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ICCAT-GBYP AERIAL SURVEY: SPAWNERS VS. JUVENILES A SWOT ANALYSIS OF BOTH PERSPECTIVES)

Antonio Di Natale[1] and M'Hamed Idrissi[1]

SUMMARY

This paper shows the result of the SWOT analysis conducted on the aerial survey, taking into account two different hypotheses: a survey conducted on spawning aggregations (as it was carried out in Phase 1 and Phase 2 of GBYP), versus a survey conducted on juveniles. This was specifically requested by the GBYP Steering Committee for better assessing future development of the GBYP activities. According to the SWOT analysis, both research approaches are useful, but the survey on spawners has much more strengths than that on juveniles, while opportunities are similar and weaknesses are higher for the juveniles.

RÉSUMÉ

Le présent document décrit les résultats des analyses SWOT réalisées sur la prospection aérienne, en tenant compte de deux hypothèses différentes : une prospection des concentrations de reproducteurs (telle que celle réalisée dans la Phase 1 et la Phase 2 du GBYP) par opposition à une prospection des juvéniles. Cette tâche a été spécifiquement requise par le Comité de direction du GBYP afin de mieux évaluer le développement futur des activités du GBYP. Selon les analyses SWOT, les deux approches de recherche sont utiles, mais la prospection des reproducteurs a beaucoup plus de force que la prospection des juvéniles, tandis que les opportunités sont similaires et les faiblesses sont supérieures pour les juvéniles.

RESUMEN

Este documento muestra el resultado del análisis DAFO llevado a cabo sobre la prospección aérea, teniendo en cuenta dos hipótesis diferentes: una prospección realizada sobre concentraciones de reproductores (como se realizó en la Fase 1 y Fase 2 del GBYP), frente a una prospección de juveniles. Esto fue específicamente solicitado por el Comité directivo del GBYP para evaluar mejor el desarrollo futuro de las actividades del GBYP. De acuerdo con el análisis DAFO, ambos enfoques de investigación son útiles, pero la prospección de reproductores tiene más fuerza que la prospección sobre juveniles, mientras que las oportunidades son similares y las debilidades mayores para los juveniles.

KEYWORDS

Bluefin tuna, ICCAT- GBYP, Atlantic Ocean, Mediterranean Sea, aerial survey, spawning aggregations, juveniles, SWOT analysis

1. Introduction

The comprehensive and co-funded ICCAT Atlantic-Wide Research Programme for Bluefin Tuna (ICCAT-GBYP) was established to improve basic data collection, understanding of key biological and ecological processes, assessment models and management.

At its 2008 annual Session the SCRS listed the aerial surveys as one of the tools to support development of fishery independent indices. At its following Session, in 2009, the SCRS included the development of fishery independent surveys as the highest priority and ICCAT at its annual Commission Meeting officially endorsed the programme.

[1] ICCAT Secretariat, C/ Corazón de Maria, 8, 6º, 28002 Madrid, Spain.

Hence, the ICCAT-GBYP identified the aerial surveys as one of the three main research activities to be accomplished during its first Phase. The GBYP Steering Committee (SC), in 2010, decided to carry out the aerial surveys only on spawning aggregations, as the best possible compromise between financial resources and research possibilities, also taking into account the available knowledge and the availability of professional observers, inviting ICCAT CPCs to possibly develop autonomous surveys on aggregations of juveniles in their respective areas of interest.

The first experience of 2010 aerial surveys was considered very positively encouraging, even though there were some logistical problems, mainly related to the access permits to some of the 24 air spaces over the Mediterranean Sea concerned by these aerial surveys (**Figure 1**). The second survey faced similar problems, but in different areas, which prevented to fully compare the results for the eastern Mediterranean.

The strategy adopted in 2010 and 2011, respectively Phase 1 and Phase 2, was articulated around the following objectives:

- Identification of the areas where the bluefin tuna spawning activity in very recent years was probably more intense or constant
- Development of a statistical-sound survey design, based on transects, using DISTANCE as the appropriate software as recommended by the GBYP Operational Meeting of February 2012
- Identification of the most reliable aerial companies for carrying out the surveys
- Necessity to provide a constant monitoring and support for these activities
- Need to get an almost real-time analysis of the results in terms of abundance (biomass) indices
- Possibility to correlate these results with oceanographic data and develop a first tentative predictive spatial model.
- Seeking for the best value-for-money through these experiences
- First necessary steps to be provided for getting a medium-time trend and developing over the years a credible abundance index of the minimum bluefin tuna spawning stock.

