

Final Report GBYP

Bluefin Tuna Aerial Survey 2019 – Area G
Eastern Mediterranean – Levantine Sea



12 July 2019

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INTRODUCTION

I. STATE OF THE ART:

The Atlantic Bluefin tuna or *Thunnus thynnus* (Figure 1) is distributed throughout the Atlantic and the Mediterranean Sea. This makes it a shared fishery resource with high market value and exploited by more than 20 countries. Improving knowledge of the biological processes of Bluefin tuna is essential in order to develop an international stock management policy for the sustainable exploitation of this resource.

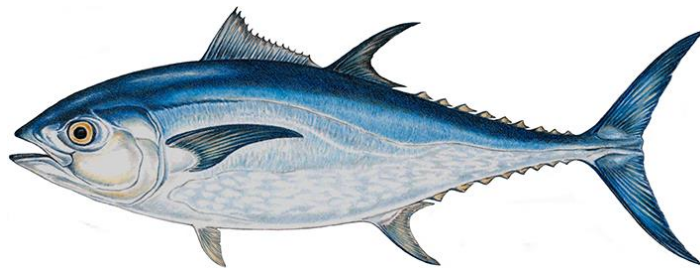


Figure 1: Atlantic Bluefin tuna, *Thunnus thynnus*

The research program of the International Commission for the Conservation of Atlantic Tunas (ICCAT), Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) aims to improve the collection of data, the understanding of key biological and ecological processes, evaluation and management models. An important point of this program are the aerial surveys of Bluefin tuna spawning populations. In this sense aerial surveys are performed in specific areas of the Mediterranean Sea since 2010.

Action Air participates in the ICCAT aerial surveys for Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) since 2013. In 2019, Action Air obtained the contract for surveying two of the four areas, namely Area E (Malta) and Area G (Levantine Sea) (Figure 2).

Area G

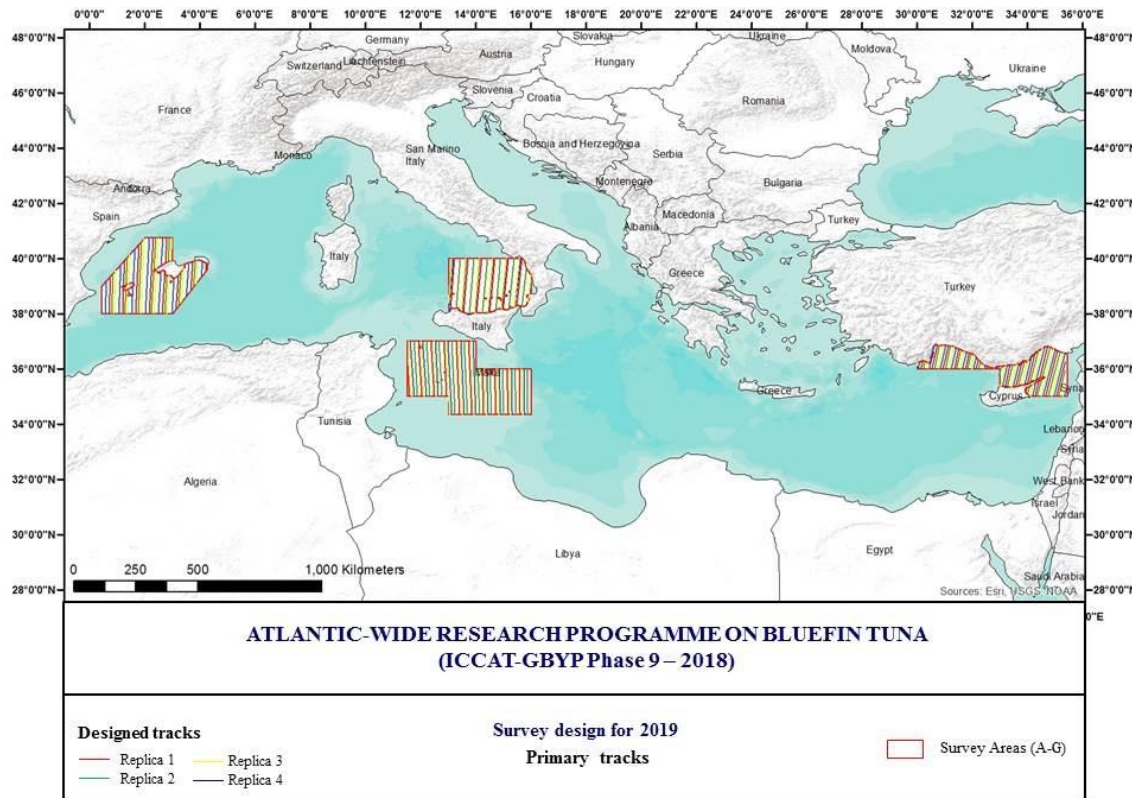


Figure 2: Survey design for 2019

II. AIM:

The primary goal of ICCAT GBYP aerial surveys is to provide a minimum annual estimate of relative abundance of Bluefin tuna in the Mediterranean Sea. All observational data are recorded, as far as possible, for all encountered species, mainly, other species of tuna and big fish, cetaceans and turtles.

This report describes the activities and results related to the aerial campaign of the Bluefin tuna spawning grounds in Area G (Levantine Sea) by Action Air for the GBYP program.

All staff involved in the surveys participated in a training session held at ICCAT headquarters in Madrid, May 22, 2019, during which details of the methodology and operational standards were explained and previous experiences in the field were discussed and shared.



Figure 3: Airplane, CESSNA 337

The activities were carried out in accordance with ICCAT's call for tenders and the technical specifications annexed to the contract. The mission was conducted between 28th May and 12th June 2019.

I. AIRPLANE AND TEAM:

Action Air Environnement is specialised in aerial surveillance, thermography and airborne geophysics for the exploitation of natural resources in a sustainable way. It has been contracted by ICCAT to conduct the 2019 Aerial Survey Campaign in Area G.

The aircraft used in this mission is a CESSNA 337 Skymaster "push-pull" with the registered call sign "F-HCOM" (Figure 3). These aircrafts were designed for marine surveillance, hence their large autonomies, their high wings and their two engines in line at the front and rear of the fuselage, which gives them a high security. In this aircraft, which has already been used for aerial surveys of Bluefin tuna, have been installed, following the ICCAT recommendations, "Bubble windows" on both sides to allow observation till the 90°. During the observations the aircraft flies at an altitude of 1000 ft and a constant speed of 100 knots (nautical mile / h).

Area G

The crew is composed for four members (Figure 4):

- Professional Pilot - Patrick Féron (P)
- Professional Spotter - Silvere Fontanet (PS)
- Scientific Spotter and Cruise Leader - Helder Araujo (SS) (CL)
- Scientific Spotter designed by Turkey - Cihan Toslak (SS)



Figure 4: Area G Crew 2019

The positioning of the crew in the aircraft is essential for good data acquisition. The pilot is positioned at the front left of the aircraft. The professional spotter is at the front right to have maximum visibility in front and on the sides. The two scientific observers are at the rear and change positions at each flight.

Area G

II. EQUIPMENT:

The aircraft was equipped with a Garmin 795 GPS and a Garmin 660 at the front of the aircraft for the pilot. The Scientific team used a Panasonic Toughbook with software *Logger* 2010 (IFAW <http://www.marineconservationresearch.co.uk/downloads/logger-2000-rainbowclick-software-downloads/>) installed and connected to a GPS device for the automatic collection of both the effort data and the sightings data. The forms were developed "ad hoc" so that they contemplated all the required fields in the effort forms and sightings respectively (we thank Antonio Vazquez who provided the software and the data tables). The GPS used was a Garmin GPSMAP 78, with GA25MCX magnetic antenna and NMEA serial connection cable (Figure 5). A 24v-220v converter was installed to supply the necessary electric power to the laptop during flights.

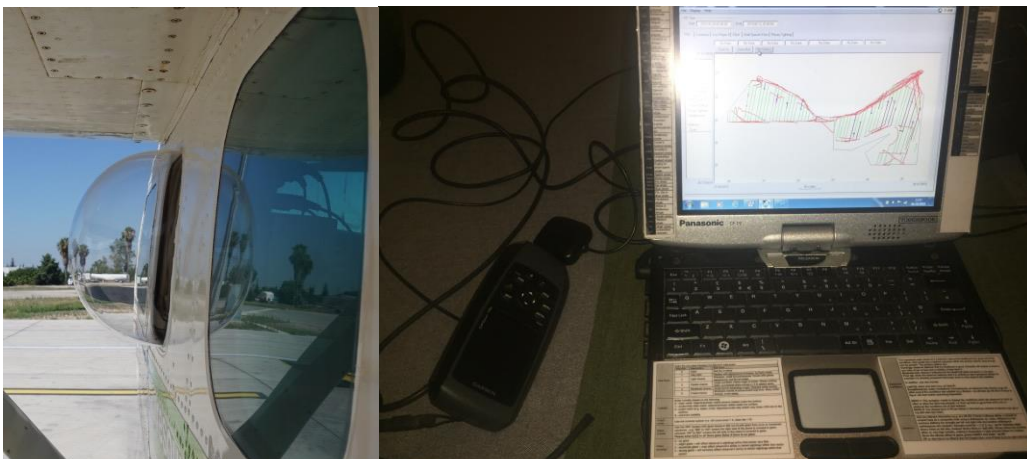


Figure 5: "Bubble windows"; Survey Set: Toughbook with Logger connected to Garmin GPS Map 78s

For data collection, scientific observers at the rear, used two SUUNTO PM 5/360PC inclinometer to measure the angle of declination between the aircraft and the sighting. This measurement makes it possible to know how far the observed school of fish is (Figure 6.). The team was equipped with a camera CANON EDS 70D with an 18-200 nm lens, a stabiliser and a polarising filter, to photograph schools of tuna and other species observed during the mission.

