

GBYP 2010

ATLANTIC-WIDE RESEARCH PROGRAM ON BLUEFIN TUNA

Areas 4, 5, 6, 7, 8 Observation Report Sept. 2010

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INTRODUCTION

The objectif of this GBYP program (ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA) was to create a DataBase of biological, ecological and weather parameters during an Aerial Survey of Red Tunas in the Meditarranean Sea (Bluefin Tuna, *Thunnus thynnus, L.*). This Study being made from planes over the Sea, in order to build Statistical Models. This program was directed by ICCAT, with the idea to collect as much Datas as possible, abiding by the Protocol established after the GBYP Programme.

Several strategical zones have been determined, and they will be also studied along the years to come (i.e 4 years (*Hammond P. and al., 2010*)) in order to finalize a complete study. ICCAT chose 6 areas (the Balearic Islands, the North of Tunisia, the North of Lybia, the Ouest of Sicilia, the North of Egypt, the South of Turkey).

The company Périgord Travail Aérien (PTA) has been granted the Market Offer for 3 out of these 6 zones : the North of Lybia (called zone 4), the North of Egypt (zone 5) and the South of Tukey (zone 6).

Two teams have been sent on site, each one composed with trois persons : a pilot, a spotter, and a scientist. The first team included Alexandre Kratz (pilot), José Molina (spotter) and Déborah Belleney (scientist) and was based at Malta, for surveys over the zone 4 (Lybia), the biggest regarding flight time planned (73 hours). The second team was composed by Paul Girmes (pilot), Fransisco Bilora Valverde (Spotter) and Morgane Ramonet (scientist) and was based in Cyprus, to overfly zone 6 et 5 (respectively 66 et 60 hours flight time planned).

This mission began on May 26th, departure of the planes from PTA's Headquarters for an initial Time schedule until end of June, allowing flights during optimum spotting conditions for Tunas at Sea surface.

This Report states for complementary information about certain technical points of the Protocol, and sets a Sum-up of all the flights made by PTA, per zone, detailing Tuna Species observations, mainly Red Tuna (*Thunnus thynnus*, *L*.) and Albacore Tuna (*Thunnus albacores*).

1. MEANS AND METHODS

1.1 The Observation Protocol

The Protocol has been defined by ICCAT, 6 zones have been chosen in the Mediterranean Sea : the Balearic Islands, the North of Tunisia, the North of Lybia, the West of Sicilia, the North of Egypt, the South of Turkey, respectively zones 1 to 6 (see Figure 1).



Figure 1 : Mediterranean Sea chart, representing the 6 working zones defined by ICCAT (source Hammond P. and al.,2010)

The mission of P.T.A. was thus to observe zones 4, 5 and 6. Each zone had been composed with North-South lanes, separeted by 30 to 60 km according to the zones. From one Survey Flight to another, the lanes had been offset in latitude. The number of Survey Flights also varied depending on the zones.

During the Flight, the job of pilot was to:

- maintain a constant speed of 100kt
- maintain an altitude of 330 m (1000 Feet)
- stay on course as precisely as possible (heading)
- > record the GPS flight track

The job of ths scientist was to :

 \succ fill the Effort Report (see Annex 1) which includes time of the observation, GPS position, altitude, weather conditions and other details,

➢ fill the Sighting Report (see Annex 2) in case of spotting a Tuna Schoal, which included time of spotting, position of the schoal, estimated mass (in tons), size (small, medium, large), and also behaviour of species,

> take pictures as much pictures as possible of the schoal in case of spotting Tunas

The job of the spotter was to :

- > maintain a carefull watching to spot for fish schoals
- > guide the pilot around the schoal in case of spotting Tunas
- > be able to determine mass, size, behaviourof the observed Tunas

Each flight was recorded on a GPS (WGS84 referential), and captured track were transfered to a computer with the help of software MapSource (software designed to operate with Garmin GPS on computers), then exported to GoogleEarth for an enhanced visibility.

Weather conditions were a limiting factor to Observation, with the following parameters to take into account : cloud base (ceiling), wind strength, and sea aspect. When not at calm sea, waves and with horses on the sea could be mistaken with tuna schoals. This is why none of the flights were carried out at more than 4 on the beaufort scale, also considering than 2 or below on the beaufort scale are the ideal observation conditions (*Hammond Philip et al. 2010*) with a maximum 1,25m high swell.

Thus the altitude notified by ICCAT was 1000Feet, some observations were made at lower altitudes (approximately 800Ft, with minimum safety altitude at 700Ft) due to low clouds ceiling, scattered or overcast. Furthermore, some weather condition have prevented the plane to take-off sometimes, (thunderstorm, haze, mist...), preventing the observation to occur whereas the weather could have been fair on site.

