AERIAL SURVEY DESIGN
OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA (ICCAT-GBYP Phase 7 - 2017)

Report

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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 four defined survey areas (overlap survey areas A to G as defined in the 2015 report), target survey time available (equivalent to 32,000 km on effort) and time for circling over detected schools to estimate their size (set at 10%). The time for flying in between lines and from and to airport each day are not considered in these calculations as they are off effort.

Transect lines are placed in a north-south direction to be approximately perpendicular to the coast or the bathymetry in all blocks.

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 design

The areas identified by the GBTP Steering Committee were used to create survey blocks in program DISTANCE (overlap survey areas A to G, see Figure 1). These areas correspond to: A: Balearic Sea; C: Southern Tyrrhenian Sea, E: Central-southern Mediterranean Sea; and G: Levantine Sea.

For the calculations of the percentage of coverage for each block, an effective half strip width of 4 km was considered. This value was chosen as it was the mean effective half strip width for all years and all areas analyzed in the previous surveys (2010, 2011, 2013 and 2015).

The proportion of the total trackline effort (32,000km) was calculated for each block according to the proportion of the surface area of each block (see Table 1).

Four replicas were assigned to each area given the high coverage given by the allocated effort in them, while keeping similar track line spacing as previous years.

Additionally, two extra replicas were designed both each area in the event that enough time is left and therefore more effort can be allocated. This should be the case in most areas, given that the total allocated

effort is 82% of the total (32,000 km), leaving in average 18% “free” leftover time for circling and potential extra replica (see Table 1 for leftover time for each area).

Table 1 shows the effort allocated to each area (primary tracks), on effort tracklines Table 2 shows the effort allocated to the extra tracklines.

The Projected Coordinate System used to calculate distances and areas in DISTANCE software was TRANSVERSE 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 Figure 10 the extra tracks.

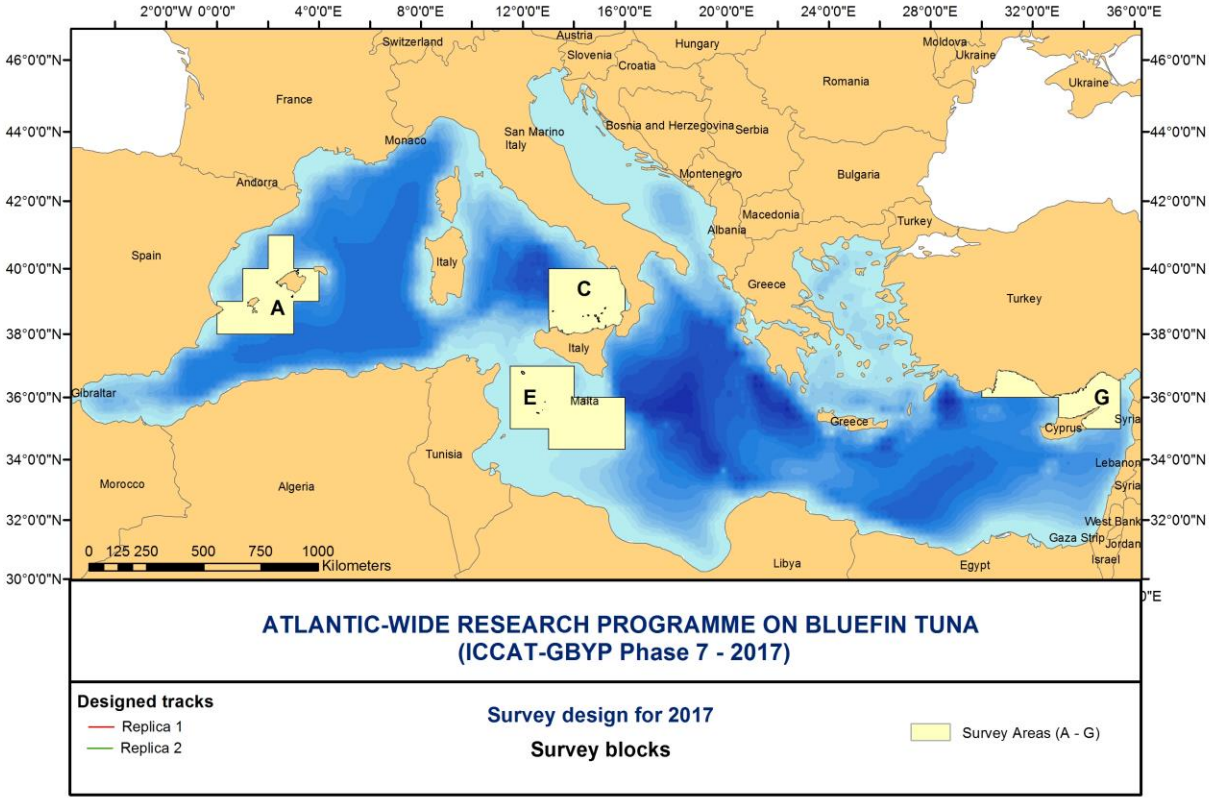

Figure 1. Survey blocks

TABLES

Table 1. Primary tracks.