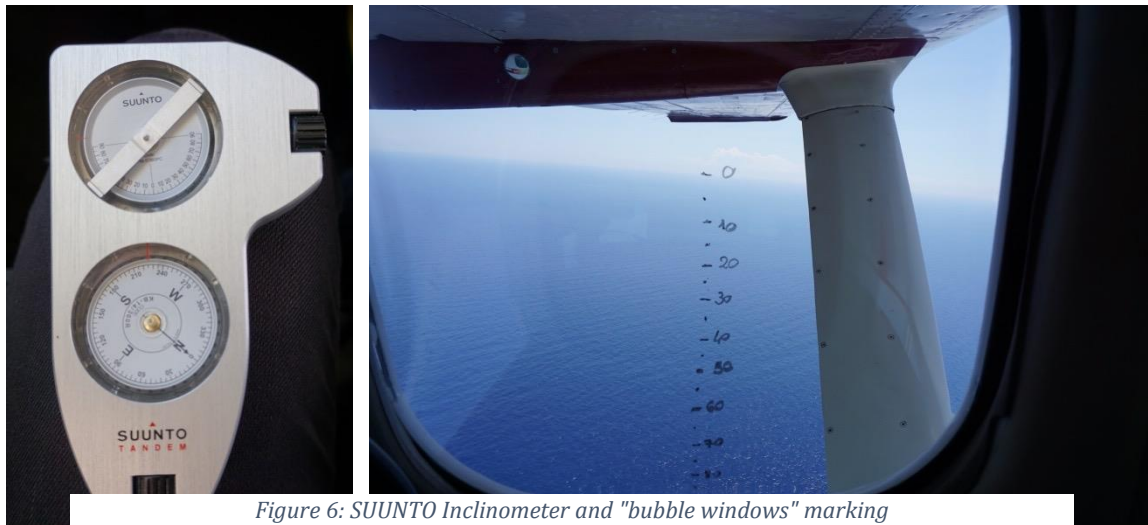


Figure 6: SUUNTO Inclinator and "bubble windows" marking

III. FLIGHT AREA:

The working area is located north-west of the Levantine Sea, between southern Turkey and the North and East of the Cyprus island. The area is divided into four replicas. Replica 1 and 2 have 14 transects each and Replica 3 and 4 have 15 transects each, totalising 58 transects with a theoretical distance of 2777.4 nm (Table 1.).

Area G

Transect	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total (nm)
Réplica 1 (nm)	75,8	100,5	110,3	90,4	56,6	46,9	5,3	4,6	18,6	25,7	32,4	49,9	51,2	14,8		683
Réplica 2 (nm)	56,7	98,3	108,2	98,1	55	48,6	19,3	2,3	13,8	33	41,1	49,5	50,9	17,3		692,1
Réplica 3 (nm)	27,5	95	104,8	108,6	59,9	51,6	45,9	1,8	8,4	29,3	38,4	47,9	51,2	12,8	4,8	687,9
Réplica 4 (nm)	9,1	95,8	103,1	110,4	64,8	50,8	46,5	4,7	6,1	24,5	35,6	45,1	51,2	51,8	14,6	714,1
Total (nm)	169,1	389,6	426,4	407,5	236,3	197,9	117	13,4	46,9	112,5	147,8	192,4	204,5	96,7	19,4	2777,4

Table 1: Area G Transects and Replicas.

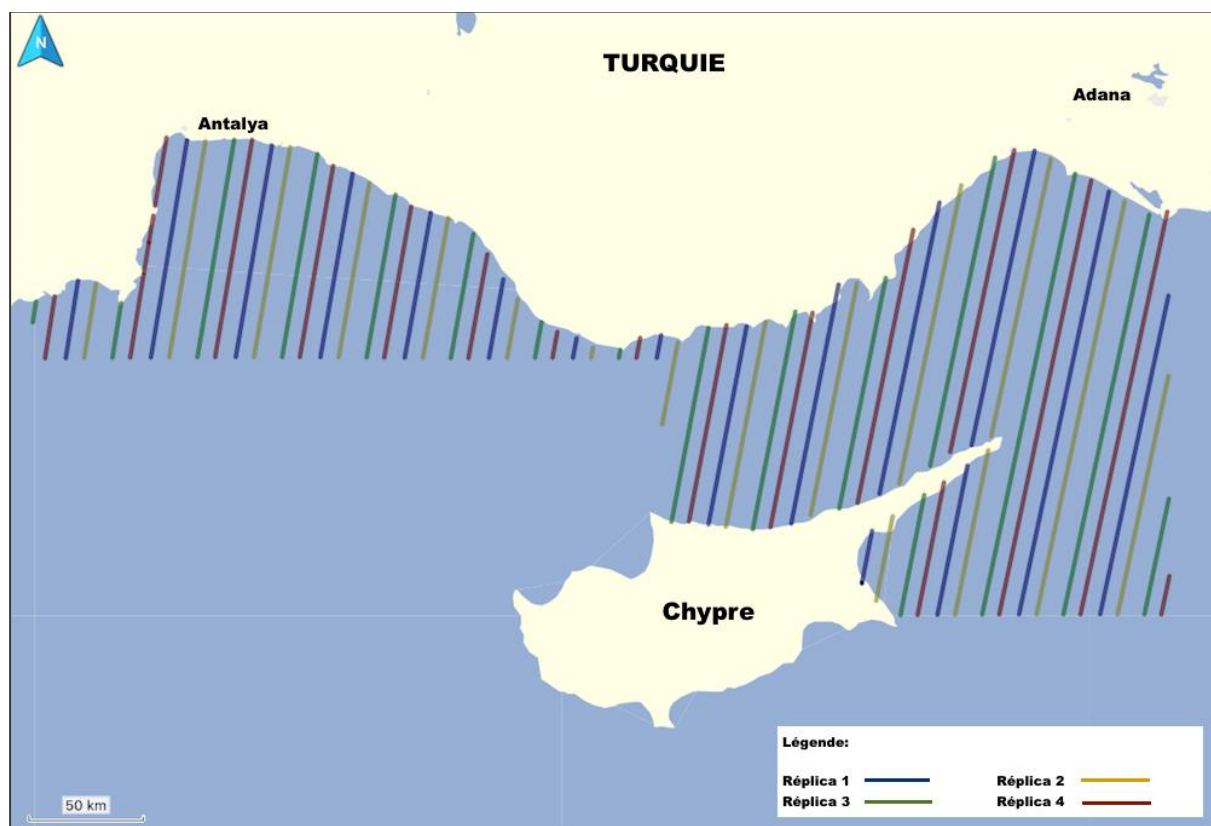


Figure 7: Theoretical lines per replica- Area G

Area G

Two bases were chosen because of their geographical location: the city of Antalya on the west and the city of Adana on the east. These airports are located near of the working area and have aviation fuel (AVGAS 100 LL).

Specific flight conditions have been defined by ICCAT to perform the mission under optimal conditions for the observation of Bluefin tuna schools. The weather conditions are the main factor that limits the observations, more particularly the force of the wind that conditions the sea state. Following the protocol, the flights were performed with Beaufort sea state equal or less than 3 and a minimum visibility of 3.5 km.

IV. FLIGHT PERMITS:

Aerial surveys of Bluefin tuna in Turkish and Cypriot airspace require lengthy and complex procedures for obtaining flight permits.

Turkey:

As we had been told we would probably get the Area G, we anticipated and initiated the procedure to get the permits before we were actually noticed the acceptance of our offer. After four campaigns the previous years, our company is now well known in Turkey and we got the permits much quicker than before (three weeks instead of a month and a half the first year).

- 14 May: letter from ICCAT accepting our offer
- 23 April: Initialization of the permit application: Action Air and Gözen Air, our agent in Turkey, to Civil Aviation.
- 30April: Letter from ICCAT to the Ministry of Food, Agriculture and Livestock which transmits the application to the Ministry of Foreign Affairs.
- 20 May: E-mail from the Ministry of Food, Agriculture and Livestock stating that our request was acceptable.
- 15 May: Information by Gözen Air that permits have been granted.

Area G

- 25 May: Departure from France of the plane and the crew, arrived in Turkey on May 27
- 28 May: Start of the survey flights

Three hazardous areas indicated on the aeronautical charts were located in the work area. The small area D 16 is permanent but did not affect very much the survey. Area D 8 South-East of Antalya was activated only once, and area D 13 South of Adana were never activated.

Once the permits have been obtained, it is important to underline the excellent working conditions in this country, as well as the professionalism and efficiency of air traffic control, airport agents and the Gözen Air assistance company.

Cyprus:

The international community, with exception of Turkey, only recognises southern Cyprus and considers northern Cyprus as an "occupied zone". Turkey recognises the north part as "Turkish Republic of Northern Cyprus", and the south as administration of Greek Cyprus. Each "part" only has jurisdiction over its territory. Internationally, for the aviation, only one FIR exists (Flight Information Region) - Nicosia (South) - which has the coverage of all Cyprus airspace). The Turkish authorities consider that the northern part of the FIR is the Ercan Advisory Airspace (Ercan is the airport of North Cyprus). Prior to each flight, the NOTAM issued by the operations of the departure airport included a detailed reminder that Ercan is the only organization authorized for air traffic control, security, search and rescue in that area.

The Cypriot part of the work area programmed by ICCAT was located entirely in the northern part. The Turkish authorities have made it clear to us that flights in that area had to be requested to the authorities of Northern Cyprus. This step was therefore taken, and an authorisation was quickly obtained without restriction or limitation of duration.

Legally, there was also a need for authorisation from southern Cyprus, as the international FIR covers the south and the north. This authorisation was obtained with some restrictions made known to ICCAT on 12 May: flying inside the area less than 12 nautical miles from shoreline is not permitted.

Area G

Before each take-off, it was necessary to phone call to the two control operations. In the same way, during flight it was necessary be in radio contact with both control operations, which required a great attention since the two frequencies - Nicosia and Ercan, are very busy. This represents a significant nuisance that affects the work on board and the internal communications.

V. OBSERVATION PROTOCOL:

Before each flight, the pilot prepares the flight plan, check weather conditions, flight authorisations and NOTAM. Cruise Leader checks the weather on the working area, checks all the equipment and verifies the survey lines.

During the flight, the observations are made along transects, when the plane is on these lines all the team are in search effort; this event is called "ON EFFORT". Between the lines the team is at rest, the so-called "OFF EFFORT".

The crew member who sees the animals first communicates it to the others. The SS on the opposite side from where the animals were detected registers on Logger 2010 software the event (F). The aircraft keeps the course until animals are abeam. In that precise moment, the SS on the side of the sighting takes the declination angle. The other SS, once again, registers on Logger 2010 software the event (A). When the angle abeam is taken, the plane leaves the transect to obtain a better estimate of the school weight and size, in that moment the SS registers on Logger the event (LE). When the circling around the individuals starts, the PS/pilot notifies the SS who registers on Logger the event (C). In the Logger, the sighting form is filled the estimates given by the PS and SS. The SS on the side of the sighting takes the photos. After some circles (depending on the difficulty of the estimate), the aircraft comes back to the point where it left and the SS registers on Logger the event (RE) (Figure 8).

At the end of each flight, the Logger 2010 databases are analysed and the data transferred to the ICCAT excel forms.

