SHORT-TERM CONTRACT FOR THE AERIAL SURVEY DESIGN OF THE ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA (ICCAT-GBYP Phase 5 - 2015)

Final Report

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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.

A third aerial survey was carried out in 2013 over an extended area, which included also the main areas surveyed in previous years. A new survey design was provided on 19 April 2013. The final report of the survey, including the data analysis, was approved on 24 September 2013 and presented to the SCRS.

The ICCAT GBYP Steering Committee, on 28-29 September 2013, approved a new map for the next aerial survey, taking into account the updated knowledge about the main and potential bluefin tuna spawning areas and the many constraints limiting the survey in various areas. At the same time, the main areas (called “internal” in the analysis) were slightly modified, taking into account the most recent sightings, while the various sub-areas were redefined.

The aerial survey was not carried out in 2014, due to the lack of sufficient funding.

The aerial survey was included among the ICCAT GBYP activities to be carried out in 2015. After the approval of GBYP plan for Phase 5 by the ICCAT Commission in December 2014, the ICCAT Secretariat was of the advice that there are sufficient opportunities for carrying out an extended survey in 2015, following the advice of the GBYP Steering Committee on 10-12 February 2015.

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 8rose), those where spawning is extremely unlikely to occur (grey) and those where it is impossible to obtain flight permits due to particular situation (red); the design should allow for more spacing transect in the “external” areas (white) and more dense transects in the other areas which were mostly surveyed before (yellow) (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-July 2015. 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 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 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, 2011 and 2013 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”). This was done so in 2013, and is designed in the same way in 2015, assuming again Scenario 2 and also for proper comparison with 2013.

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. It was also used in the percentage of coverage calculations in 2013, although a final truncation distance was chosen at 5 km, which would mean a better coverage if similar truncation is chosen during the analysis of 2015 data.

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). 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 (777 km), C_inside (278 km) and E_inside (247 km) when surveying A_outside, C_outside and E_outside respectively, as these cross-overs can be used to do nearby on-effort tracklines in the A_inside, C_inside and E_inside blocks respectively. The total final trackline is 38,308 km, which leaves 3,692 km (8.8% of the total available, close to the 10% expected) for potential circling over fish schools. The percentage for potential circling goes from 7.5% to 11.7% (average of 9.9%) in the “inside” blocks, and from 3.9% to 10.5% (average of 7.6%) in the “outside areas”, where much less density is expected and therefore less time for circling would be needed.

Given that the blocks have been modified, especially the “outside” ones, a comparison of the surface areas, allocated effort and coverage is shown in Table 3. These differences will need to be taken into account when comparing the resulting densities in 2015 with 2013. In general, the survey area has been reduced in 31% due to the extended Restricted Airspace and the extension of the areas considered as “No spawning”. But this affects only to the “outside” areas, which has been reduced in 39%, while de “inside” areas has been increased slightly, in 11.5%. The “inside” areas with larger extension were C and G with around 20% increase. As for the “outside” areas, E, B and F were reduced between 56% and 68%, while the rest only between 3% and 16%. These changes led to obvious changes in the designed tracks length and in the coverage. Taking into account that the same amount of effort is available (21,000 km for the “inside” areas and 21,000 for the “outside” areas), the coverage has been reduced in the “inside” areas by 9% and increased in the “outside” areas by 62%, with a global increase of almost 7% of coverage.

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 Figure 10 the extra tracks.

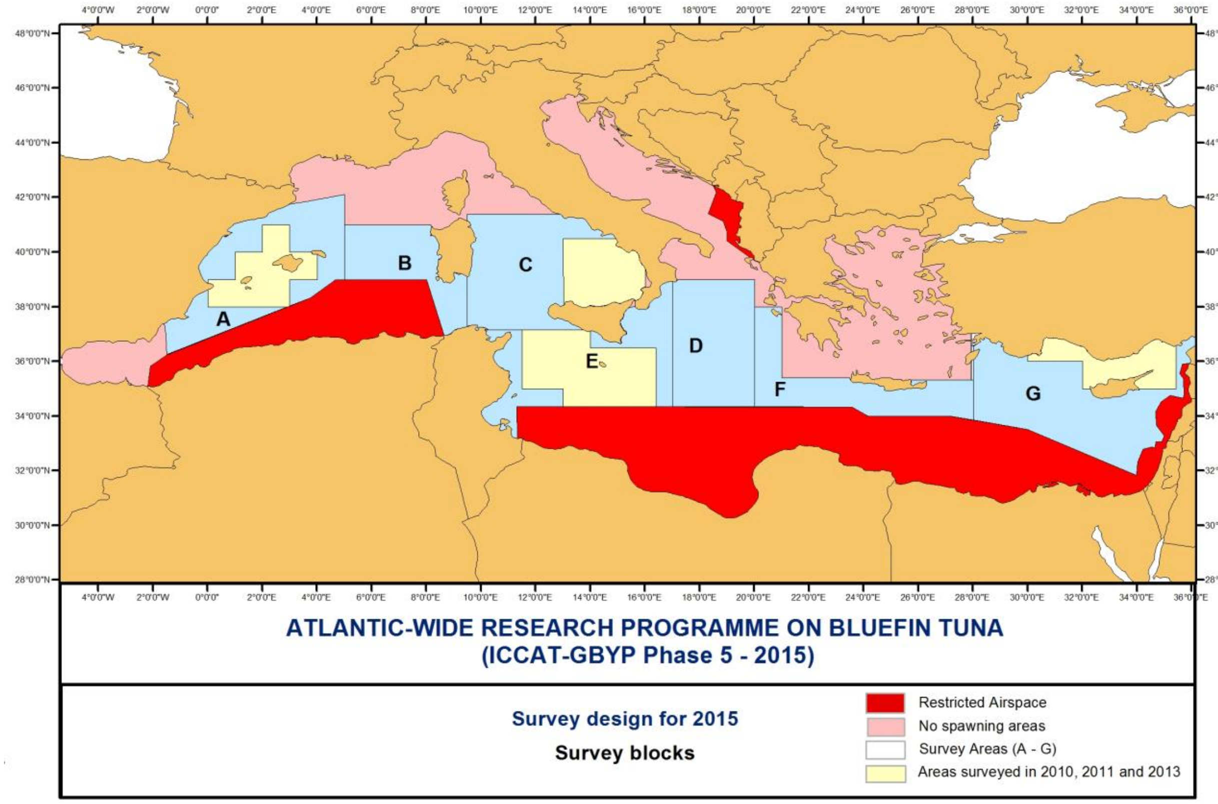


Figure 1. Survey blocks

TABLES

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

Sub-area	Area (km²)	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 (50%)										
A_inside	62,150	19.9	4,177	30.0	43.9	1,291 1,435	1,815 1,935	2,725	3,751	3,751
C_inside	64,610	20.7	4,342	36.0	38.4	1,650 1,694	1,897 1,937	3,345	3,834	3,834
E_inside	117,718	37.7	7,911	36.3	38.0	3,053 3,108	3,515 3,578	6,160	7,090	7,090
G_inside	68.013	21.8	4,571	29.9	45.6	1,475 1,473	2,108 2,120	2,948	4,228	4,228
Sub-Total	**312,490**	**100,00**	**21,000**			**15,179**	**18,903**	**15,179**	**18,903**	**18,903**
Outside areas (50%)										
A_outside	123,351	12.7	2,664	8.7	74.0	1,634	3,162			2,385
C_outside	149,607	15.4	3,231	8.3	76.6	1,887	3,177			2,899
E_outside	92,378	9.5	1,995	7.6	80.7	1,024	2,164			1,917
G_outside	241,447	24.8	5,214	10.7	62.8	3,720	4,873			4,873
B_total	87,334	9.0	1,886	10.3	60.9	1,310	1,722			1,722
D_total	147,666	15.2	3,189	11.2	62.8	2,402	2,956			2,956
F_total	130,585	13.4	2,820	9.8	73.5	1,834	2,653			2,653
Sub-Total	**972,368**	**100,00**	**21,000**			**13,811**	**20,707**			**19,405**
Total	**1,284,858**		**42,000**			**28,990**	**39,610**			**38,308**