The main four spawning aggregation areas identified cover the Balearic Islands, the Tyrrhenian Sea, the Central Mediterranean (between Malta and Libya), and the Eastern Mediterranean. These sub-areas were confirmed by the CPC scientists at the GBYP Operational Meeting and then by adopted by the GBYP SC. The sub-areas surveyed in 2011 are illustrated by **Figure 2** and those covered in 2011 by **Figure 3**.

These two successive GBYP aerial surveys were designed by the same expertise team, based on the line transect sampling survey using the software DISTANCE (http://www.runwpa.st-and.ac.uk/distance/) (Cañadas A. *et al*, 2011). The design was statistically sound.

The necessary indices, in terms of predicted total weight and numbers of individuals of bluefin tuna, the encounter rates and density of schools and their corresponding means, were estimated from the conventional distance sampling (CDS, design-based method) as presented by **Table 1**, and later on from the spatial modelling (model-based method). From this latter, it was possible to develop a first tentative predictive model applied firstly on 2010 aerial survey data and then on the 2011 ones, using real-time sightings and correlating them with the SST. These two methods are compared in **Table 2.** This spatial model, which is able to provide the minimum quantity of BFT spawners by area and time, can be further improved with other parameters.

The SCRS, in 2010 and 2011, approved the results of the aerial survey conducted by GBYP, and the ICCAT Commission endorsed this opinion, and requested an analysis concerning the necessary needs in terms of minimum surface to be surveyed and of minimum number of years necessary for providing an abundance trend over a more extended area. These analyses provided several scenarios. Within the best possible scenario (20% recovery rate in the survey period and 15% CV), the number of surveys required should be at least 5 (**Table 3**), while under the worse possible scenario taken into account (5% recovery rate and 27% CV) the minimum number of surveys required should be 13 (**Table 4**).

The analysis concluded that considering the strict management measures, the reduced fishing season, the sequence of recent years with strong recruitment, it would be possible that a reliable trend of abundance of bluefin tuna spawning biomass could be obtained after a minimum of 6 years of extensive aerial surveys (100,000 km/year).

The aerial surveys on Bluefin tunas juveniles were conducted on a national base by IFREMER, over 7 years, from 2000 to 2011(Fromentin *et al*., 2012), following a DISTANCE methodology with transects, adapted to the characteristics and possibilities offered by juvenile bluefin tuna aggregations in terms of estimations of the groups. The results, which were presented in various years to SCRS, were obtained analysing the observations and taking into account mostly the number of schools in the area and their concentrations.

Table 5 resumes the most relevant data from the various surveys conducted in the Gulf of Lion by IFREMER, with the related CVs, while **Figure 4** shows the various designs used for the different surveys. **Figure 5** shows the spatial distribution of the juvenile Bluefin tuna schools.

The trend obtained by this survey was tentatively used for running a sensitive analysis during the 2012 bluefin tuna stock assessment, demonstrating the feasibility of using aerial survey data for improving the assessment inputs.

In 2012, the GBYP Steering Committee recommended suspending the aerial survey on spawning aggregations, because the extended survey (about 100,000 km on tracks) would request a minimum budget of about 1,200,000 Euro and, due to the considerable budget constraints, it was impossible to have all other GBYP activities at the same time and particularly an intensive tagging, which requires a similar yearly budget.

2. Material and methods

The GBYP Steering Committee on February 2012 requested the GBYP Coordination to assess the possibility of shifting the target of the aerial survey from spawning aggregations to juveniles, possibly by attributing this task to an external expert. Due to the lack of available experts and also to the absence of a specific budget line, the analysis was conducted directly by the GBYP Coordination, based on the internal expertise and knowledge.

The two available approaches covered two different areas (the Gulf of Lion for the juveniles and several Mediterranean areas for the spawners), in a different number of years (7 for juveniles and 2 for spawners), with different intensities and partly with different technical particulars; the survey method was based on the same approach (DISTANCE), but the tracks were set in different ways. All these pints together made it difficult to directly compare the two different survey approaches.

In this case, it was decided to carry out a SWOT analyses (Strength, Weakness, Opportunities and Threats). Both approaches are useful, but the survey on spawners has much more strengths than that on juveniles, while opportunities are similar and weaknesses are higher for the juveniles. The SWOT analysis or SWOT matrix is a very well know tool for helping in questioned decisions, taking into account internal and external factors that are favorable or unfavorable to achieve the objective. This methodology is attributed to Albert Humphrey and was developed in the '60s at Stanford, but no specific literature is available.

As a matter of fact, usually the SWOT analysis is done by a team leader, for discussing the results with other colleagues and gets a decision. This methodology is frequently used in marketing or commerce but it was used many times also in scientific research fields.

