off effort sightings that weren't estimated: they are not represented on the maps but are noticed in the annexed sightings forms. With different levels of confidentiality, these sightings were supposed to be possible BFT schools. The same for one sighting in the Area D (Ionian Sea).

No sightings of other pelagic fish species took place in all the surveyed area.

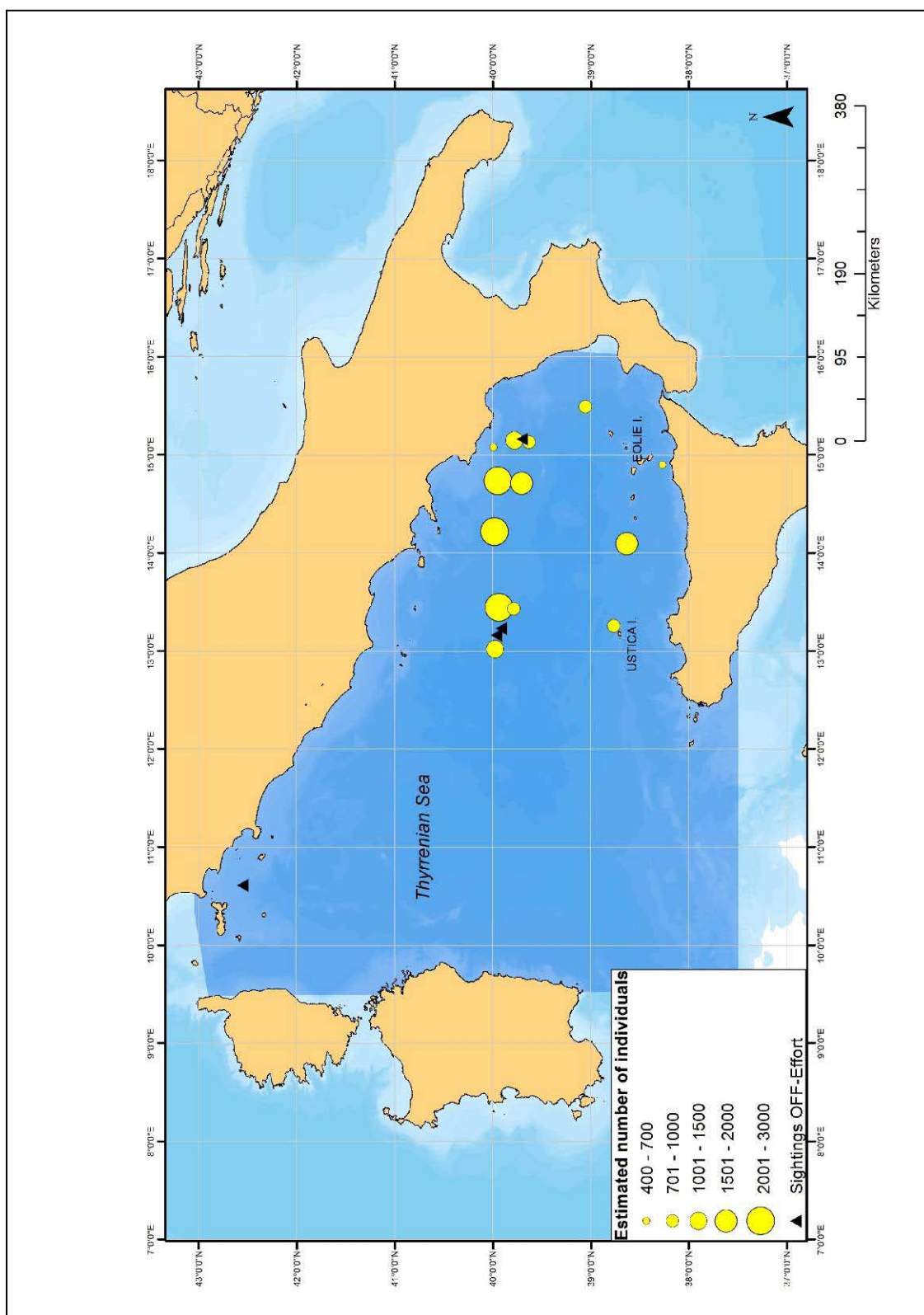


Figure 15 - Map of the BFT sightings, number of individuals: Subarea C

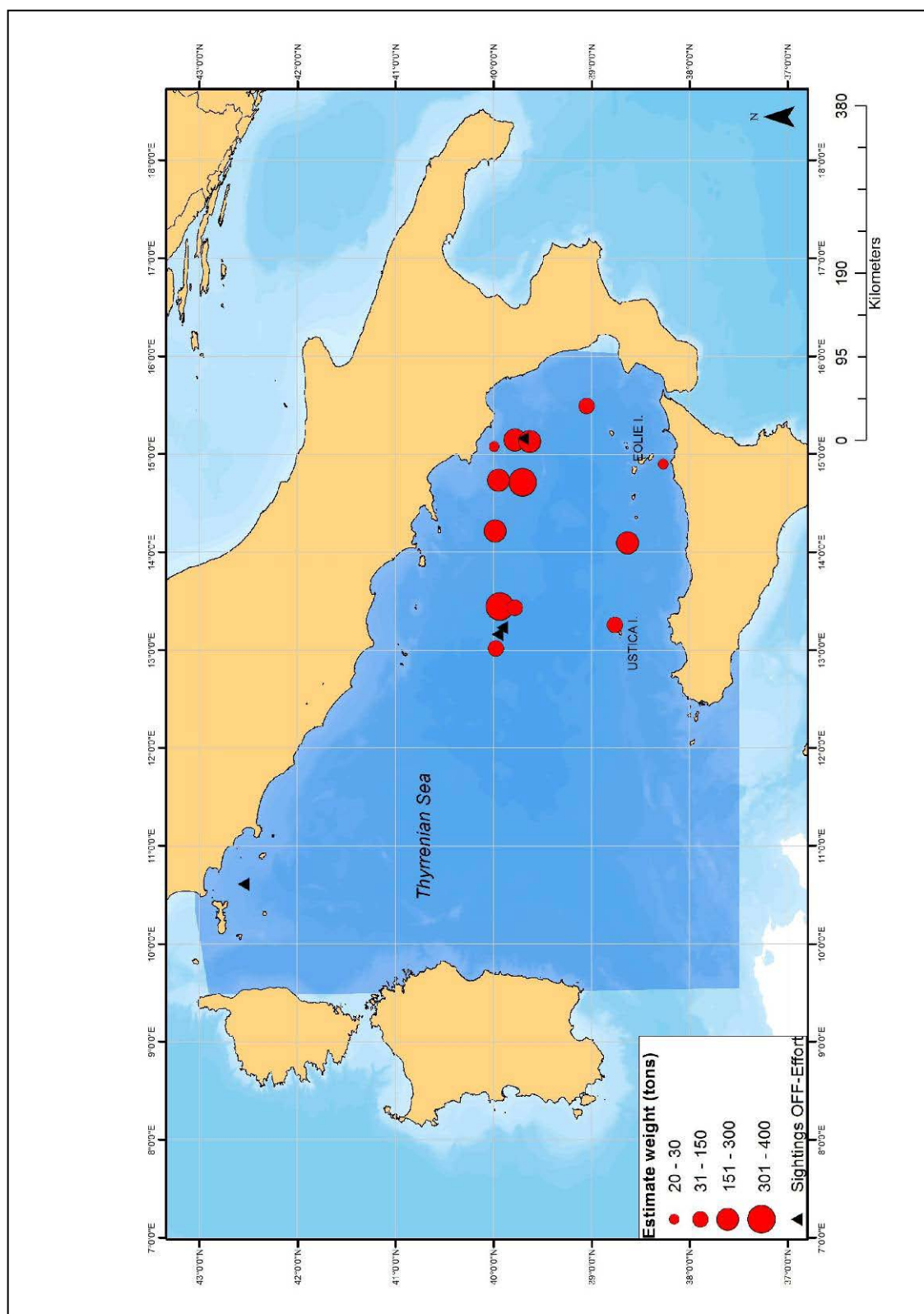


Figure 16 - Map of the BFT sightings, total weight: Subarea C

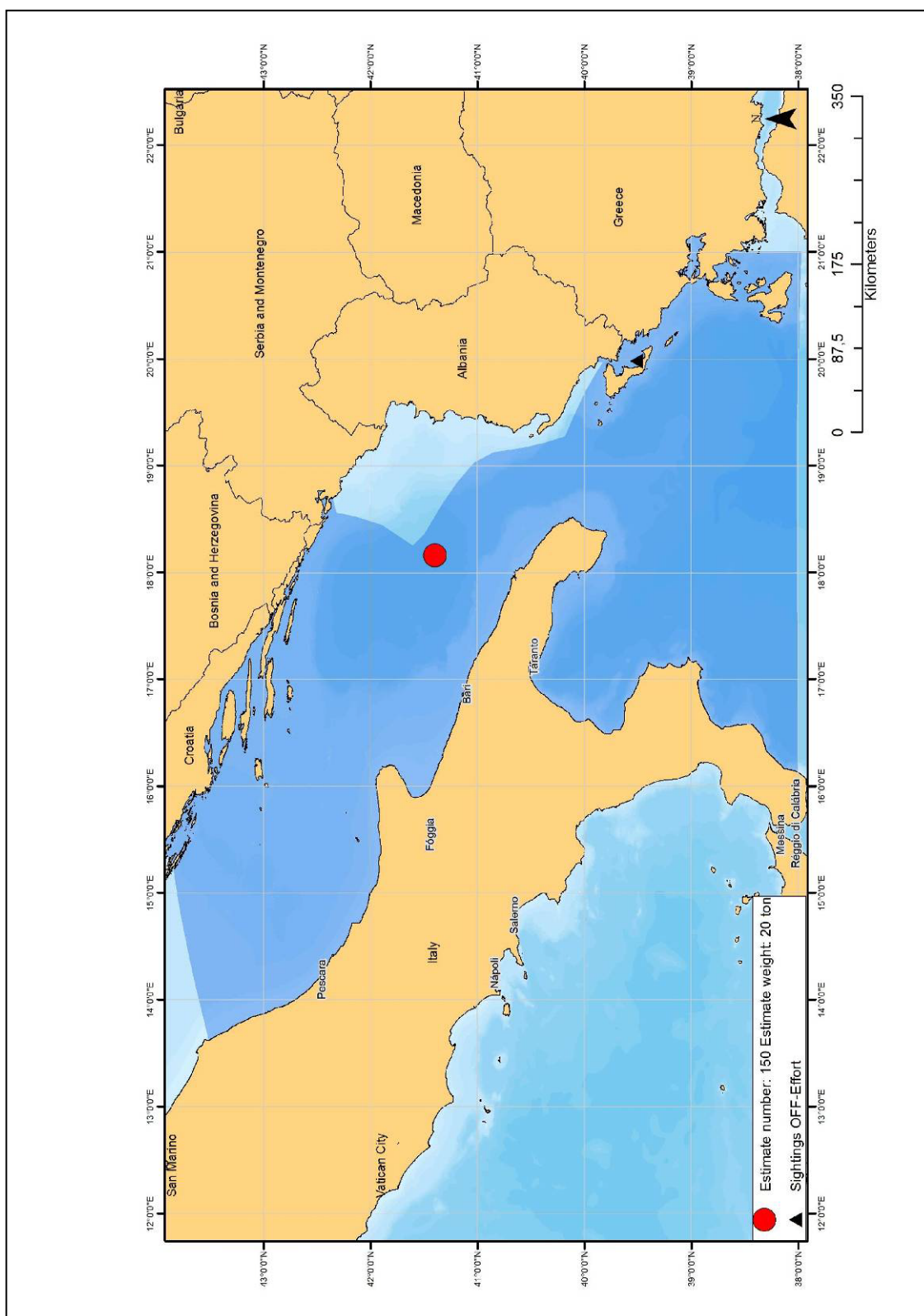


Figure 17 - Map of the BFT sightings, number and weight: Subarea D

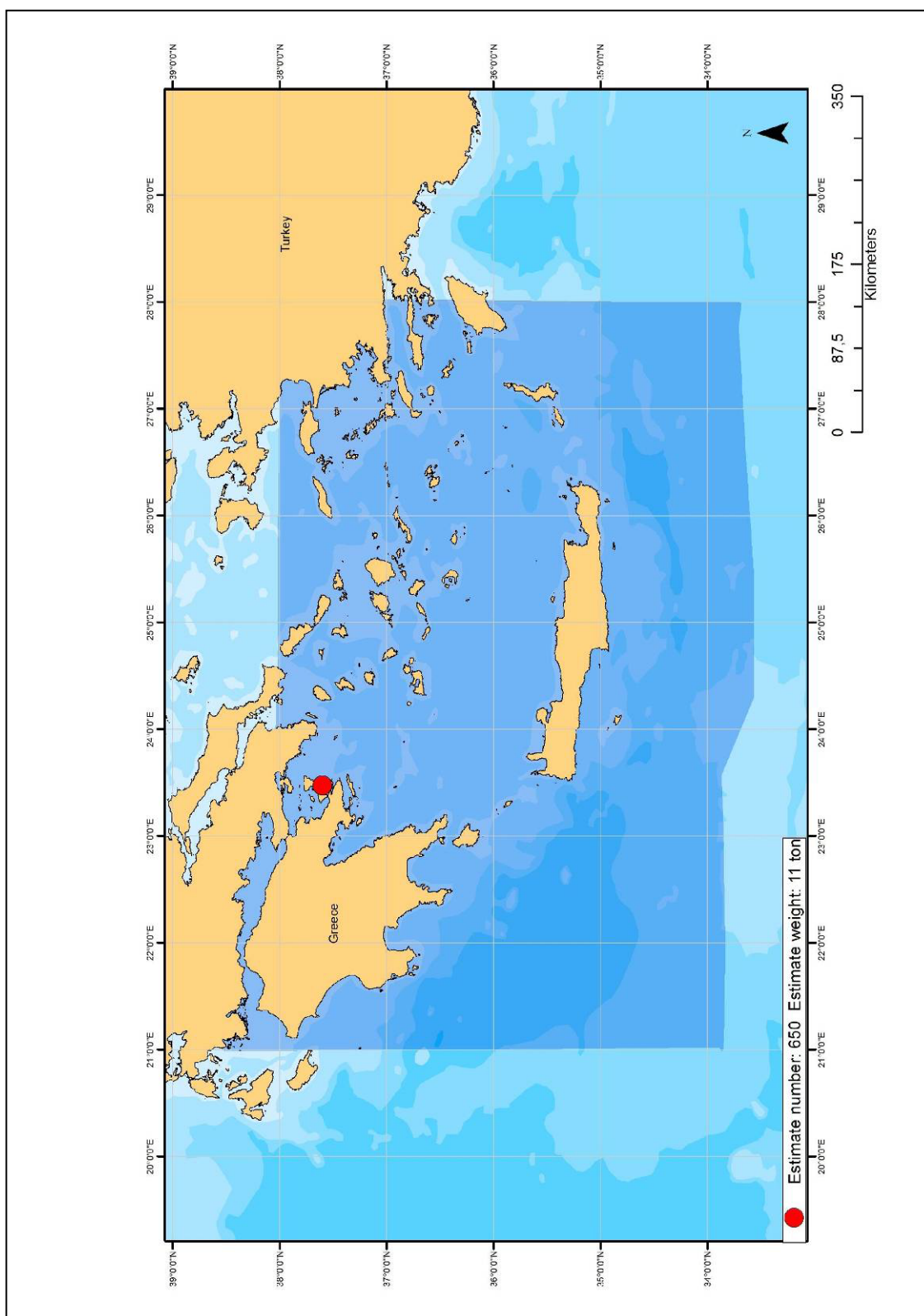