Area G

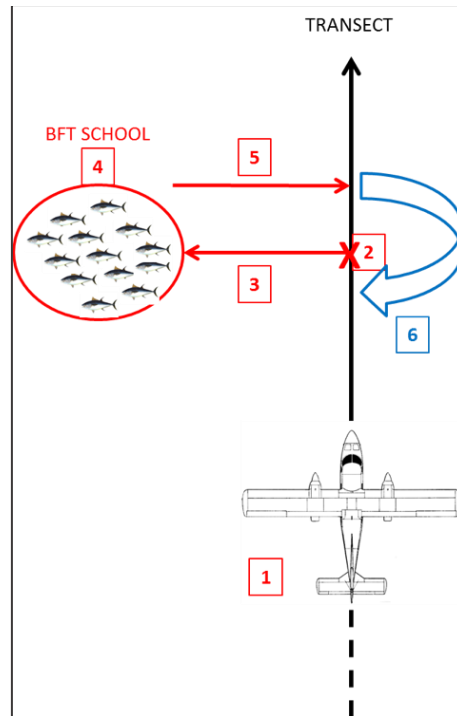


Figure 8: Diagram of the protocol to follow in case of observation. 1 = F, 2 = A, 3 = LE, 4 = C, 6 = RE.

RESULTS

I. FLIGHT RECORDS:

A total of 12 census flights were performed during the mission. Two flights were cancelled before take-off due to poor weather forecasts, one because predicted wind above Beaufort 3 (June 6th) and another because of predicted storms in the survey area and airport area (June 9th). June 3rd was day-off. On June 10th there was no flight due to airplane maintenance (Table 2).

In the eastern track-lines we experienced a very long loss of GPS satellites on main pilot's and cruise leader's GPS as informed daily by Preflight Information Bulletin (PIB):

RECENTLY, GPS SIGNAL INTERRUPTIONS HAVE BEEN REPORTED BY THE PILOTS OF THE AIRCRAFT OPERATING WITHIN SOME PARTS OF NICOSIA FIR. AIRCRAFT OPERATORS OPERATING WITHIN NICOSIA FIR ARE ADVISED TO EXERCISE CAUTION.

FROM: 20 MAR 2018 10:04 **TO:** PERM

Thanks to pilot's second GPS (also working on GLONASS), mission could be flown normally. For that reason there are some gaps in the bellow presented maps. Cyprus (South) only authorizes flights beyond the lines 12 nautical miles from shoreline. Consequently some lines (transects) have to be cut in two (Figure 9).

Altitude is the most commonly affected parameter: erratic information or small variations of +/- 200 feet when compared to aircraft baro-altimeter.

Table 2: Flight records summary.

Dates		Airports		Flight duration	Survey	Transect
		Take off	Landing			
26 May 2019	Sund.	Cuers	Figari	1:25		Ferry
26 May 2019		Figari	Kerkira	4:20		Ferry
27 May 2019	Mond.	Kerkira	Dalaman	3:47		Ferry
27 May 2019		Dalaman	Antalya	1:05		Ferry
28 May 2019	Tuesd.	Antalya	Adana	5:04	1	Replica 1: Tr 14 thru 7
29 May 2019	Wednes	Adana	Adana	3:49	2	Replica 1: Tr 3N, 4, 5, 6
30 May 2019	Thursd.	Adana	Adana	3:09	3	Replica 1: Tr 1, 2, 3S
31 May 2019	Frid.	Adana	Adana	3:49	4	Replica 2: Tr 17N, 18,19,20
01 June 2019	Saturd.	Adana	Adana	3:17	5	Replica 2: Tr 15, 16, 17S
02 June 2019	Sund.	Adana	Antalya	4:50	6	Replica 2: 21 thru 28

Area G

03 June 2019	Mond.					Day-off
04 June 2019	Tuesd.	Antalya	Adana	4:13	7	Replica 3: Tr 41 thru 36
05 June 2019	Wednes	Adana	Adana	3:48	8	Replica 3: Tr 31, 30, 29
06 June 2019	Thursd.					Flight cancelled (weather)
07 June 2019	Frid.	Adana	Antalya	3:54	9	Replica 3: Tr 32, 33, 34, 35
08 June 2019	Saturd.	Antalya	Adana	5:28	10	Replica 4: Tr 57 thru 51
09 June 2019	Sund.					Flight cancelled (weather)
10 June 2019	Mond.					Aircraft maintenance
11 June 2019	Tuesd.	Adana	Adana	3:35	11	Replica 4: Tr 47,48,49, 50
12 June 2019	Wednes	Adana	Adana	2:54	12	Replica 4: Tr 46, 45

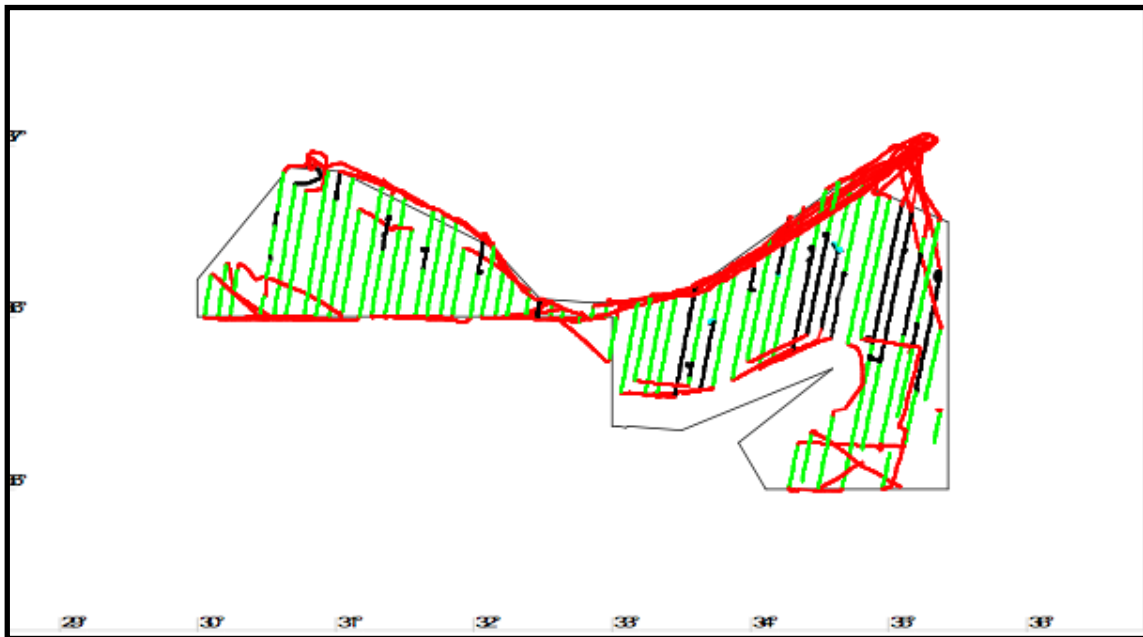


Figure 9: Overview of all flights performed on area G. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join; Blue - circles

In the replicate 1 of the predicted 683 nm were flown 600.5 nm (87,92%). The difference between the theoretical effort and realised effort lies on the 12nm buffer around Cyprus, some miles on line 13 near to Antalya airport and 15 nm on line 1 that can be performed due to military exercises (Figure 10).

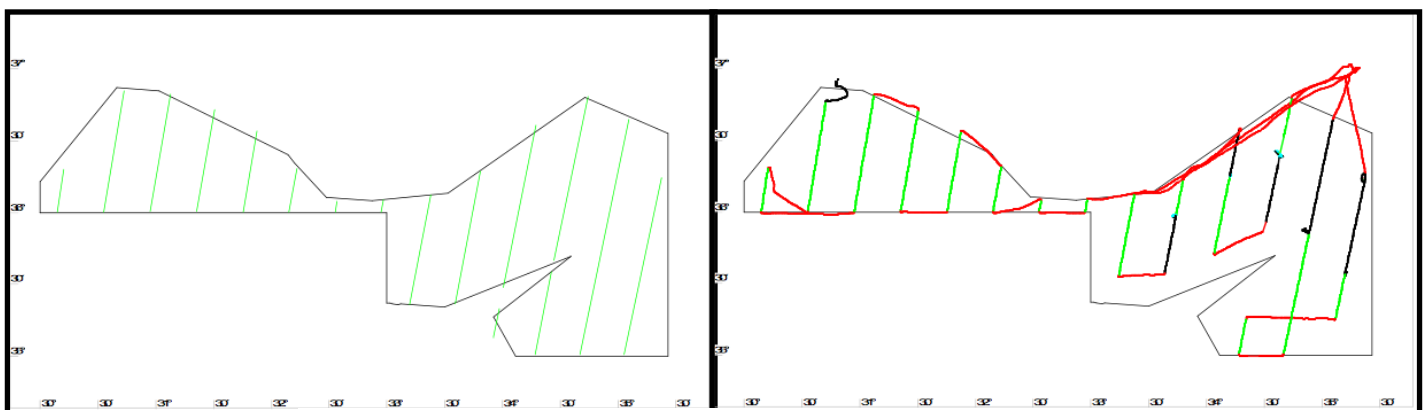


Figure 10: Left -Replica 1 theoretical effort ; Right - Replica 1 effort performed.

Area G

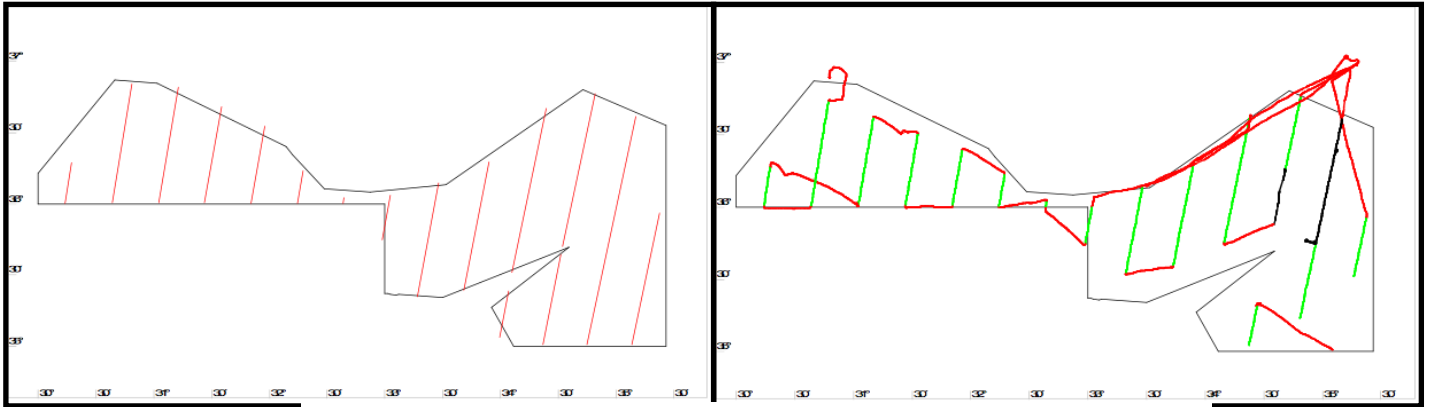


Figure 11: Left -Replica 2 theoretical effort ; Right - Replica 2 effort performed.

