SHORT-TERM CONTRACT FOR THE AERIAL SURVEY DESIGN OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA (ICCAT-GBYP Phase 4 - 2013)

Final Report

19 April 2013

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Background and objectives

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

An important element of this programme is to develop fisheries independent indexes of population abundance. Therefore in 2010 and 2011 aerial surveys have been conducted in the Mediterranean on the most documented spawning grounds.

In 2010 an analysis of the aerial survey was conducted and this included a power analysis that evaluated the ability of the survey to detect population trends in the East Atlantic and Mediterranean bluefin recovery plan. This original analysis was based on data from a single year. However, inter-annual variation (e.g. due to environmental variation and changes in population distribution) in abundance levels within areas will result in uncertainty in abundance estimates to be underestimated and the power of the survey to detect recovery to be overestimated. Despite many operational difficulties and problems, data have been collected in 2011 in Areas 1, 2 and 3CM (GBYP Phase 2) and a first power analysis was conducted for proposing two main scenarios for a Mediterranean comprehensive survey.

Due to the impossibility to have the required funds and the guarantee for obtaining all permits from all countries in the Mediterranean area, the Steering Committee recommended suspending the aerial survey in 2012.

Following the Commission meeting in 2012, during which several CPCs required to carry out the aerial survey in 2013, the GBYP Steering Committee requested a further assessment for evaluating a comprehensive survey, taking into account the limited amount of funds available for this part of the annual project.

A study was carried out to assess the feasibility of a large-scale aerial survey on bluefin tuna spawning aggregations in all the Mediterranean Sea, as well as carrying out a similar assessment for the same areas previously surveyed, in order to analyse the power to detect population trends that consider additional variance, to obtain data that could be used as fishery independent indices for operating models. The report was provided on January 15, 2013, and accepted by the ICCAT.GBYP Steering Committee.

After several official contacts with all ICCAT CPCs concerned by the extended survey, the ICCAT Secretariat was of the advice that there are sufficient opportunities for carrying out an extended survey in 2013, following the advice of the GBYP Steering Committee on December 2012.

This work includes:

A. An operational survey design for the whole Mediterranean Sea, shared in 7 different sub-areas from A to G), except for the areas identified in the attached map without any historical spawning and those where it is impossible to obtain flight permits due to particular situation; the design should allow for more spacing transect in the areas which were not surveyed in any previous GBYP aerial survey and more dense transects in the areas surveyed before (Scenario 2 of the study produced on January 15, 2013, with 50% of the density out); the total transect length should be about 42,000 km; the number of replicates shall take into account the total length constrain.
B. The tables and maps for each subarea, for providing the necessary information to be used in the Call for tenders for carrying out the survey in June 2013. In addition to the minimum number of replicates by sub-area, at least one additional replicate should be included and clearly identified as additional.

Survey design methods

Program DISTANCE http://www.ruwpa.st-and.ac.uk/distance/, the "industry standard" software for line transect distance sampling, includes a robust software engine for designing survey transects to achieve equal coverage probability over the survey area. Input to the program includes survey area coordinates or a GIS shape file of the same, information on coverage (e.g. spacing, number of transects, total length of transect), whether transects should be laid out as parallel or zig-zag lines, etc. From this input, the program simulates multiple surveys according to the design specified and generates information on the survey, including a visual representation of how well equal coverage probability has been achieved. The survey design input parameters can then be modified until an optimum design is achieved.

Aerial surveys for bluefin tuna in the Mediterranean Sea are designed here using program DISTANCE based on: the eleven defined survey areas (survey areas A to G; and sub-areas surveyed in 2010 and 2011 within blocks A, C, E and G), target survey time available (equivalent to 42,000 km), time for circling over detected schools to estimate their size (set at 10%), and time for flying in between lines (set between 10 and 15% depending on the line separation in each block).

Transect lines are placed in a north-south direction to be approximately perpendicular to the coast in most blocks (except in block D where 45º where chosen to keep this criterium).

Surveys are designed as equal spaced parallel lines rather than zig-zag lines. Parallel line designs achieve equal coverage probability exactly – an important design feature. However, a disadvantage (compared to a zig-zag design) is that some flying time is spent in transit between transects. Time spent transiting can be minimised by increasing airspeed between transects. In addition, there is some advantage to having short off-effort periods between transects to allow observer(s) to rest.

Survey designs

The areas identified by the GBTP Steering Committee were used to create survey blocks in program DISTANCE (survey areas A to G; and sub-areas surveyed in 2010 and 2011 within blocks A, C, E and G, see Figure 1).

The total effort available (42,000 km) according to Scenario 2 of the Feasibility study carried out at the beginning of 2013, in which the density of fish outside spawning areas (previously surveyed areas) is half of that inside the spawning areas. Therefore, 50% of coverage (21,000 km) is allocated to the areas outside (called from now on "outside areas") and 50% (21,000 km) is allocated to the spawning areas previously surveyed (called from now on as A_inside, C_inside, E_inside and G_inside, or generically "inside areas").

For the calculations of the percentage of coverage, an effective strip width of 7km (3.5km half width) was considered. This value was chosen as it was the most common approximate width resulting in most blocks both in 2010 and 2011.

The proportion of the total trackline effort (21,000km) for the inside areas was calculated for each block according to the proportion of the surface area of each block, and the same was done for the outside areas (see Table 1).

Given the low coverage given by the allocated effort in the outside areas, only one replica of tracklines was assigned to those blocks. Two replicas were assigned to the inside areas given the much higher coverage given by the allocated effort in them.

Additionally, an extra replica was designed both for the inside and the outside areas in the event that more resources may be used and therefore more effort can be allocated. Table 1 shows the effort allocated to each block (primary tracks), both the on effort tracklines and the total trackline (including the off effort bits joining on effort legs) are shown in this table. Table 2 shows the effort allocated to the extra tracklines.

Last column of Table 1 (Final Total) shows the total trackline, removing the "off-effort" bits of tracks that would cross over A_inside (554 km) and E_inside (630 km) when surveying A_outside and E_outside respectively, as these cross-overs can be used to do nearby on-effort tracklines in the A_inside and E_inside blocks respectively. The total final trackline is 38,576 km, which leaves 3,424 km (8.2% of the total available, close to the 10% expected) for potential circling over fish schools. The Projected Coordinate System used to calculate distances and areas in DISTANCE software was TRANSEVERSE MERCATOR.

Appendix 1 gives a simple map and the list of coordinates for all primary tracks for each block. Appendix 2 gives the same information for the extra tracks.

Figures 2 to 9 show the primary tracks for all blocks, and Figures 10 to 17 the extra tracks.