Figure 18 - Map of the BFT sightings, number and weight: Subarea F



Table 8 - Overview of the BFT estimated sightings

ID	Block	Survey	Transect	Date	Time sighting	Time abeam	Decl. angle	Lat initial sighting	Lon initial sighting	Cue	School size	Est. weight (t)	% small	% medium	% large
1	C in	1	2 rep 2	18/6	11:50	11:50	2	39,04993	15,49350	splash	750	150			100
2	C in	1	3 rep 2	18/6	15:06	15:08	5	39,77808	15,14707	splash	1500	200		100	
3	C in	OFF	OFF	18/6	15:15			39,69310	15,16064	splash	3000	600			100
4	C in	1	3 rep 2	18/6	15:20	15:22	6	39,62598	15,13170	splash	1000	200			100
5	C in	1	3 rep 2	18/6	17:34	17:34	16	39,70346	14,71190	ripples	2000	400			100
6	C in	1	4 rep 2	18/6	17:46			39,94657	14,73485	ripples	3000	190		100	
7	C in	1	7 rep 2	19/6	15:55			39,93456	13,44376	ripples	2700	400		90	10
8	C in	OFF	OFF	19/6	16:04			39,90675	13,23063	ripples	1500	75		100	
9	C in	OFF	OFF	19/6	16:10			39,95560	13,16431	ripples	1500	300			100
10	C in	1	8 rep 2	19/6	16:16	16:16	12	39,97475	13,01674	splash	1200	85		100	
11	C in	1	7 rep 2	19/6	16:46	16:48	20	39,77991	13,43193	ripples	750	150			100
12	C in	1	3 rep 1	20/6	14:38	14:39	12	39,99014	15,07740	ripples	700	30		100	
13	C in	1	3 rep 1	20/6	15:42	15:42	21	38,26718	14,89972	ripples	400	20		100	
14	C in	1	7 rep 1	21/6	11:03	11:03	21	38,76072	13,25896	ripples	800	100		50	50
15	C in	1	5 rep 1	21/6	12:16	12:16	12	38,62779	14,09424	shining	2000	250		100	
16	C in	1	5 rep 1	21/6	13:10	13:10	30	39,98073	14,21673	ripples	2500	300		100	