1.2 The Plane

The plane type was Cessna 337 – Sky Master, a twin-piston with central traction. Both engines thus both propellers are on the fuselage axis, one afterwards the other rearward. The wings are in a upper position, enabling full-time observation of the sea on the sides. Other characteristics are detailed on Figure 2.



Figure 2 : Characteristics of the Cessna 337 Skymaster (source : Jane's World Aircraft Recognition Handbook)

Both planes used were the same model Cessna 337 Skymater : registrated N53420 for zone 4 (Lybia) and registrated N86306 for oriental Mediterranean. These planes had already been flying over the sea to search for Tuna Schoals before, for Mediterranean Thoniers senneurs. Despite very safe, these planes have nevertheless visibility flaws as every other type of aircraft.

Air flow disturbed from front propeller, so as the sometimes rather low position of the pilot and spotter (the two persons seated on the front seats in the plane) does not allow a very good visibility just in front of the plane. The different angles of visibility are detailed further (Figure 3). Angles are represented around the plane's symetrical axis and are the same both sides of the aircraft. In red are the "dead angles" (no visibility), which represent about 30° to the front, and about 45° to the rear per side, so nearly 150° obstructed out of 360°. In green is represented the ideal angle of observation and spotting, thanks to which the spotter has a very good possibility to detect a tuna schoal, and in blue the angle where visibility can be reduced due to the wing support.



Figure 3 : Different lateral visibility angles for the spotter, on the right hand sideof the Cessna 337 (source : Morgane Ramonet after Jane's World Aircraft Recognition Guide)

We can estimate a total lateral visibility angle of 105° per side, thus 210° on complete horizon, but knowing that the spotter, as seated on the right hand side, was a much more likely to actually detect a fish schoal on the right hand side. Left side is obstructed by scientist in the rear and pilot in the front seat, even if they also watch carrefuly. Furthermore, planes not being equiped with a bulb window the overhead visibility is limited, the estimated angle is around 40 degrees (Figure 4).



Figure 4 : The overhead "dead angle" from the plane above the sea, on the right hand side of the Cessna 337 (source : Morgane Ramonet after Jane's World Aircraft Recognition Guide)

For the spotter, visibility can be enhanced on demand with short banking of the plane, realised by the pilot. While taking air shots, a plane bank of 30° to 45° allows a very good overhead of the observed Tunas Schoal.

1.3 Cameras

While observing the Tunas Schoals, taking air pictures can allow a completion with image for the Database. Many parameters can be taken into account while taking shots. For instance, the Cameras used were synchronized with Garmin GPS clocks (UTC time slot) and the output compressed format for files generated was JPG. The lenses used were Nikon 70-200 and Nikon 70-300, other main characteristics of cameras are described in following Table 1.

Caractéristiques techniques	Nikon D40X	Nikon D90	
Nb de pixels effectifs en millions	10,2	12,9	
Nb total de pixels en millions	10,75	12,3	
Filtre polarisant	Circulaire, verre CPL 67 (BW)	Circulaire, verre CPL 77 (BW)	
Téléobjectif Nikon	70-300mm	70-200mm	
Sensibilité ISO (indice d'exposition recommandé)	100-1600 ISO	200-1600 ISO	
Taille lentille frontale	67mm	77mm	
Angle de champs	24x36mm	24x36mm	
Définition maximum (L)	3872 x 2592 pixels	4288 x 2848 pixels	
Plage de détection	-1 à +19 IL (ISO 100 à 20°C)	-1 à + 19 IL (ISO 100 à 20°C)	
Plage d'exposition	 - 0 à 20 IL (mesure matricielle couleur 3D ou pondérée centrale) - 2 à 20 IL mesure en spot 	 - 0 à 20 IL (mesure matricielle et pondérée centrale) - 2 à 20 IL en spot 	
Vitesse d'exposition	30 à 1/4000s par incréments de 1/3 IL, Pose B	30 s à 1/4000 s, Pose B	

Tableau 1 : Main characteristics of Nikon D40x and D90.

2. RESULTS

2.1 Zone 4 : Libya

Malta being the nearest european country from zone 4, it was the only available possibility for the Team to be based to operate the Survey over North Lybia. It was just impossible to be based in Lybia, which might have been more efficient, at least for a large central part of the zone. Thus unfortunately from Malta, it required 1 hour and a half to reach the Survey zone, leading to a reduced operating time on site.