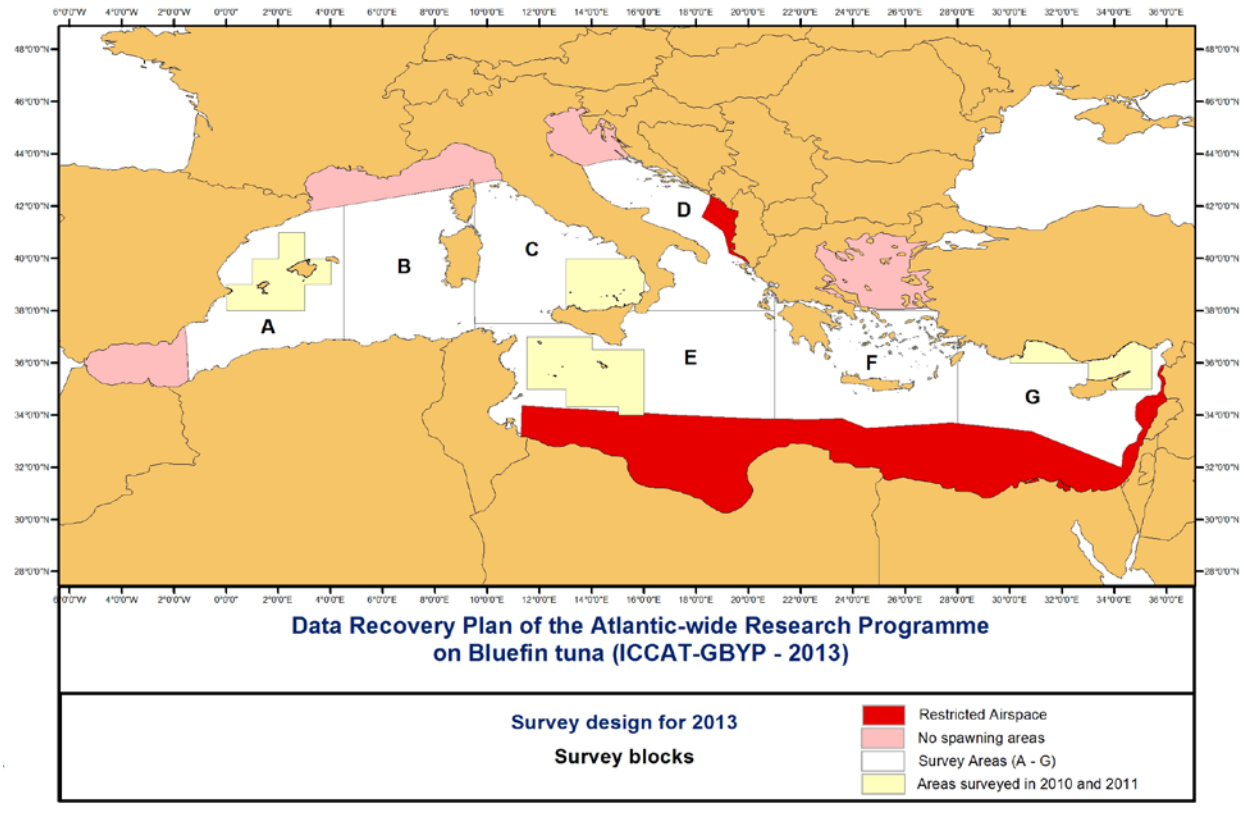


Figure 1. Survey blocks

TABLES

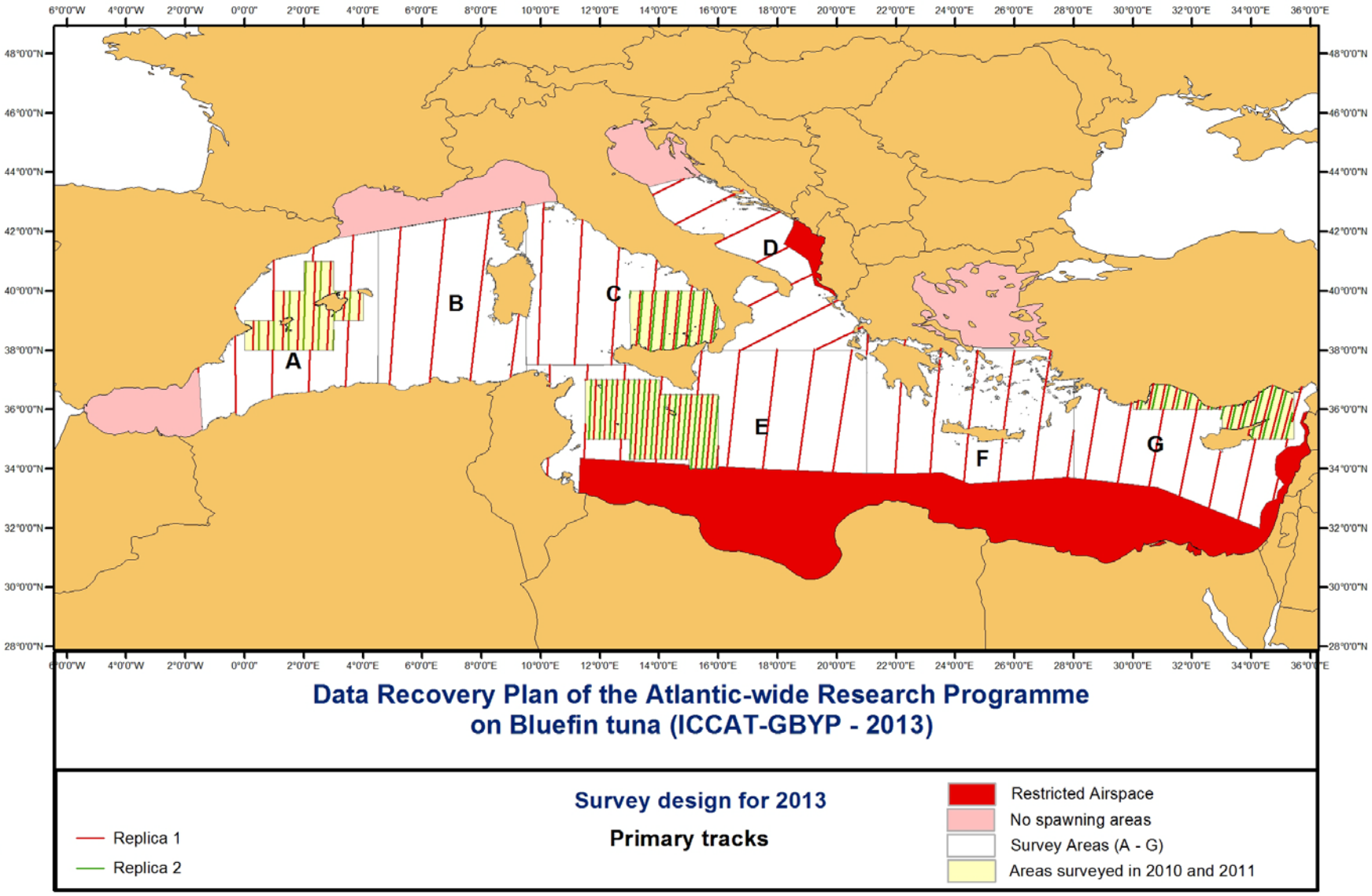
Table 1. Primary tracks. See description for last column (*) above in the text.

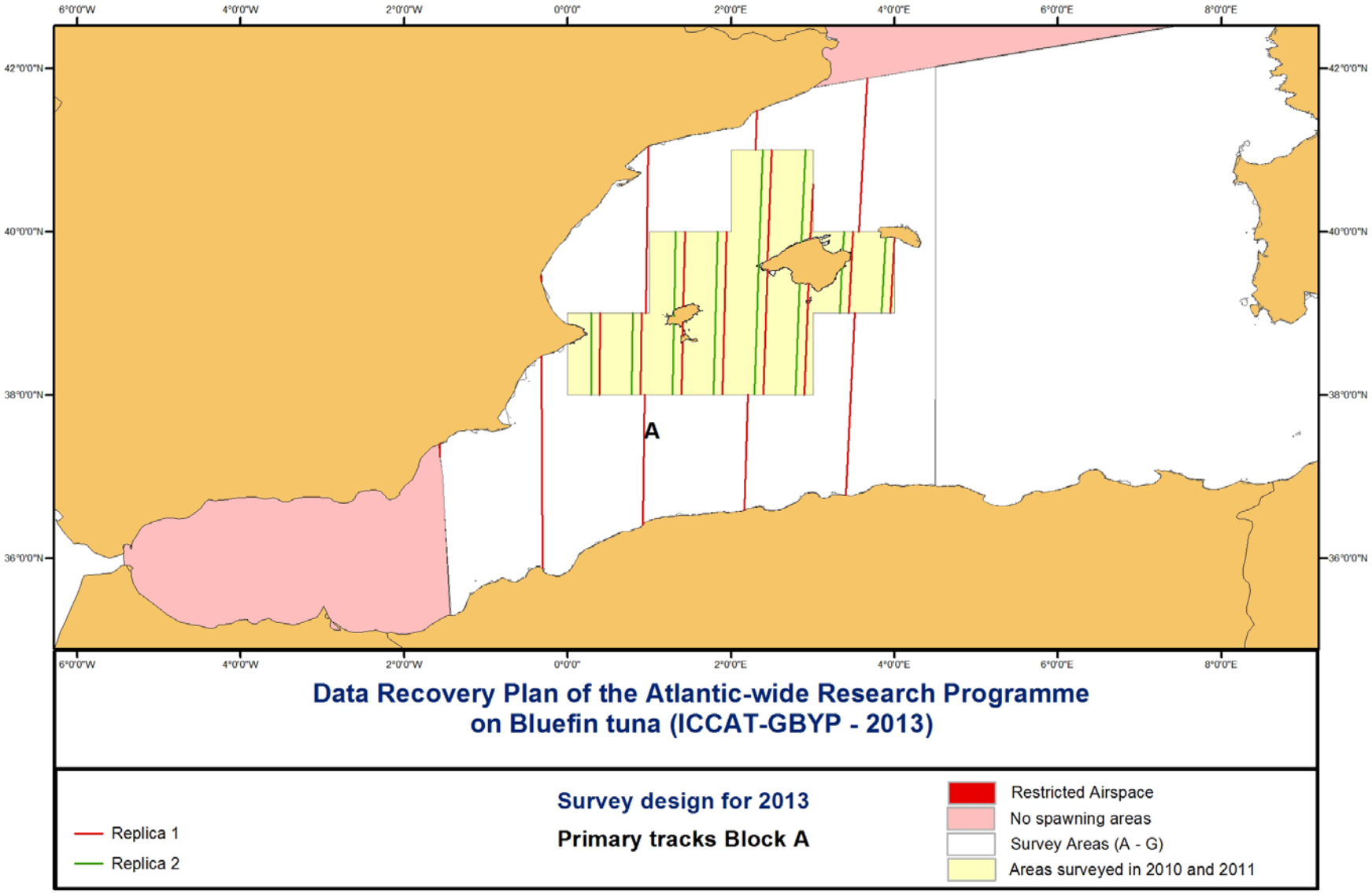
Sub-area	Area (km^2)	Proportion of total area	Expected proportional Length of Trackline on Effort	Percentage coverage	Line spacing per replica	On effort track (replica 1-replica 2)	Total track (replica 1-replica 2)	On effort track (total)	Total track (total)	Total effort track (Final total *)
Inside Areas										
A_inside	62,194	22.18	4,658	31.2	43.9	1,388 1,442	1,901 1,928	2,830	3,829	3,829
C_inside	54,177	19.32	4,058	35.8	37.3	1,428 1,426	1,665 1,739	2,854	3,404	3,404
E_inside	107,673	38.40	8,065	41.3	32.8	3,150 3,387	3,839 3,759	6,537	7,634	7,634
G_inside	56,329	20.09	4,219	36.9	39.5	1,447 1,410	2,074 2,057	2,857	4,131	4,131
Sub-Total	**280,373**	**100,00**	**21,000**			**15,078**	**18,998**	**7,666**	**9,670**	**9,670**
Outside areas										
A_outside	173,435	10.84	2,276	5.10	111.0	1,380	2,666			2,112
C_outside	179,121	11.19	2,351	6.70	110.7	1,734	2,210			2,210
E_outside	294,314	18.39	3,863	6.00	114.0	2,571	4,441			3,811
G_outside	249,064	15.57	3,269	6.20	111.0	2,237	3,205			3,205
B_total	236,092	14.76	3,099	6.20	121.0	2,082	2,459			2,459
D_total	171,047	10.69	2,245	5.20	127.0	1,300	2,234			2,234
F_total	296,961	18.56	3,898	5.80	115.0	2,558	3,547			3,547
Sub-Total	**1,600,034**	**100,00**	**21,000**			**13,862**	**20,762**			**19,578**
Total	**1,880,407**		**42,000**			**28,940**	**39,760**			**38,576**