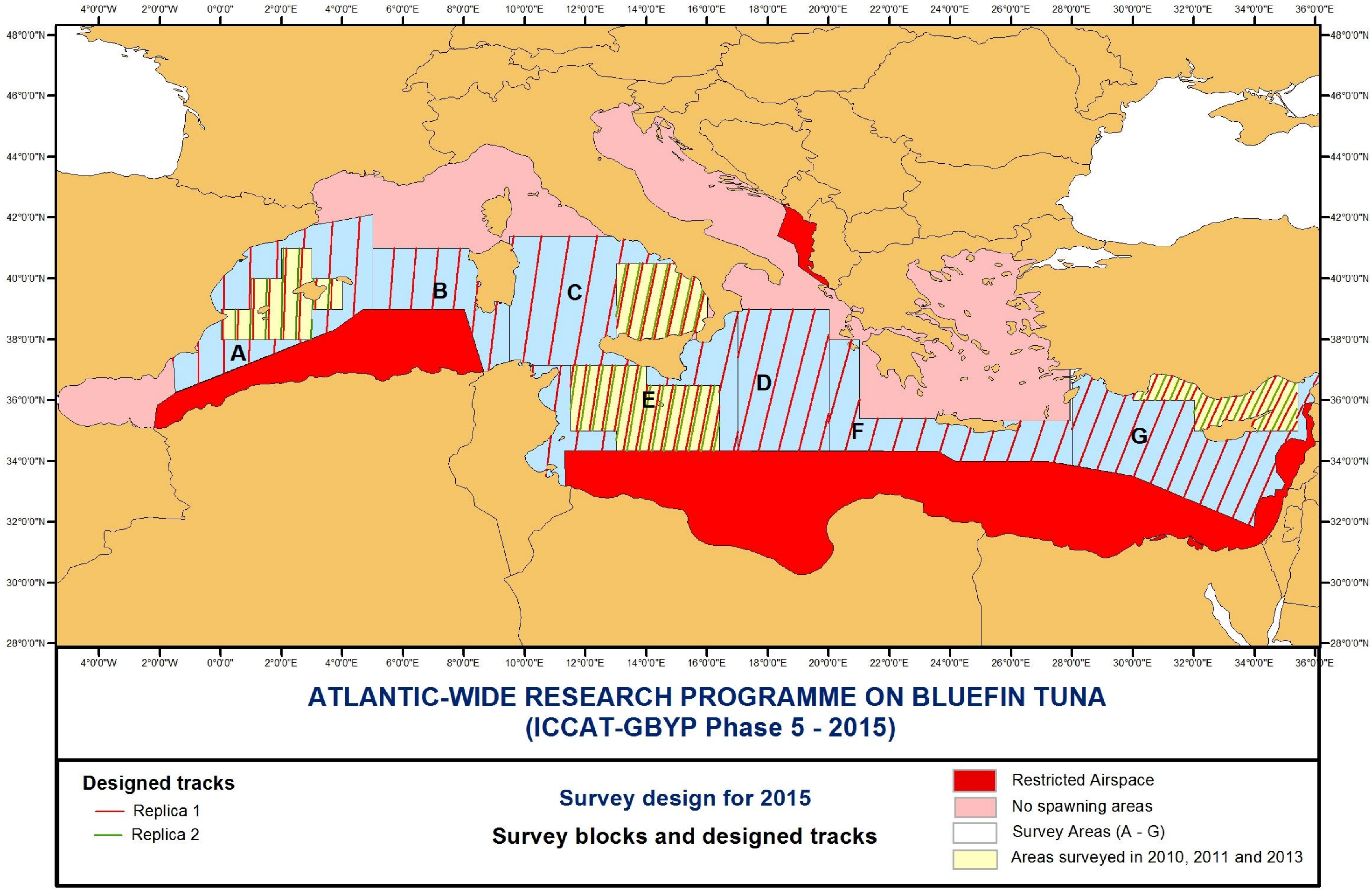
Table 2. Extra tracks.

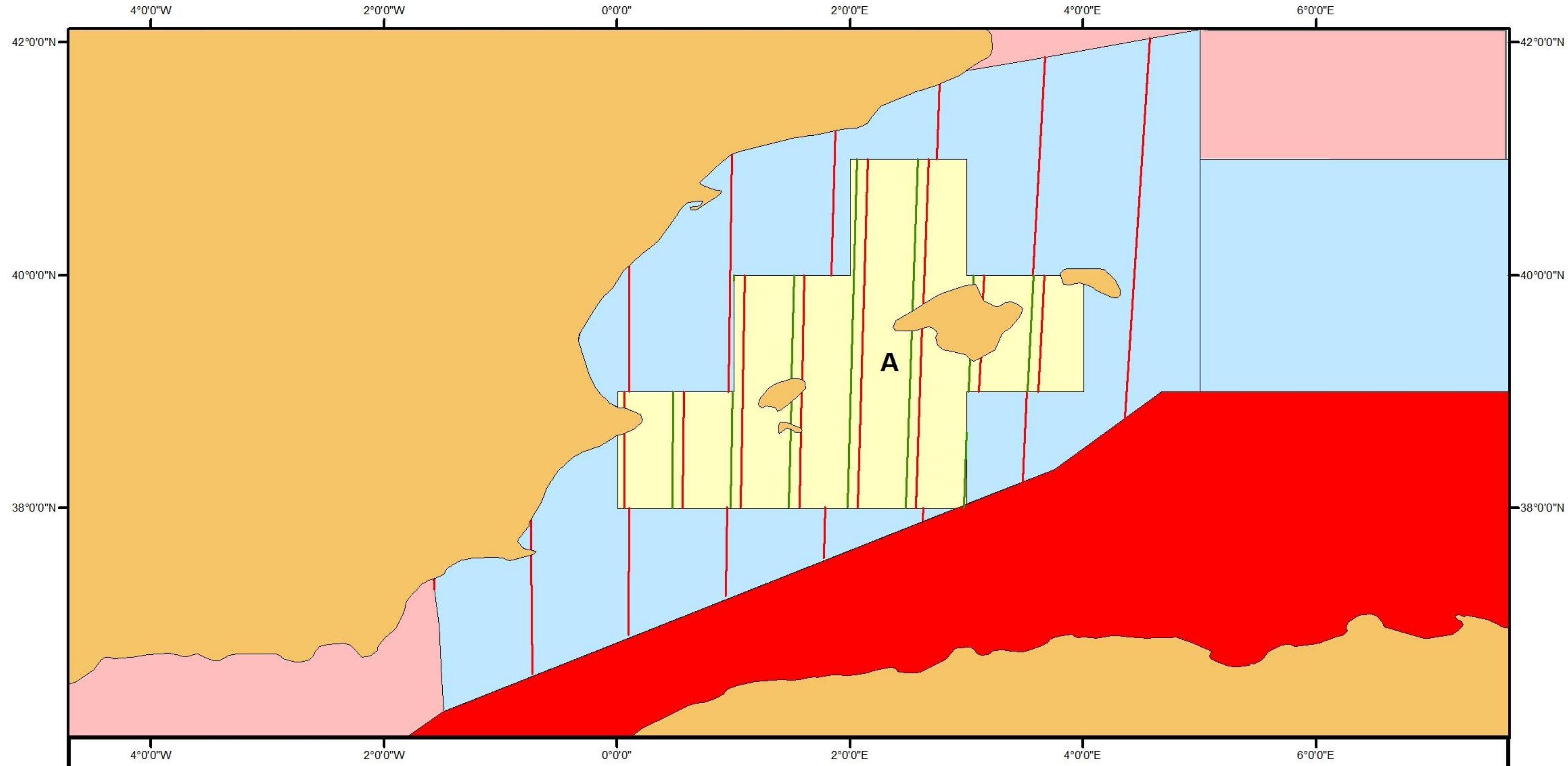
Sub-area	Area (km^2)	Line spacing per replica	On effort track	Total track
Inside Areas				
A_inside	62,150	43.9	1,459	1,936
C_inside	64,610	38.4	1,735	2,061
E_inside	117,718	38.0	3,161	3,664
G_inside	68,013	45.6	1,507	2,168
Sub-Total	**312,490**		**7,862**	**9,828**
Outside areas				
A_outside	123,351	74.0	1,660	3,042
C_outside	149,607	76.6	2,038	2,783
E_outside	92,378	80.7	1,018	2,183
G_outside	241,447	62.8	3,809	4,862
B_total	87,334	60.9	1,396	1,829
D_total	147,666	62.8	2,307	2,923
F_total	130,585	73.5	1,824	2,673
Sub-Total	**972,368**		**14,053**	**20,295**
Total	**1,284,858**		**21,915**	**30,123**

Table 3. Comparison between 2013 and 2015.