Furthermore, without authorizations from lybian authorities, Team had to cut out lanes 50 Nautical miles (Nm) from the lybian coasts. In this process, only 4 lanes out of 11 were feasible. In the following days, the FIR (Flight Information Region) administrated by lybian Air Control) was entirely forbidden. As northern limits of this FIR is located 34°20'00"N, so around 110 Nm and 250 Nm from the coastline, and covers consequently the whole zone 4.

This is why two other zones, 7 and 8, have been defined by ICCAT board a few days after aknowledgment of the situation, in order to be able to carry on the mission. In doing so, therotical time effort (number of hours) the be flown over zone 4 were reported to zone 7 and 8.

Geographical boundaries of zone 4 could be divided into two parts, a northern area $33^{\circ}00'00''N$ down to lybian coast high, $14^{\circ}11'19,9''E$ to the right to $17^{\circ}39'32,0''$ E wide (7 lanes north) and southern part from $32^{\circ}00'00''N$ down to lybian coast high, $14^{\circ}39'32,0''E$ to $19^{\circ}48'54,0''$ E wide (5 lanes south, see Figure 5).



Figure 5 : boudaries of Zone 4 (Libya) (source : Déborah Belleney after Google Earth)

The area was to be covered by 7 surveys, each of them divided into 11 lanes, spaced by 60 Km. Each survey being separated form another by 1 km in latitude.

2 flights have been carried out on lanes 5, 6, 7 of survey 1, on june 3rd and 5th 2010 (Figure 6).



Figure 6 : Tracks of survey 1, lane 5, 6, 7 of zone 4. (source : Déborah Belleney after Google Earth)

On this figure, tracks of flight 1 is in yellow, lanes 5 and 6 of survey 1 on june 3^{rd} , and on june 5^{th} with red track the lane 7 during flight 2 : flight 2 had to be interrupted due to lybian authorities (again). It had been impossible after this flight to resume any survey.

We can also spot on the map the rather long distance between Malta and north lanes, requirering for the future different solutions for Lybia : flight time to get to the working zone had been here greater than work time ! This is why on these two flights before closure of the lybian airspace, 9.9 hours had been flown for only 1.8 hours really onsite (see Table 2) with 3 lanes of survey 1.

Dates	Numéro Survol	heures de prospection Heures Bloc-B	
03/06/10	1	0,20	5,2
05/06/10	1	0,18	4,7
	Total	0,39	9,9

Table 2 : hours flown (Block-Block) and on site zone 4, per d

During the two flights, a Tuna Schoal has been detected and observed as approaching lane 6. A dozen individuals of Red Tunas (BFT), of medium size (25 to 150 kg), for 0.25 ton.

2.2 Zone 8 : East of Malta

As explained before, zone 8 (East Malta) had been created on june 10^{th} 2010, following closure of lybian airspace on june 5^{th} 2010. Waiting for new zone 8 "designs", and as the weather was finaly fair, PTA had carried out 2 flights, on 6 and 7 of june, East of Malta. Following, these 2 flights named "essai 1" and "essai 2" had been validated by ICCAT, and treated with other zone 8 flights that could start from june 14^{th} . (Figure 7)



Figure 7 : Chronology from june 5th to 14th 2010.

2.2.1 ZONE DESCRIPTION : "ESSAIS" AND ZONE 8

Flights "essai 1" and "essai 2" had been defined ont the same model than other surveys of zone 4 for instance, with 3 lanes separated by 60 km, and surveys spaced by 18,5 km from one to another flight. Which gave following geographical boundaries : $34^{\circ}20'00''N$ (lybian FIR limit) – $36^{\circ}01'00''N$ and $16^{\circ}20'00''E - 14^{\circ}50'00''E$.

Zone 8 also had the lybian as a southern limit, and Malta Island as a Westerly limit. The team being based in Malta, a survey per day could be carried out. Observations began on june 14^{th} 2010 and have been flown in alternance with flights over zone 7. Geographical boundaries were : $34^{\circ}20'00''N - 36^{\circ}00'00''N$ and $15^{\circ}00'00''E - 16^{\circ}00'00''E$, that is to say 7200 sqnm (milles Nautiques²) (Figure 8).



Figure 8 : Zone 8 boundaries (source : Déborah Belleney after Google Earth)

2.2.2 SURVEY AND HOURS FLOWN RESULTS

The observing period extended from june 6th to july 31st. The Team based in Malta (closed from site) could realize one whole survey per flight, so per day, thus 9 flights had been necessary to cover the 8 surveys of zone 8. With 2 surveys "essai" (Figure 9) and 6 surveys directly provided by ICCAT (Figure 10, then detail for each survey in annexe 4) representing 44.9 hours of flight (block-block), that is to say 31.1 hours of real prospection (Table 3).