Sub-area	Area (km^2)	Proport. of total area	Expected proport. Length of Trackline on Effort	Expected proport. Length of Trackline on Effort (minus 10% for circling)	% coverage	Line spacing per replica	On effort track Replica 1	On effort track Replica 2	On effort track Replica 3	On effort track Replica 4	Total on effort track	Leftover effort
A	61,933	23.3	7,461	6,715	20.1	35.0	1,659	1,589	1,629	1,523	6,400	14.2
C	53,868	20.3	6,489	5,841	18.7	42.5	1,270	1,273	1,228	1,332	5,103	21.4
E	93,614	35.2	11,278	10,150	19.3	41.3	2,199	2,216	2,326	2,321	9,062	19.6
G	56,211	21.2	6,772	6,095	19.6	39.5	1,431	1,410	1,404	1,455	5,700	15.8
Total	**265,626**		**32,000**	**28,800**			**6,559**	**6,488**	**6,587**	**6,631**	**26,265**	**17.9**

Table 2. Extra tracks.

Sub-area	Area (km^2)	Line spacing per replica	On effort Extra track 1	On effort Extra track 2
A	61,933	35.0	1,653	1,442
C	53,868	42.5	1,325	1,236
E	93,614	41.3	2,319	2,227
G	56,211	39.5	1,435	1,412
Total	**265,626**		**6,732**	**6,317**

