ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP)
AERIAL SURVEY PROTOCOL 2017

1 Introduction

The objectives of the comprehensive ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (GBYP) are to improve basic data collection and our understanding of key biological and ecological processes in the Mediterranean Sea, and to develop a robust scientific management framework.

An important element of this programme is to develop fisheries independent indices of population abundance. Therefore, since 2010 aerial surveys have been conducted in the Mediterranean on the most documented spawning grounds. The frequency and study areas of these surveys have been variable over the years, and because of this there are some statistical problems in obtaining accurate and comparable abundance estimates for this period of time.

There have also been some differences in the data collection protocols which have partly biased and affected further analyses and results. If yearly comparable abundance estimates are needed, it is essential to carry out surveys following exactly the same data collection and analysis methodology.

This aerial survey protocol will try to detect potential data collection problems identified in previous years and will be an agreed reference document that will have to be followed by all companies contracted by ICCAT in 2017.

1.1 Target species

The core objective of the ICCAT GBYP aerial survey is to provide annual relative abundance minimum estimates for bluefin tuna (*Thunnus thynnus*) spawners in the Mediterranean Sea. However, data will be also collected (when possible) for all species encountered (mainly other tunas and big fish, cetaceans, and turtle species) if this does not compromise data collection for the target species.

1.2 Overview of methodology

The ICCAT GBYP surveys will use line-transect DISTANCE sampling to estimate abundance. The survey aircrafts will follow pre-designed tracklines in the survey blocks as described in Cañadas & Vázquez, 2017 (**Figure 1**).

The main idea of the line-transect DISTANCE sampling method is to obtain a precise abundance estimate of a highly representative sample area, and extrapolate its density to the total area in each survey block. In those studies where the objects of interest are sessile and easily detectable it is possible to define the sample area before carrying out the survey, whereas when observing non-easily detectable species such as other fish or cetaceans, the sample area must be estimated afterwards.

Therefore, it is essential to obtain a precise sample area to avoid bias during the extrapolation process.

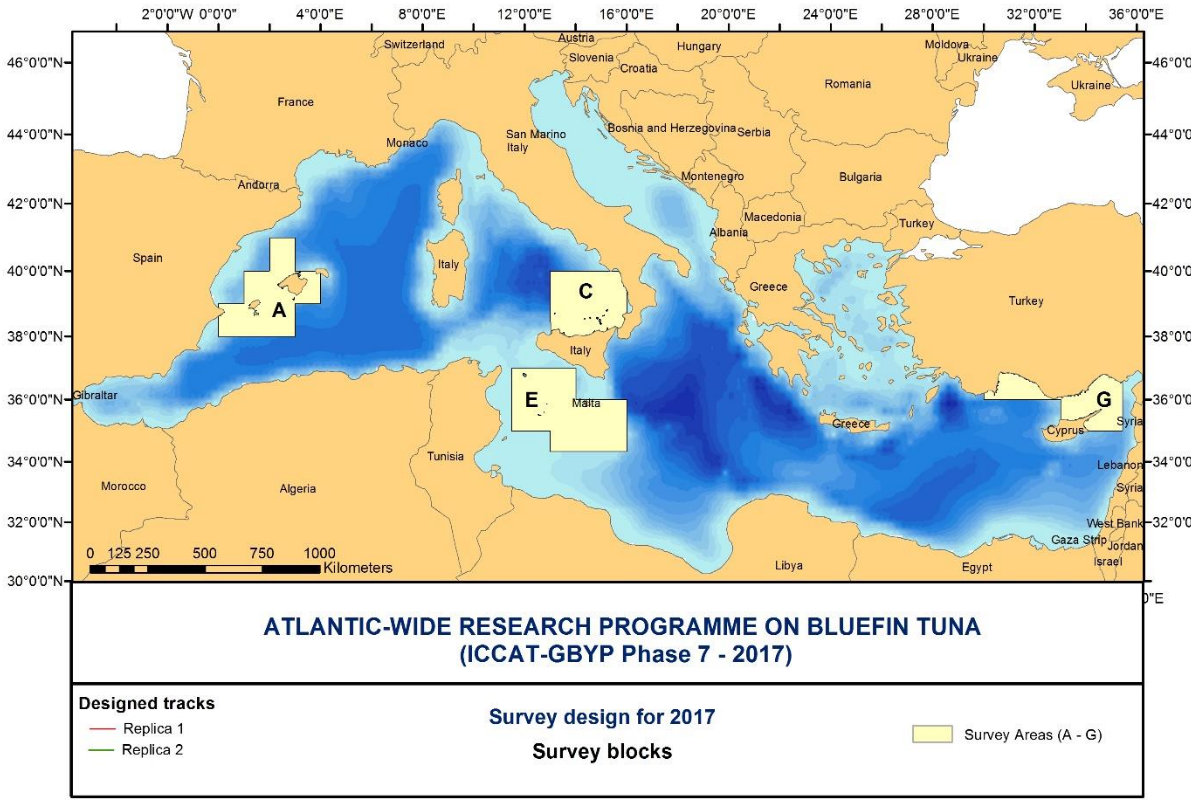


Figure 1. Survey blocks for 2017.

1.3 How to estimate a sample area

The estimated sample area is calculated by collecting perpendicular distances to the study objects, bluefin tuna in this case. When spotting sessile objects, perpendicular distances (p) can be measured directly when the object is abeam (**Figure 2A**), but when working with moving animals, traditionally perpendicular distances (p) are calculated from angles (ϴ) and radial distances (r) (**Figure 2B**).