Figure 9 : tracks of essai 1 (in red) and essai 2 (in white) (source : Déborah Belleney after Google Earth)



Figure 10 : Tracks of surveys 1 to 6 of zone 8, and Tuna Schoals observed. (source : Déborah Belleney after Google Earth)

Dates	Numéro Survol	heures de prospection	Heures Bloc-Bloc	Comments
06/06/10	7	3,50	5,0	
07/06/10	8	3,40	5,1	
14/06/10	1	5,00	6,6	
17/06/10	2	0,90	3	Bad weather on zone
25/06/10	2	3,30	4,8	
05/07/10	3	3,70	5	
06/07/10	4	2,50	4	
15/07/10	5	4,50	5,7	
31/07/10	6	4,30	5,7	
	Total	24,20	44,9	

Table 3 : hours flown (Block-Block) and on site zone 4, per date.

In the Table above, flights "essai 1" and " essai 2" of june 6th and 7th 2010, had been numered as surveys 7 and 8. On june 17th 2010, once arrived on site, cloud base was too low to allow Tuna spotting conditions. A non-efficient test of 0.9 hour had been carried out on lane 1 of survey 2. It had been renew on june 25th 2010.

2.2.3 TUNA SCHOALS OBSERVATION

During the 9 observation days, 7 surveys allowed observation of seven Tuna Schoals that have been listed in the table hereunder. With each schoal corresponds a waypoint, numbered in a chronogical order in accordance with the sequence order of observation on the zones 4, 7 and 8. (table 6, full table in Annexe 3)

Date	Time	num	Subarea	Survey	Transect	Species	School size	Estimated weight en tonne
13-07-10	10:15	6	7	3	1	BFT	М	45
13-07-10	13:10	7	7	3	1	BFT	L	450
13-07-10	09:20	8	7	3	1	BFT	М	350
14-07-10	12:39	9	7	4	3	BFT	М	0,5
02-08-10	09:40	14	7	6	1	BFT	L	7,5
02-08-10	10:20	15	7	6	1	BFT	L	2,5
03-08-10	11:05	16	7	7	2	BFT	М	5

Tableau 6 : Tuna Schoals observed on zone 7.

It represents 400.5 tons of BFT of 25 to 150 Kg and 460 tons of BFT of 150 to 250 Kg. That is to say 860.5 tons including 845 tons of Rd Tunas (*Thunnus thunnus*) the same day, on july 13th 2010 day of survey 3, lane 1.

No Tuna Schoal were observed during these two "Essai" flights. On the other hand during these two days, 2 Tuna Boats have been spotted, with their cage. On june 6^{th} the spotter indicated up to 200 tons of tuna in the Seine. One june 7^{th} , only one seine has been observed, filled with around 200 tons again of Red Tunas. Then between june 14^{th} to 31^{st} , 8 Tunas Schoals of BFT, mid-size (25 to 150 kg) have been spotted, within 3 days. Two major Tuna Schoals of 750 tons each have been observed on july 5^{th} 2010, the first at 8h43 the other at 8h45. It could be a unique Schoal, divided into two parts as the plane was flying by.

On the whole, it represented 1777 tons of Red Tunas (observed within 3 days of survey, whereas 9 fligths had been carried out on a 56-days sampling period.

2.3 Zone 7 : West of Malta

Zone 7 is limited south by zone 3, and the Island of Malta for Estern part, zone 3 being flown by other contractors then PTA. The Team being based in Malta, it enabled to fly a survey per day. Observations occurred from june 20th to August 3rd2010 and have been carried out in alternance with surveys of zone 8.

2.3.1 ZONE DESCRIPTION : "ESSAIS" AND ZONE 8

The geographical boundaries of this zone were : $36^{\circ}00'00''N - 37^{\circ}00'00''N$ and $12^{\circ}00'00''E - 14^{\circ}00'00''E$, that is to say 7200 sqnm (miles Nautiques²) (Figure 11).



Figure 11 : Zone 7 boundaries. (source: Déborah Belleney after Google Earth)

2.3.2 SURVEY AND HOURS FLOWN RESULTS

For this study, zone 7 had been divided into 10 surveys of 4 lanes, spaced from one another by 60 Km. One Km separates each survey start. 7 surveys have been flown out of the 10 available (Figure 12 and tracks of each survey in Annexe 5)



Figure 12 : Surveys 1 to 7 of zone 7, with Tunas Schoals Observed (source: Map source et Google Earth)

As shown on Figure 11 lane 1 of survey 1, passing threw Panteleria Island were no propsection possibility, from 10h20 ($36^{\circ}41'08,9''$ N ; $12^{\circ}00'08,6''E$) to 10h30 ($36^{\circ}50'36,2''N$; $11^{\circ}59'54,6''E$). All these flights had been carried out within 9 days of flights from june 20th until August 3rd 2010, representing 36.9 hours total flight time (block-block) and 28.1 prospections hours (Table 5).