By definition, the SWOT matrix is subjective and not objective, even if the goal is to provide the most objective subjective components. It is mandatory to be realistic in providing the various inputs, because otherwise it can be useless. There are several techniques available for better identify and define the various components, but most of them converge on several points. Strengths and weakness are more commonly "internal" factor, while opportunities and threats are usually external factors.

The SWOT analysis was previously used in ICCAT only at once, when it was necessary to provide decision support for the tagging strategy to be adopted by GBYP.

3. SWOT Analysis

The two main matrixes are provided in the following page. It was necessary to use all the available knowledge to complete each matrix and define Strength, Weaknesses, Opportunities and Threats elements. As a matter of fact, some elements were easy to obtain from both surveys, while others were obtained from various experiences in this field.

The first matrix concerns the aerial survey on Bluefin tuna spawning aggregations, while the second is related to Bluefin tuna juvenile aggregations.

4. Results

Looking at the various components, the <u>Strength</u> components are more numerous (7) for spawners than those on juveniles (3). In terms of the various Strength components, some are very important: the impossibility to confuse large tunas with other species, the well identified peak in the spawning period (which provides a more concentrated effort need and a minor variability in the same season, and a more favourable weather situation. On the other hand, the larger number of years for which data are available for juvenile aggregations is also an important Strength component.

Looking at the <u>Opportunities</u>, they are slightly more numerous for juvenile aggregations (8) than for spawners (7), but they are very similar, except for the specificity that juvenile abundance provides almost real-time information about the recruitment.

<u>Weaknesses</u> are clearly heavier in the case of juvenile aggregations (10 against 7 for spawners). In this case, even if there are several common items, there are some points which are quite important, like the lack of any knowledge in various Mediterranean areas, the lack of previous surveys (commercial or scientific) in many areas and, last but certainly not least, the fact that juvenile bluefin tunas are usually mixed-up with other tuna species in several areas (not in all), making it impossible to provide a reliable estimation of the species.

Threats have common components, but of course the different season (spring-summer for the spawners and late summer-autumn for the juveniles) may play in favour of spawners, due to the usual better weather conditions in that season. The permits issue is very serious, because the domestic procedures in each country may be able to seriously affect even the most perfect plan, even in the presence of the best good will of each CPC concerned. According to a recent experience, this may happen even for other GBYP activities, if conducted in national waters of many CPCs.

Of course, the analysis can be even more sophisticated, attributing a numerical “weight” to the various components, but in this case the subjective bias will certainly increase.

From this analysis, it is clear that both types of surveys, on spawning aggregations and juveniles, are very useful for many reasons and they both provide good opportunities in setting up trend indices of the abundances.

Looking more deeply at this SWOT analysis, the aerial surveys on bluefin spawning aggregations (**Table 6**) shows more strengths and opportunities than the aerial surveys on bluefin tuna juvenile aggregations (**Table 7**). Moreover, the aerial surveys on bluefin tuna juvenile aggregations show more weaknesses than the surveys targeting spawners.

Threats and some of the weaknesses are common for both targets. The aerial surveys for bluefin tuna juvenile aggregations should pay a “fee“ to the lower level of knowledge in many areas, which unavoidably implies a sort of exploratory approach in the first year. The feasibility of the survey in areas where bluefin tuna juvenile and other species are contemporary in the same feeding ground should be also assessed. For sure, one of the key factors is that adult Bluefin tuna cannot be confused with other species, while juveniles are quite often mixed with other tuna-like species having almost the same size and similar colour if seen from the aircraft.

There are good possibilities that innovative data coming from the survey might be used for various types of models (Management Procedure, Population Assessment, predictive spatial models, etc.). The aerial surveys are the tool for providing real-time information about the fraction of the stock under study (spawners or juveniles) and for improving the knowledge about many aspects of the current natural history of bluefin tuna.

In terms of budget, the aerial surveys demonstrated to be cost-effective: the average final cost was 9.95 Euro per km/flight on transects and the total cost for conducting the two GBYP surveys was about 580,000 Euros in two years, certainly much less that other GBYP activities.

All these factors combined, seems to indicate that aerial surveys on spawning aggregations may have more solid chances of success than the surveys on juveniles, then confirming the good basis for the choice made at the beginning by the Commission, the SCRS and the GBYP Steering Committee.

5. Conclusions and recommendation

Considering the two aerial surveys campaigns carried out successively during the two last years (2011 and 2012) under the ICCAT-GBYP, it is clear that it is possible to get the abundance trend indices needed for better assessment of the status of bluefin tuna stock, even better if these aerial surveys would be conducted over a long period of time.