17	C out	OFF	OFF	22/6	13:21			42,54428	10,61370	splash	600	40		100	
18	F	1	5	24/6	10:02			37,59905	23,46935	ripples	650	11	100		
19	F	OFF	OFF	26/6	10:48			39,50800	19,98127	ripples	160	1	100		
20	D	1	4	2/7	11:02	11:02	17	41,39503	18,16299	splash	1500	20	100		

The percentage values are calculated on the number of individuals.



The exact positions of the tuna schools are shown in the Table 9.

Table 9 - Positions of the schools spotted on effort

ID	Date	Time sighting	Lat animals	Long animals
1	18/06/2013	11:50	39,07121	15,35665
2	18/06/2013	15:06	39,71320	15,21744
3	18/06/2013	15:15	39,67761	15,19864
4	18/06/2013	15:20	39,61300	15,16047
5	18/06/2013	17:34	39,70894	14,69820
6	18/06/2013	17:46	39,93908	14,71630
7	19/06/2013	15:55	39,90781	13,30585
8	19/06/2013	16:04	39,90675	13,23063
9	19/06/2013	16:10	39,95560	13,16431
10	19/06/2013	16:16	39,97575	13,02834
11	19/06/2013	16:46	39,76333	13,41845
12	20/06/2013	14:38	39,96949	15,02740
13	20/06/2013	15:42	38,26910	14,90628
14	21/06/2013	11:03	38,76277	13,25001
15	21/06/2013	12:16	38,63877	14,12653
16	21/06/2013	13:10	39,97980	14,22341
17	22/06/2013	13:21	42,54428	10,61370
18	24/06/2013	10:02	37,59449	23,48174
19	26/06/2013	10:48	38,34222	22,29532
20	02/07/2013	11:02	41,39140	18,17162

(The positions were taken on the centre of on the GPS track surrounding the school)

3.4 Methodological remarks

As concerning the results, qualitative remarks are here reported as a support for the statistical analysis to be implemented for the whole macro - area.