In the replicate 2 of the predicted 692 nm were flown 538,73 nm (77,85%). The difference between the theoretical effort and realised effort lies on the 12nm buffer around Cyprus, some miles on line 27 near to Antalya airport and the north of lines 26, 25 and 24 due to active dangerous area D 8 (Figure 11).

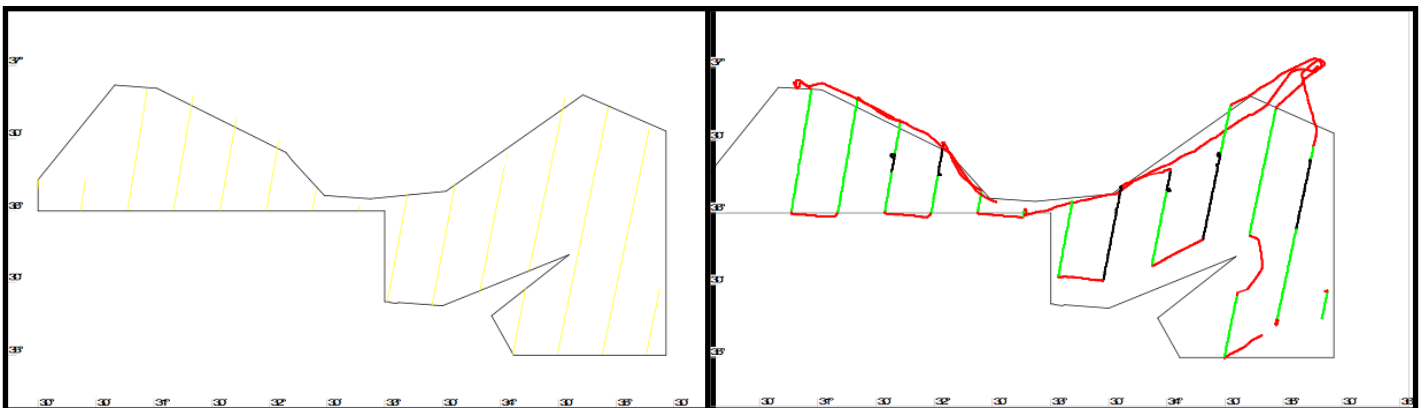


Figure 12: Left -Replica 3 theoretical effort ; Right - Replica 3 effort performed.

In the replicate 3 of the predicted 687 nm were flown 600,55 nm (87,42%). The difference between the theoretical effort and realised effort lies on the 12nm buffer around Cyprus and tracks 43 (4,7 nm) and 42 (7,1 nm) not flown due to weather conditions in the area (western of the cape) and Delta area near the cape always active (Figure 12).

Area G

In the replicate 4 of the predicted 714 nm were flown 610,55 nm (85,51%). The difference between the theoretical effort and realised effort lies on the 12nm buffer around Cyprus, tracks 44 (9,6 nm) not flown due to safety reasons and southern part of line 46 (27,37 nm) and 47 (11,4 nm) due to military exercises (Figure 13).

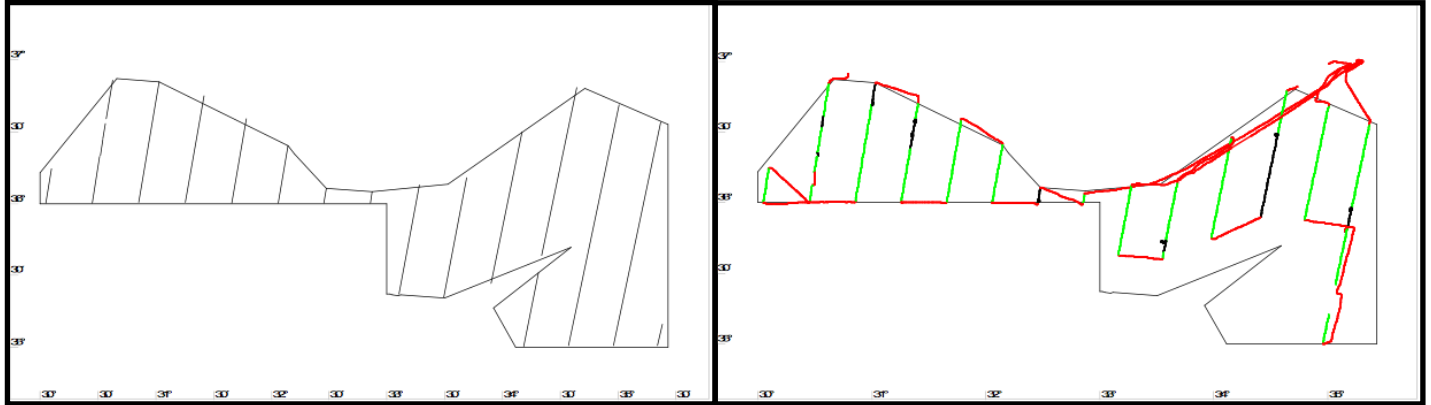


Figure 13: Left -Replica 4 theoretical effort ; Right - Replica 4 effort performed.

Area G

II. DAILY LOG:

The results are presented on a daily basis, including a summary table, a map of the GPS tracks of the flight with sightings and the relevant comments. Time expressed in UTC (or GMT).

Aerial Survey 28th May:

SURVEY DATA SUMMARY	
Date	28/05/19
Survey	1
Departure Time	09:05:00
Landing Time	14:10:00
Total Time	05:05:00
On effort Time	02:30:00
Off effort Time	02:25:00
Photos	NO

SIGHTINGS DATA SUMMARY			
ALB	0	STR	0
BFT	0	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	13	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0		
PIL	0		
SHA	0		
SPE	0	TOTAL	13

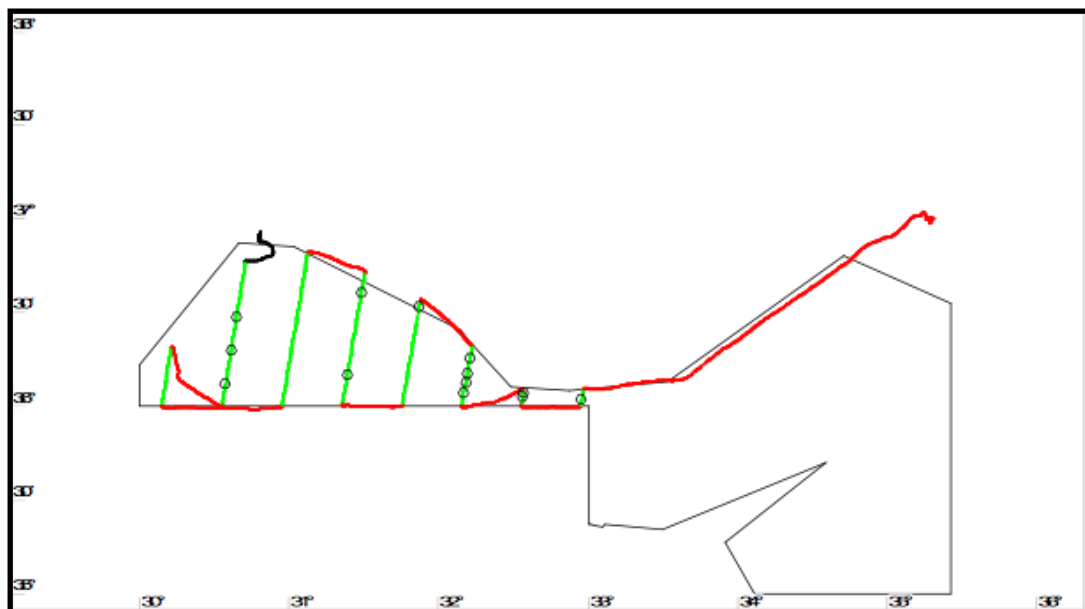


Figure 14: Survey 1. Replica 1. Lines 14,13,12,11,10,9,8,7. Legend: Red lines- off-effort; Green lines- on-effort; Black circles - Loggerhead turtle sightings

Comments: First survey flight. Without any significant comment. Done transect 14 to transect 7 (Replica 1) - we started the East part of replica (last lines numbers). Hand GPS altitude is slightly different from the airplane altimeter altitude.

Area G

Aerial Survey 29th May:

SURVEY DATA SUMMARY	
Date	29/05/19
Survey	2
Departure Time	08:47:00
Landing Time	12:36:00
Total Time	3:50:05
On effort Time	2:40:05
Off effort Time	1:10:05
Photos	YES

SIGHTINGS DATA SUMMARY			
ALB	7	STR	0
BFT	2	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	10	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	1
PIL	0		
SHA	0		
SPE	0	TOTAL	20

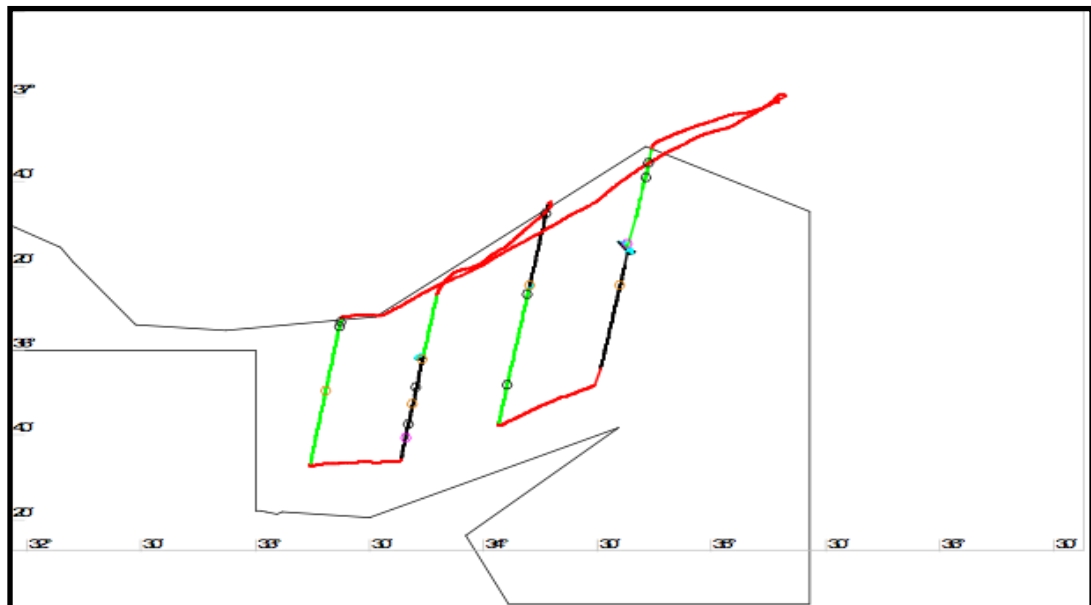


Figure 15: Survey 2. Replica 1. Lines 6, 5, 4 and 3. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Pink circles - Bluefin tuna; Yellow circles-Albacore; Grey circle - Cuvier's beaked whale.