As demonstrated by the survey carried out in the Gulf of Lion, if budget constraints are not allowing for a continuous series of survey (one per year), then small series of surveys (i.e.: 2-year sets, with one or two year gaps) could be equally able to provide reliable trends.

At the same time, a more extended survey is certainly much more representative than a survey in a small area, but there is always a balance between research optimal requirements, budget constraints and realistic possibilities.

As a famous Italian poet (Dante Alighieri, 1317) wrote in the XIV century: "*vuolsi così cola ove si vuole ciò che si puote e più non dimandare*"[2] (Divine Comedy, Gate of Hell, III, 95-96), and this sentence clearly shows the obvious limits we have for everything we search for.

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[2] The best translations for this sentence in ancient Italian are the followings: "This deed has so been willed where one can do whatever he wills" or "It is so willed there where is power to do that which is willed; and farther question not."

Table 1. Detailed results of the ICCAT-GBYP Aerial Surveys of 2011 and 2011 on bluefin spawning aggregations in the Mediterranean Sea.

Year	2010				2011			
Sub-area	1	2	3 (left truncation)	6	1	2	3CM (left truncation)	6
Survey area (km²)	62,264	52,461	90,796	55,034	62,264	52,461	100,471	nd
Number of transects	52	45	42	55	131	77	65	nd
Transect length (km)	6,301	8,703	5,288	3,482	9,977	8,771	11,429	nd
Effective strip width x2 (km)	9.66	2.92	9.66	2,92	7.03	7.03	0.66	nd
Number of schools	7	6	19	31	11	10	35	nd
Encounter rate of schools	0.0011	0.0007	0.0036	0.0089	0.0014	0.0011	0.0031	nd
%CV encounter rate	51	43	39	25	32	31	24	nd
Density of schools (1000 km²)	0.157	0.237	0.508	3,054	0.196	0.162	3,98	nd
%CV density of schools	55	53	44	39.8	37	36	26	nd
Mean weight (t)	127.1	124.2	50.6	62.1	84.8	42.7	102,8	nd
%CV weight	8	5,6	2.5	12.9	26	44	27	nd
Total weight (t)	1,244	1,54	2,335	10,434	1.033	364	44,837	nd
%CV total weight	56	53	51	41.9	56	54	41	nd

Table 2. Predicted total weight and animal abundance of bluefin tuna in each survey block from spatial modelling (in black) and from conventional distance sampling (CDS, in blue) for 2011 aerial survey.

Block (Sub-area)	**Spatial Modelling Mean Weight, in kg (CV)**	CDS Weight, in kg (CV)	**Spatial Modelling Mean Animal abundance, # (CV)**	CDS Animal Abundance, # (CV)
1	1,198,833 (0.583)	1,033,00 (0.429)	11,154 (0.582)	9,616 (0.429)
2	238,485 (0.679)	364,000 (0.544)	1,625 (0.605)	2,477 (0.458)
3M	51,828,826 (0.569)	44,837,000 (0.414)	642,819 (0.592)	549,276 (0.420)
Total	**53,266,144**	**46,234,000**	**655,598**	**561,369**

Table 3. Power analysis: identification of the various CVs under the two hypotheses of total number of surveys and the various rate of recovery scenarios during the survey period.

CV of abundance	Number of complete surveys	Rate of recovery per survey period
0.27	5	26%
	10	7%
0.21	5	20%
	10	6%
0.19	5	19%
	10	5%
0.15	5	15%
	10	4%

Table 4. Power analysis: identification of the minimum number of aerial surveys required under the various scenarios of recovery rates during the survey period and the different CVs.

Rate of recovery per survey period	CV of abundance	Number of complete surveys
5	27%	13
	15%	9
10	27%	9
	15%	7
20	27%	6
	15%	5

Table 5. Summary of the main results of the aerial surveys on Bluefin tuna juveniles (from Fromentint *et al*., in press).

Year	Number of transects per year (-)	Number of transects with observations per year (-)	Mean number of detected schools per transect (-)	Mean density (# school. nm^{-1})	Coefficient of variation of the density (%)
2000	6	5	9.7	0.0068	44.6
2001	8	5	7.9	0.0056	43.5
2002	9	5	5.8	0.0041	55.4
2003	11	10	9.5	0.0066	26.2
2009	8	8	35.0	0.0253	35.4
2010	5	5	34.0	0.0237	47.5
2011	8	8	37.6	0.0271	25.7

Table 6. SWOT Analysis. Aerial survey on Bluefin tuna spawning aggregations.