Sub-area	Area (km^2)		% change	On effort track		% coverage		% change
	2013	**2015**		**2013**	**2015**	**2013**	**2015**	
Inside Areas								
A_inside	62,194	62,150	-0.07	1,287	1,459	31.20	30.00	-3.85
C_inside	54,177	64,610	19.26	1,623	1,735	35.80	36.00	0.56
E_inside	107,673	117,718	9.33	3,306	3,161	41.30	36.30	-12.11
G_inside	56,329	68,013	20.74	1,450	1,507	36.90	29.90	-18.97
Sub-Total	**280,373**	**312,490**	**11.46**	**7,666**	**7,862**	**36.30**	**33.05**	**-8.95**
Outside areas								
A_outside	173,435	123,351	-28.88	1,618	1,660	5.10	8.70	70.59
C_outside	179,121	149,607	-16.48	1,334	2,038	6.70	8.30	23.88
E_outside	294,314	92,378	-68.61	2,517	1,018	6.00	7.60	26.67
G_outside	249,064	241,447	-3.06	2,247	3,809	6.20	10.70	72.58
B_total	236,092	87,334	-63.01	2,063	1,396	6.20	10.30	66.13
D_total	171,047	147,666	-13.67	1,356	2,307	5.20	11.20	115.38
F_total	296,961	130,585	-56.03	2,458	1,824	5.80	9.83	69.48
Sub-Total	**1,600,034**	**972,368**	**-39.23**	**13,593**	**14,053**	**5.89**	**9.52**	**61.63**
Total	**1,880,407**	**1,284,858**	**-31.67**	**21,259**	**21,915**	**16.95**	**18.08**	**6.67**

Figures 2 to 9. Primary Tracks





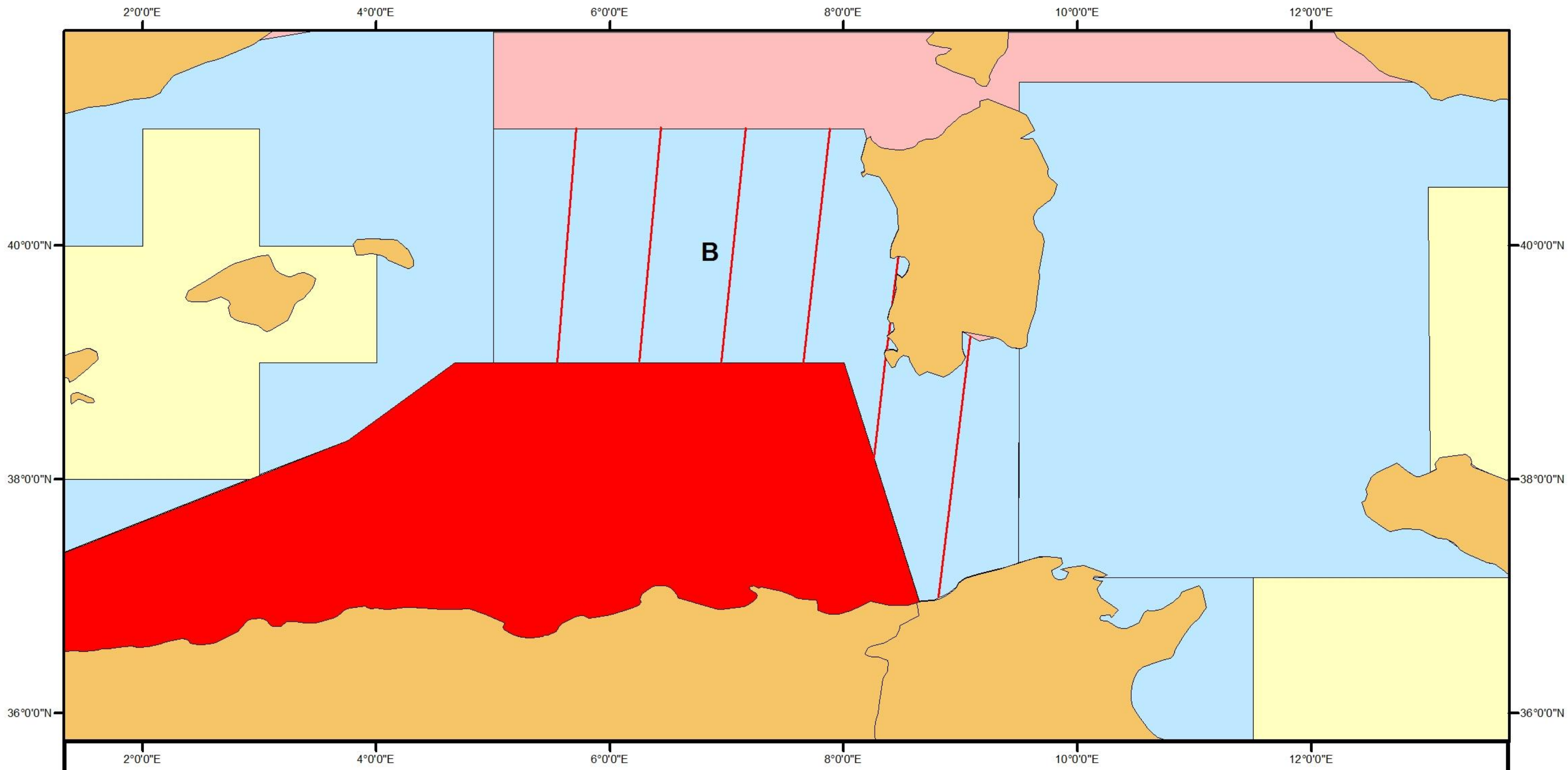
ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA
(ICCAT-GBYP Phase 5 - 2015)