Comments: Second day of campaign. Done lines 6 to 3 (Replica 1), except the southern part of line 3 that was surveyed on next flight. 12 nm buffer around northern Cyprus couldn't be penetrated. We didn't change positions between scientific observers because Cihan didn't feel comfortable with laptop and Logger software. Some times the GPS didn't catch the signal and the position was rounded to the nearness GPS coordinate position.

Area G

Aerial Survey 30h May:

SURVEY DATA SUMMARY	
Date	30/05/19
Survey	3
Departure Time	08:13:00
Landing Time	11:22:00
Total Time	03:09:00
On effort Time	02:26:32
Off effort Time	00:42:28
Photos	NO

SIGHTINGS DATA SUMMARY			
ALB	1	STR	0
BFT	2	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	11	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0		
SHA	0		
SPE	0	TOTAL	14

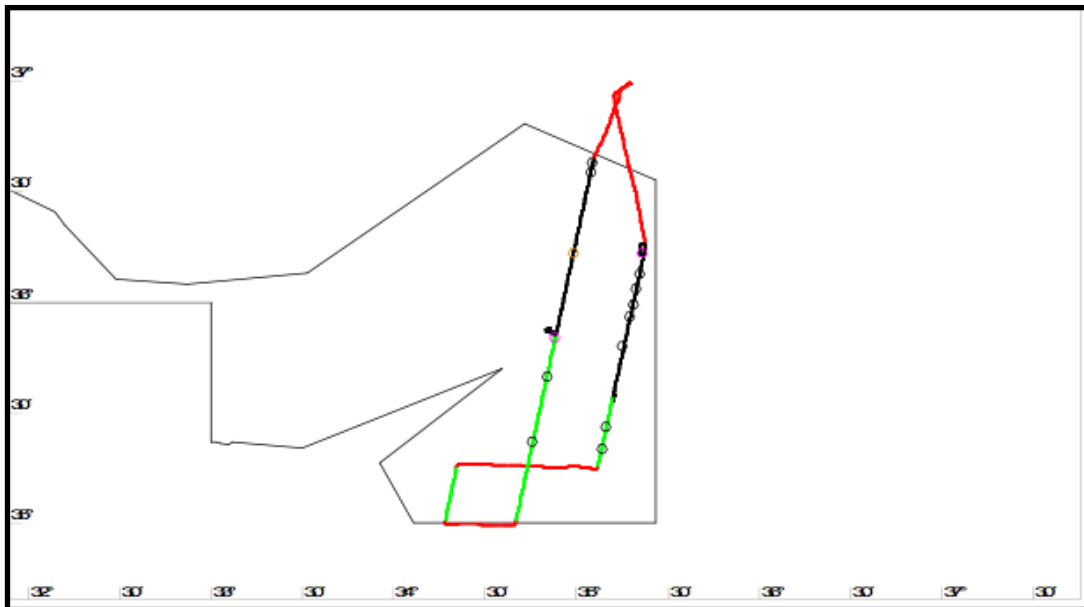


Figure 16: Survey 3. Replica 1. Lines 2, 1 and southern part of line 3. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Pink circles - Bluefin tuna; Yellow circles-Albacore.

Comments: Third campaign day. Done lines 1,2 and remaining southern part of line 3 (Replica 1). 12nm restriction on Cyprus area. Dangerous area D 13 not activated could be penetrated. Because of Russian Navy rocket firing area, 15 miles south of transect 1 could not be flown. Couldn't take photos because of a problem with photograph machine. Sometimes the GPS didn't catch the signal and the position was rounded to the nearness GPS coordinate position. Started to change positions between scientific observers.

Area G

Aerial Survey 31st May:

SURVEY DATA SUMMARY	
Date	31/05/19
Survey	4
Departure Time	08:10:00
Landing Time	12:00:00
Total Time	03:50:00
On effort Time	02:35:28
Off effort Time	01:14:32
Photos	NO

SIGHTINGS DATA SUMMARY			
ALB	3	STR	0
BFT	2	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	9	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0		
SHA	0		
SPE	0	TOTAL	14

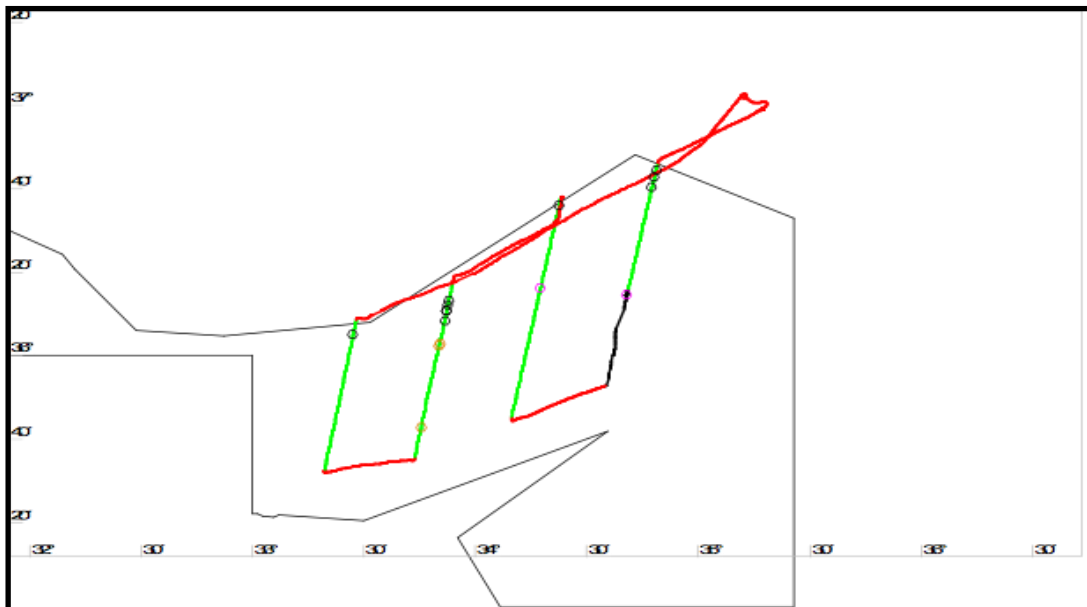


Figure 17: Survey 4 - Replica 2. Lines 17 (N), 18, 19 and 20. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Pink circles - Bluefin tuna; Yellow circles-Albacore.

Comments: Forth campaign day and first flight on Replica 2. Done lines 17 (north) to 20. 12nm restriction on Cyprus area. This flight was inverted due to military activity East of Cyprus. GPS signal loss a few minutes on track 17. Couldn't take photos because of a problem with photograph machine.

Area G

Aerial Survey 01st June:

SURVEY DATA SUMARY	
Date	01/06/19
Survey	5
Departure Time	08:26:00
Landing Time	11:43:00
Total Time	03:17:00
On effort Time	02:23:17
Off effort Time	0:53:43
Photos	YES

SIGHTINGS DATA SUMARY			
ALB	4	STR	0
BFT	0	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	3	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0	OTH	1
SHA	0		
SPE	0	TOTAL	7

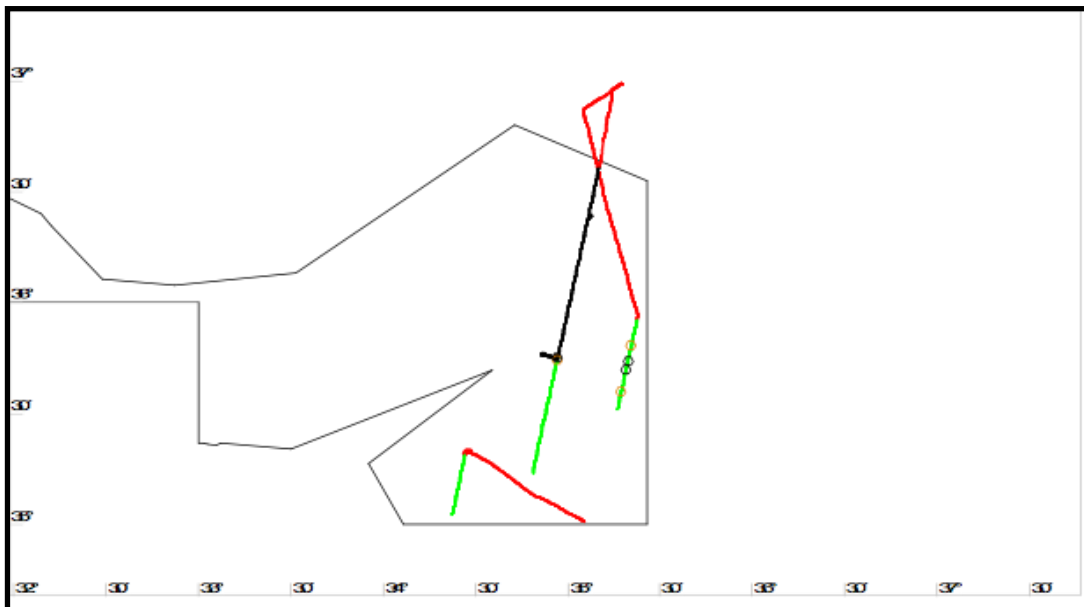


Figure 18: Survey 5 - Replica 2. Lines 17 (S), 16 and 15. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Yellow circles-Albacore.

Comments: Fifth day of campaign. Done lines 15, 17 (remaining southern part) and 16 (Replica 2) . A very long loss of GPS satellites signal on main pilot's and cruise leader's GPS. Thanks to pilot's second GPS (also working on GLONASS), mission could be flown normally. Erratic altitude indication per moments (up to plus 1200 feet). 12nm restriction on Cyprus area. Dangerous area D 13 not activated could be penetrated. In the sighting OTH (other) we left the transect even if the angle was inferior to 4 degrees - perhaps bonito or albacore.