Figure 2. Primary Tracks for all areas

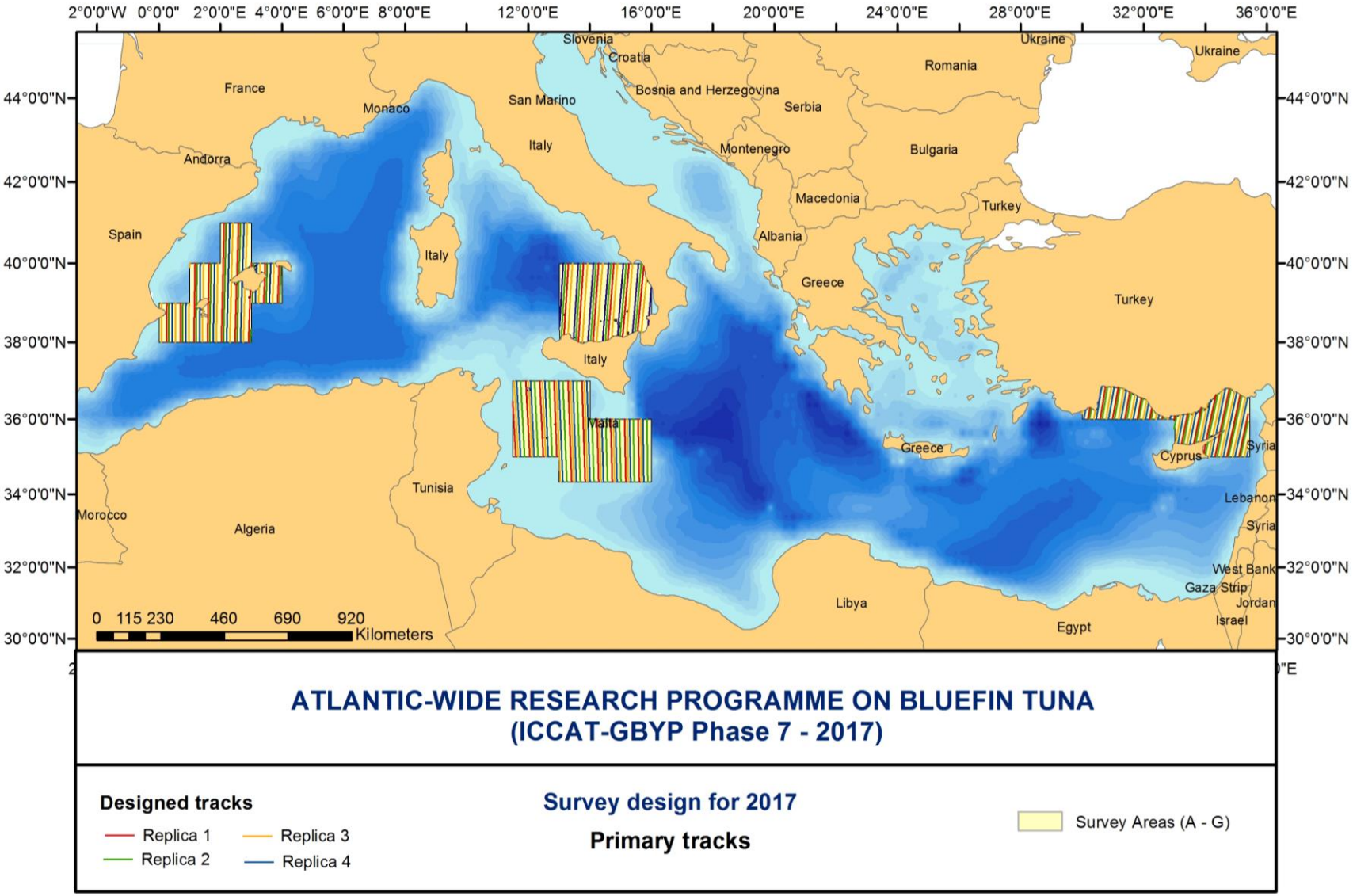

Figure 3. Primary Tracks for Area A