Designed tracks
- Replica 1
- Replica 2

Survey design for 2015

Survey blocks and designed tracks

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010, 2011 and 2013



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Designed tracks

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Survey design for 2015

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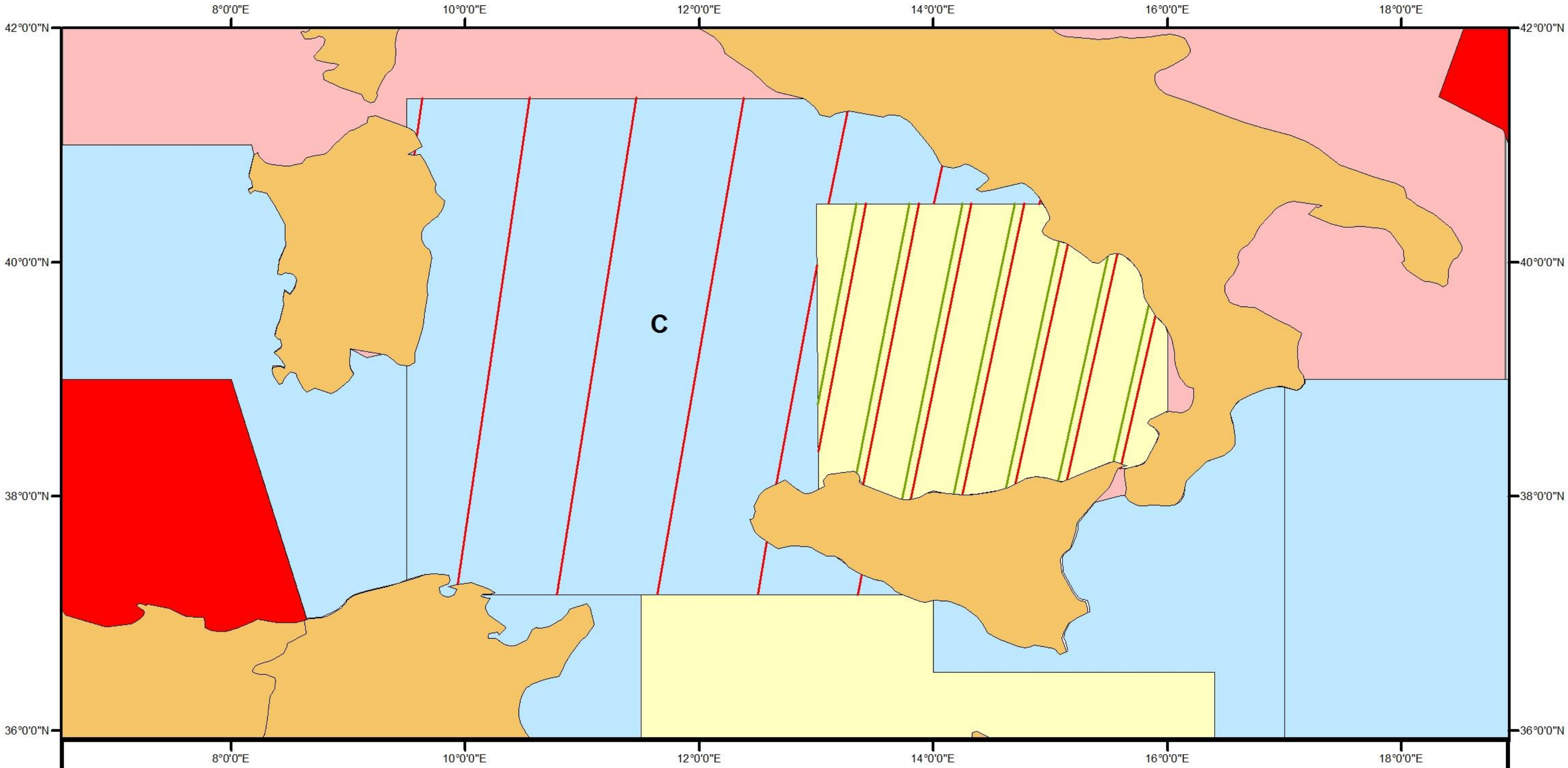

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(ICCAT-GBYP Phase 5 - 2015)