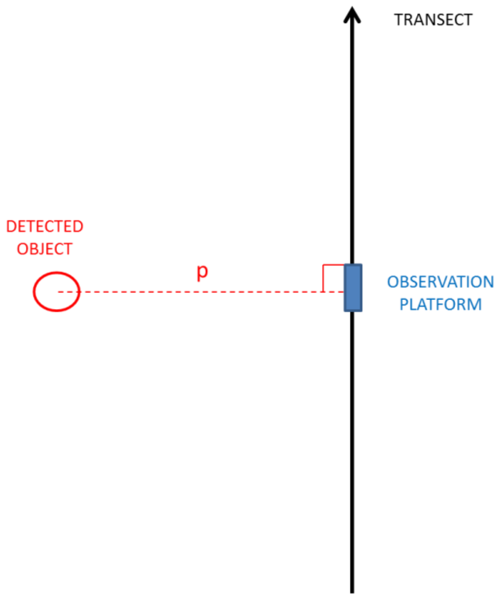


Figure 2A

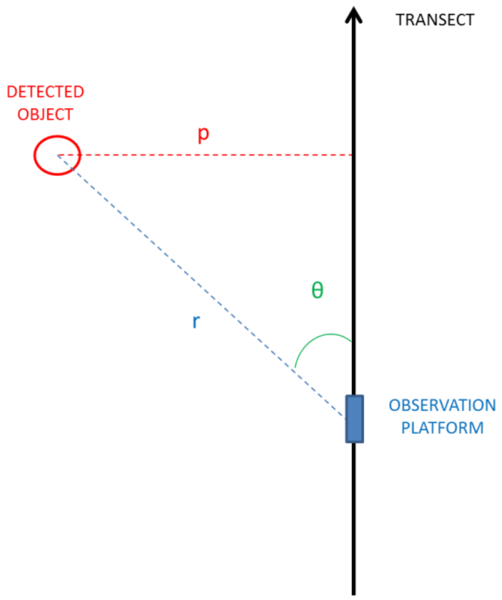


Figure 2B

In shipboard line transect surveys the second method is usually used to estimate perpendicular distances. In contrast, in aircraft line transect surveys where the aircraft is travelling at a much faster speed and the observers are in the rear seats looking through the bubble windows, perpendicular distances are recorded when animals are detected abeam. In aerial surveys the observation platform is located above sea level, where animals are detected, and therefore declination angles (α) as provided by the inclinometer are recorded in order to estimate perpendicular distances between detected objects and the transect (**Figure 3**).

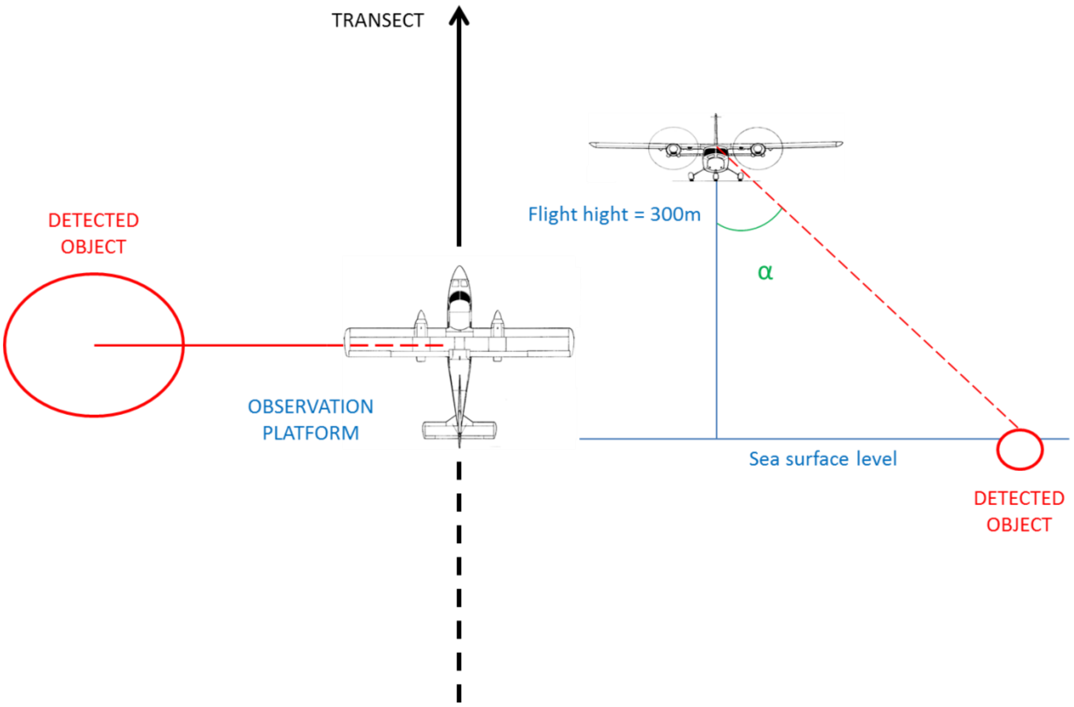


Figure 3. Traditional procedure to estimate perpendicular distances in aerial surveys using inclinometers.

The specifications on how the declination angle must be recorded will be described later in this protocol.

After the survey has been conducted, the so-called "effective strip width" is calculated using DISTANCE software, by adjusting the shape of the perpendicular distance frequencies histogram to a mathematical "detection function". Once the sample area has been calculated, it is possible to obtain the sample density.

1.4 Why is it important to obtain accurate declination angles and perpendicular distances?

As explained earlier, in order to establish the sample area and density, it is necessary to record perpendicular distances. If declination angles, and therefore perpendiculars distances, are not recorded properly, significant bias can occur as shown in the next example.

Let us suppose that our block area is 100 square kilometres, our total transect length is 20 km and 45 schools have been detected during the survey carried out. If we estimate an "effective strip width" of 0.25 km on each side of the aircraft, the sample area would be 20x0.25x2 = 10 square kilometers. The sample density would be 45/10 = 4.5 animals per square kilometre and in extrapolating this density value to the total block area the abundance would be 450 animals.

However, the declination angles and perpendicular distances can be overestimated. For example, for an "effective strip width" of 0.5 km, the sample area would be 20x0.5x2= 20 square kilometres and the sample density 45/20= 2.25 animals per square kilometer. Therefore, the abundance in the total block area would be 225. This is exactly half the number of animals.

IN CONCLUSION, IT IS ALWAYS ESSENTIAL TO OBTAIN ACCURATE RECORDS OF DECLINATION ANGLES!

2. The team

The aircrafts must have upper wings and bubble windows. The survey must to be conducted at a constant speed (100 knots) and altitude(300 m).

The survey team consists of a pilot (having previous experience in bluefin tuna spotting activities), a professional spotter (with previous experience in bluefin tuna spotting activities), and two scientific spotters (with experience in aerial surveys, preferably in bluefin tuna ones).