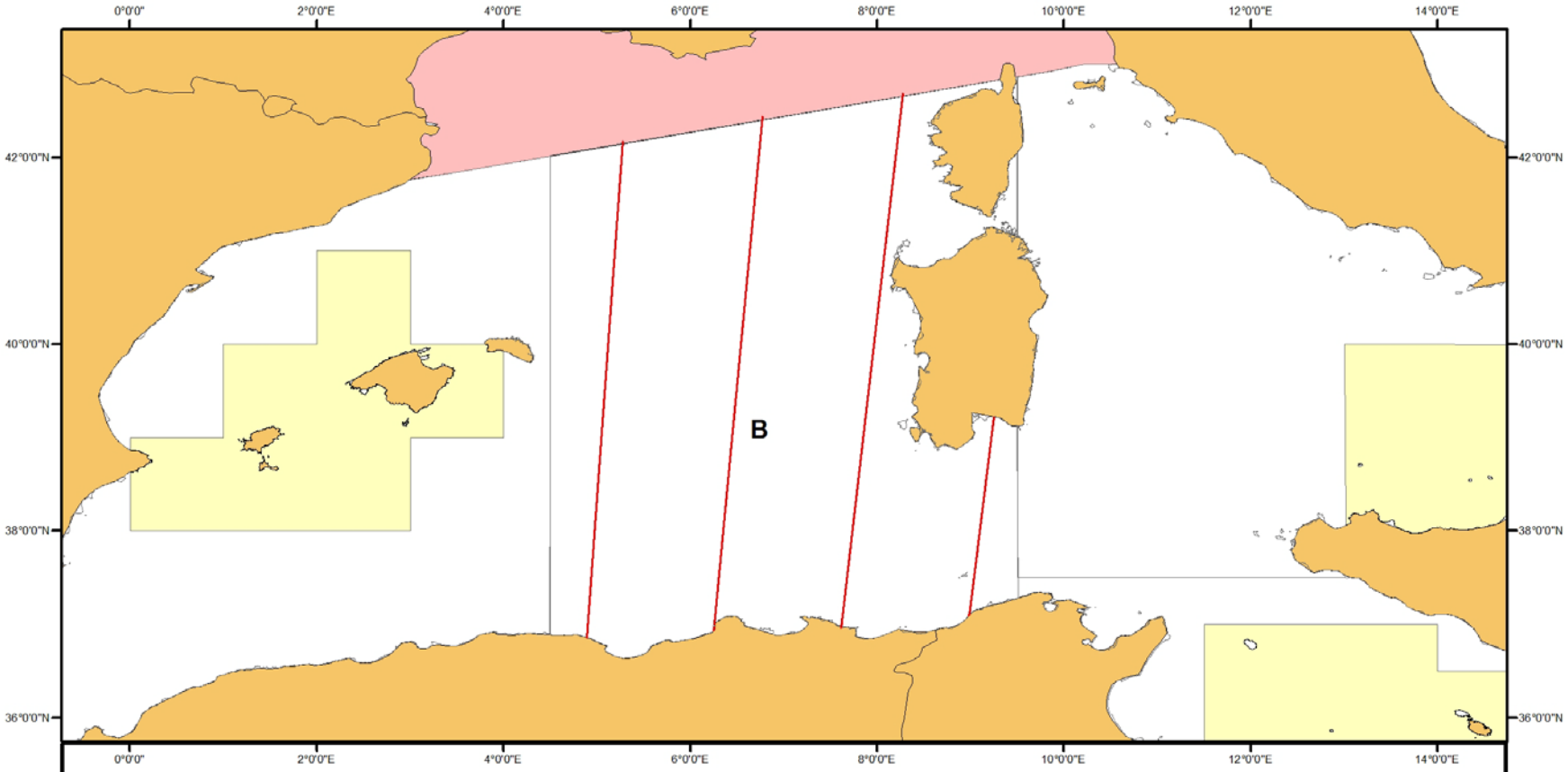
Table 2. Extra tracks.

Sub-area	Area (km^2)	Line spacing per replica	On effort track	Total track
Inside Areas				
A_inside	62,194	43.9	1,287	1,932
C_inside	54,177	37.3	1,623	1,801
E_inside	107,673	32.8	3,306	3,770
G_inside	56,329	39.5	1,450	2,167
Sub-Total	**280,373**		**7,666**	**9,670**
Outside areas				
A_outside	173,435	111.0	1,618	2,810
C_outside	179,121	110.7	1,334	2,219
E_outside	294,314	114.0	2,517	4,548
G_outside	249,064	111.0	2,247	3,308
B_total	236,092	121.0	2,063	2,699
D_total	171,047	127.0	1,356	2,217
F_total	296,961	115.0	2,458	3,568
Sub-Total	**1,600,034**		**13,593**	**21,369**
Total	**1,880,407**		**21,259**	**31,039**

Figures 2 to 9. Primary Tracks




6°0'0"W
4°0'0"W
2°0'0"W
0°0'0"
2°0'0"E
4°0'0"E
6°0'0"E
8°0'0"E
42°0'0"N
40°0'0"N
38°0'0"N
36°0'0"N
A
Data Recovery Plan of the Atlantic-wide Research Programme
on Bluefin tuna (ICCAT-GBYP - 2013)
Survey design for 2013
Primary tracks Block A
Replica 1
Replica 2
Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011



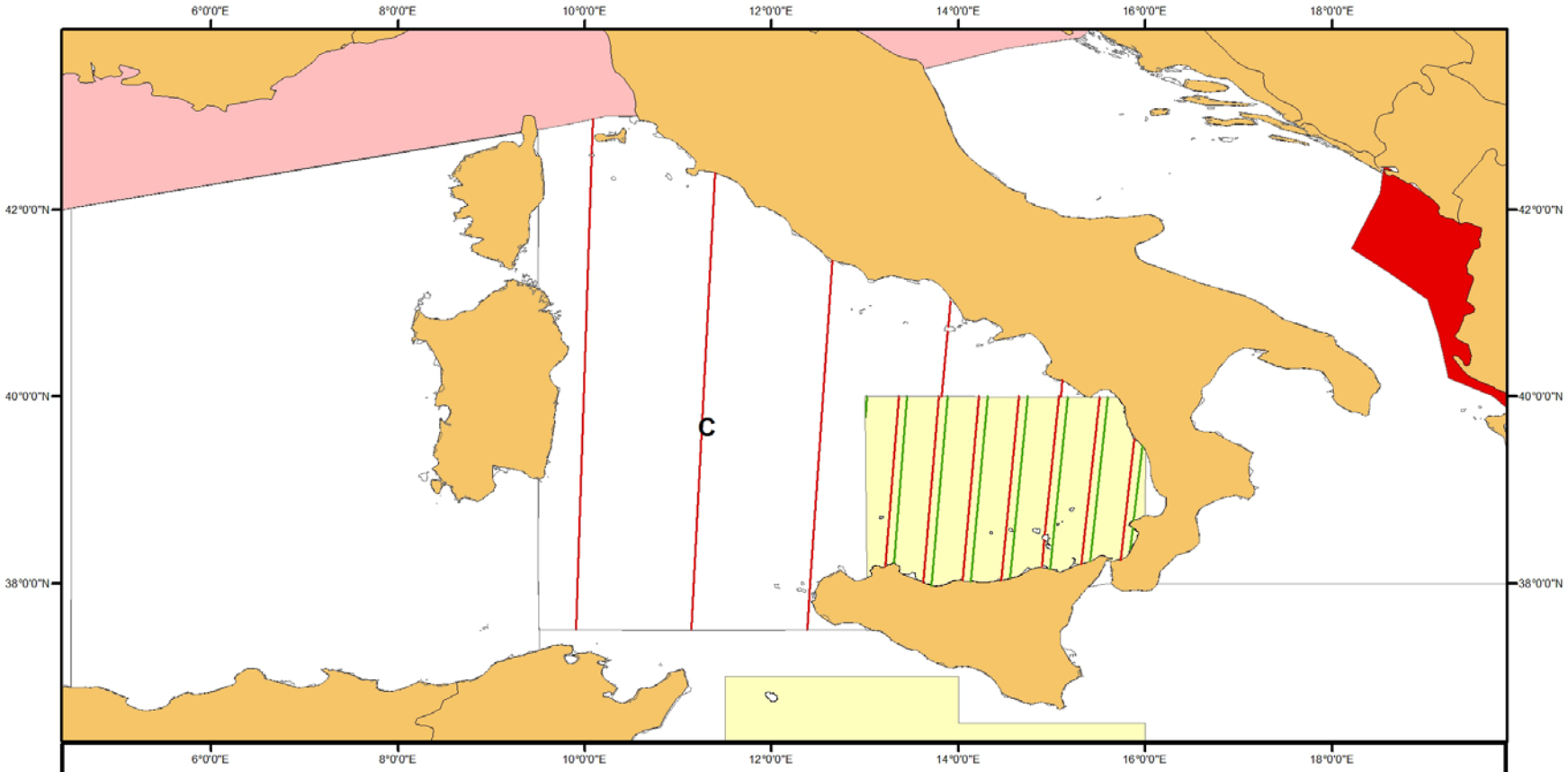
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Replica 1