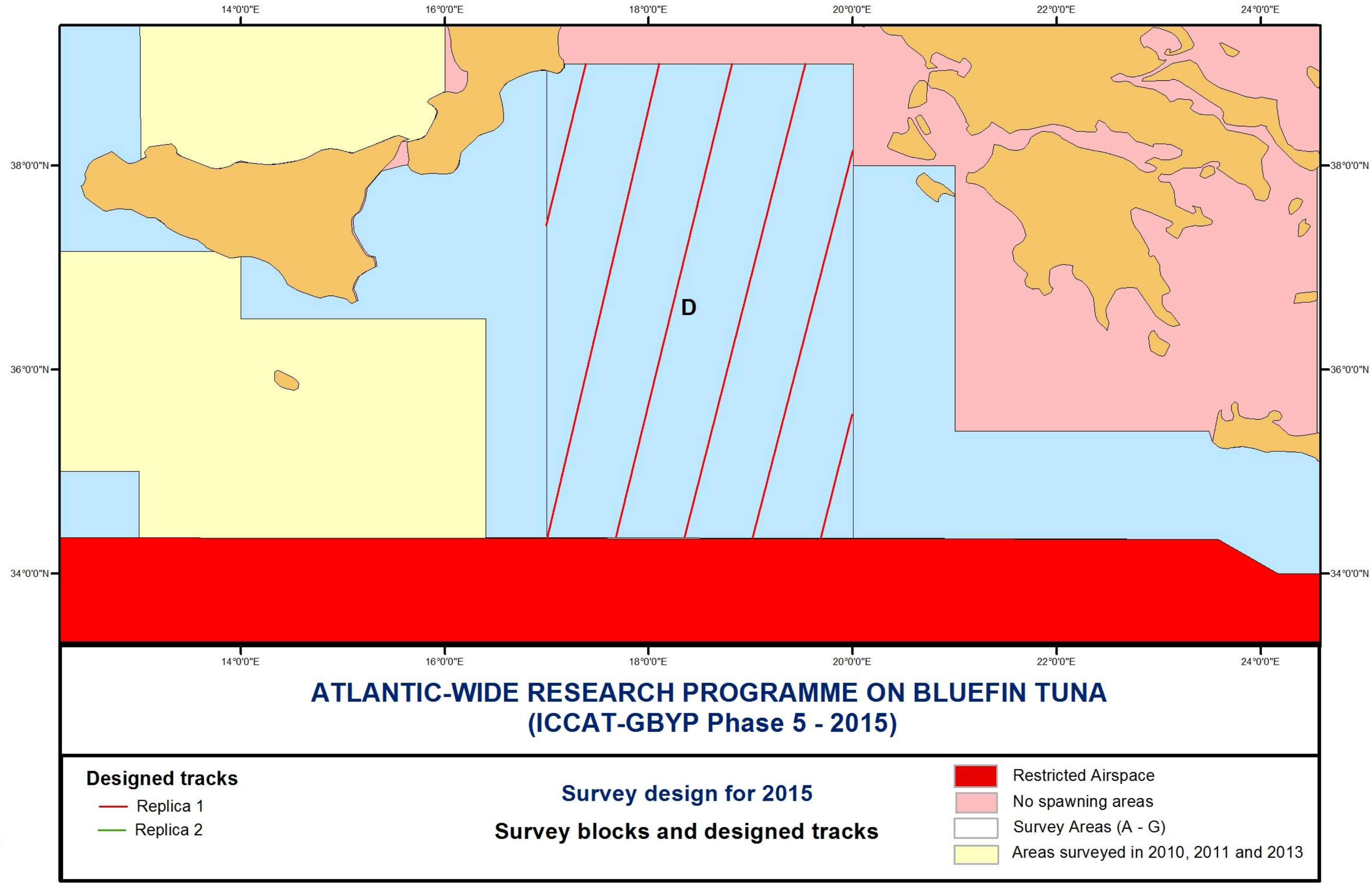
Designed tracks

- Replica 1
- Replica 2

Survey design for 2015

Survey blocks and designed tracks

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010, 2011 and 2013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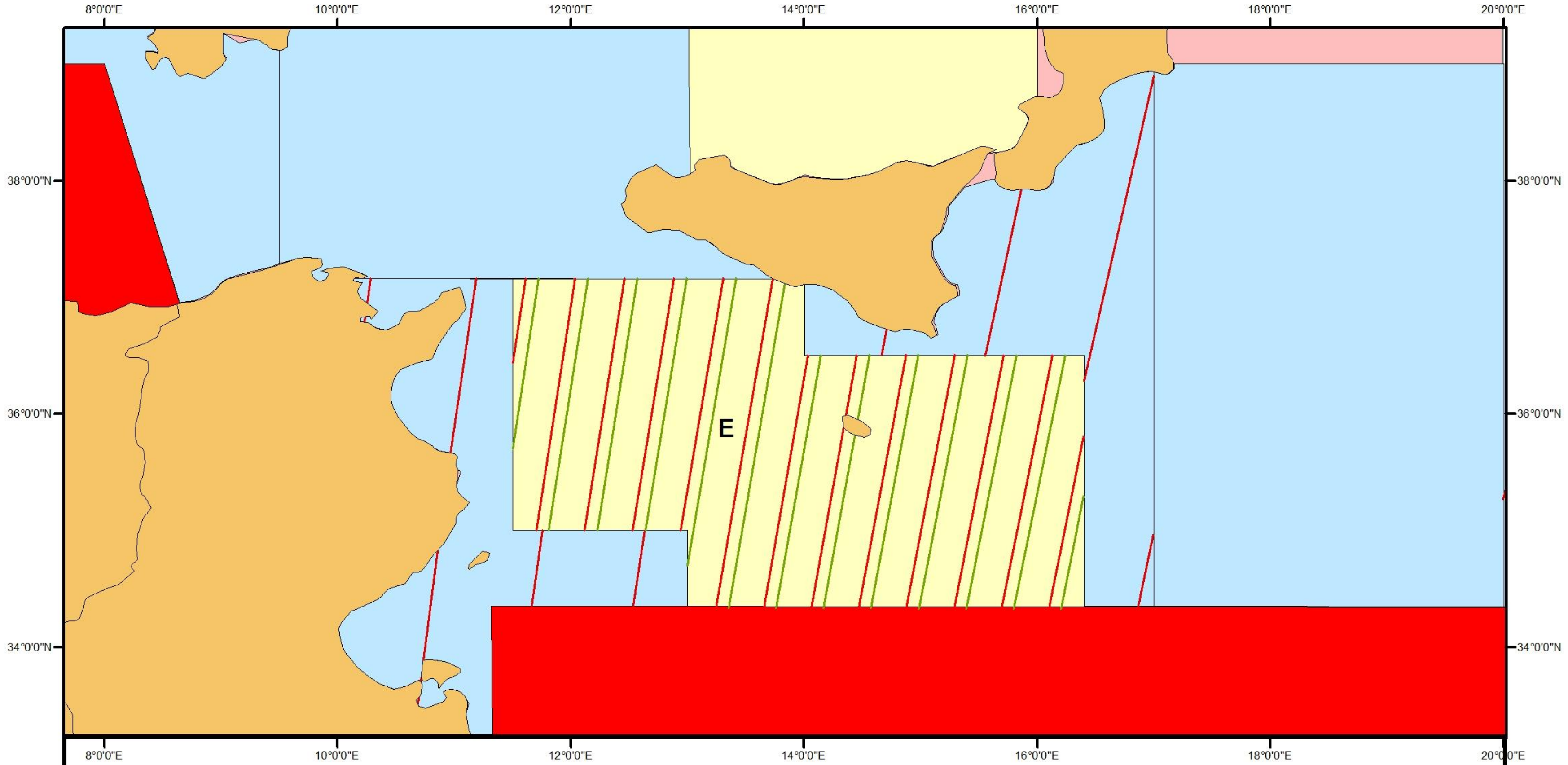
16°0'0"E
18°0'0"E
20°0'0"E
22°0'0"E
24°0'0"E
38°0'0"N
36°0'0"N
34°0'0"N
D
ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA
(ICCAT-GBYP Phase 5 - 2015)
Designed tracks
Replica 1
Replica 2
Survey design for 2015
Survey blocks and designed tracks
Restricted Airspace
No spawning areas
Survey Areas (A - G)
Areas surveyed in 2010, 2011 and 2013



ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA
(ICCAT-GBYP Phase 5 - 2015)