Pilot (P): This person is the authority inside the aircraft, is responsible for flight safety and his/her decisions are mandatory for all the crew members.

- Before starting the journey, once all checks have been made, he/she will ensure that the aircraft is ready for flying.
- During the flight, his/her duties (among the usual ones) will be to keep the aircraft just on the trackline (no more than 200-400 m far away from the line), at a constant speed (100 knots) and altitude (300 m). When a bluefin tuna school is detected and once it is abeam, he/she will leave the transect and fly around the school to take better estimates of size and weight.
- He/she should also be a professional tuna spotter, even if his/her involvement in spotting will be minor compared to the usual duties of a pilot.
- After the journey he/she will be responsible for checking the weather forecast and for deciding if the conditions are secure to fly the next day. The effort starting point must be discussed with the Scientific Spotter responsible for data collection.

Professional spotter (PS): This person is usually the most experienced in detecting bluefin tuna schools and estimating weight and school size. His/her task will be to search for BFT schools and give all the requested data to the scientific spotter (species, group size and weight). He/she should train the other team members how to detect BFT schools and how to estimate weight and size. He/she will always be in the front right seat in "on effort" mode (**Figure 4**). He/she may take other seats only in "off effort" mode.

Although the target species is BFT, provided that the main objective of the survey is not compromised, he/she shall also give the same data when detecting other tuna species, big fish, cetaceans and turtle species.

Scientific spotter **(SS)**: The most experienced SS will be the person mainly responsible for data collection, determining with the pilot the starting point for each day, and ensuring good effort coverage, as required by the DISTANCE sampling methodology. He/she will be the called *"Cruise Leader (CL)"*. The other SS will help him/her.

In "on effort" mode, one of the SS will record the effort search conditions at every starting / finishing point and whenever any of the search conditions change. The two SS will alternate in carrying out this task.

The sighting data will be recorded by the SS who is on the opposite side from where the sighting is detected. The other SS shall provide or check the basic data on declination angle, species, group size and weight**; the spotters on the same side will provide their personal independent estimate of the school size and possibly the weight and those data shall be both recorded on the sighting form.** When circling over the school, the SS on the side closer to the sea will be in charge of taking photos.

The SS will rotate every time the aircraft lands or at mid cruise time in case of long cruises.

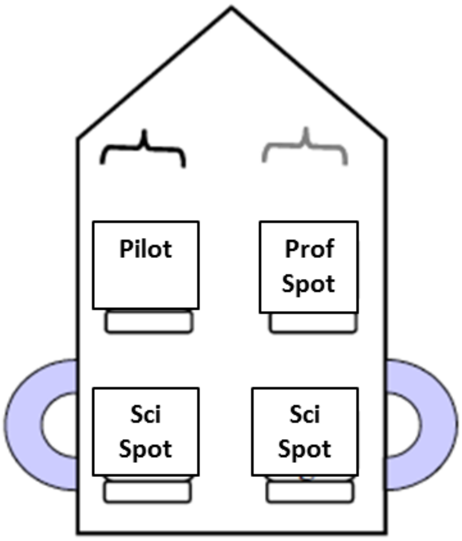


Figure 4. Positions of each team member in the aircraft.

3. Conditions for survey

Generally, a sea state of 3 or less on Beaufort scale, in conjunction with other minimum requirements (e.g. minimum visibility of around 3.5 km) are necessary to have survey conditions good enough for BFT spotting. Bad weather conditions mean winds over 3 on Beaufort scale, or low clouds (less than 300 m from the surface), or heavy rain, or very limited visibility due to fog. Bad weather conditions prevent reliable observation of tuna schools close to the sea surface.

It is the responsibility of the CL to determine if conditions are acceptable from a scientific point of view and the pilot determines whether conditions are appropriate from a safety point of view; <u>in case of discrepancy the pilot's decision is final.</u>

The decision whether it is appropriate to carry out the survey on any particular day (or to abort a survey) will be taken by the CL and the pilot, based on the best available weather forecast and the prevailing conditions. Information for this can be obtained from a number of sources including airports, various internet sites, shipping forecasts, etc.

Operative time shall be limited by good light conditions.

In addition to the objective parameters (sea state, turbidity, cloud cover, glare, etc.), it has been found that "subjective" estimation of overall sighting conditions best correlate with actual sightings data. As BFT is the primary target species for the ICCAT GBYP aerial surveys, the estimation of overall sighting conditions is based on the observers' opinion as to the probability of seeing BFT in the primary search area (i.e. from dead ahead to abeam and out to a declination angle of 20°). Conditions may vary on either side of the plane (particularly, but not exclusively, due to glare). Three categories can be chosen to be filled for each side (note that their definitions are necessarily vague as they represent a subjective estimation of a variety of factors):

Good: This is when the observer believes that the likelihood of seeing BFT within the search area is reasonably good. Normally, good subjective conditions will require a sea state of 2 or less on a Beaufort scale and a turbidity of less than 2.

Moderate: This is when the observer believes that the likelihood of seeing any BFT within the search area is lower than good.

Poor: This is when the observer is not able to detect any BFT within the search area. For example when the searching area of one side is completely covered by strong glare. If both sides are assessed as "poor" the searching effort has to stop and change to "OFF".

In an ideal world, we would survey the whole area in "good" conditions, which should be the aim. However, there must be a balance between coverage in good conditions and the need to cover as much of the survey area as possible; it is better to cover an area in moderate conditions than not to cover it at all. Therefore, depending on the time available, it may be necessary to cover some areas in moderate conditions. This will ultimately be the cruise leader's decision, in consultation with the pilot.

There is no advantage in extensive flying in poor conditions hoping for improvements (of course, never circle in poor conditions). Data collected in poor conditions (on both sides of the trackline) will not be included in the analyses and thus extensive surveying in poor conditions is simply an inefficient use of expensive flying hours. Again, it is the cruise leader's responsibility, after consultation with the pilot, to decide to abandon surveying for the day.