2.4 Zone 5 : Egypt

For the Egyptian zone, a flight has been realised on june 9th from the base of Paphos (Cyprus), with the authorization number. Once arrived near the Observation area, the Egyptian Civil Aviation only authorized overflying the area at a altitude of 8000 Feet, refusing the flight at the working altitude of 1000 Feet (330m), thus it was impossible to work. Without a proper authorization "on flight", despite the civilian and military authorization number on the paper, the team had to turn back.

So just a 2.7 hour-flight has been carried out directly on this zone. (More details on the attempt can be found on the report from the Pilot), giving way to no observation results. So the Team based in Cyprus focused on zone 6 (South of Turquey).

2.5 Zone 6 : south of Turquey

For this Turquey zone, the Team was based in Paphos, south western part of Cyprus, in a relatively central position regarding the zone to study. The arrival on site was realised on june 3rd 2010, after being delayed and held in Malta by bad weather conditions.

2.5.1 FLIGHT HOURS DESCRIPTION

Flights took place from june 5^{th} to 30^{th} 2010, for a total flight time of 66 hours block-block (100% of the time effort planed), corresponding to 29.4 observation hours (Table 7).

date	Avion	Heures Block-block	prospection	zone 6 – Turquie
5-juin-10	N86306	5,2	1,9	delayed by ATC 30 minutes
7-juin-10	N86306	2	0	Bad weather on zone
11-juin-10	N86306	4,7	2,3	
12-juin-10	N86306	6	3,3	
13-juin-10	N86306	4,9	2,6	
15-juin-10	N86306	2	0,1	Bad weather on zone
16-juin-10	N86306	4,5	2,1	
17-juin-10	N86306	5,2	2,3	
18-juin-10	N86306	3	0,9	REJECTED by turkish civil aviation
19-juin-10	N86306	3,5	1,6	Bad weather on zone
21-juin-10	N86306	5,4	3,3	
25-juin-10	N86306	5,2	2,3	
27-juin-10	N86306	5,1	3,2	
28-juin-10	N86306	4,3	1,9	
30-juin-10	N86306	5	1,6	
	Total	66	29,4	

 Table 7 : Flight time description on zone 6 (hour tenth) per day flown

Bad weather conditions on site, despite good forecast, urged the Team to fly back to the base in Paphos (Cyprus) without being able to work on june 7th and 15th 2010.

2.5.2 PROSPECTION ZONE DESCRIPTION

The prospection zone was located North of the lanes in rose on the map (Figure 13). Western part of the zone is limited to the North by the turkish Coastline, and by the South by parallel $35^{\circ}00'00''N$ for lanes 1 to 7 and parallel $36^{\circ}00'00''N$ for Eastern part, with lanes 8 to 13. In latitude, the zone extended on around 530 Km from point 35° 08' 00''E, until the Syrian Coastline, 35° 50' 00''E. It represented a whole surface of 53033,784 Km².



Figure 13 : Zone 6 description, boundaries and flight constraints (source: Morgane Ramonet after Google.Earth 2010)

Each Survey was composed by 13 lanes, disposed North to South from east to west. This zone was related to certain constraints : two airports (area in yellow on the map) in south of Turkey (Antalya to the West and Adana to the East) forced the Team to shorten the lanes, and the zone determined on the map had to be modified to match with Air Trafic Control requirements (from Turkish civilian Aviation). This is why the area in red had never been authorized to be overflown, including lane 13 of Survey. This specific area was located inside Syrian airspace (FIR) which would not give any specific overflying authorizations. This also concerned the north-east point of Cyprus Island, administrated by the Turkish Army, urging the Team to fly the long way around instead, unfortunately for working flight time compared to total flight time to get to the other side of the Island.

2.5.3 FLOWN SURVEYS

The 66 hours flown enabled the Team to realize 3 complete surveys (except for lane 13) and a fourth survey nearly complete (with lane 12 partialy overflown), during 15 flying days, from june 5^{th} to 30^{th} 2010.

The flights for the first survey on zone occurred from june 5th to $12^{th} 2010$ within 3 valid flights (and a void flight on june 7th due to bad meteorological conditions on site), that is to say 17.9 hours flight time (block-block) for 7.5 hours prospection on site (Figure 14).