Survey design for 2013

Primary tracks Block B

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010 and 2011



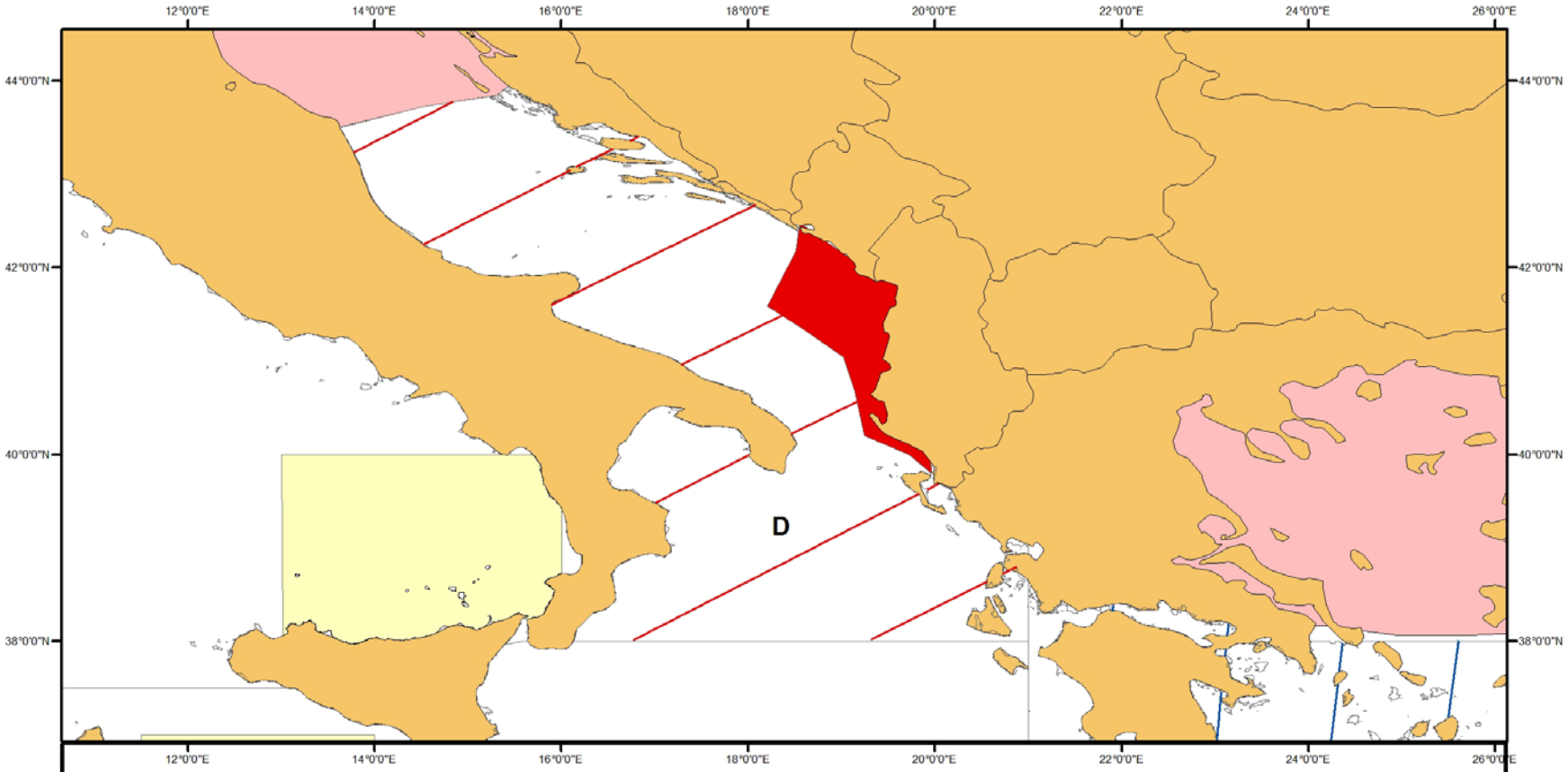
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Primary tracks Block C

Replica 1
Replica 2

Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011



Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Primary tracks Block D

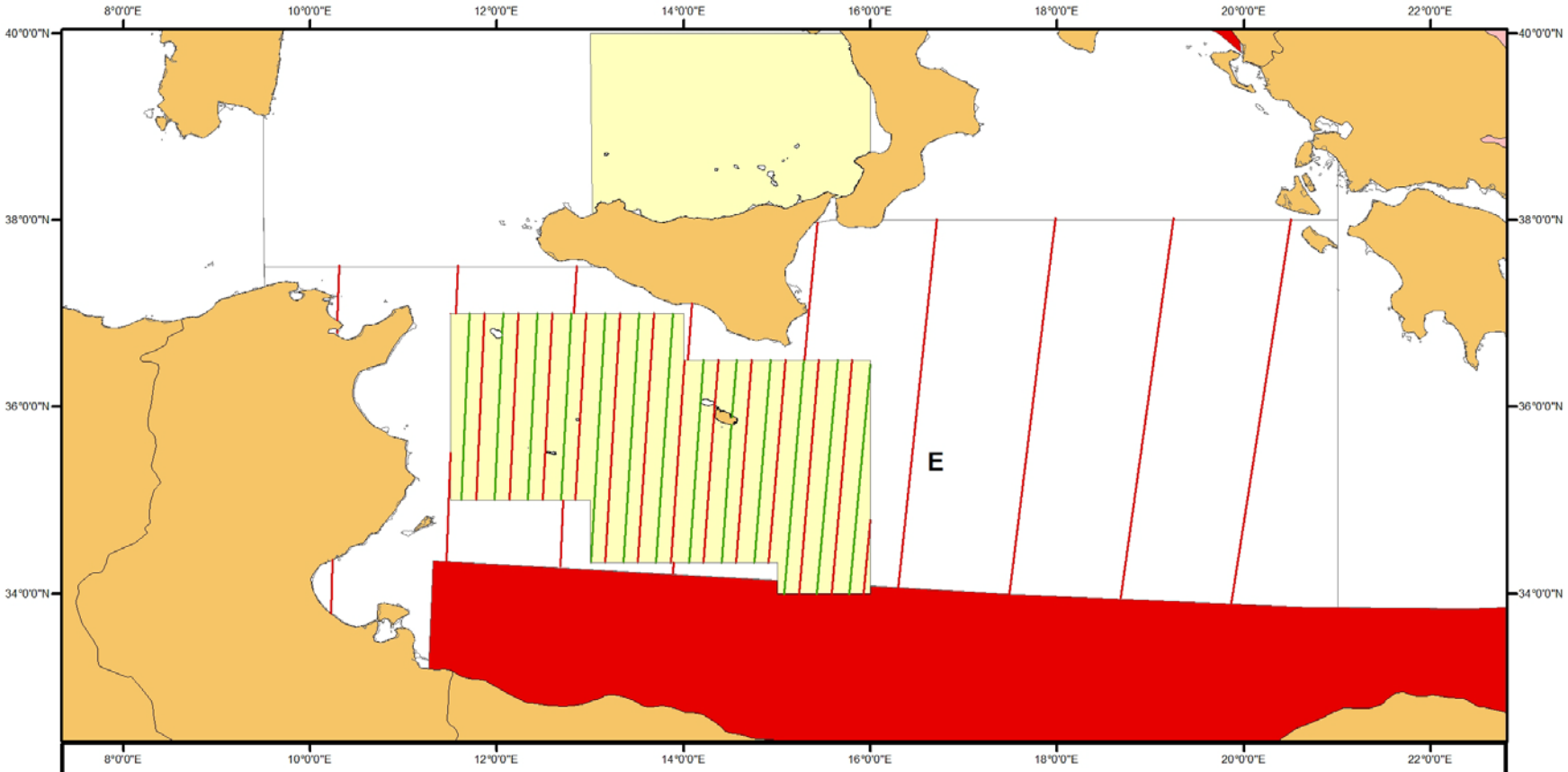
Replica 1

Restricted Airspace

No spawning areas

Survey Areas (A - G)