4. Equipment

4.1 Essential equipment

- Clinometers (3 or 2) – mandatory
- Effort and sighting forms (ring binder preferred) – mandatory
- 2 GPS and rechargeable batteries – mandatory
- 1 camera with high sensitivity, and zoom lenses 70-200 or 75-210 or 80-200, equipped with a polarized filter and memory cards – mandatory
- Laptop with external hard disk – mandatory
- 4 notebooks, 4 pens and 4 pencils
- 2 permanent waterproof marker and alcohol 96º
- 1 videocamera
- Binoculars 7x50
- Digital recorders

4.2 Personal equipment

- Passport (mandatory when the area includes non-EU countries) or national identity document – mandatory
- ICCAT ID cards – mandatory
- Sunglasses (possibly polarised) and watch
- Water and food
- Sickness pills
- Comfortable clothes
- Windscreen cleaners

5. Searching behaviour

DISTANCE sampling methodology suggests selecting the proper speed and altitude after some preliminary survey work. As shown in the 2013 survey reports, the altitude and speed during field work were approximately 1000 ft and 100 knots, respectively. As reference, **Figure 5** shows the correlation between the key declination angles and perpendicular distances at the altitude of 1000 ft.

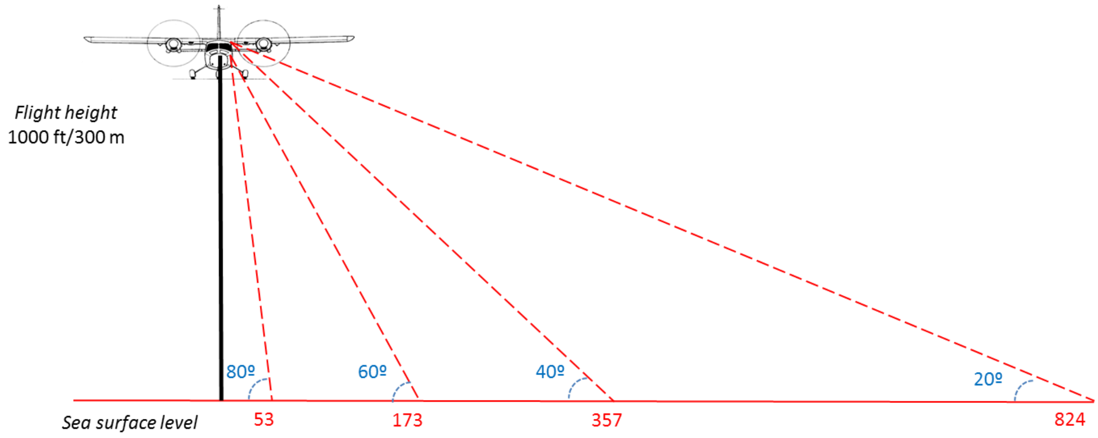


Figure 5. Correlation between the key declination angles and perpendicular distances at an altitude of 1000ft = 300m.

Ideally, the altitude would be high enough so that the animals would be undisturbed, thus avoiding movement prior to detection. Nevertheless, the aircraft should be flown as low as possible to enhance detection of animals and ICCAT GBYP has decided on an altitude of 300 m. Line transect methods are appropriately named because the distance is critical; the closer to the vertical sighting the better the methodological approach and the quality. Search behaviour must try to optimize the detection of animals in the vicinity of the line, and search effort or efficiency should decrease smoothly with distance. The aims are to ensure that the detection function has a broad shoulder and the probability of detection at the line is unity (Buckland, *et al.*, 1993).

According to this, observers must be trained in how to search for animals and which proportion of areas (declination angles) should be sampled with more intensity. Always concentrate most of the effort in the closest area, between 90º and 40º, and less effort for animals up to 20º (**Figure 6**). Occasional effort should be devoted in looking at a lower angle (higher distance) but never more than 7.5 km far from the aircraft.

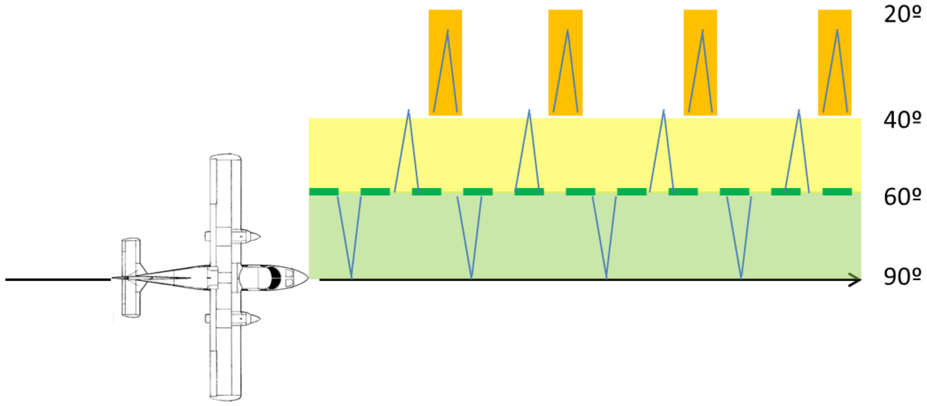


Figure 6. Scheme of search behavior in aerial surveys.

Table 1 provides a list of distances from the perpendicular of the aircraft according to various declination angles at 300 m altitude. Sightings at a distance more than 7.5 km, even if recorded, will not be included in the analysis.

Declination angle	Perpendicular distance(m)
90	0
85	26
80	53
75	80
70	109
65	140
60	173
55	210
50	252
45	300
40	358
35	428
30	520
25	643
20	824
15	1120
10	1701
5	3429
2,3	7469

Table 1. Correlation between declination angles and perpendicular distances.

6. Collecting data

It is mandatory to provide ICCAT GBYP with effort forms, sighting forms and all GPS track data in Excel format.

6.1 Effort data form

Aerial surveys are conducted at relatively high speed (100 knots), so generally effort conditions should not change in full “on effort” period. One of the SS shall fill out the effort form just before starting the transect, when the aircraft is at the right altitude and speed and on the correct course. If any of the search conditions changes in the “on effort” period, then a new “on effort” form must be completed by the SS. The effort form must also be filled at the end of each transect, while the aircraft is still at the same altitude and speed and on the same course.