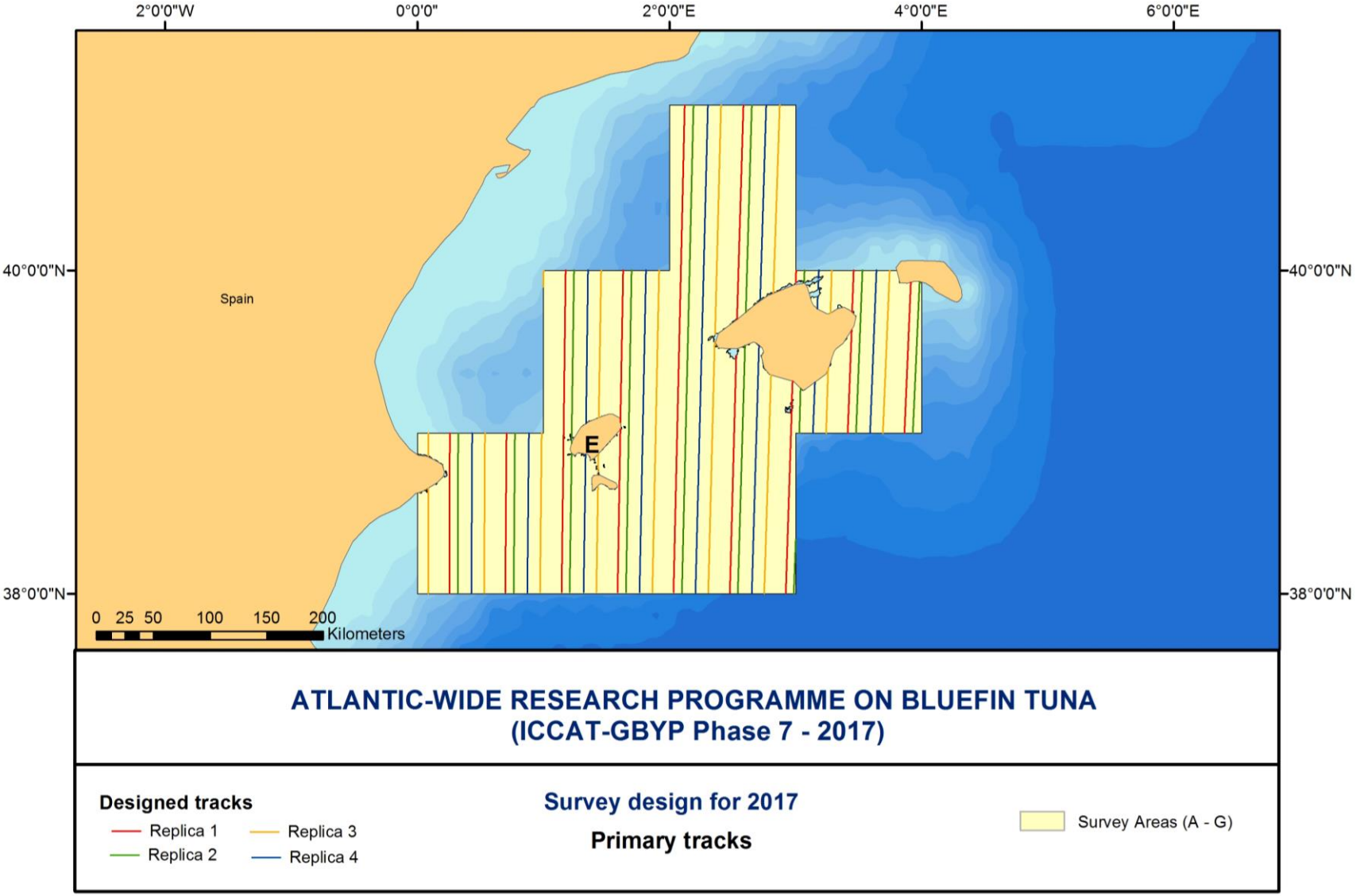

Figure 4. Primary Tracks for Area C

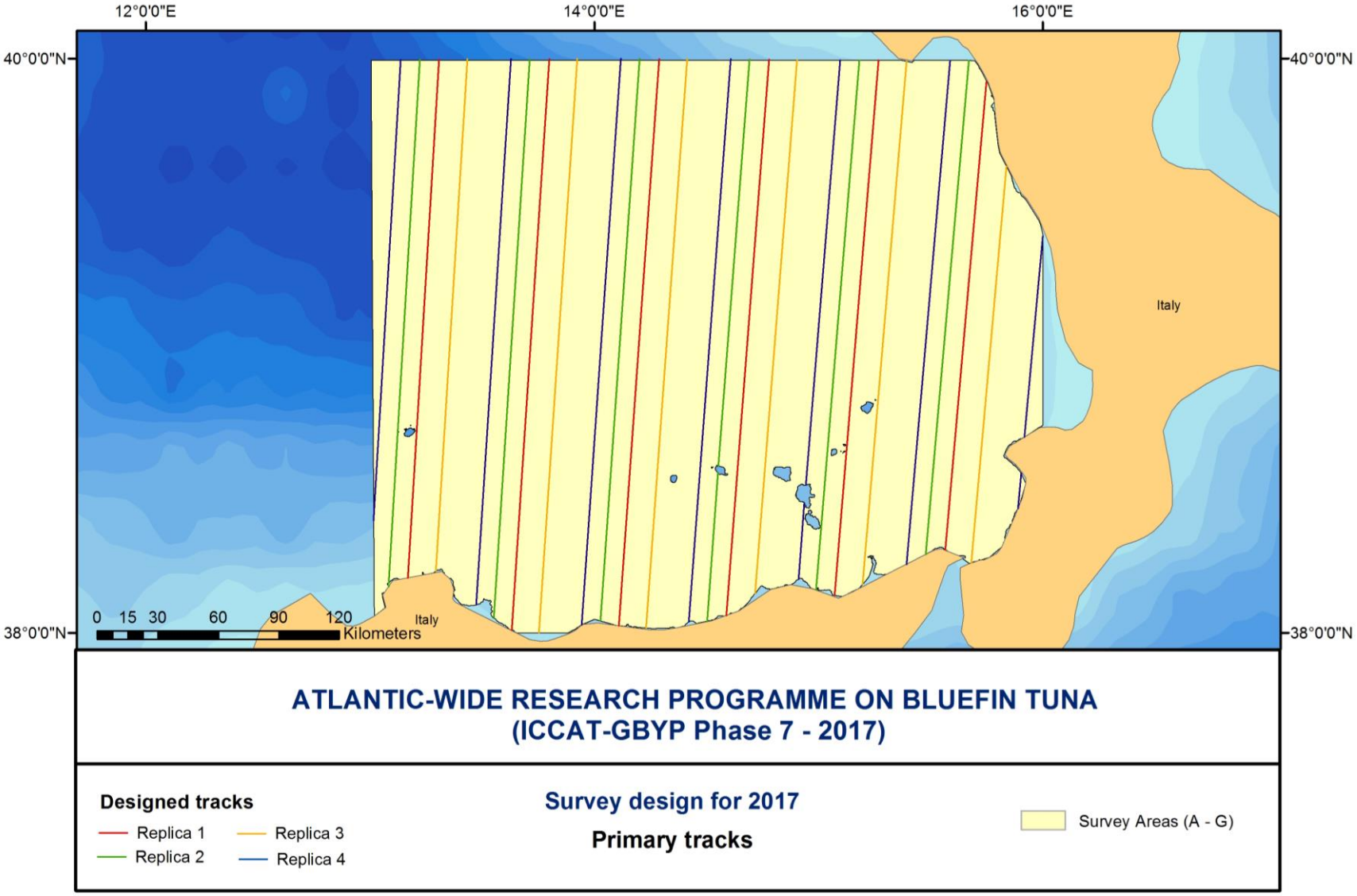