Strengths	**Weaknesses**
1. Already existing experience in various areas, with already 2 years of data and analyses **2.** Well-defined identification of schools (impossibility of species mixing) **3.** Good scientific knowledge of the most relevant spawning areas **4.** Well-defined peak of spawning, with temporal limits **5.** High percentage of days of good weather conditions **6.** Acceptable assessment of the schools in terms of quantity and number **7.** The predictive spatial model showed good possibilities.	**1.** Difficulties for extrapolating the values from the most relevant spawning areas to the less – known areas **2.** Difficulties for setting-up an intercalibration procedure with so many variables **3.** High inter-annual variability in some areas **4.** Changes in oceanographic conditions may affect the presence or the density **5.** BFT schools swimming well below the surface are not visible and if they are just below the surface the effective strip width is lower. **6.** Need to constantly keep a high level of training **7.** Uncertain financial support
Opportunities	**Threats**
1. The only available technology for providing real-time large-scale observations of BFT spawners **2.** High value in terms of direct scientific knowledge **3.** Good possibility to identify and provide an overall trend, to be used like the CPUE in the assessment **4.** Develop new Management Procedure Models **5.** Profiting of the first 2-year survey data **6.** Improving the predictive model with additional variables **7.** Improving the knowledge of non-target species without any additional cost	1. The complex geo-political situation in the area 2. The high number (24) of airspaces under different jurisdiction (8 belong to non-ICCAT CPCs) 3. Mechanical troubles to the aircrafts can seriously affect the survey 4. Strong winds can limit the survey 5. Potential spawning areas might not be active every year 6. Loss of key staff if not continuously used 7. Sustainable financial backing

Table 7. SWOT Analyses. Aerial survey on Bluefin tuna juvenile aggregations.

Strengths	**Weaknesses**
1. Multi-year data and analyses available from one area 2. Good scientific knowledge of some among the most relevant areas where juveniles BFT aggregate 3. Large season for finding the aggregations (Aug-Dec)	**1.** Experience in only one area, for scattered years **2.** Presence of various species of similar size on the same feeding ground (impossible to discriminate species) **3.** Very limited knowledge about many areas **4.** Difficulties for extrapolating the values from the most relevant areas to the less–known areas **5.** Difficulties for setting-up an intercalibration procedure with so many variables **6.** Very high inter-annual variability in some areas **7.** Changes in oceanographic conditions or food chain may affect the presence or the density **8.** JBFT aggregations swimming well below the surface are not visible and if they are just below the surface the effective strip width is lower. **9.** Need to constantly keep a high level of training **10.** Uncertain financial support
Opportunities	**Threats**
1. The only available technology for providing real-time large-scale observations of BFT juveniles **2.** Improvements of real-time knowledge of recruitment **3.** High value in terms of direct scientific knowledge **4.** Good possibility to identify and provide a trend for some areas, to be used like the CPUE in the assessment **5.** Develop new Management Procedure Models **6.** Profiting of the survey data already available from one area **7.** Possibility to develop a predictive model **8.** Improving the knowledge of non-target species without any additional cost	1. The complex geo-political situation in the area 2. The high number (24) of airspaces under different jurisdiction (8 belong to non-ICCAT CPCs), particularly relevant because of the need to operate over more coastal areas 3. Mechanical troubles to the aircrafts can seriously affect the survey 4. Strong winds and a low percentage of good weather conditions can limit the survey 5. Aggregation areas might not be active every year 6. Loss of key staff if not continuously used 7. Sustainable financial backing