<table>
<tr><td>Date</td><td>Enter the day/month.</td></tr>
<tr><td>Time</td><td>Enter GMT Hour (hh:mm:ss)</td></tr>
<tr><td>Event</td><td>ON: start effort. OFF: end effort. LA: flying over land.
LE: leaving transect. RE: rejoin transect.</td></tr>
<tr><td>LAT</td><td>Enter latitude (example: 35º 14.45 or 35.24583) decimals are preferred
https://www.fcc.gov/encyclopedia/degrees-minutes-seconds-tofrom-decimal-degrees</td></tr>
<tr><td>LON</td><td>Enter longitude (example: 2º 18.33 or 2.30916) decimals are preferred
https://www.fcc.gov/encyclopedia/degrees-minutes-seconds-tofrom-decimal-degrees</td></tr>
<tr><td>Subarea</td><td>Survey area in Figure1 (A-I, C-I, E-I or G-I).</td></tr>
<tr><td>Survey</td><td>Number of survey. Each flight is a new survey.</td></tr>
<tr><td>Transect</td><td>Code of the transect that is going to be surveyed.</td></tr>
<tr><td>Pilot</td><td>Enter the numeric code (XX) for the pilot</td></tr>
<tr><td>Front spotter</td><td>Enter the numeric code (XX) for the spotter on the front seat.</td></tr>
<tr><td>Spotter on the left rear sit</td><td>Enter the numeric code (XX) for the spotter on the left rear seat behind the pilot</td></tr>
<tr><td>Spotter on the right rear seat</td><td>Enter the numeric code (XX) for the spotter on the right rear seat</td></tr>
<tr><td>Altitude</td><td>Enter the flight altitude in meters</td></tr>
<tr><td>Sea State</td><td>Enter the sea state following the Beaufort wind scale:
<table>
<tr><td>Beaufort Force</td><td>Sea State</td><td>Description</td></tr>
<tr><td>0</td><td>Calm</td><td>Sea like a mirror</td></tr>
<tr><td>1</td><td>Very Light</td><td>Ripples with appearance of scales, no foam crest</td></tr>
<tr><td>2</td><td>Light breeze</td><td>Wavelets, small but pronounced. Crest with glassy appearance but do not break</td></tr>
<tr><td>2.5</td><td></td><td>Start to appear some isolated whitecaps</td></tr>
<tr><td>3</td><td>Gentle breeze</td><td>Large wavelets, crests begin to break. Glassy looking foam, occasional white horses</td></tr>
<tr><td>4</td><td>Moderate breeze</td><td>Small waves becoming longer, frequent white horses</td></tr>
</table></td></tr>
<tr><td>Haze</td><td>Enter the haze intensity. 0: no haze; 1: slight; 2: moderate; 3: diffused; 4: heavy/foggy</td></tr>
<tr><td>Turbidity</td><td>Enter turbidity parameter based on the following:</td></tr>
</table>

	0 - clear water: animals visible at many m depth 1 - moderately clear water: animals visible under the surface 2 – moderately turbid water (e.g. mud): animals visible just under the surface 3 – turbid: full lack of transparency
Clouds	Use the octaves system (i.e. full cloud cover = 8, clear sky = 0)
Glare Side	Enter the side where glare is: P: port; S: starboard, SP: port and starboard
Glare Sector	Use the 360° system (NB dead ahead is 360 not 0) with glare from XX° to XX° measured clockwise - e.g. 360° to 180° means the right side of the plane is covered in glare whereas 180° to 360° means the left side of the plane is covered by glare
Glare Intensity	Enter glare intensity based on the following: 0 - no glare 1 - slight glare - very little effects on observations 2 - moderate glare - may affect sightings in the sector 3 - strong glare - severely affecting sightings
Subjective Search Conditions (PORT)	This represents subjective view of the scientific spotter behind the pilot, of the likelihood that, considering all of the conditions (Beaufort, glare, turbidity,..etc), they would see a BFT within the primary search area if present. The primary options are: **Good** (G): the spotter believes that the likelihood is good. Normally will require at least a sea state of 2 or less and a turbidity of less than 2. **Moderate** (M): the spotter believes that the likelihood while not good, is not poor. **Poor** (P): the spotter is not able to detect any BFT within the search area. For example when the searching area of one side is completely covered by strong glare.
Subjective Search Conditions (STARBOARD)	This represents subjective view of the scientific spotter behind the professional spotter, of the likelihood that, considering all of the conditions (Beaufort, glare, turbidity,..etc),, they would see a BFT within the primary search area if present. The primary options are: **Good** (G): the spotter believes that the likelihood is good. Normally will require at least a sea state of 2 or less and a turbidity of less than 2. **Moderate** (M): the spotter believes that the likelihood while not good, is not poor. **Poor** (P): the spotter is not able to detect any BFT within the search area. For example when the searching area of one side is completely covered by strong glare.
Comments	Enter any relevant comment if needed.

6.2 Sighting data form

Aerial surveys are conducted at high speed, so the spotter has around 5 seconds to detect animals in the search area. Every crew member must know what to do when a sighting is announced. Some examples about who has to do what are explained below in point 7.

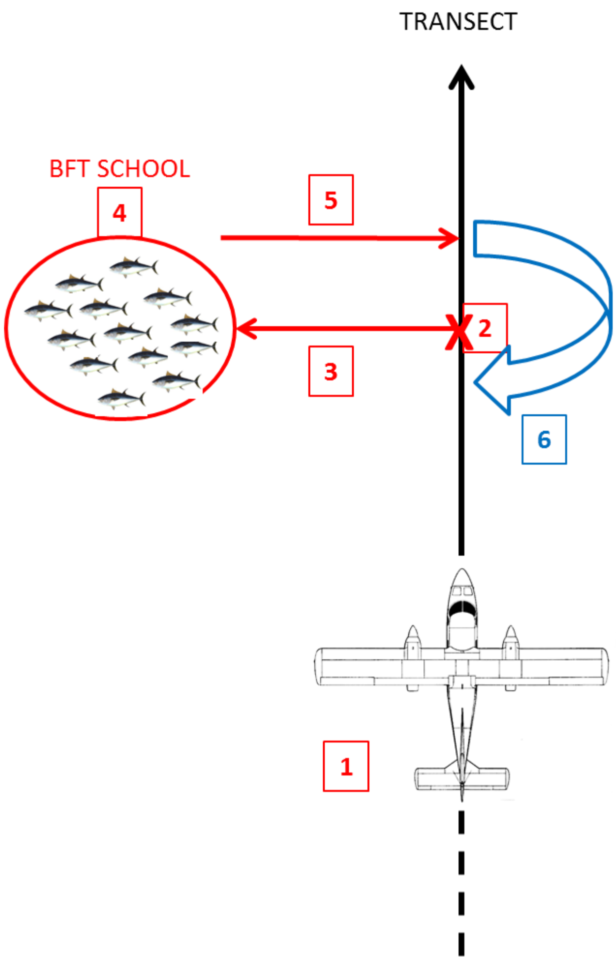
THE SIGHTING DATA MUST BE FILLED BY THE SCIENTIFIC SPOTTER LOCATED ON THE SIDE OPPOSITE FROM THE DETECTED ANIMALS.