Areas surveyed in 2010 and 2011



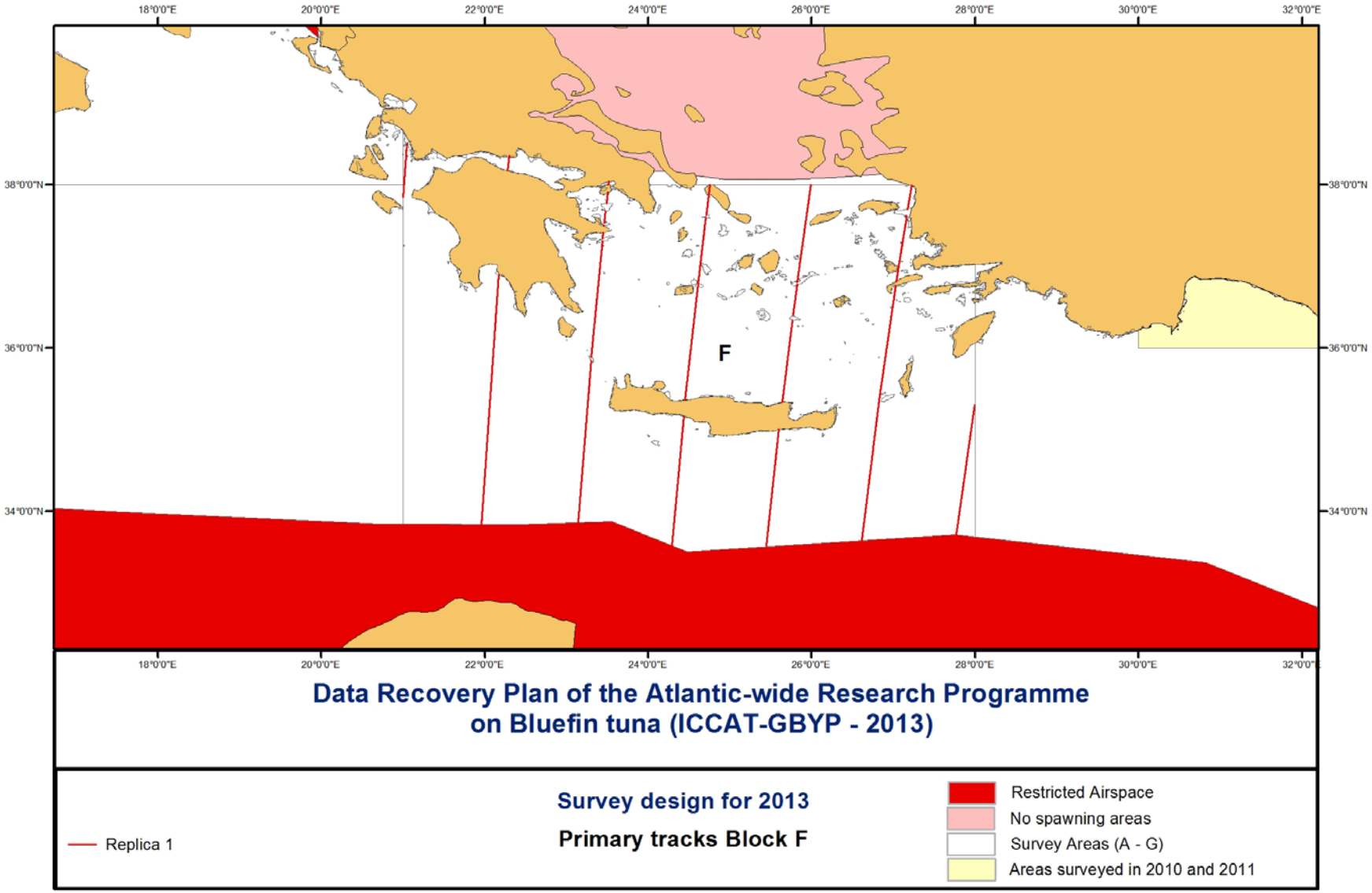
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

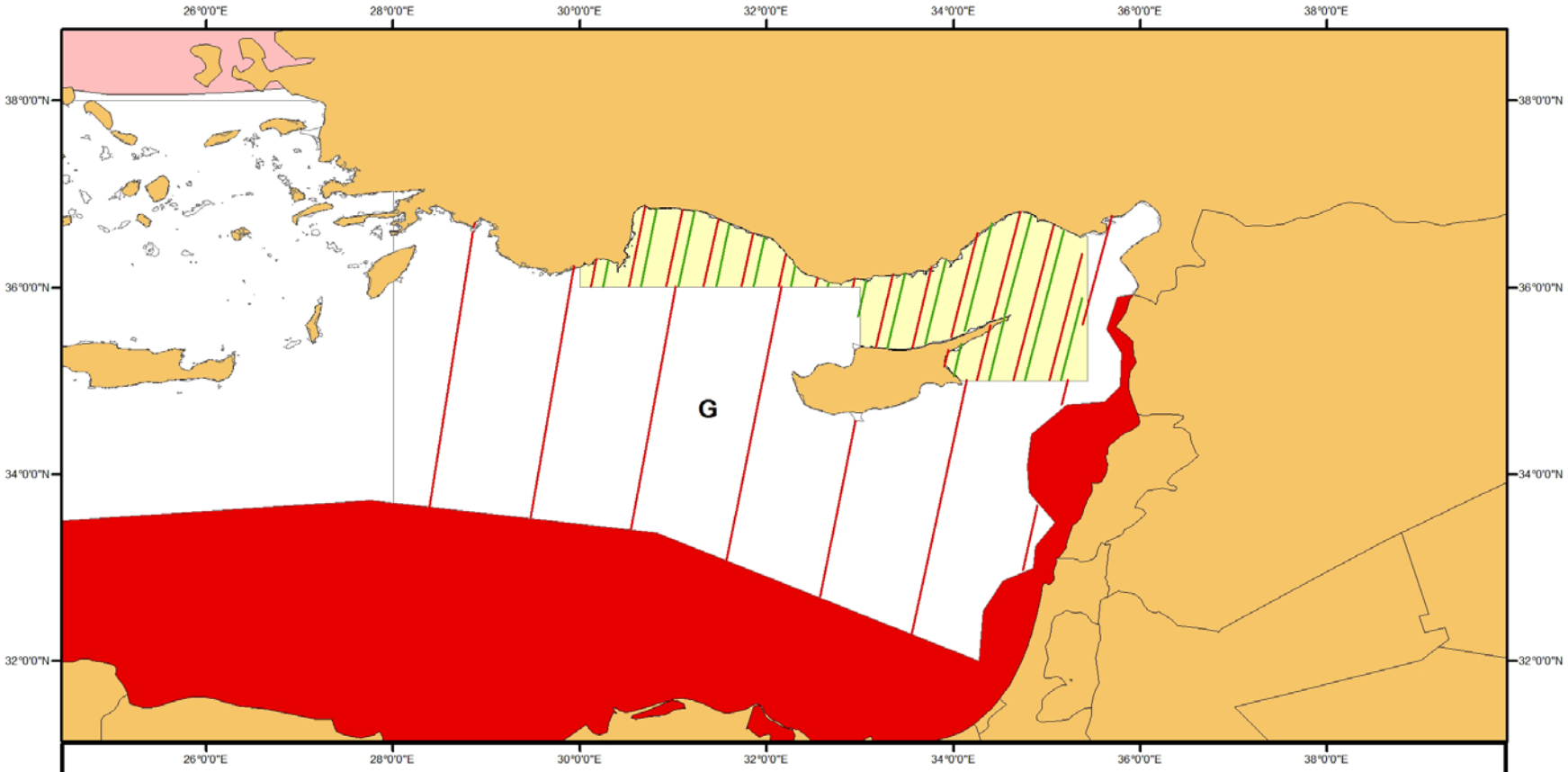
Survey design for 2013

Primary tracks Block E

Replica 1
Replica 2

Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011


18°0'0"E
20°0'0"E
22°0'0"E
24°0'0"E
26°0'0"E
28°0'0"E
30°0'0"E
32°0'0"E
38°0'0"N
36°0'0"N
34°0'0"N
F
Data Recovery Plan of the Atlantic-wide Research Programme
on Bluefin tuna (ICCAT-GBYP - 2013)
Survey design for 2013
Primary tracks Block F
Replica 1
Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011



Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

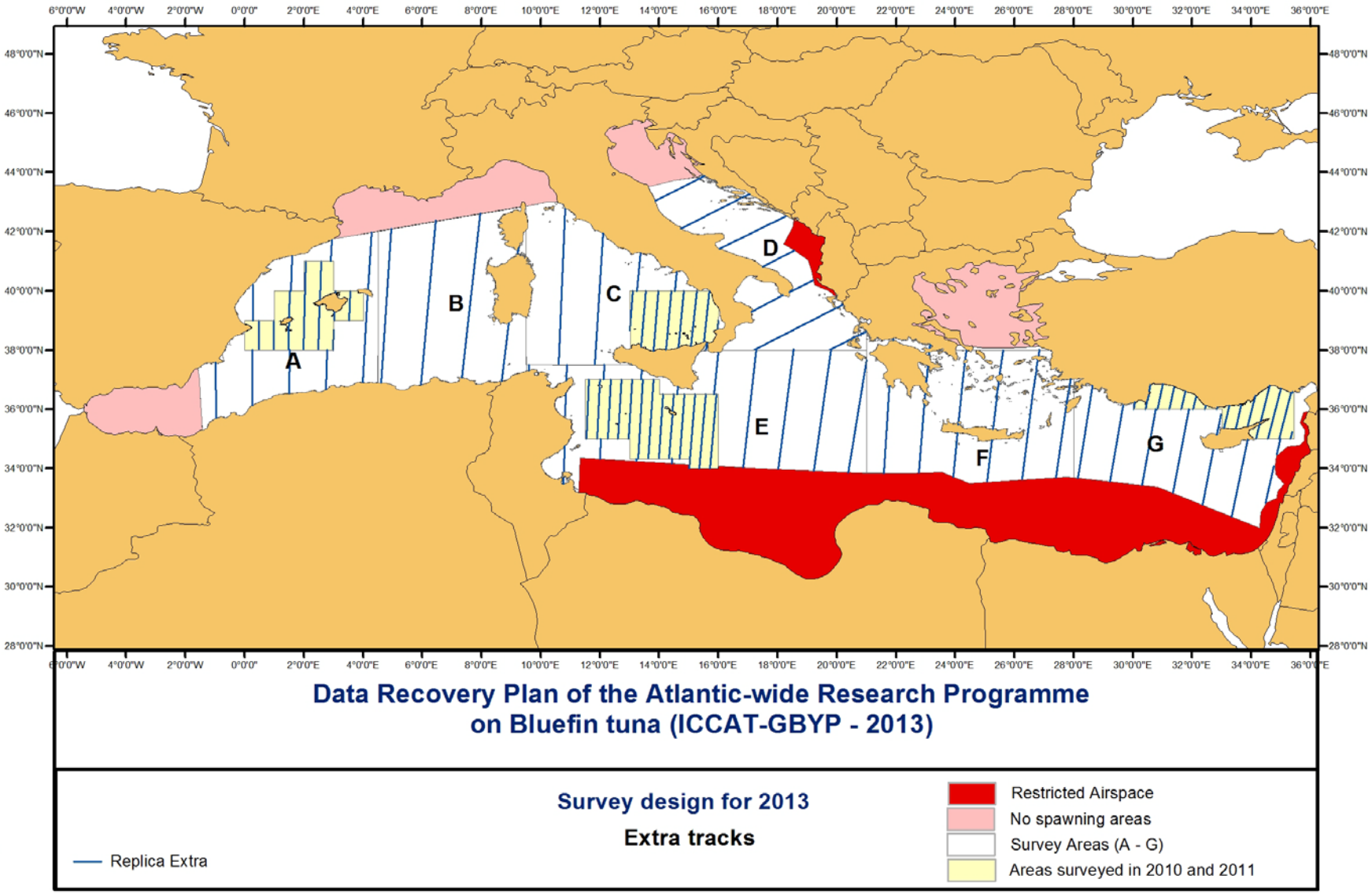
Survey design for 2013

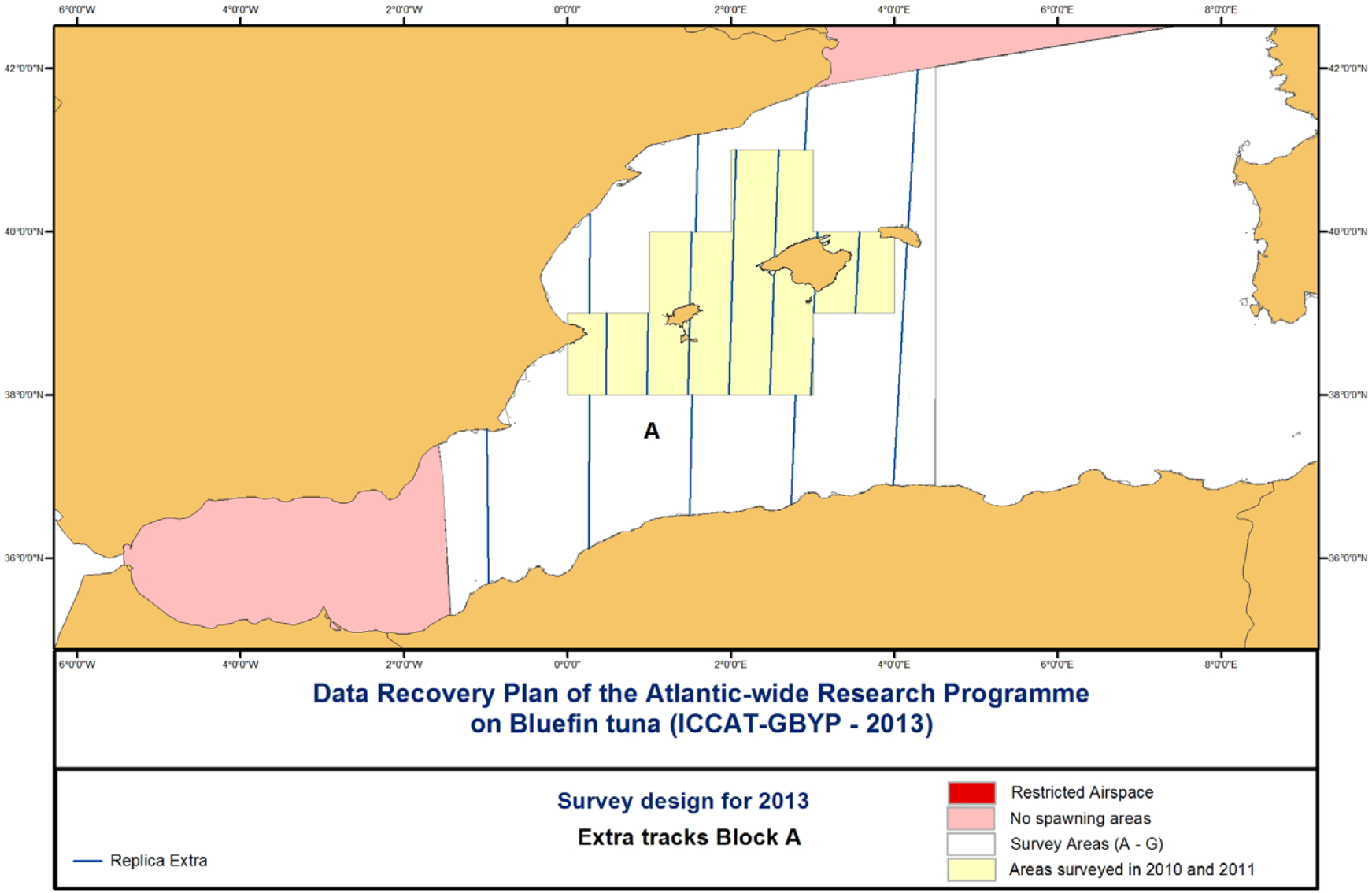
Primary tracks Block G

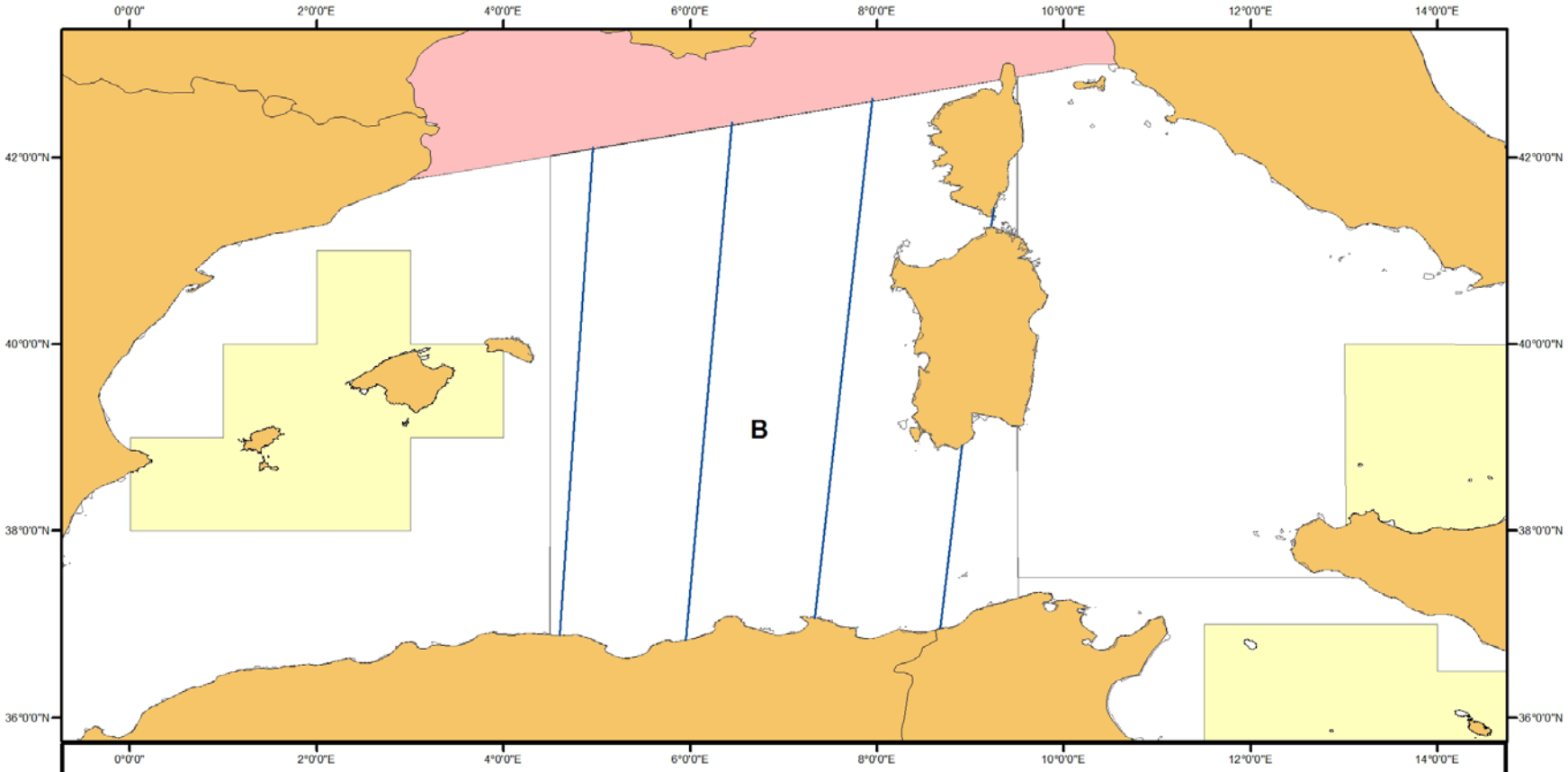
Replica 1
Replica 2

Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011

Figures 10 to 17. Extra Tracks




6°0'0"W
4°0'0"W
2°0'0"W
0°0'0"
2°0'0"E
4°0'0"E
6°0'0"E
8°0'0"E
42°0'0"N
40°0'0"N
38°0'0"N
36°0'0"N
A
Data Recovery Plan of the Atlantic-wide Research Programme
on Bluefin tuna (ICCAT-GBYP - 2013)
Survey design for 2013
Extra tracks Block A
Replica Extra
Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011