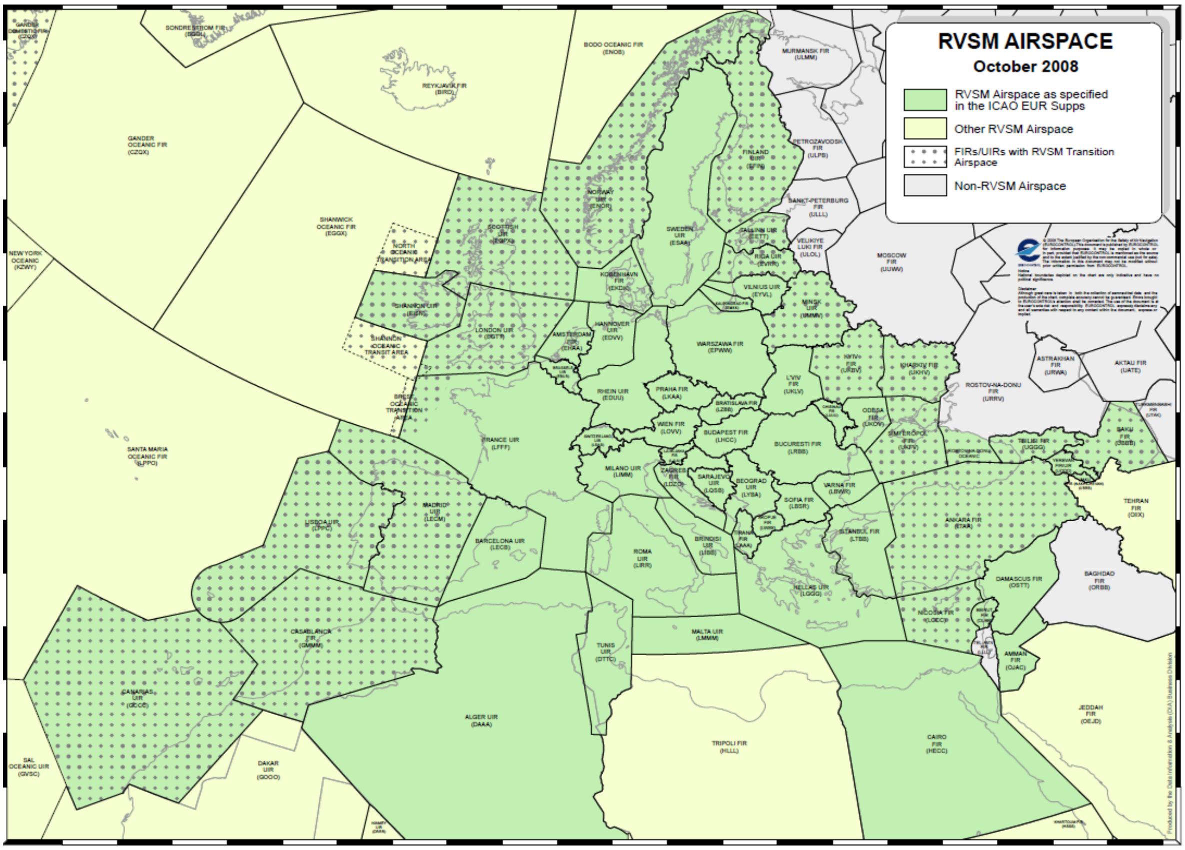

Figure 1. Map of the various air-spaces in the Mediterranean area.

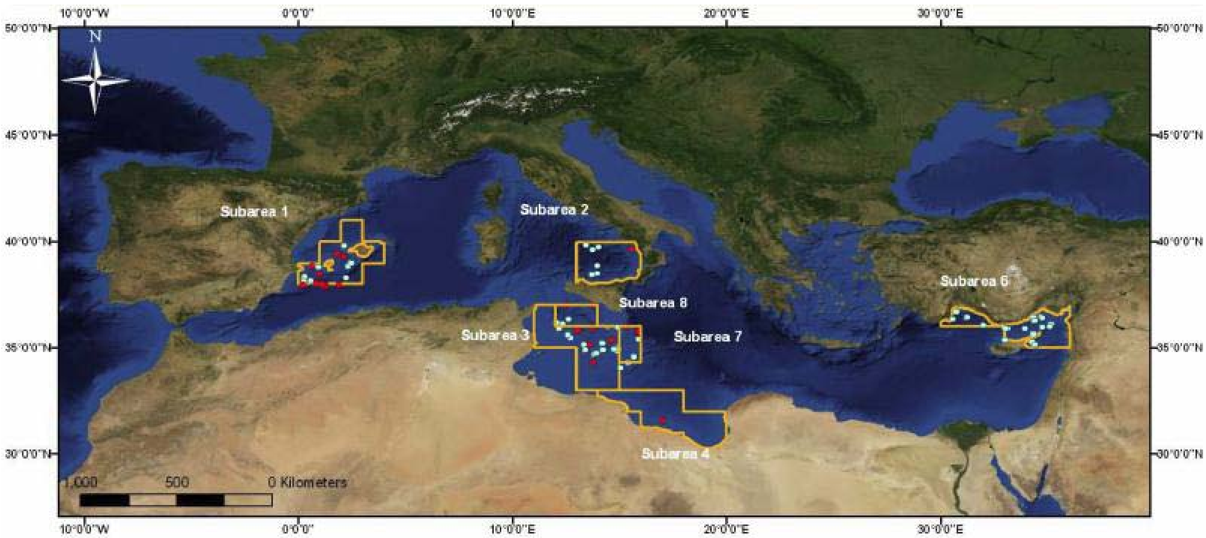

Figure 2. Effective areas surveyed in 2010 (some areas were not surveyed for force majeure reasons).