Number	Enter the accumulated sighting number
Date	Enter the **day/month**.
Time	Enter **GMT** Hour (hh:mm:ss)
Event	Enter the event code. **F:** when animals first sighted, **A**: when animals abeam, **C**: when arriving over the animals for circling
LAT	Enter latitude (example: 35º 14.45 or 35.24583) https://www.fcc.gov/encyclopedia/degrees-minutes-seconds-tofrom-decimal-degrees
LON	Enter longitude (example: 2º18.33 or 2.30916) https://www.fcc.gov/encyclopedia/degrees-minutes-seconds-tofrom-decimal-degrees
Abeam?	Enter **Y** if the angle has been recorded abeam or **N** if the angle has not been recorded abeam.
Angle abeam	Enter the angle abeam in degrees
Altitude	Enter the flight altitude in meters at the moment of taking the angle abeam
Observer	Enter the two numbers identifying each spotter (XX)
Cue	Enter cue code based on the following: **SP: splash** = fish jumping clear off the water or splashing on a side. **RI: ripples** = fish swimming just below the surface, with the dorsal side moving the surface. **SH: shining** = classical behaviour of spawners, when fishes come to the surface, swimming on a side for a few seconds, reflecting the sun light like mirrors. **TR: travelling** = fish going clearly in a certain direction. **UN: underwater** = body seen under water surface. **SU: surface** = body seen at surface. **VG: vessel/gear** = vessel or gear detected just before animals. **BL: blow** (cetaceans). **JU: jump** (cetaceans). **SL: slick, flukeprint** (cetaceans). **BI**: **birds**. **CE**: **cetaceans**. **FI: fish**. **OT: other**.

<table>
<tr><td>Species</td><td>Enter species identification code based on the following:
<table>
<tr><th>FISH SPECIES</th><th>CETACEAN SPECIES</th><th>OTHER MARINE SPECIES</th></tr>
<tr><td>BFT: bluefin tuna</td><td>SPE: sperm whale</td><td>MOS: monk seal</td></tr>
<tr><td>ALB: albacore</td><td>FIN: fin whale</td><td>CAR: loggerhead turtle</td></tr>
<tr><td>SWO: swordfish</td><td>MIN: minkie whale</td><td>LEA: leatherback turtle</td></tr>
<tr><td>SHA: shark</td><td>WHA: other whale</td><td>UNT: unidentified turtle</td></tr>
<tr><td>MOB: manta</td><td>COD: common dolphin</td><td>OTH: other</td></tr>
<tr><td>UNF: unidentified fish</td><td>SDO: stripped dolphin</td><td></td></tr>
<tr><td></td><td>BOT: bottlenose dolphin</td><td></td></tr>
<tr><td></td><td>RDO: roughtooted dolphin</td><td></td></tr>
<tr><td></td><td>UDO: unidentified dolphin</td><td></td></tr>
<tr><td></td><td>KIL: killer whale -Orca</td><td></td></tr>
<tr><td></td><td>RIS: Risso´s dolphin</td><td></td></tr>
<tr><td></td><td>PIL: pilot whale</td><td></td></tr>
<tr><td></td><td>CUV: Cuvier´s beaked whale</td><td></td></tr>
<tr><td></td><td>UMM: unidentified cetacean</td><td></td></tr>
</table></td></tr>
<tr><td>Size PS</td><td>Enter the school size estimated by the Professional Spotter</td></tr>
<tr><td>Weight PS</td><td>Enter the weight in kilograms estimated by the Professional Spotter</td></tr>
<tr><td>Size P/SS</td><td>Enter the school size estimated by the Pilot or the Scientific Spotter</td></tr>
<tr><td>Weight P/SS</td><td>Enter the weight in kilograms estimated by the Pilot or the Scientific Spotter</td></tr>
<tr><td>Leave?</td><td>Enter Y: yes if have left the transect to get closer to animals, and N: if not</td></tr>
<tr><td>Photos?</td><td>Enter Y: yes if photos of the school have been taken, and N: if not</td></tr>
<tr><td>Numbers</td><td>Enter the number of the first and last photo that have been taken, as in the LCD camera. Set the same time of the GPS.</td></tr>
<tr><td>SCHOOL COMPONETS</td><td>Enter estimates (in number of individuals) based on the following:
% Small: individuals < 25 kg.
% Medium: individuals from 25 to 150 kg.
% Large: individuals from 150 to 300 kg.
% Giant: individuals > 300kg.</td></tr>
<tr><td>Cetaceans</td><td>Enter Y: yes if there were cetaceans associated with BFT, and N: if not</td></tr>
<tr><td>Birds</td><td>Enter Y: yes if there were birds associated with BFT, and N: if not</td></tr>
<tr><td>Comments</td><td>Enter any relevant comment if needed</td></tr>
</table>

7. Actions to follow when a BFT sighting is detected

7.1 Case 1. The school is close enough to obtain all data



1. The crew member who sees the animals first shall communicate it to the others. The SS on the opposite side from where the animals were detected shall fill out the number, date, hour, event (F) lat and lon.

2. The aircraft keeps the course until animals are abeam. In that precise moment the SS on the side of the sighting shall take the declination angle. The other SS shall once again fill out the hour, event (A), lat, lon, angle, observer, cue, and species, and fill with "Y" in column "Abeam

3. It is mandatory in all BFT sightings[1] to leave the transect to obtain a better estimate of the school weight and size, when the pilot gives the signal to leave, the SS shall note time, event (LE), lat and lon.