Area G

Aerial Survey 02nd June:

SURVEY DATA SUMMARY	
Date	02/06/19
Survey	6
Departure Time	07:46:00
Landing Time	12:30:00
Total Time	04:44:00
On effort Time	03:26:33
Off effort Time	01:17:27
Photos	NO

SIGHTINGS DATA SUMMARY			
ALB	0	STR	0
BFT	0	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	0	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0		
SHA	0		
SPE	0	TOTAL	0

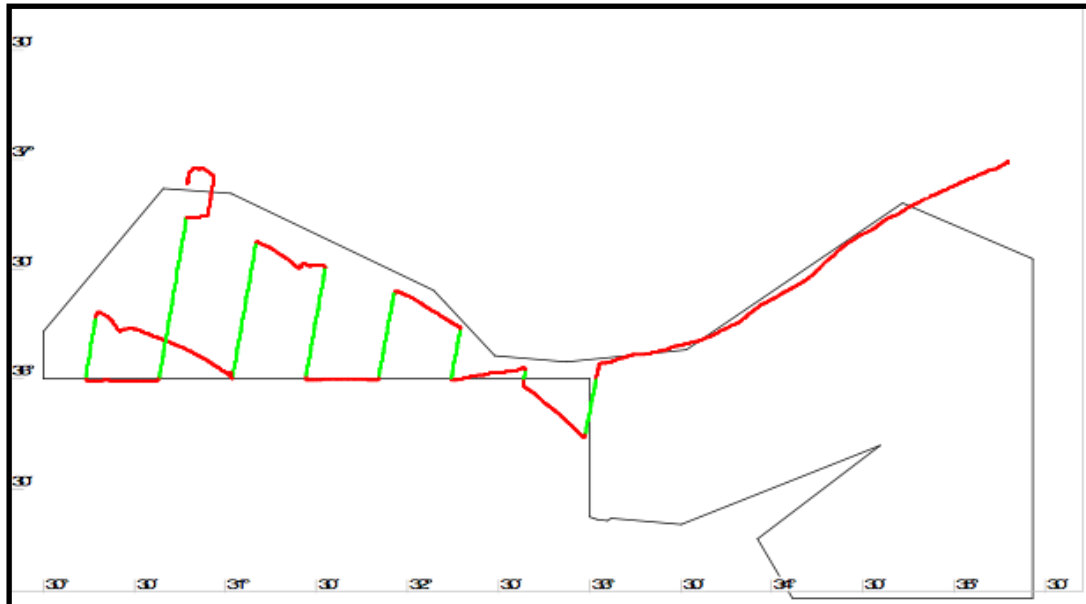


Figure 19: Survey 6- Replica 2. Lines 21, 22, 23, 24, 25, 26, 27 and 28. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles

Comments: Sixth day of campaign and last flight on Replica 2. Done lines 21 to 28 (Replica 2). We performed first line 28 and then 27 for logistical airport approach conditions. The top north of lines 23, 24, 25 e 26 couldn't be penetrated because dangerous area D 8 was activated. Final 9nm on line 27 couldn't be performed because of airport restrictions. Day with zero (0) sightings. Several tuna fishing boats stopped in the area, and two of them in fishing activity were far from the line transect.

Area G

Aerial Survey 04th June:

SURVEY DATA SUMMARY	
Date	04/06/19
Survey	7
Departure Time	06:22:00
Landing Time	10:35:00
Total Time	04:13:00
On effort Time	02:50:32
Off effort Time	01:22:28
Photos	YES

SIGHTINGS DATA SUMMARY			
ALB	0	STR	0
BFT	1	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	3	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0		
SHA	0		
SPE	0	TOTAL	4

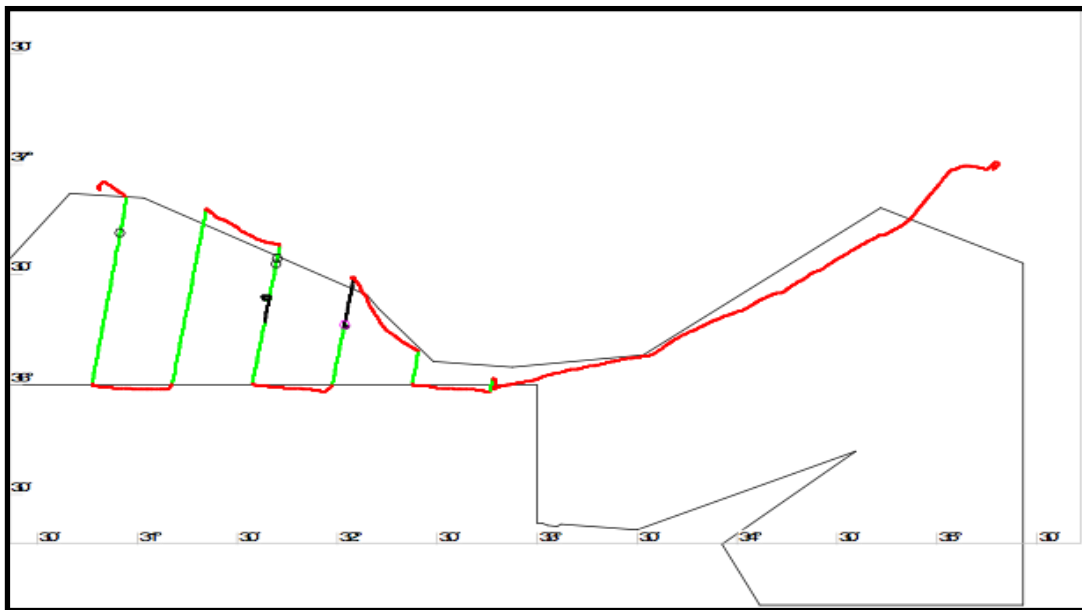


Figure 20: Survey 7- Replica 3. Lines 41, 40, 39, 38, 37 and 36. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Pink circles - Bluefin tuna

Comments: Seventh survey day. First flight on replica 3 performed from west to east side. Done lines 41, 40, 39, 38, 37 and 36. We didn't performed line 43 and 42 because of weather conditions in the area (western of the cape). Also in that area there were flying restrictions (Delta area near the cape always activated). Area Delta 8 could be penetrated this time. First time when spawning tuna fish were spotted (animals with more than 25 kg).

Area G

Aerial Survey 05th June:

SURVEY DATA SUMMARY	
Date	05/06/19
Survey	8
Departure Time	07:00:00
Landing Time	10:48:00
Total Time	03:48:00
On effort Time	03:07:08
Off effort Time	00:40:52
Photos	NO

SIGHTINGS DATA SUMMARY			
ALB	2	STR	0
BFT	0	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	1	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0		
SHA	0		
SPE	0	TOTAL	3

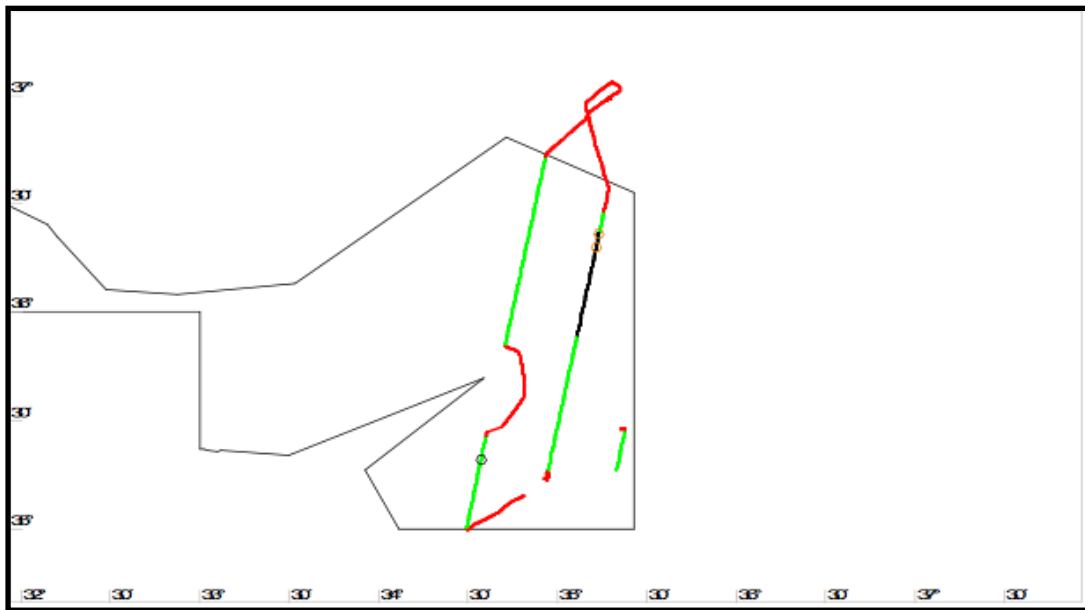


Figure 21: Survey 8 - Replica 3. Lines 30, 29 and 31. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle; Yellow circles - Albacore

Comments: Eighth survey day. Second flight on replica 3. Done lines 30, 29 and 31. 12 nm buffer around northern Cyprus couldn't be penetrated. Huge loss of GPS signal on southern part of lines 30 and 29. Flight only possible in that area thanks to second pilot GLONASS signal GPS. Erratic altitude indication per moments. Off effort on line 30 - Floating persons in a survival suit spotted and reported to Air Control center.

Area G

Aerial Survey 07th June:

SURVEY DATA SUMMARY	
Date	07/06/19
Survey	9
Departure Time	06:48:00
Landing Time	10:42:00
Total Time	03:54:00
On effort Time	02:25:30
Off effort Time	01:28:30
Photos	YES

SIGHTINGS DATA SUMMARY			
ALB	2	STR	0
BFT	1	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	3	MIN	0
MAN	0	UDO	1
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0	OTH	2
SHA	0		
SPE	2	TOTAL	11

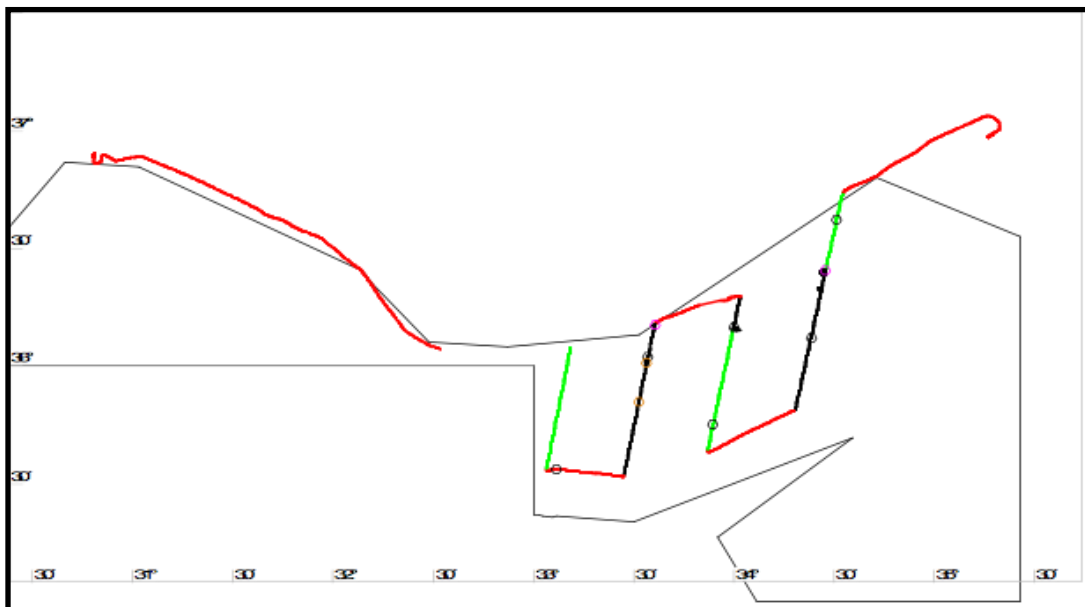


Figure 22: Survey 9 - Replica 3. Lines 32, 33, 34 and 35. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- re-join and circles; Black circles - Loggerhead turtle, Sperm whale and other; Pink circles - Bluefin tuna; Yellow circles - Albacore

Comments: Ninth survey day. Third and last flight on replica 3. Done lines 32, 33, 34 and 35. When off effort, after finishing the line 35, some miles without GPS signal. 12 nm buffer around Northern Cyprus couldn't be penetrated. 2 Sperm whales sightings when off effort. The sightings OTH (other) refer to unidentified fish species, one Sunk and the other possibly Albacore.