Figure 14 : Tracks of flights on 5, 11 and 12 of june 2010, representing survey 1 (source : Morgane Ramonet after Google.Earth 2010)

This first survey gave way to observation of 11 Red Tuna Schoals (BFT, *Thunnus thynnus*) with a concentration of 82% on lanes 10,11 and 12 at the East of the zone.

This second survey was flown from june 13^{th} to 17^{th} 2010, within 4 flights corresponding to 16.6 hours flight time (block-block) including 7.1 hours of prospection on site (Figure 15).



Figure 15 : Tracks of flights on 13,15,16 and 17 of june 2010 representing survey 2 (source : Morgane Ramonet after Google.Earth 2010)

Seven schoals of Albacores Tunas (ALB, *Thunnus albacares*) have been identified at waypoints 12, and 14 to 19 on zone and a Red Tuna Schoal (BFT, *Thunnus thynnus*) at waypoint 13. Points 14 to 19 stand for only 6 Albacores Tunas schoals identified and pictured, but the spotter estimated that around 20 schoals were present in this area of 4 square milles². Observations Results are detailed in paragraph 2.5.4.

The third survey was flown from june 18th to 25th within 4 flights, in a total flight time of 17.1 hours (bock-block) including 8.1 prospection hours. This survey gave way to an important number of observations with 22 schoals identified, spread on the whole zone. (figure 16).



Figure 16 : Tracks of flights on 18,19, 21 25 of june representing survey 3 (source : Morgane Ramonet after Google.Earth 2010)

The two species Albacore and Red Tunas (ALB, *Thunnus albacares* and BFT, *Thunnus thynnus*) were observed on zone. Waypoints 20 to 26 on the Western part of the zone, waypoint 30 in lane 9 and waypoints 32 to 36 and 38 to 41 in lane 10 are BFT schoals that is to say 17 waypoints, representing 77% of observations during this survey. The 5 other waypoints are ALB observations at waypoints 27 to 29, 31 and 37. Again the Team could spot a higher concentration in the eastern part, with close to 40% of observations in lane 10. The Team could also stress that observations 24 to 37 were all on the same day (june $21^{st} 2010$) and representent around 61% of lane 10 observations.

The fourth survey was flown from june 27th to 30th 2010 within 3 flights for a total flight time of 14.4 hours (block-block) including 6.7 prospection hours. This survey is not complete since total flight effort time had been reached for the zone : so lane 12 has been been flown 20 minutes instead of around an hour (Figure 17)



Figure 17 : Tracks of flights on 27, 28 30 of june, representing survey 4 (source : Morgane Ramonet after Google.Earth 2010)

This survey only gave way to six observations, the 2 first on the western part of the zone in lane 2, and the last two at the extreme East on lane 12 and the two others in central position in lane 8 and 9. Waypoints 42, 43 on the west and 46, 47 on the East are Red Tuna spotting (*Thunnus thynnus*). Waypoint 44 was Albacore Tuna (*Thunnus albacares*), and waypoint 45 stands for Bonitou Tuna (BLT, *Auxis rochei*).

2.5.4 TUNA SCHOALS OBSERVATION

As result on zone 6, the 4 surveys on zone allowed to identify 47 shoals of 3 different species : Red Tunas, Albacore and Bonitou in different proportions (Table 8).

Espèce/ survol	Survol 1	Survol 2	Survol 3	Survol 4	TOTAL
BFT, Thunnus thynnus	11	1	17	4	33 (70,2 %)
ALB, Thunnus albacares	0	7	5	1	13 (27,7%)
BLT, Auxis rochei	0	0	0	1	1 (2,1%)

Table 8 : Tuna Schoals observed zone 6, by species, number and surveys

2.5.4.1 <u>Red Tunas (BFT)</u>

Red Tunas (BFT) represented most of the observations with 70.2%. They were observed during each survey in very different proportions though, with two surveys having high concentrations, 11 and 17 schoals respectively in survey 1 and 3. The observation number of Albacore Tunas (ALB) was also significant with 27.7%. Albacore Tunas were spotted along surveys 2 to 4 with a higher concentration during surveys 2 and 3, that is to say from june 16th to 21st 2010. The unique observation of Bonitou Tuna (BLT) with an approximate mass of 2 tons is anecdotal, since very unlikely to be spotted due to their small size (with an average of 2 Kg) and due to their behaviour (constantly under the surface). Moreover, this was not the tagetted specie for the spotter.