4. When starting the circles, the pilot shall notify the SS who will note again, time, event (C), lat and lon. This position shall correspond to the limit of the circle so the position of the sighting shall be calculated after the survey with GIS tools. Circles must always be clockwise; therefore, the PS has the best view of the school. ". **<u>It is MANDATORY always to record both estimates by the PS and the SS independently</u>.** In the case where the school has been detected by another crew member, SS shall note both separate estimates (from the pilot or the other SS plus the PS). The SS on the same side is in charge of taking photos when possible.

The PS shall look at the school for improved estimates and the SS on the same side can take better photos.

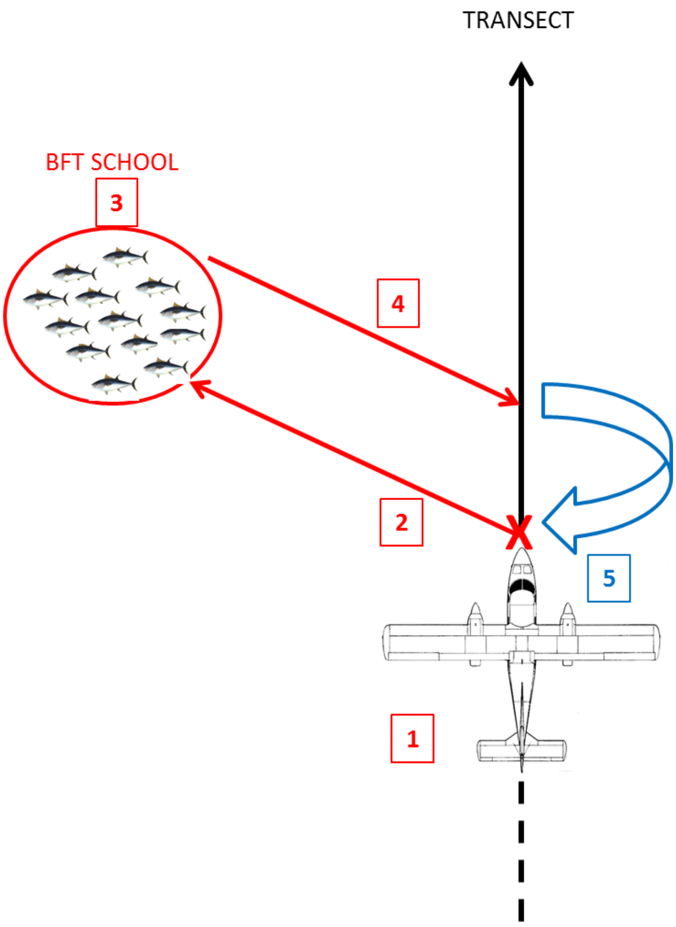
5. After 1 or 3 circles (depending on the difficulty of the estimate), the aircraft shall return to the point where it left the transect. During this short period, the SS ensures that all data have been properly recorded.

6. The pilot shall manoeuvre as shown in **Figure 7** and shall notify the SS when the aircraft returns to the transect is reached. SS shall note hour, event (RE), lat and lon.

[1] See point 7.3 for exceptions.

Figure 7. How to proceed in a normal sighting situation.

7.2 Case 2. There is a high risk of losing the school before being abeam



1. The crew member who sees the animals first shall communicate it to the others, pointing out that there is a high risk of losing the animals. The SS on the opposite side from where the animals are detected shall fill out the number, date, hour, event (F) lat and lon. The pilot shall notify when leaving the transect (please note that you are leaving the transect before sighting is abeam). If is possible to measure the angle before leaving the transect, notice that it was taken before being abeam by writing "N" in column Abeam. When the aircraft leaves the transect the SS shall write in event (LE) and record time, lat, lon.

2. While the aircraft maintains the course towards the animals, the SS shall fill out observer, cue and species.

3. When starting the circles, the pilot shall notify the SS who will again note time, event (C), lat and lon. This position shall correspond to the limit of the circle so the position of the sighting shall be calculated after the survey with GIS tools. Circles must always be clockwise; therefore, the PS will have the best view of the school.

It is MANDATORY always to record both estimates by the PS and the SS independently . In the case where the school has been detected by another crew member, SS shall note both separate estimates (from the pilot or the other SS plus the PS). The PS shall look at the school for improved estimates and the SS on the same side can take better photos.

4. After 1 or 3 circles (depending on the difficulty of the estimate), the aircraft shall come back to the point where it left the transect. During this short period, the SS ensures that all data have been properly recorded.

5. The pilot shall manoeuvre as shown in **Figure 8** and shall notify the SS when the aircraft returns to the transect is reached. SS will note hour, event (RE), lat and lon.

Figure 8. How to proceed if there is a high risk of losing the school before being abeam.

7.3 Case 3. Two or more schools are detected at the same time.

Although is not common, during the survey it is possible to detect two or more schools of BFT at the same time, on the same side or on both sides. Whenever is possible, each group should be registered as a single sighting as shown in Case 1. However, in the field it is not always possible to do this, for example, when there is a high risk to lose the location of the first sighting while trying to being abeam of the second one to get a precise angle measurement.

So, in this tricky situation, the CL should assess the situation and identify the easiest group to be tracked. Before leaving the transect, perpendicular distances of all sightings should be registered and only then the aircraft can leave the transect and start circling around the schools that was previously identified as the easiest one. Once finished circling around the first school, and if still possible, the aircraft can immediately fly towards the other school, without returning to the transect, and start circling around the second one. If the conditions allow for it, the same should be repeated with the third and any further school, provided that their perpendicular distances had been taken. Once circling around all schools has been done, the aircraft should return to the same point of the transect from which it has left (**Figure 9a, 9b**).

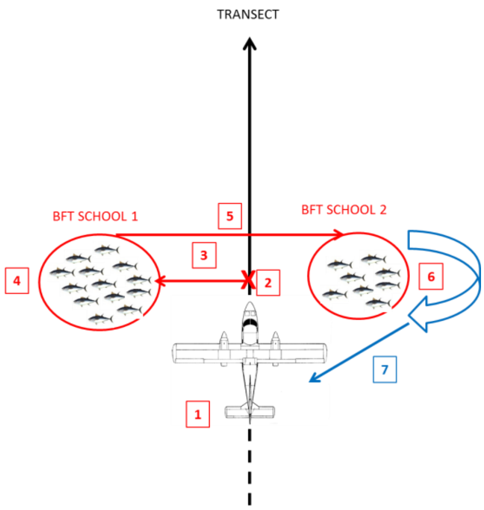


Figure 9a. Two sightings detected at the same time on two sides located relatively close one from the other.