Figure 5. Primary Tracks for Area E

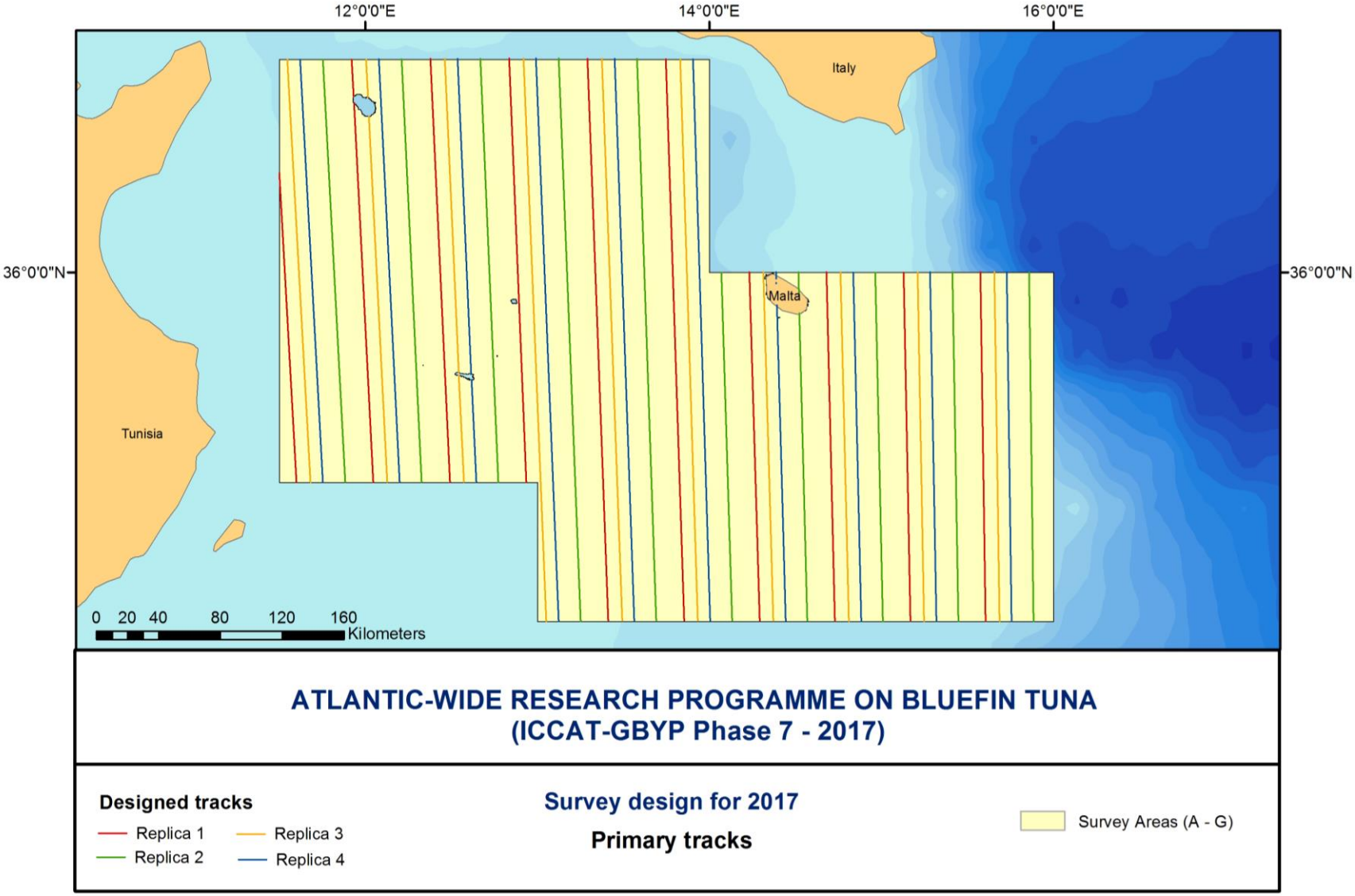

Figure 6. Primary Tracks for Area G