As previously described in 1.1 the spotter's role extended to other parameters beyond the pure schoals detection : determine the observed individuals size, mass and behaviour information. Here is a comparison of cumulated schoals mass (in tons) depending on their location on surveys. When dividing each survey into 3 areas, from lane 1 to 5 for western part, 6 to 9 for central part and 10 to 12 for eastern, it allows to stress a more suitable area for observation.(Figure 18).





This figure points out that surveys 1 to 3 had more important cumulated mass with respectively 934 and 1000 tons. Moreover, separation of the zone into 3 areas (Western, central and Easter) stresses the Eastern area to be the more suitable for observation. Acutally 95% of survey 1 total mass was located there, 100% total mass in survey 2, 45% in survey 3 and 97% in survey 4. This can lead to two hypothesis, either schoals were more numerous in this Eastern area, or their mass was greater (individuals size or total number of individuals). According to surveys maps and this table (Table 9), it could be pointed out rather clearly than mass importance in this Eastern area is linked with the numbers of observed schoals

	Ouest	centre	Est
survol 1	2	0	9
survol 2	1	1	1
survol 3	4	4	9
survol 4	2	0	2

Table 9 : Observation number per survey and area on zone 6

This table enables a new question, effectively the number of aerial observations in survey 1 and 3 was the same, but figure 18 had a total mass of 882.5 tons for Eastern part of survey 1, whereas 495 tons for survey 3. It could then be interesting to visualise mass of each waypoints on Eastern part to better understand the schoals composition evolution between june 12th and 25th, respective date of flights over this Eastern part for survey 1 and 3. (Figure 19).



Figure 19 : Mass visualisation of schoals on eastern part, according to survey at stake.

This figure indicates that tunas schoals observed on june 25th were smaller, with an average of 43.9 tons for survey 3, whereas average is 98 tons for survey 1 with more than 6 schoals reaching or above 100 tons, whereas in survey 3 one single schoal reached over 100 tons. Individual mass of Tunas estimated by the spotter were also smaller during survey 3, with an average of 30 Kg per individual, whereas at least 45 Kg per individual in survey 1 observations, but this individual mass alone cannot explain mass differences.

Tuna Schoals observed along survey 3 are then smaller individual size and smaller total mass (less indivuduals per schoal).

2.5.4.2 <u>Albacores Tunas</u>

This specie represented 27.7% of the observations number, concentrated on surveys 2 and 3 (0 observations in survey 1 and one observation in survey 2). All waypoints are located in the same area of lanes 8 to 11. The individual size estimated is always the same, between 10-15 Kg per tuna. In the other hand, schoals configuration vary (Figure 20).



Figure 20 : Albacores Tunas Schoals mass (tons) according to waypoints

There were isolated schoals observed in waypoint 12, 27 and 28 with quite small mass (respectively 20, 2 and 2 tons). Besides, the 6 identified observations of waypoints 14 to 19 stand for more : there were on zone around 20 schoals of 20-30 tons each, that is to say a medium mass of 500 tons on a 4 square miles surface. Other observations were schoals composed by 2 groups, more or less merged with a schoal head well ahead in distance generally speaking (see pictures). The total mass of observations can be estimated at around 750 tons

As a conclusion on these results, in most cases BFT observations (*Thunnus thynnus*) and ALB observations (*Thunnus albacores*) took place in the eastern part of lanes 8 to 12. The 33 BFT observations (*Thunnus thynnus*) representing an average biomass of 2114 tons, and the 13 ALB observations (*Thunnus albacores*) representing an average biomass of 750 tons, next to the 2 tons of bonitou (*Auxis rochei*).

3. DISCUSSION

The objective of this mission was to collect as many biological and meteorological Datas as possible, while observation of Red Tuna schoals (*Thunnus thynnus*), in order to establish mathematical models on spawning population migration, and presence of young tunas, etc.

Prospections zones choosen by ICCAT were specificcally known areas of spawning, and consequently fishing areas also. The protocole established by ICCAT (*Hammond*, *P.*, 2001) is relatively simple, thus reproductible from a year to another. Nevertheless it might remain a few points to enhance aiming at a better Datas quality ?

The spotters were, as far as PTA was concerned, ancien spotters for the fish industry, consequently very experienced but also specialised in searching for big-size Tunas. It could be noticed that observation parameters could vary according to spotters, such as perpendicular distance, precision on biomass and size of tunas. Switching people during a mission, such as what PTA had to deal with on Malta areas, can rise bias on datas. It might be interesting in the future that all spotters abide by the very same technical observation protocol, in order to limit this bias ?

The planes used (Cessna 337, Skymaster) are upper wings plane ideal to watch the sea, but as described in Methods and Means has dead angles. Both PTA Teams used this plane, but it seems not all other Teams did so. Having several airplane types to carry out the observations could also induce a bias. Fit the aircrafts with bulb windows could possibly lower the bias between different planes ?