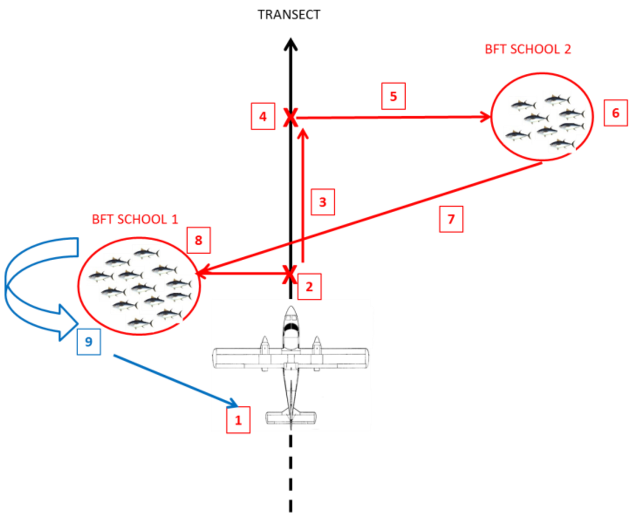


Figure 9b. Two sightings detected at the same time on two sides located relatively far one from the other.

If a secondary sighting was detected after leaving the transect to circle a primary sighting, the CL should prioritize the collection of size and weight of the first one and after that fly to the secondary sighting (**Figure 10**).

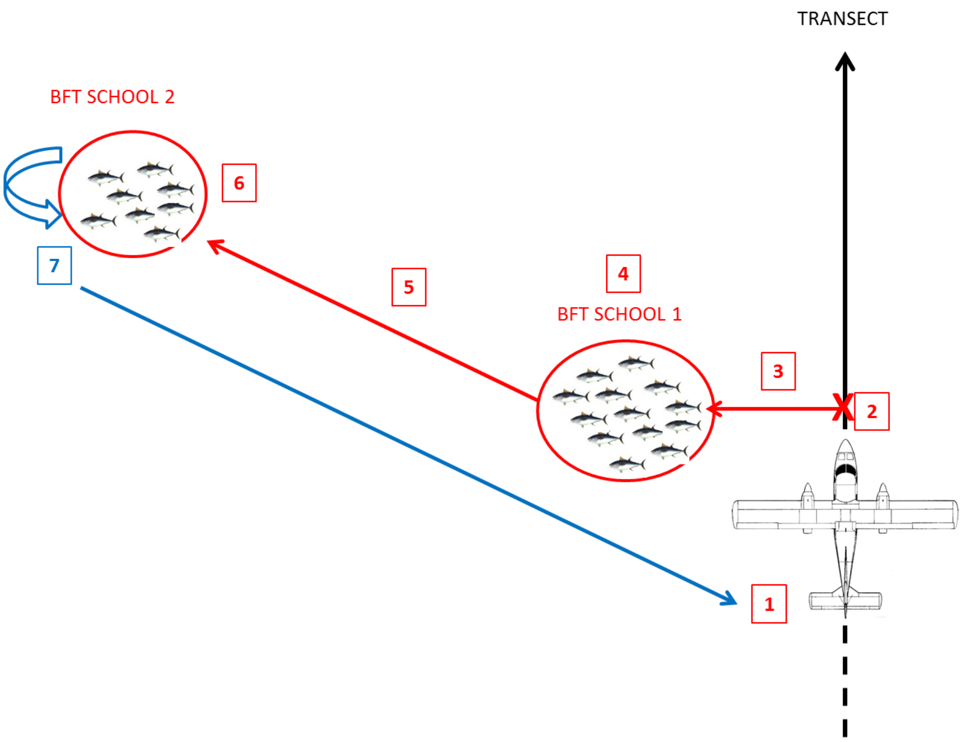


Figure 10. A secondary sighting detected after leaving the transect to circle a previous one.

In the case that the two sightings were too close to distinguish angles, both should be considered as only one sighting **(Figure 11).**

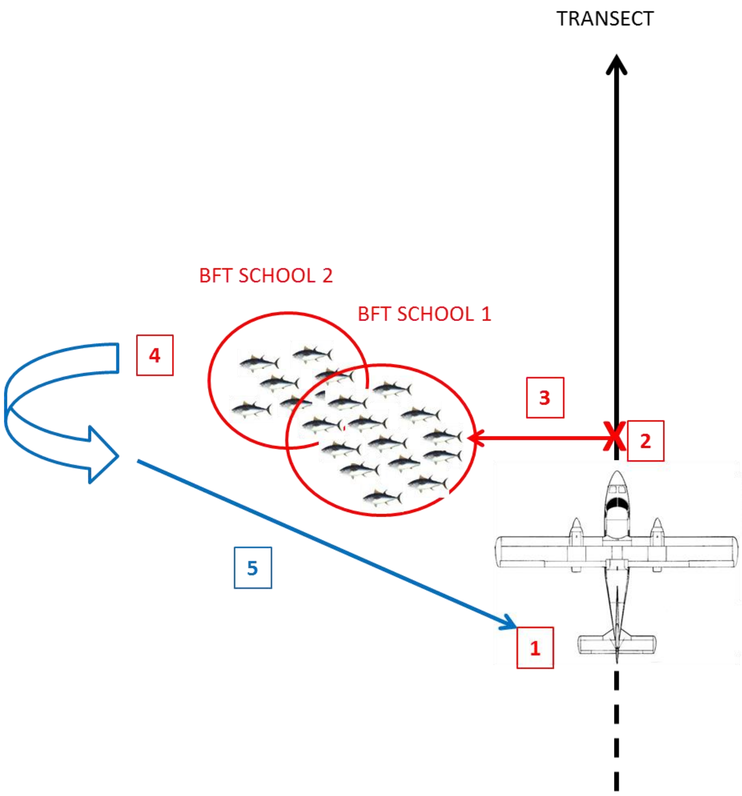


Figure 12. When two sightings are detected very close one from the other, they must be considered as only one sighting.

8. Contact details

Whenever you are in doubt, please ask for clarification:
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