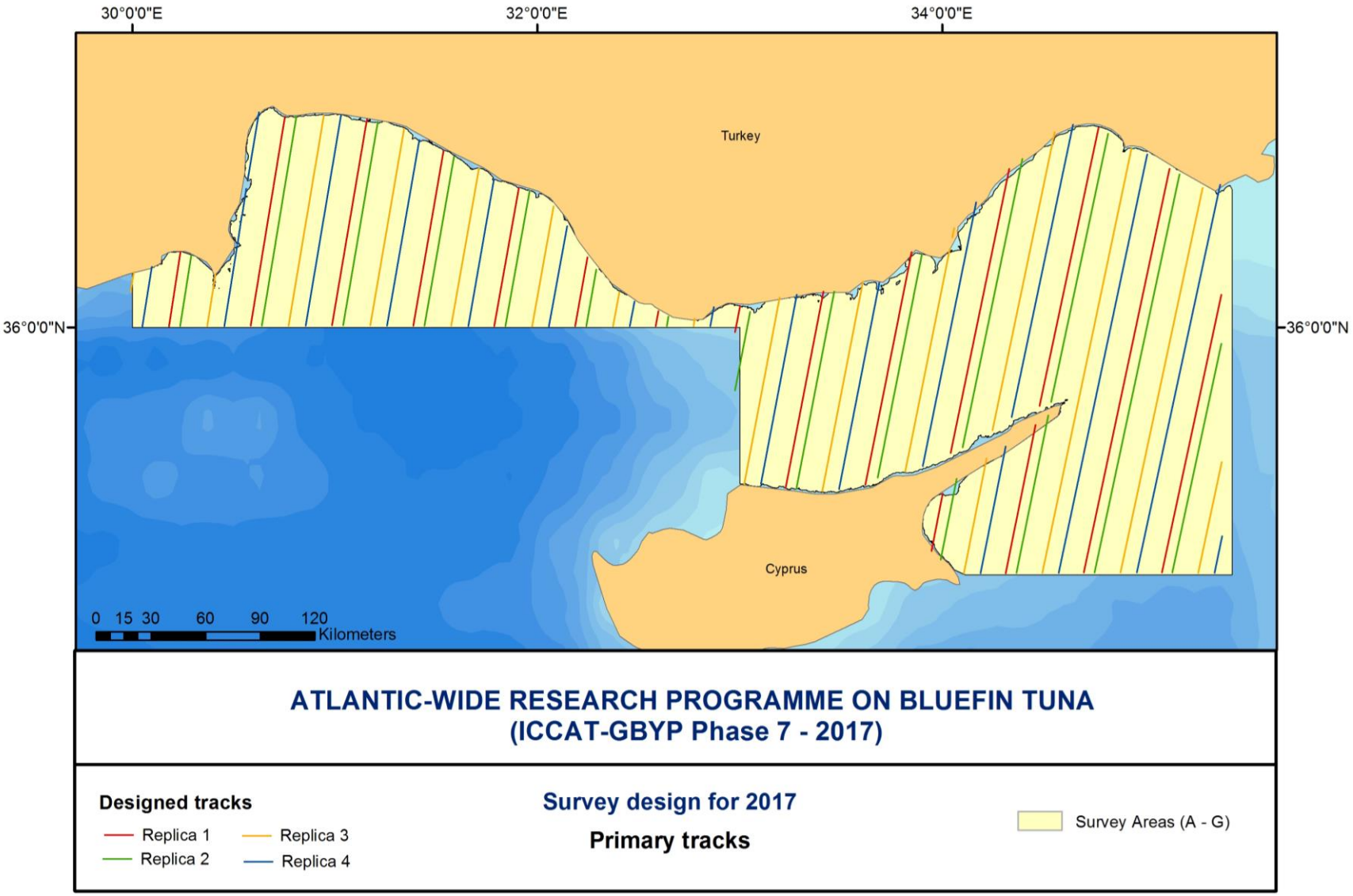

Figure 7. Extra Tracks for Area A

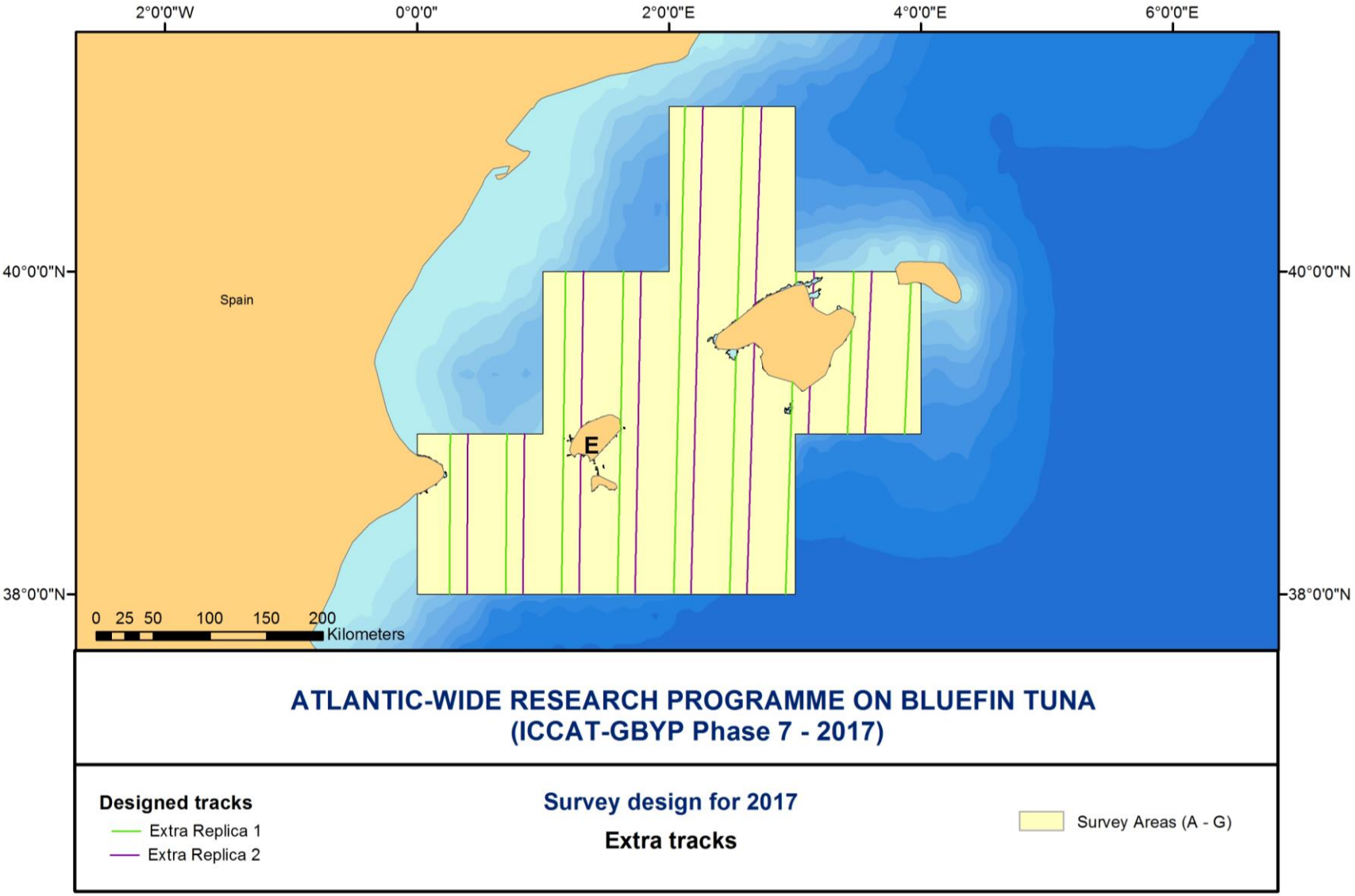