Area G

Aerial Survey 08th June:

SURVEY DATA SUMMARY	
Date	08/06/19
Survey	10
Departure Time	06:58:00
Landing Time	12:26:00
Total Time	5:28:00
On effort Time	03:51:54
Off effort Time	01:36:06
Photos	YES

SIGHTINGS DATA SUMMARY			
ALB	0	STR	0
BFT	3	SWO	0
BOT	1	UMM	0
FIN	0	UND	0
LOG	11	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0	OTH	0
SHA	0		
SPE	0	TOTAL	15

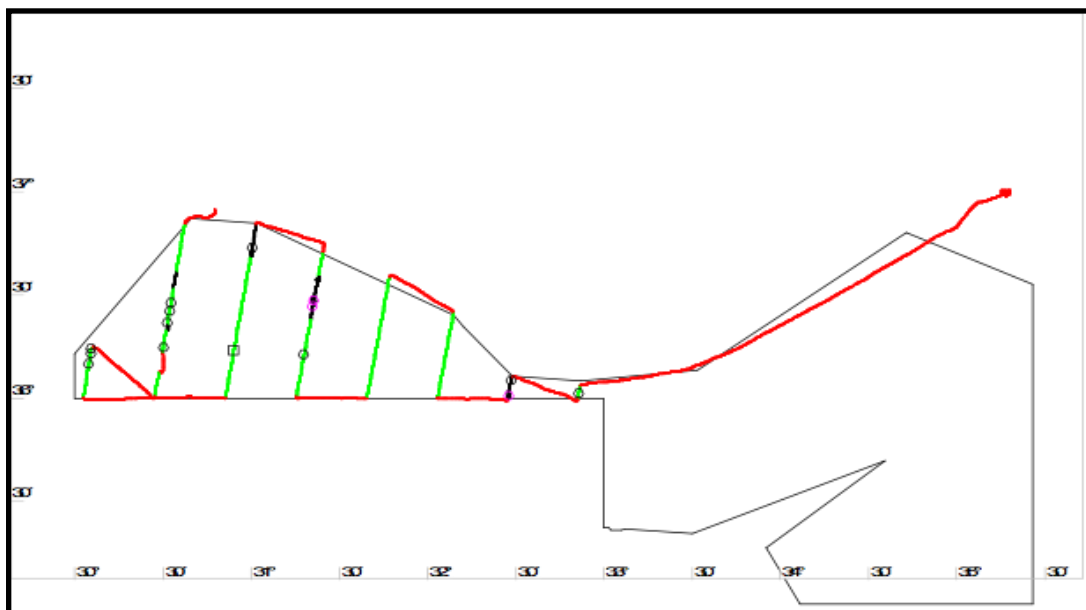


Figure 23: Survey 10- Replica 4. Lines 57, 58, 56, 55, 54, 53, 52 and 51. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- land, re-join and circles; Black circles - Loggerhead turtle, Sperm whale and other; Pink circles - Bluefin tuna; Black square - Bottlenose dolphin

Comments: Tenth survey day. First flight on Replica 4. Done lines 57, 58, 56, 55, 54, 53, 52 and 51. On line 57 sometimes we flew over land and needed to avoid one Delta area. Seems that the logger was not catching the correct GPS time on Bluefin tuna sighting. We needed to correct the coordinates manually. Dangerous area D 8 not activated could be penetrated.

Area G

Aerial Survey 11th June:

SURVEY DATA SUMARY	
Date	11/06/19
Survey	11
Departure Time	07:05:00
Landing Time	10:44:00
Total Time	03:39:00
On effort Time	02:18:13
Off effort Time	01:20:47
Photos	YES

SIGHTINGS DATA SUMARY			
ALB	0	STR	0
BFT	0	SWO	0
BOT	0	UMM	0
FIN	0	UND	0
LOG	1	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0	OTH	3
SHA	0		
SPE	0	TOTAL	4



Figure 24: Survey 11 - Replica 4. Lines 47, 48, 49 and 50. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- land, re-join and circles; Black circles - Loggerhead turtle and Other.

Comments: Eleventh survey day. Second flight on Replica 4. Done lines 47, 48, 49 and 50. 12 nm exclusion zone around Cyprus couldn't be penetrated. Military exercises in the area added 3 more nm to the exclusion zone, so we couldn't fly in a 15 nm buffer around Cyprus. 3 sightings of OTH (other) refer to Bullet tuna, *Auxis rochei*. GPS gap between some minutes after take off and first 'on effort' without affecting survey lines.

Area G

Aerial Survey 12th June:

SURVEY DATA SUMMARY	
Date	12/06/19
Survey	12
Departure Time	07:28:00
Landing Time	10:22:00
Total Time	02:54:00
On effort Time	02:12:15
Off effort Time	00:41:45
Photos	YES

SIGHTINGS DATA SUMMARY			
ALB	0	STR	0
BFT	2	SWO	0
BOT	1	UMM	0
FIN	0	UND	0
LOG	4	MIN	0
MAN	0	UDO	0
NIC	0	WHA	0
NIF	0	CUV	0
PIL	0	COD	4
SHA	0		
SPE	0	TOTAL	10

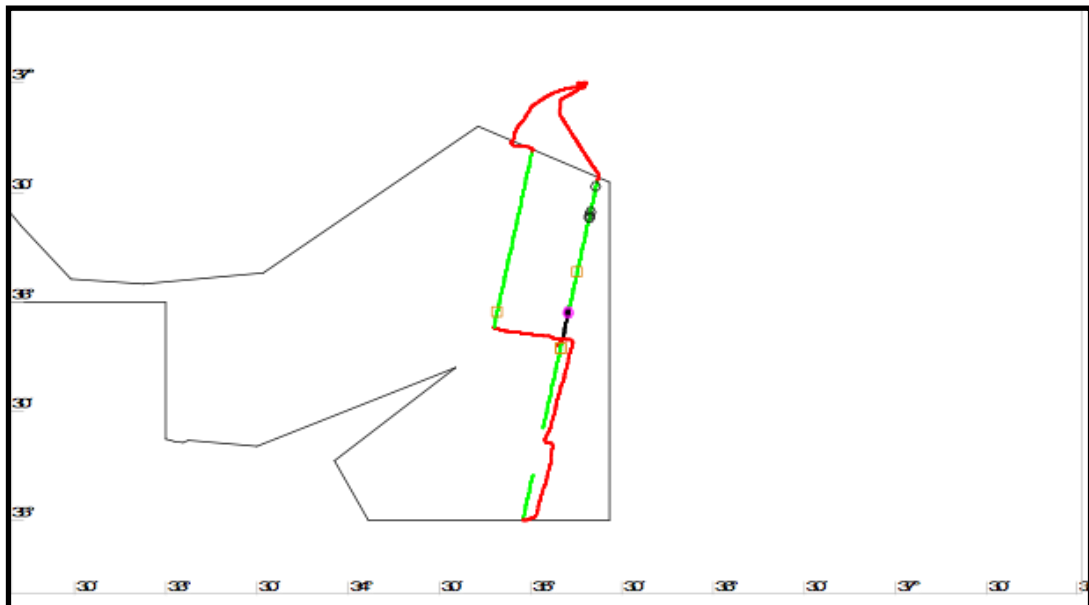


Figure 25: Survey 12 - Replica 4. Lines 45 and 46. Legend: Red lines - off-effort; Green lines - on-effort; Black lines- land, re-join and circles; Black circles - Loggerhead turtle; Pink circles - Bluefin tuna; Yellow square - Bottlenose dolphin

Comments: Twelfth survey day. Third and last flight on Replica 4. Done Lines 45 and 46. 12 nm exclusion zone around Cyprus couldn't be penetrated. Additionally, military exercises on east of Cyprus didn't allow us to perform south part of line 46 and 47. This exercises didn't have a finish date scheduled so we decided not to wait for clearance, and to perform the remaining 30 nautical miles, since it can take more than 2 weeks. We didn't perform the line 44 (with around 10 nm) because of safety reasons – too closer from Syria and military bases. Loss of GPS Signal in a portion of south 45 line. Dangerous area D 13 not activated could be penetrated. End of the mission.

Area G

III. TOTAL SIGHTINGS IN AREA G:

A total of 114 observations were registered on area G, including 31 tunas [13 *Thunnus thynnus* (BFT) and 18 *Thunnus albacores* (ALB) observations]. 83 observations of other species have been recorded; including 68 *Caretta caretta* (CAR), 4 *Delphinus delphis* (COD), 1 *Tursiops truncatus* (BOT), 1 *Ziphius cavirostris* (CUV), 1 Unidentified dolphin (UDO), 2 observation of *Physeter catodon* registered off-effort (SPE) and 6 Others (3 of which are Bullet tuna, *Auxis rochei*) (Table 3).

The observations of *Thunnus albacores* represent 530 individuals for a total weight of 8645 Kg. Small individuals composed all the schools observed with weight ranging from 10 to 20 Kg.

For the other species, the four observations of *Delphinus delphis* represent 35 individuals; the single observation of *Tursiops truncatus* represent 8 animals; the 68 observations of *Caretta caretta* represent 123 individuals - although animals were always sighted separately, in high density areas they were grouped.

Table 3: All sightings.

Specie	Number of Sightings	Number animals	Weight
ALB	18	530	8645
BFT	13	914	16566
BOT	1	8	-
CUV	1	1	-
CAR	68	123	-
OTH	6	1153	3950
SPE	2	2	-
COD	4	35	-
UDO	1	8	-
TOTAL	114	2774	

Area G

IV. BLUEFIN TUNA SIGHTINGS IN AREA G:

In the Area G 914 Bluefin tuna individuals were observed, grouped in 13 schools with a total weight of 16566 Kg (Table 4, Figure 22). All the individuals were spotted underwater. With exception of some animals in sightings number 71 and 100 and sightings number 98 and 99, all the sighted Bluefin tuna in the area had ≤ 20 Kg.