The main difficulties were linked to the available time: for future programs, the 2013 experience allowed us to understand the correct procedures to obtain the flight permits and to understand where they are not necessary. As the first time for Unimar, it should have been necessary more time for this, but for any future experience it will be possible to move in the right way with less effort.

Regarding the methodological aspects of the sightings, no significant difference with the past campaigns is worth of notice. It is confirmed that the bubble windows are comfortable for vertical spotting, but at the same time they create big disturbance for photographs and long distance spotting because of the strong light reflection and sight distortion, despite any attempt to darken the window top.

Also when the camera was set with the fastest opening (up to 1/2000), the photographs were "blurry" or distorted: this could be the result of the spherical window interference.

In order to print the forms to carry onboard, it was necessary to adapt the format and reduce them into two pages each. In the file versions, we suggests to eliminate the cells blocks, that caused problems in filling in the forms. For any future program, could be useful to set up a "on field" form, in a printable format.

Prior to the first flight, an external GPS antenna was applied internally on the upper part of the bubble window with a paper tape, in order to overcome the signal reception problems of the control GPS observed in the past campaigns from inside the airplane. In this way, the antenna was positioned out of the wing coverage. Despite this, in some track point we observed signal problems and the GPS track such as speed, height or position anomalies, but in no case interfering with the observations.

Glasses with polarised lenses are useful to watch under the water surface, but we observed that through the bubble windows they increase the sun reflection on the glass and disturb the long distance spotting.

Out of 15 "on effort" sightings, for 13 ones the route was left once abeam. In 2 sightings, the route was left directly going straight to the school.

The clinometers were used when abeam, but the difficulties in using them are confirmed: first, the problems due to the short time available in many cases between the sighting and the break track; second, the measurement rather inaccurate due to the movements of the airplane and the short time available. In the case of the farther schools, a difference in few degrees means a long distance. The measurements taken from the GPS tracks are more affordable.



4. DISCUSSION

Compared to 2010 and 2011 Unimar surveys, 2013 program was wider and more complex, especially regarding the management, coordination and setting-up aspects. Despite the former experiences provided us a lot of useful elements to take into consideration for the organisation and the management of the field activities, this year we had to face a lot of new issues mainly linked to the transnational dimension of the 2013 campaign.

The international dimension of the survey introduced a series of new problems and a greater number of variables and unknown aspects to deal with.

As said in the Results paragraph, during the preparatory phase the coordination team dedicated a great effort and time first to understand the correct procedures to request the flight permits to the foreign countries authorities and then to contact repeatedly the authorities to obtain the permits where necessary.

As concerning the results of the surveys, a preliminary screening highlights a presence of more schools spotted in the southern Tyrrhenian compared to the 2010 and 2011 campaigns: 7, 3 and 13 on effort sightings). The big difference with 2011 is more emphasised considering the shorter survey in the same area (7 transects vs. 11 and 2 replicas vs. 4). The survey period start was 18 June for both 2011 and 2013: this could make the two surveys comparable. In 2010, the survey extension was the same (11 transects, 4 replicas), but the survey started on the 4th June and 6 out of 7 sightings were performed on between the 5th and the 7th of June.

The importance of Subarea "C inside" for the presence of spawners aggregations has been confirmed. During the fishing season, the bulk of the catches of the Italian purse - seiners operates in this area and only a minor part from the area South of Sicily. In the other two subareas, no adults schools were observed.



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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.

Weather forecast websites

Mediterranean Wave Forecast	http://isramar.ocean.org.il
Windfinder	http://it.windfinder.com/
Windguru	http://www.windguru.cz
Consorzio Lamma	http://www.lamma.rete.toscana.it
Aeronautica Militare Italiana	http://www.meteoam.it/
The European Aviation Weather Center	http://euro.wx.pilotots.net
Hellenic National Meteorological Service	http://www.hnms.gr
GNOO	http://www.ogs.trieste.it



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6. ANNEXES

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3. Photos
4. Other species sightings
5. Power Point presentation
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7. Mediterranean surface temperature