Figure 8. Extra Tracks for Area C

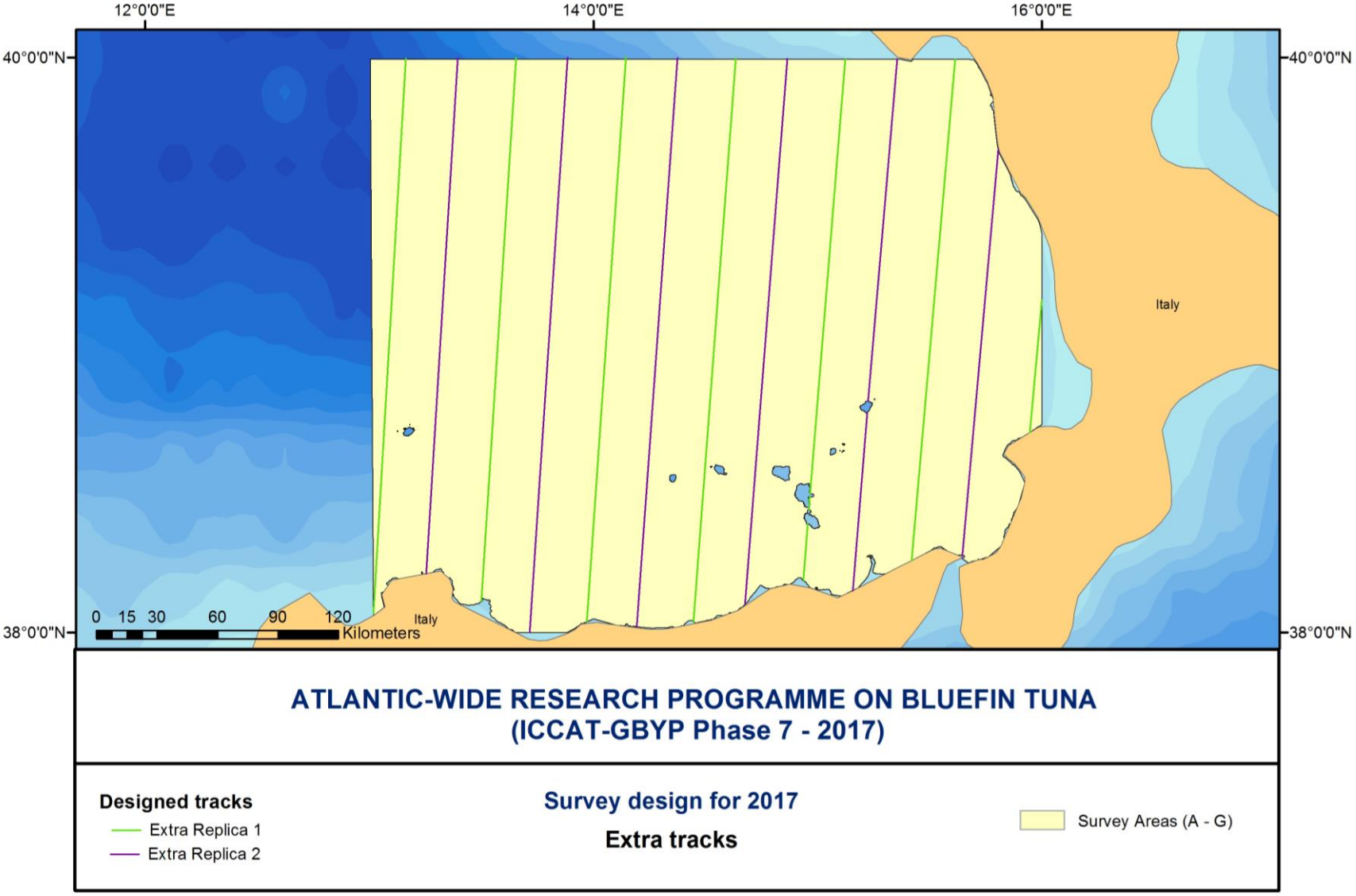

Figure 9. Extra Tracks for Area E