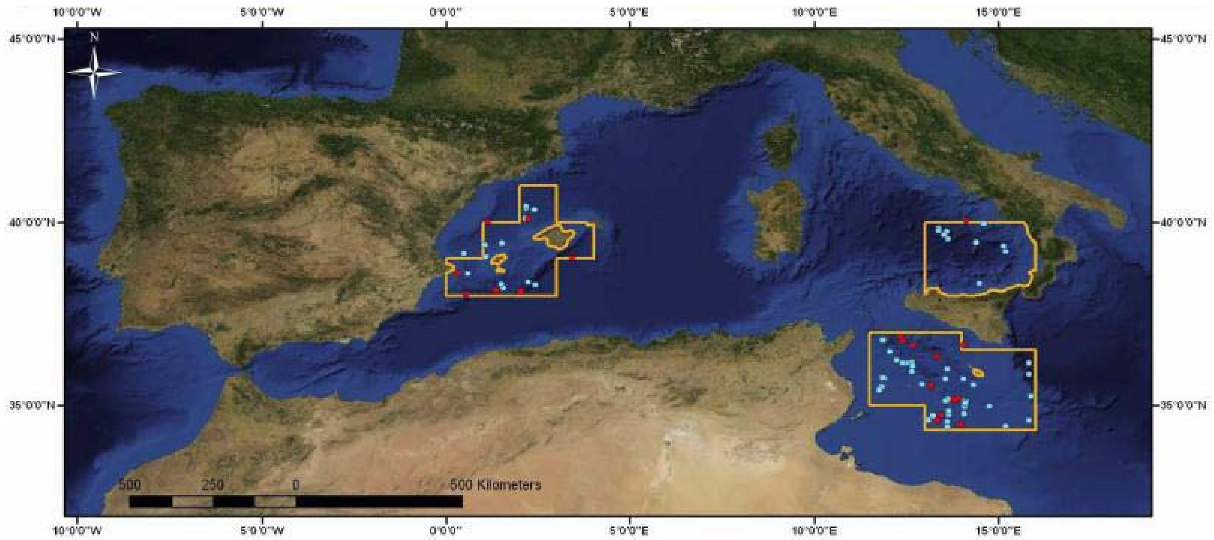

Figure 3. Effective areas surveyed in 2011 (some areas were not surveyed for force majeure reasons).

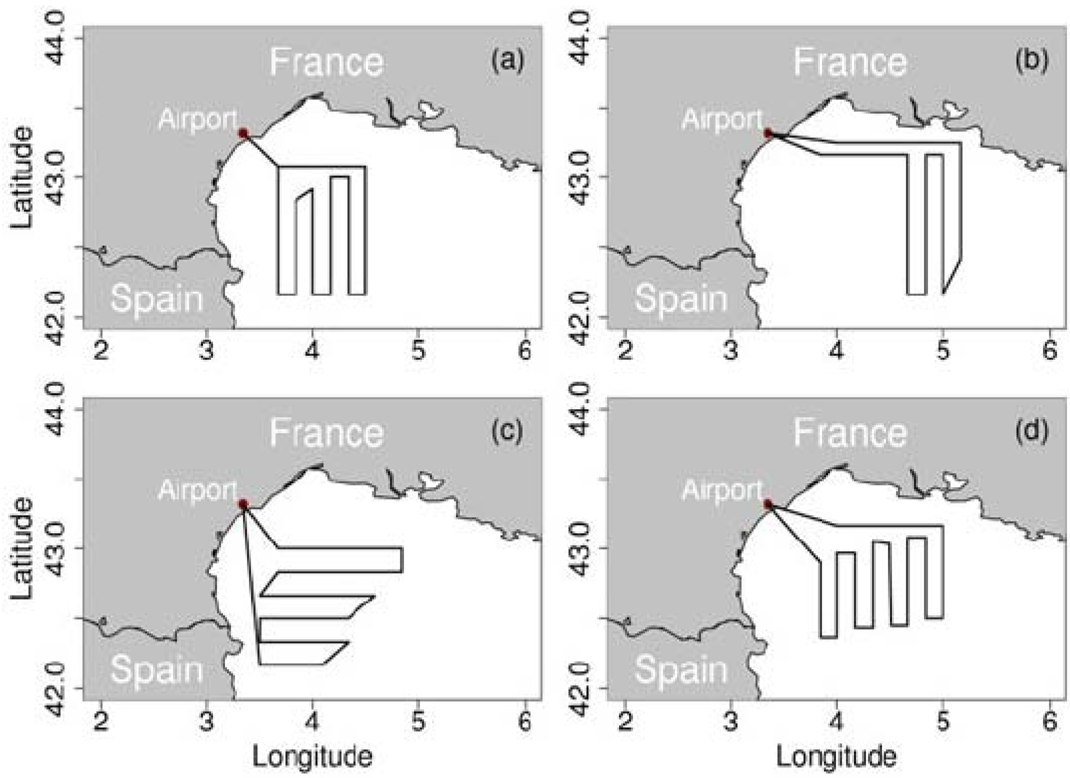

Figure 4. Maps of the different tracks used in the Gulf of Lion (from Fromentin *et al.*, in press).