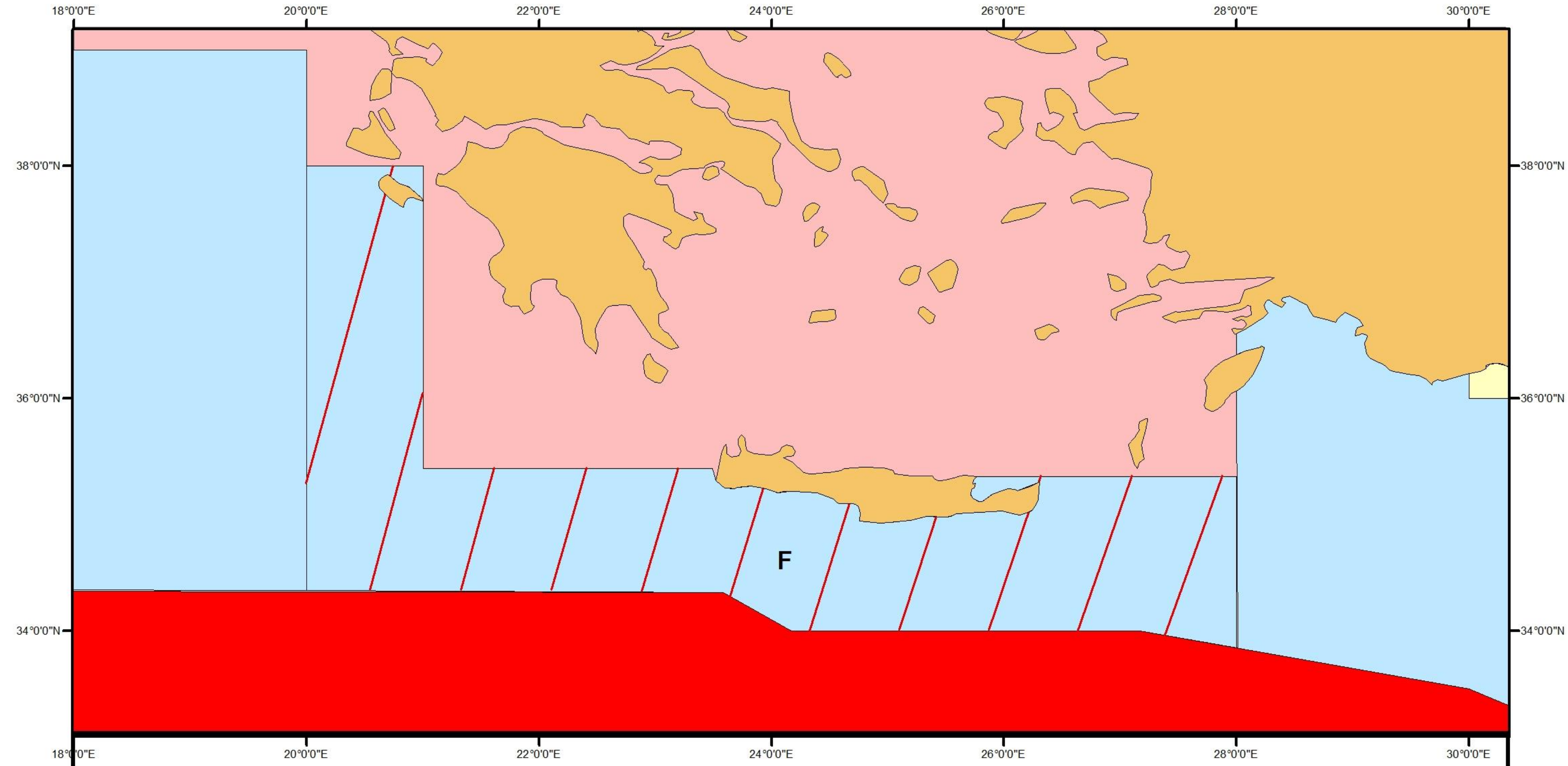
Designed tracks

- Replica 1
- Replica 2

Survey design for 2015

Survey blocks and designed tracks

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010, 2011 and 2013



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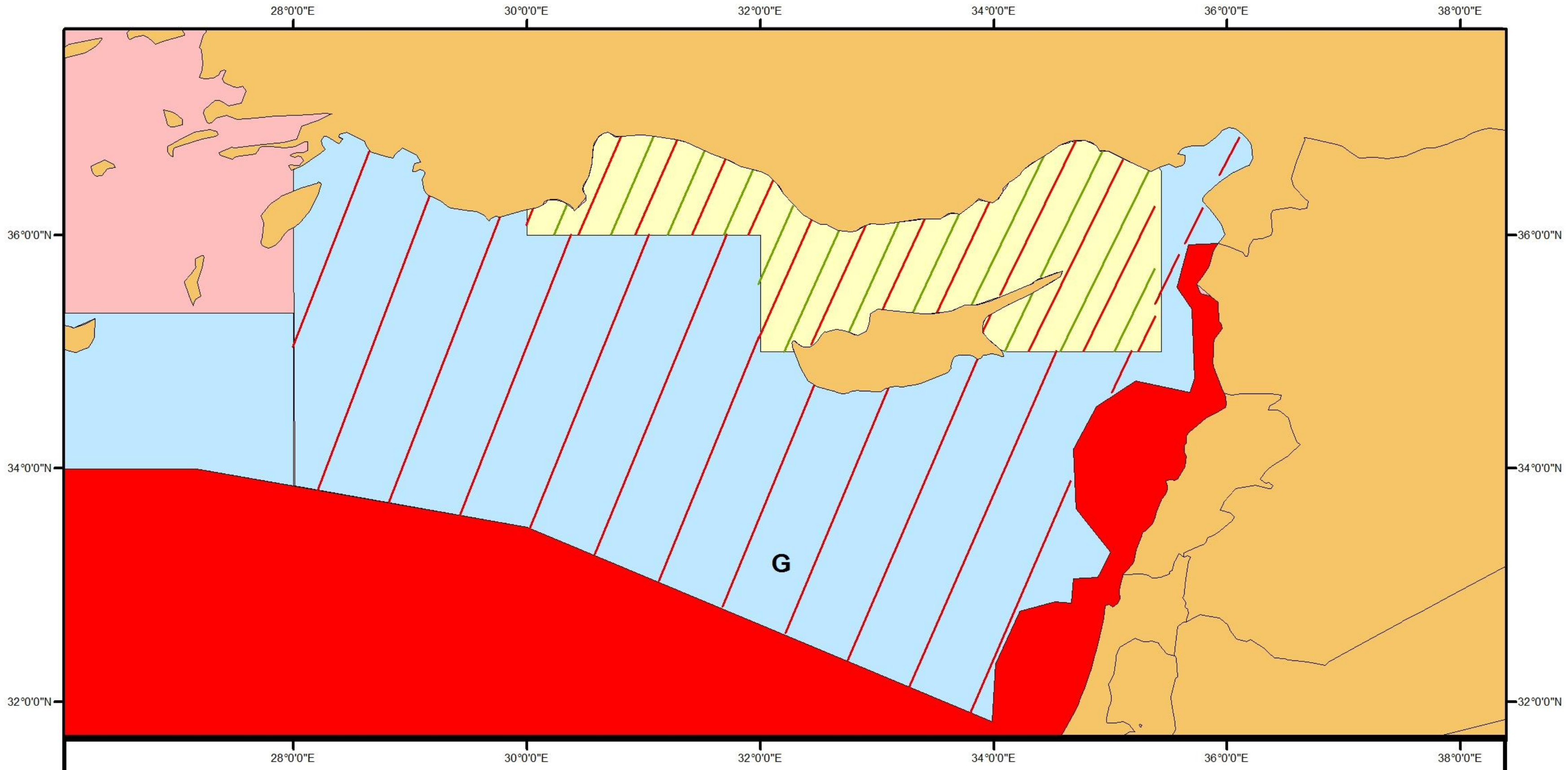
(ICCAT-GBYP Phase 5 - 2015)

Designed tracks
- Replica 1
- Replica 2

Survey design for 2015

Survey blocks and designed tracks

- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010, 2011 and 2013



ATLANTIC-WIDE RESEARCH PROGRAMME ON BLUEFIN TUNA
(ICCAT-GBYP Phase 5 - 2015)