Teams were based in Cyprus for Turkish area, in a rather central position for the zone to study, and in Malta initialy for Lybian area in a remote location from the zone to study. (Then same location for area around Malta, which was perfect). The location of the base for each zone could also be enhanced on the years to come, trying to base planes near the middle of zones to study, according to diplomatic authorizations ?

Regarding results, this first year of Study shows a lot of diversity between zones, which can be partly explained by all sort of delays Teams had to cope with (including especially bad weather conditions on sites this year), time-shifting observations beyond what was originally planed.

Offsetting observation could disturb results. Red Tunas have a spawing cycle relatively well-know in Mediterranean Sea with spawing dates from may in eastern Mediterranean (Turkish and Egyptian zone) and from june in central Mediterranean (Malta zones) (*Heinisch, G., and al., 2008*). These spawning periods are the best to observe spawning Tunas, grouped and searching for food at the surface. Next to them, only small individuals (below 25 Kg) and medium size individuals (25 à 150 Kg) were observed in zone 6 (Tukey), including mostly schoals with 30 to 50 Kg individuals, so non matures or juvenile spawning (*Heinisch, G., and al., 2008.*). None individuals above 100 Kg could be observed in zone 6. First flights began on june 5th in zones 4 and 6 at the same time, time period which could likely lead to observation of big-individuals schoals in central Mediterranean (zone 4) but seemed a little late already for zone 6, since spawning period is very short from end of may (*Karakulak, S., and al., 2003*).

Moreover, this year the fishing-season extended from may 15th til june 15th. It is then likely that part of the big size spawning individuals had aleady been caged before observation on sites. This hypothesis could be verified in the future by checking in parallel the captures datas observed by spotters at sea working for ICCAT on fishing-boats ? For central Mediterranean, time period seemed thus more suitable for flights aiming observation of big-individuals schoals. Considering a Red Tuna becomes mature at the age of 4, for an approximate mass of 25 Kg, several schoals of these spawning individuals could be observed on zone : in zone 8 for instance, sizes varried between 25 to 300 Kg. But for zone 7, the late date of flights from june 20th might have biased spawning observations, as some of them might already be in cage or migrating.

4. CONCLUSION

The GBYP programme aims to collect as much basic data as possible, with biological and ecological informations for ICCAT while aerial observation of BFT schoals.

Zones at stake here are the ones for which PTA (Périgord Travail Aérien) had been granted the Study, that is to say zones 4, 5 and 6 respectively North Libya, Egypt, and South Turkey.

To face diplomatic situations, flight effort time had to be moved from zones 4 and 5 to zones 7 and 8. Total flight time realized was 158.8 hours (block-block) for 75.78 hours of active prospection on differentes zones. For Malta zones (4, 7 and 8), 91.7 hours have been flown (out of 73 initialy planed on zone 4 : 9.9h for zone 4, 36.9h for zone 7 and 48.9h for zone 8). Zone 5 (Egypt) couln't be overflown. A flight of 2.7h had been realizes on june 9th and 18.7h reported on Malta zones 7 and 8, reaching a total of 21.4h out of 60 initially planed. In zone 6 (Turkey) 100% of time effort could be realized with 66 hours.

Regarding final results, this first year of Study shows diversity according to zones. In Eastern Mediterranean, flights gave way to 47 Tunas schoals observations, including 33 BFT (*Thunnus thynnus*), 13 ALB (*Thunnus albacores*) and 1 bonitou tuna schoal (*Auxis rochei*), respectively 2114, 750 and 2 tons. For BFT (*Thunnus thynnus*), there were mostly individuals with mass between 30 to 60 Kg. Flights occurred from june 5th to 30th 2010 in 15 flights, with rather few bad weather constraints. On the opposite in Central Mediterranean, numerous flights have been canceled or delayed due to bad weather conditions. This is mostly why flights occurred from june 3rd until august 3rd 2010, exceeding by far what was initially planed. flights gave way to 47 Tunas schoals observations 1, 7 and 8 schoals so 0.25 tons, 860.5 tons and 1 777 tons of Red Tunas (*Thunnus thynnus*), respectively on zones 4, 7 and 8. On zone 4, Red Tunas observed were smaller sized (below 25Kg), whereas average size (25 to 150 Kg) on two other zones, even up to 300Kg for certain on zone 7.

In order to obtain an accurate tendancy of Tunas observations, it would be interesting to compare them with studies to come in the following years of the GBYP programme to confirm these first results.

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