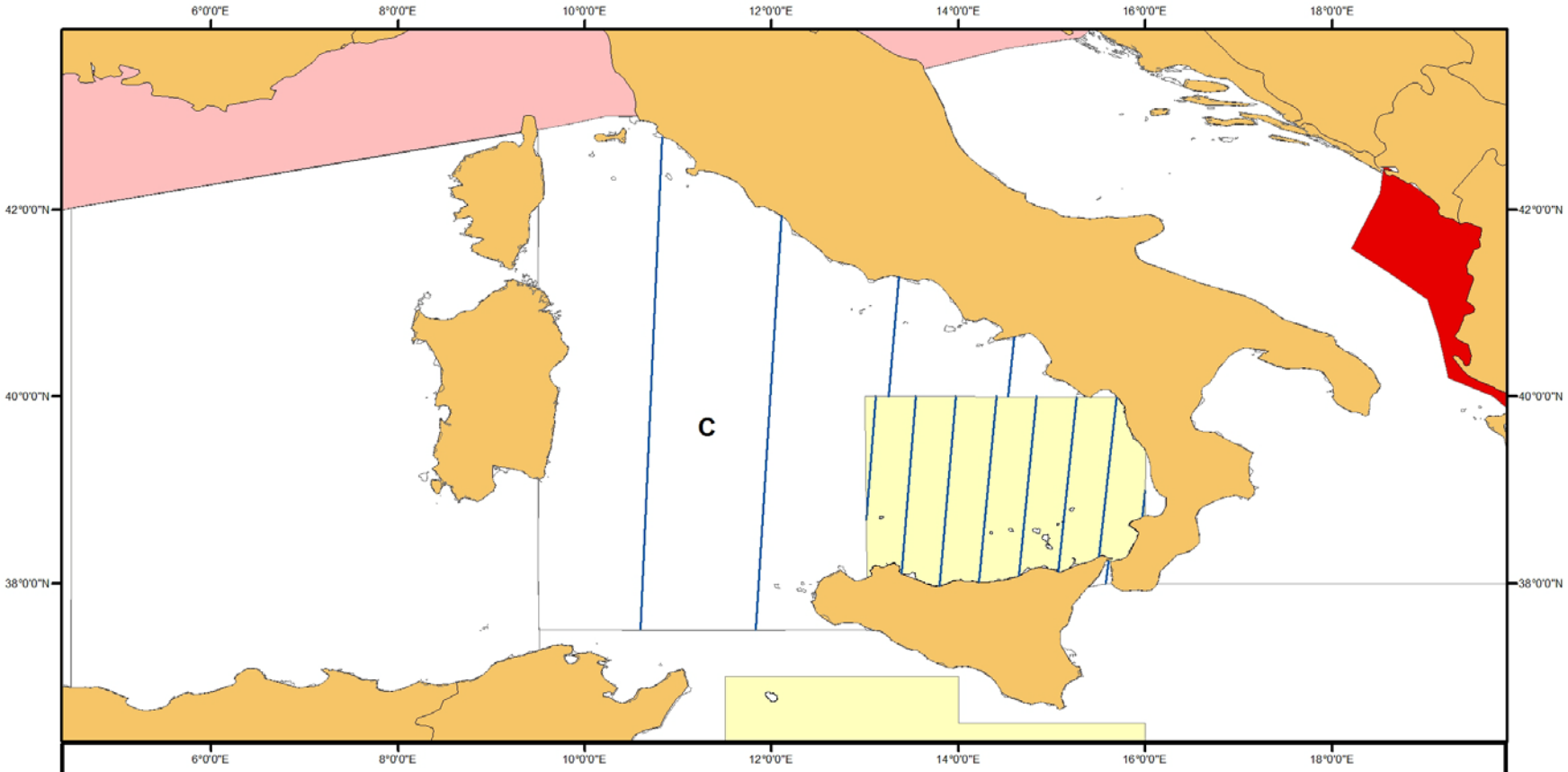
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block B

Replica Extra

Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010 and 2011



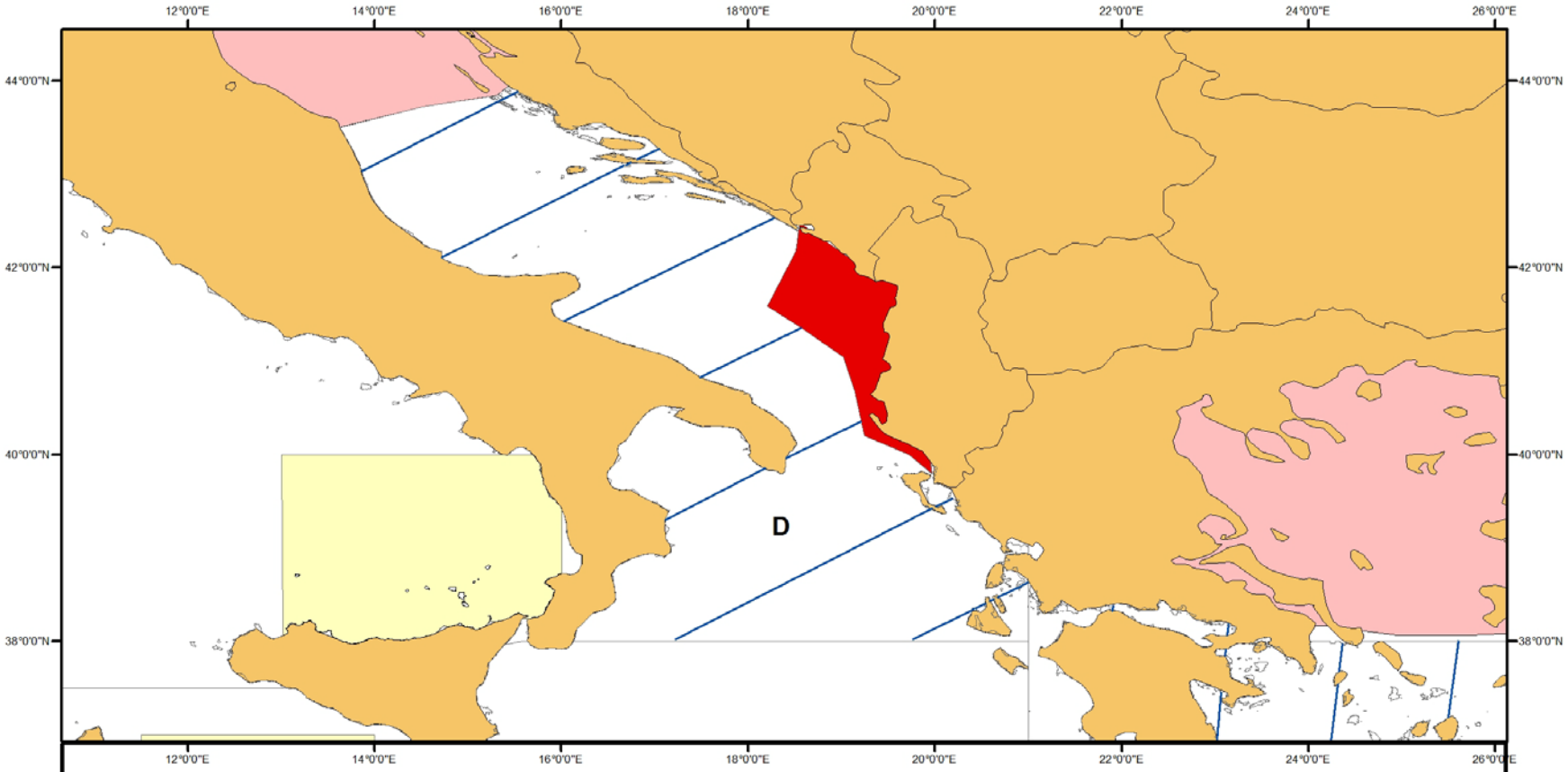
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block C

Replica Extra

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010 and 2011



Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block D

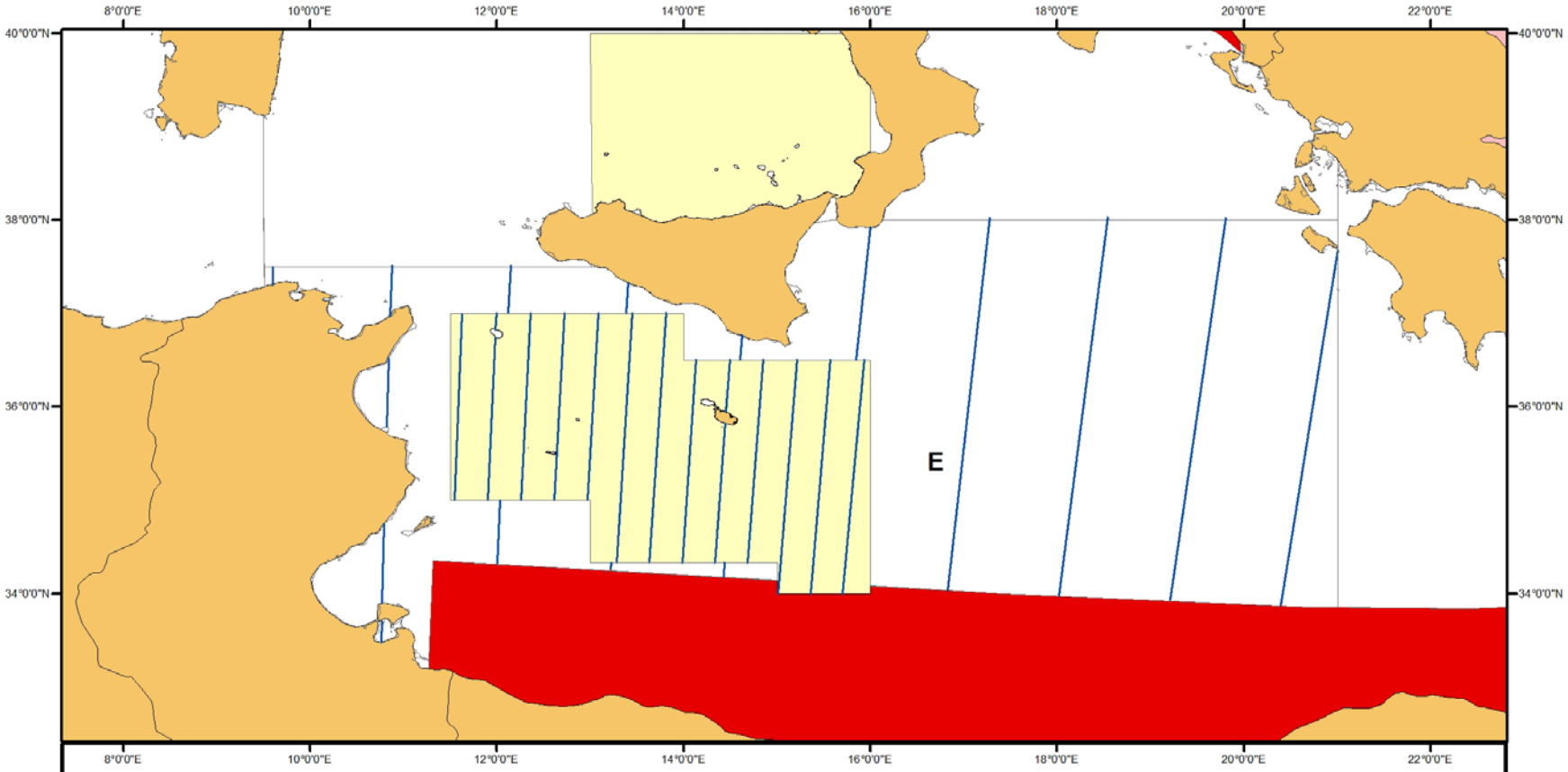
Replica Extra

Restricted Airspace

No spawning areas

Survey Areas (A - G)