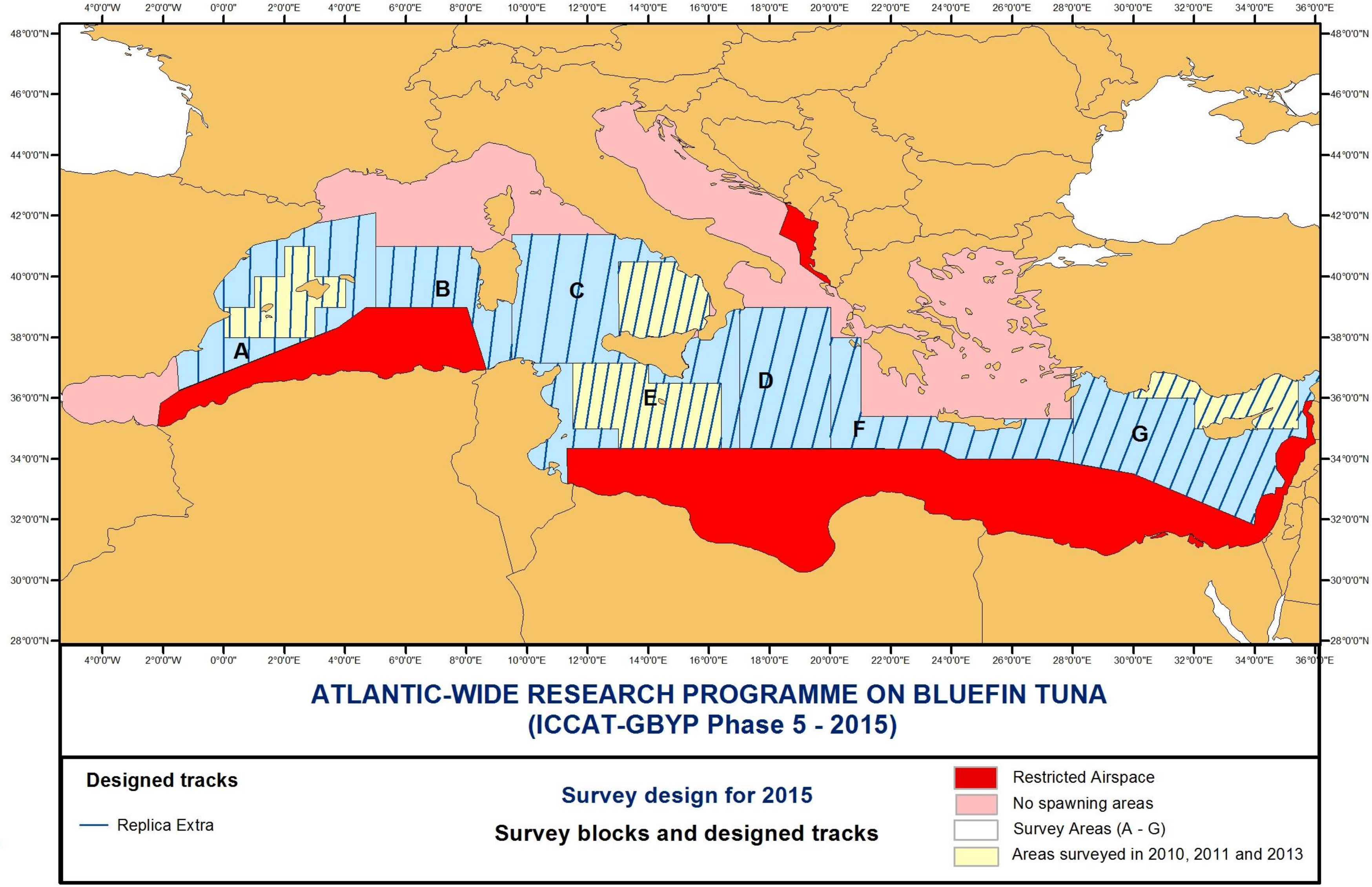
Designed tracks
- Replica 1
- Replica 2

Survey design for 2015

Survey blocks and designed tracks

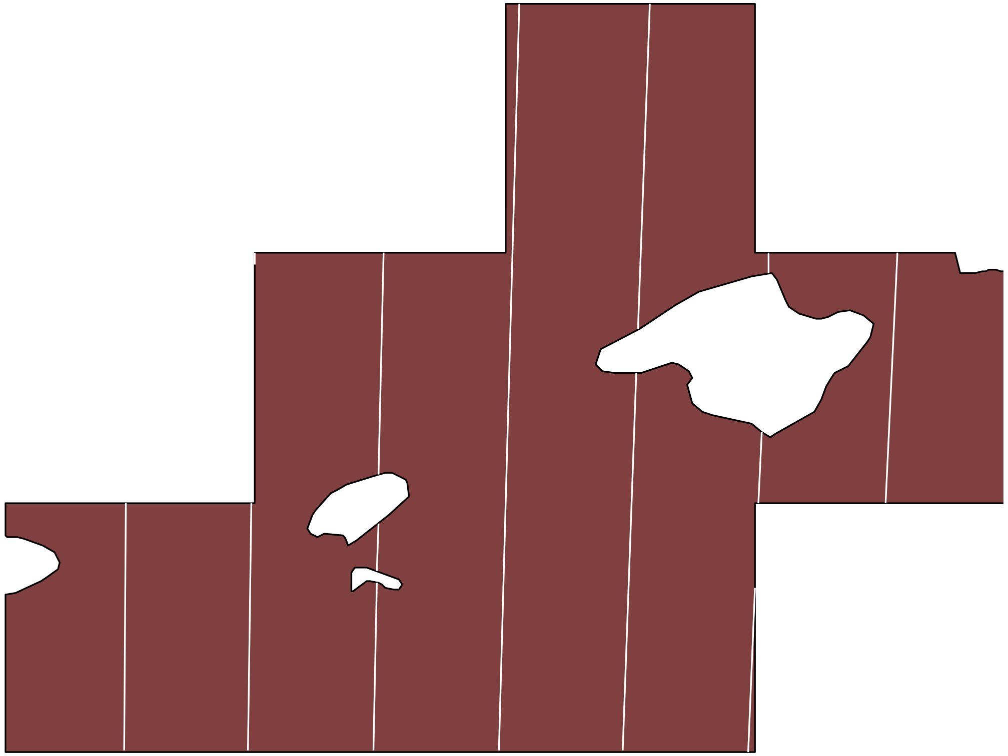
- Restricted Airspace
- No spawning areas
- Survey Areas (A - G)
- Areas surveyed in 2010, 2011 and 2013

Figure 10. Extra Tracks



Appendix 1
Primary Tracks

Block A Inside
Replica 1



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  0.9864071 39.00006
  --
  0.9999935 39.9553
  1.000645 40
  --
Sampler 3
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  1.486726 38.67794
  --
  1.487687 38.72434
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  1.495798 39.11168
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  2.999897 38.65619
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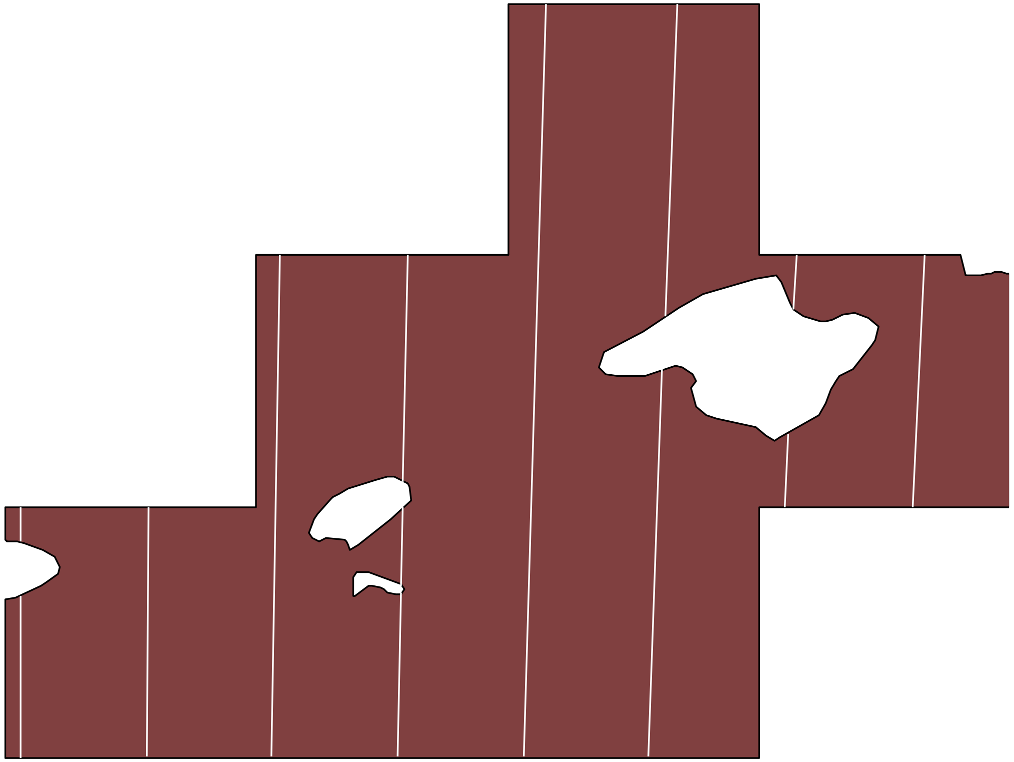
Replica 2



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    6.170269E-02 39.00025
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  Sampler 2
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  --
Sampler 3
  1.061166 38.00875
  1.09135 40.00036
  --
Sampler 4
  1.56131 38.00956
  1.575278 38.65742
  --
  1.575963 38.68868
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  1.585114 39.10143
  1.605724 40.00103
  --
Sampler 5
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  2.151782 41.00056
  --
Sampler 6
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  2.617064 39.54571
  --
  2.62501 39.756
  2.673814 41.00095
  --
Sampler 7
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  3.116663 39.29292
  --
  3.138933 39.78857
  3.148622 40.00043
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Sampler 8
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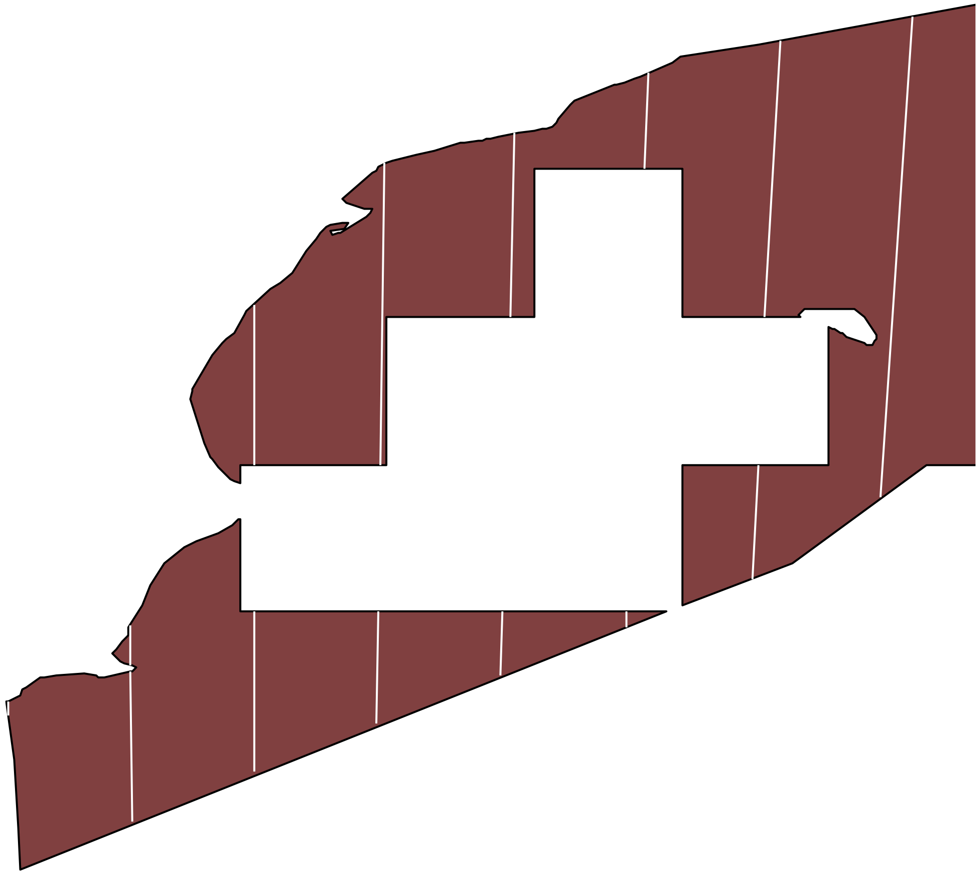
Block A Outside
Replica 1