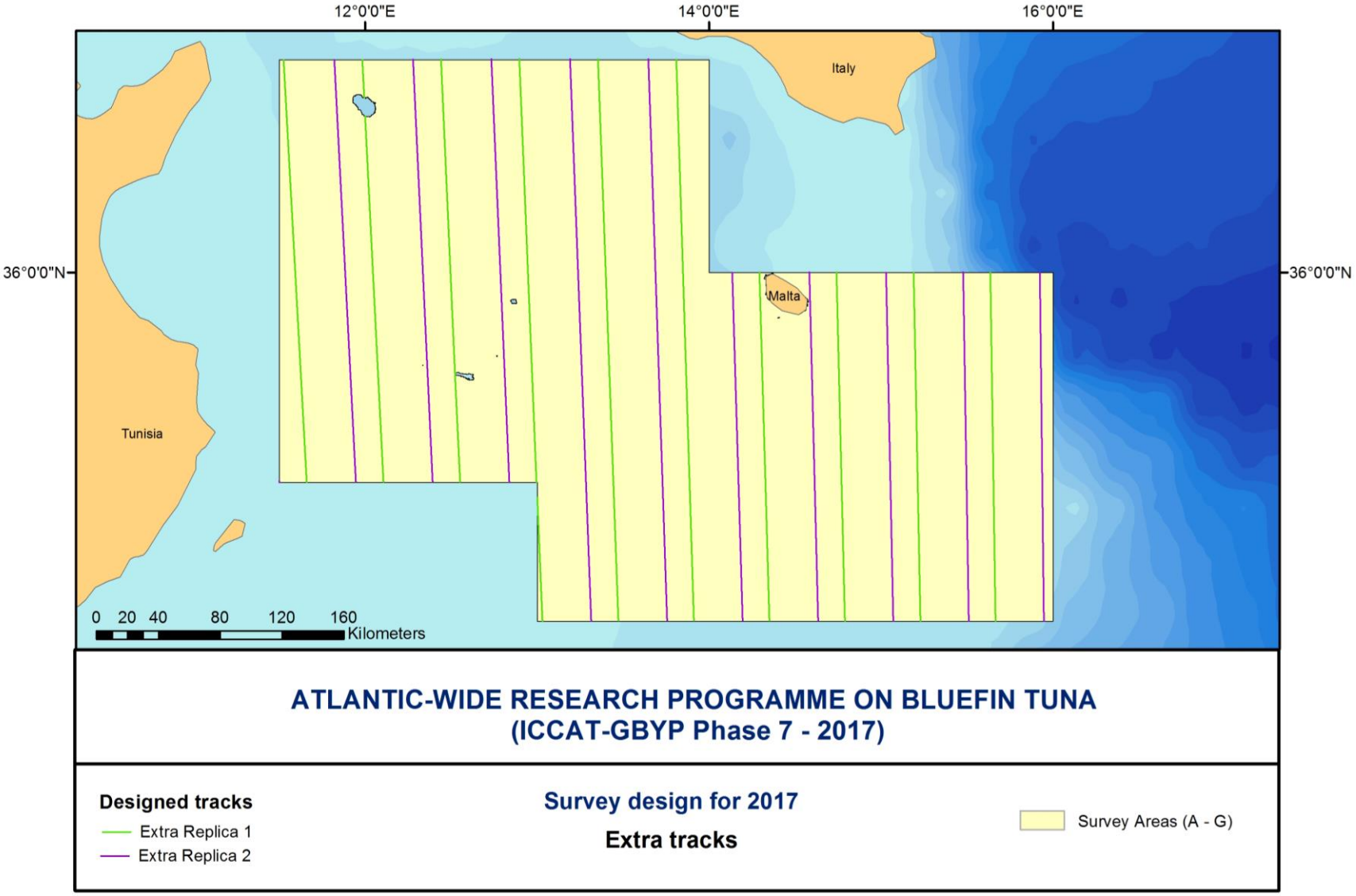
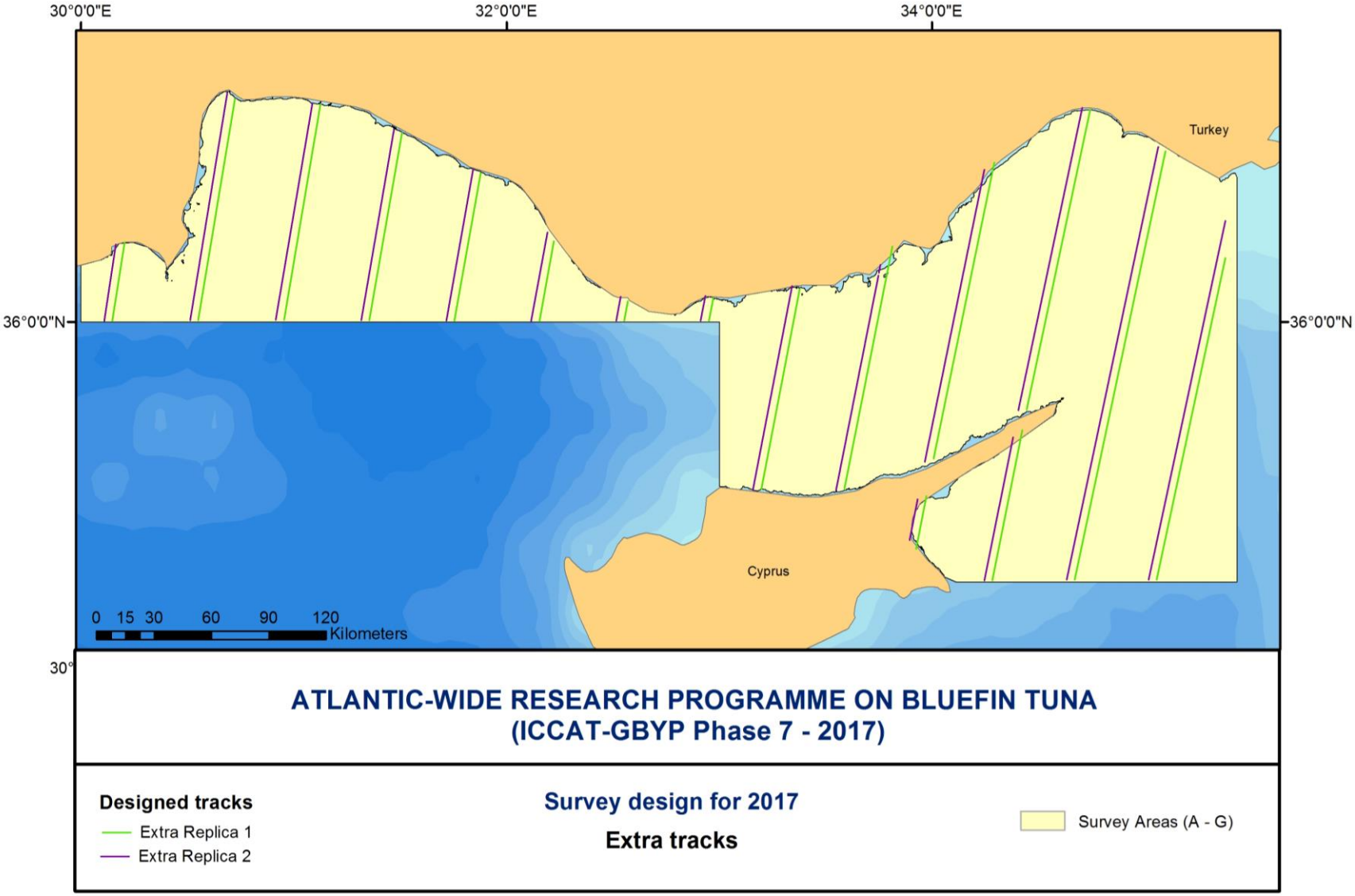
Figure 10. Extra Tracks for Area G