Areas surveyed in 2010 and 2011



Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block E

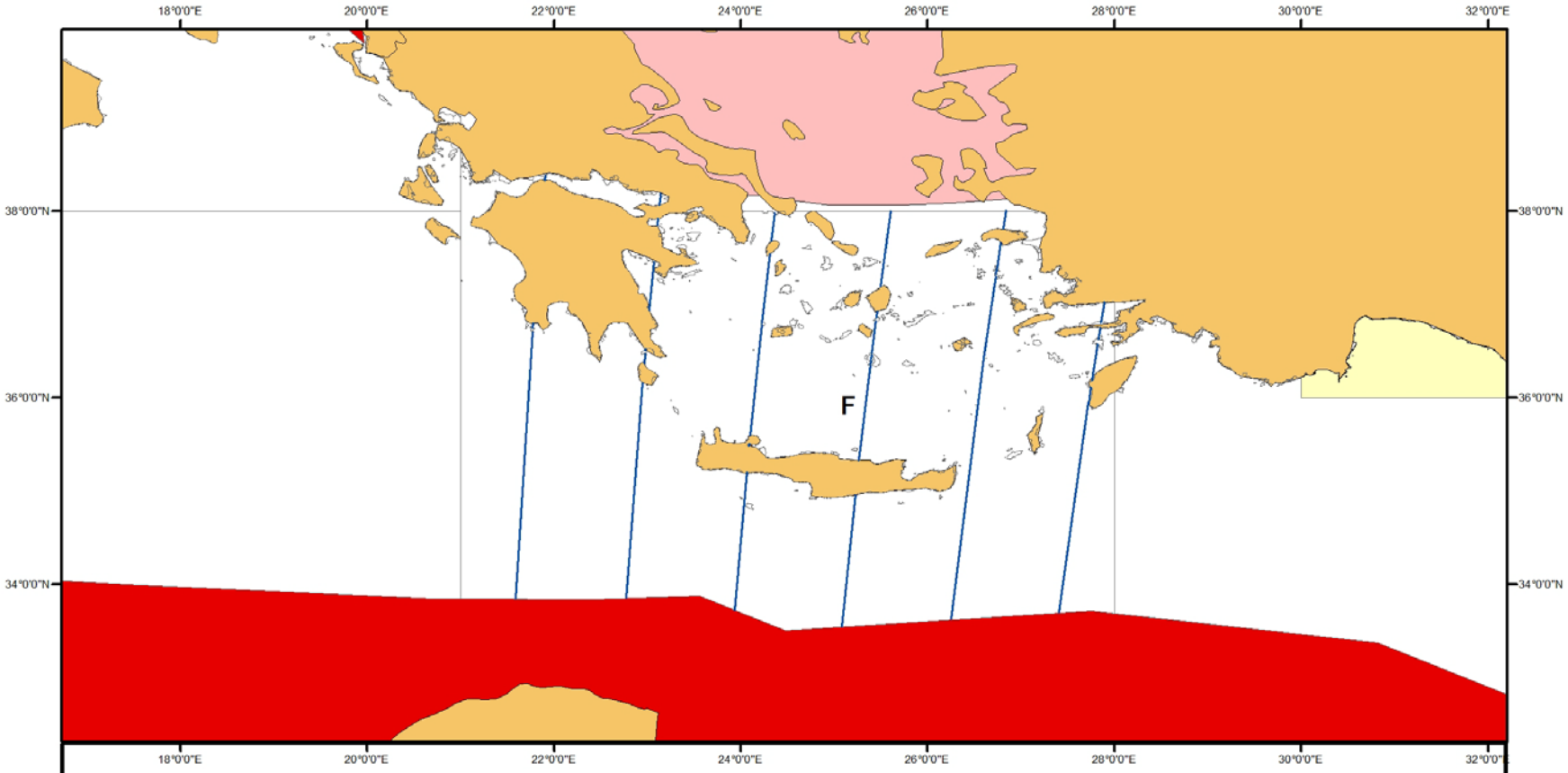
Replica Extra

Restricted Airspace

No spawning areas

Survey Areas (A - G)

Areas surveyed in 2010 and 2011



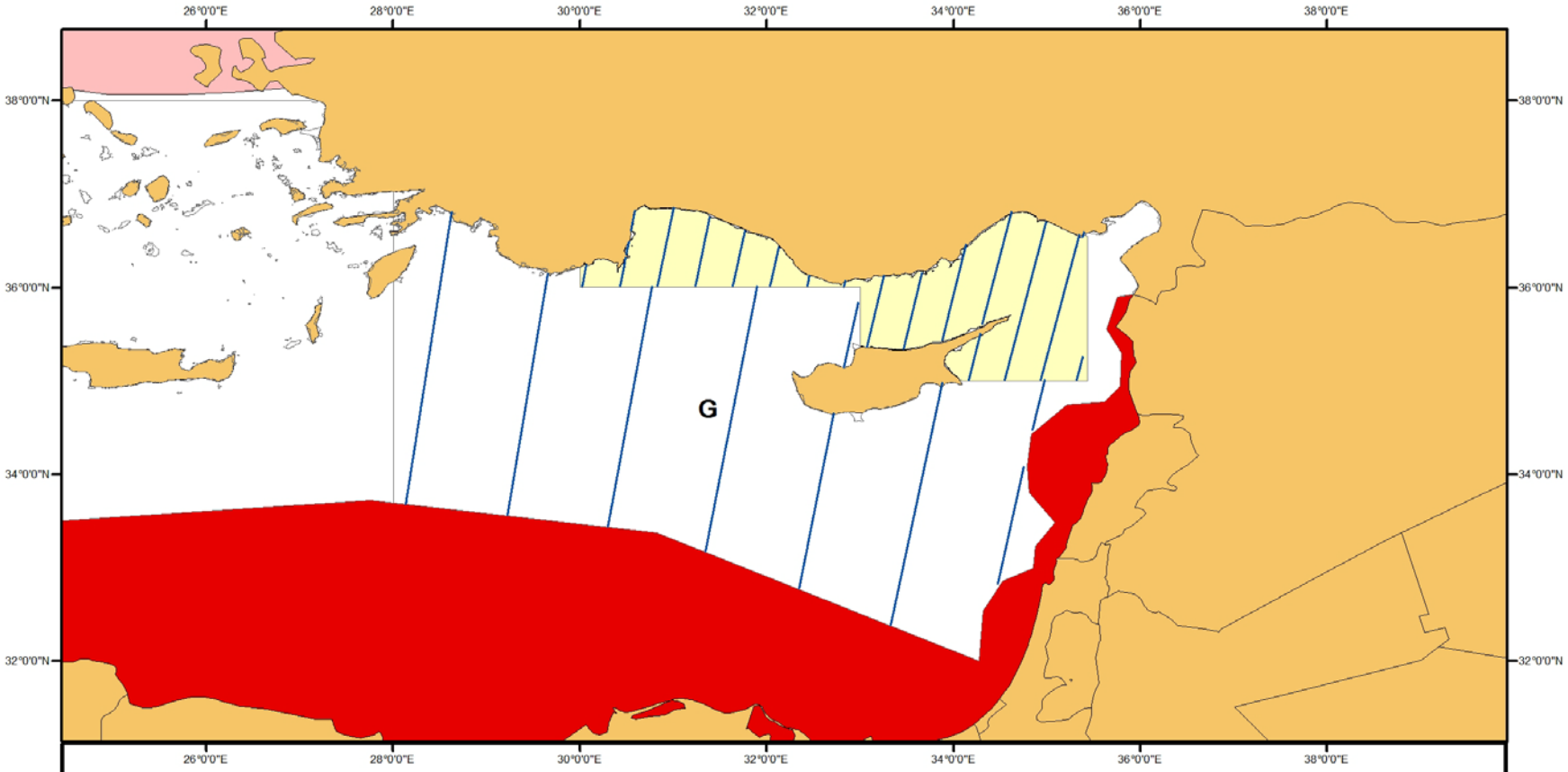
Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block F

Replica Extra

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010 and 2011



Data Recovery Plan of the Atlantic-wide Research Programme on Bluefin tuna (ICCAT-GBYP - 2013)

Survey design for 2013

Extra tracks Block G

Replica Extra

Restricted Airspace

No spawning areas

Survey Areas (A - G)

Areas surveyed in 2010 and 2011