Table 4: Bluefin Tuna sightings.

Sighting number	Date	Hour	Latitude	Longitude	Total number	Average weight	Total Weight
24	29/05/2019	09:15:49	36,40769	34,63355	200	15	3000
29	29/05/2019	11:11:10	35,65610	33,65901	200	20	4000
42	30/05/2019	08:42:19	36,21542	35,36535	300	15	4500
43	30/05/2019	10:33:55	35,83421	34,88325	30	15	450
55	31/05/2019	08:48:54	36,24142	34,68016	20	15	300
56	31/05/2019	09:37:28	36,24142	34,68016	2	18	36
71	04/06/2019	08:43:36	36,26330	32,03212	40-10	20-80	1600
81	07/06/2019	07:22:15	36,40513	34,45896	40	20	800
98	08/06/2019	09:35:49	36,46777	31,35599	3	40	120
99	08/06/2019	09:42:30	36,38001	31,33733	4	40	160
100	08/06/2019	11:00:17	36,00748	32,45734	30-10	25-40	1150
113	12/06/2019	08:11:09	35,95208	35,20795	15	18	270
114	12/06/2019	08:14:36	35,94193	35,20512	10	18	180
TOTAL					914		16566

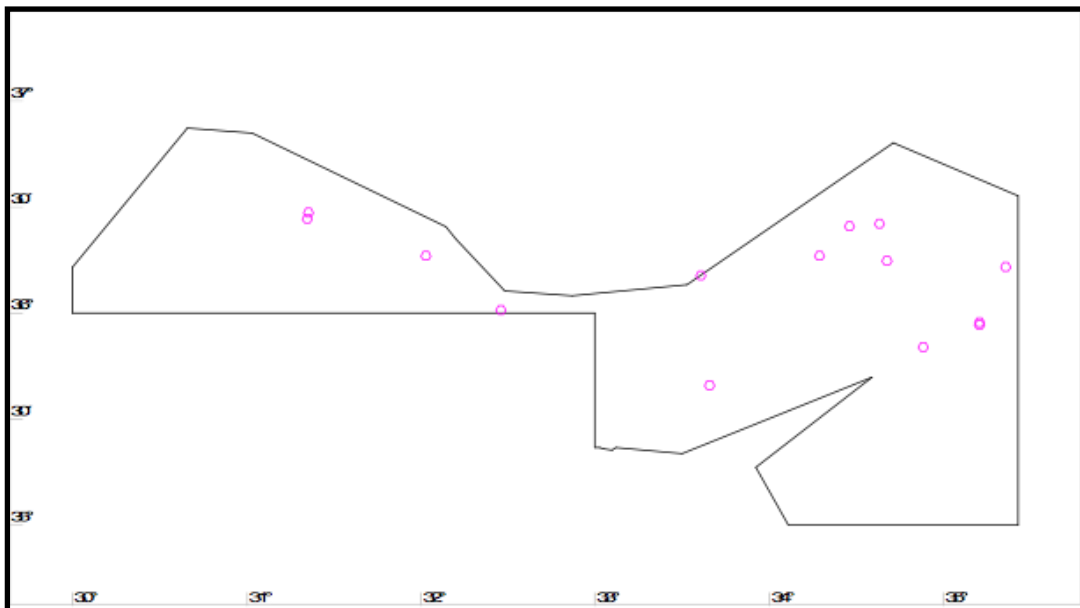


Figure 26: Bluefin tuna sightings in the survey area.

Area G

V. SIGHTINGS BY OBSERVER:

The frequency distribution histogram of the sighting's angles allows making a preliminary evaluation of the efficiency of the observers. Figure 27 shows the frequency histogram of the sighting's angles recorded for each of the observers, for all the species. In this survey none of the SS detected sightings of BFT. In the case of Helder Araújo, he focused the search effort between 90 and 40 degrees as indicated in the protocol. In the case of Cihan Toslak, he focused his search mostly between 50 and 30 degrees.

The PS tends to focus the search effort on the farthest area of the transect between 50 and 10 degrees (Figure 28).

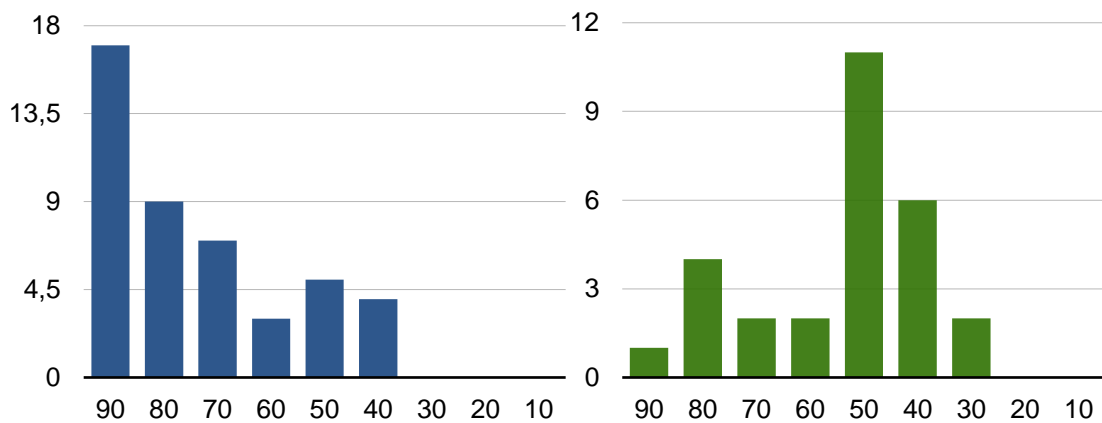


Figure 27: Frequency of the sightings angles of all the species registered by each scientific observer. Left chart: Helder Araújo; Right chart: Cihan Toslak

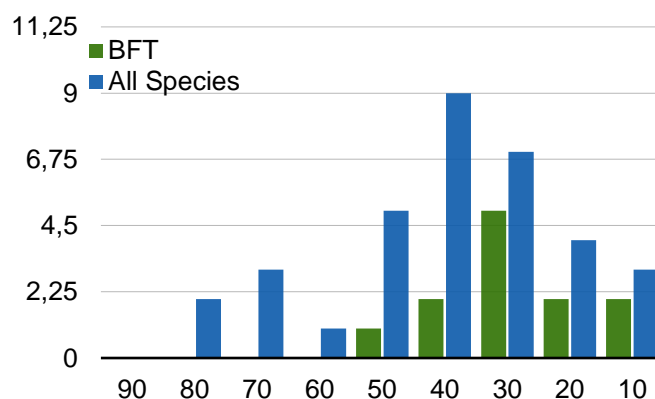


Figure 28: Frequency of the sightings angles of all the species registered by the professional spotter. Green for Bluefin tuna; Blue for All species.

CONCLUSION

The survey was performed in sixteen days, between 28th May and 12th June, which represents 1-day flight in each 1,33 day. This was an excellent mark and was obtained due to the great weather conditions in the area. With the exception of two days, the forecast was always perfect.

Unfortunately, sometimes, fly the survey area isn't not easy. This difficulty lies in the fact that it's a "hot zone" with some geopolitical issues, and several military exercises. For that reason, it was not possible to survey all the predicted tracks. Even so, it was possible to perform 86,24% (2395,33 nm) of the predicted effort.

From the methodology point of view, the use of Logger 2010 software supposed an advantage, since it facilitated the data acquisition and the further data analysis. Our team being French – Portuguese – Turkish had some language misunderstandings. It's essential for future missions in Turkey, to ensure the level of English of all the team members.

In the third survey day, it was not possible to take photos, due to a problem with the Photograph machine that was quickly solved. Even so, taking pictures from the bubble window was difficult, due to shape of the windows. The round windows create a visual distortion and a particular diffraction. Even with appropriate settings, as speed and sensor aperture, some pictures were fuzzy or distorted. This seems to be caused by the glass interferences.

A first analysis of the data shows that Bluefin tuna sighted individuals were, in the majority of the cases, non-spawning fish with a weight less or equal to 20 Kg. These data are in agreement with the data collected in previous campaigns.

Despite the fact there were a considerable number of tuna fishing boats in the area, we only recorded 13 Bluefin tuna schools (all underwater). The reason for these low numbers can be related with the fact the Bluefin tuna are in the deep, the biggest fish have more discrete behaviour or the fish didn't arrive in the area. In some occasions, we flew over the tuna cages and we noticed that most of the catch is small or medium size fish (less than 80 kg).

Area G

As recommendations for future campaigns, and in order to better understand the behaviour of spawning Bluefin tuna in the area, we suggest to conduct the campaign during a whole month. In this sense, we suggest one week per replica, in the case of a favourable weather forecast. This may imply an increase in expenses, but it can give a better "picture" of Bluefin tuna behaviour and real numbers in the area.

Weather forecast websites:

<https://www.passageweather.com>

<https://isramar.ocean.org.il>

<http://www.oceanography.ucy.ac.cy/cycofos/bulletin.html>

Area G

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ABSTRACT

The Action Air Company has participated in the ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) aerial surveys since 2013. In 2019, Action Air obtained the contract for survey of two out of the four areas, namely Area E (Malta) and Area G (Levantine Sea). All staff involved in the surveys participated in a training session held at ICCAT headquarters in Madrid, May 22, 2019, during which details of the methodology and operational standards were explained and previous experiences in the field were discussed and shared. The methodology used in the aerial survey of Mediterranean Bluefin tuna spawners is the so-called "line transect" methodology. In Area G between May 28 and June 12, 47 hours and 50 minutes have been flown to cover 5817 nautical miles, of which 32 hours, 47 minutes and 27 seconds were used to cover 2395,33 nautical miles "on-effort". The survey was performed in sixteen days, which represents 1 day flight in each 1,33 days. This was an excellent mark and was obtained due to the great weather conditions in the area. It was possible to perform 86,24% (2395,33 nm) of the predicted effort (2777,4 nm). It was not possible to survey all the predicted effort due to some geopolitical restrictions and several military exercises in the area. In the Area G, there were observed 914 *Thunnus thynnus* individuals, grouped in 13 schools with a total weight of 16566 Kg. All the individuals were spotted underwater and mostly had ≤ 20 Kg. In addition to the sightings of the target species, it was recorded 18 *Thunnus albacores* observations, 68 *Caretta caretta*, 4 *Delphinus delphis*, 1 *Tursiops truncatus*, 1 *Ziphius cavirostris*, 1 Unidentified dolphin and 2 observation of *Physeter catodon*.