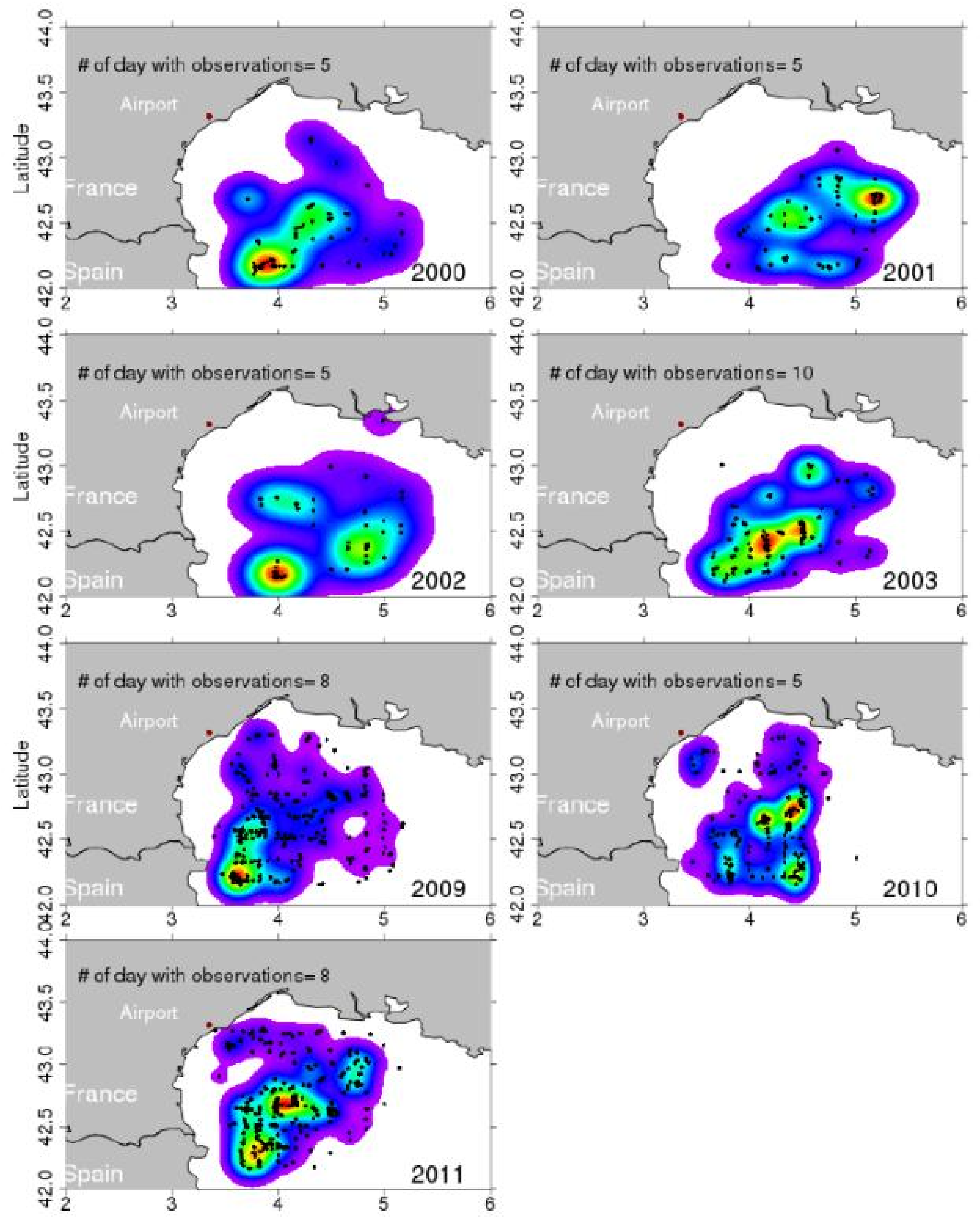

Figure 5. Spatial distribution of the bluefin tuna schools of juveniles detected during the various surveys (from Fromentin *et al*., in press).