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Number of samplers: 8

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Sampler 2
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  -0.7393922 37.59581
  --
  -0.7398469 37.64172
  -0.7424583 37.90331
  --
Sampler 3
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  9.878145E-02 38.00118
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  0.1017239 40.08292
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Sampler 4
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  0.9410871 38.00787
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  0.9540913 39.00019
  0.982976 41.04267
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Sampler 7
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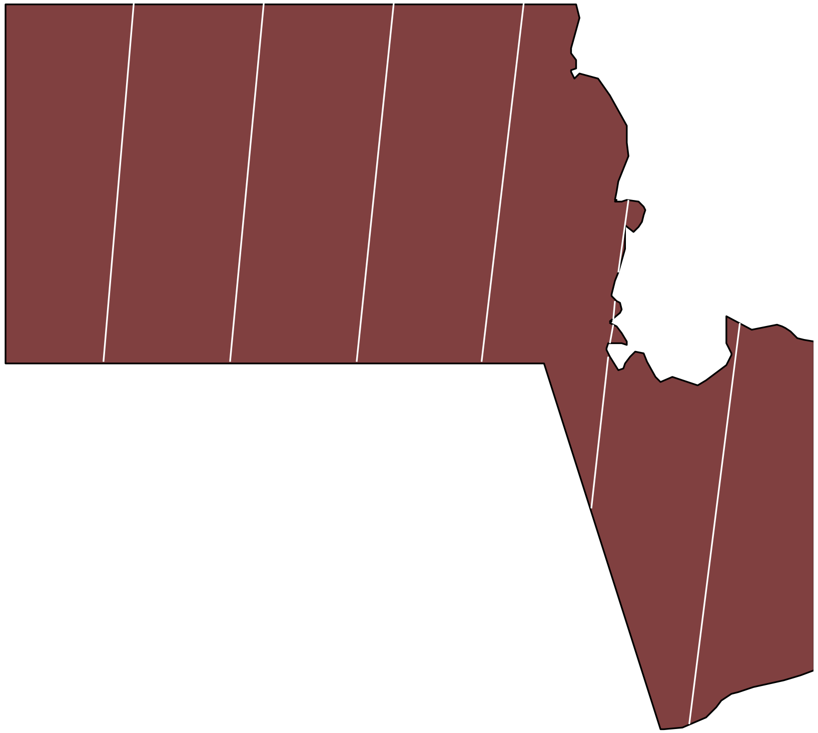
Block B
Replica 1



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    7.15748 41.00957
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  Sampler 4
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    7.88012 41.00368
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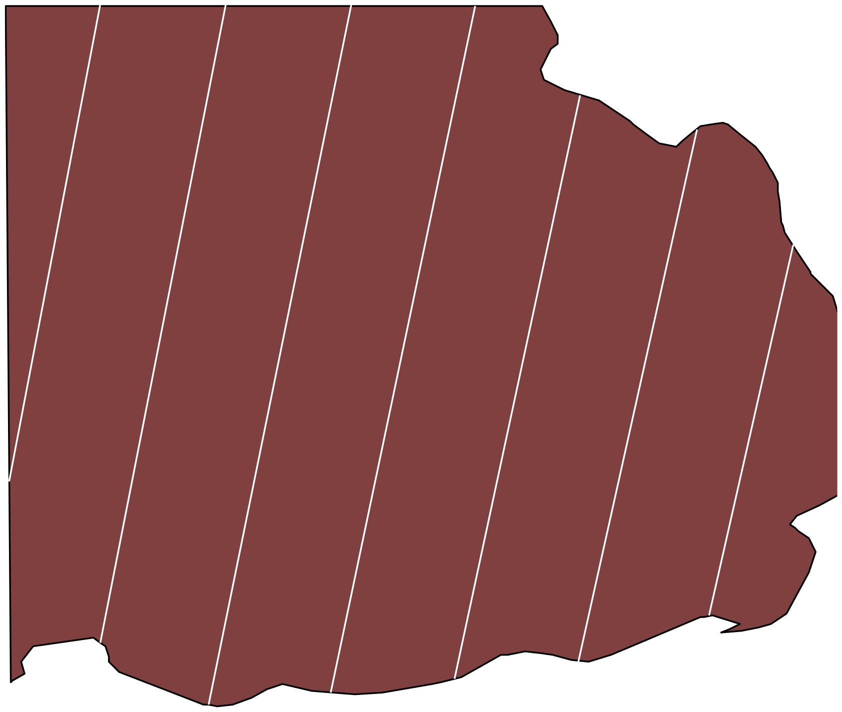
    --
    8.366977 39.11309
    8.379179 39.21528
    --
    8.382807 39.24556
    8.394993 39.34694
    --
    8.41411 39.50494
    8.463729 39.90926
    --
  Sampler 6
    8.809147 36.98815
    9.084092 39.22389
    --
```

Block C Inside

Replica 1



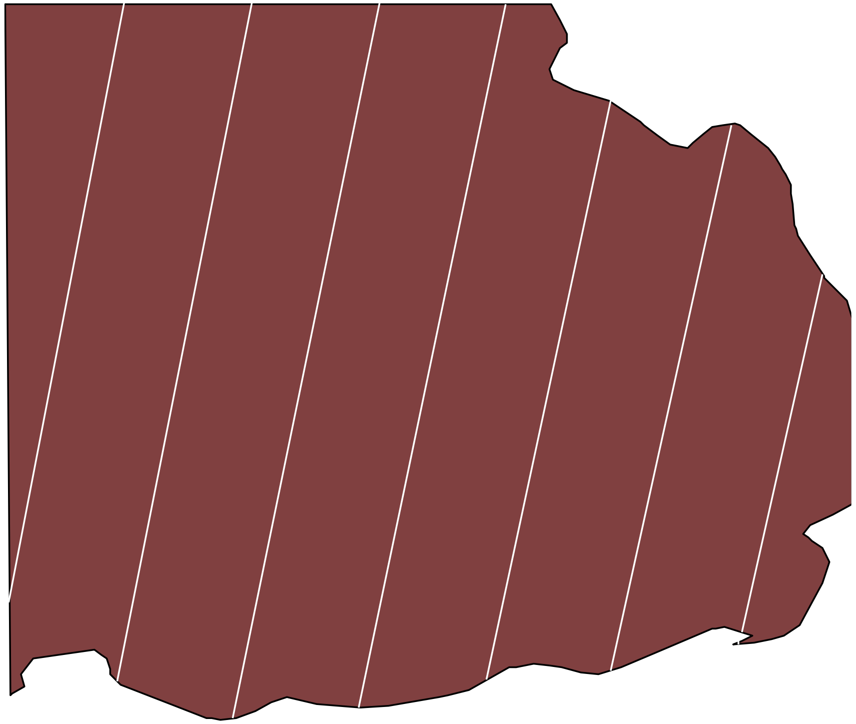
```
Type of sampler:    Line
Number of samplers: 7

List of samplers:
    x-coord  y-coord

  Sampler 1
    13.01117 38.78464
    13.34314 40.50244
    --
  Sampler 2
    13.33998 38.20088
    13.79403 40.50405
    --
  Sampler 3
    13.73173 37.97431
```

```
  14.24444 40.50384
  --
Sampler 4
  14.17438 38.02119
  14.69433 40.50181
  --
Sampler 5
  14.61789 38.07018
  15.07086 40.17928
  --
Sampler 6
  15.06482 38.13321
  15.48937 40.05354
  --
Sampler 7
  15.53403 38.29538
  15.83702 39.6346
  --
```

Replica 2



```
Type of sampler:    Line
Number of samplers: 7

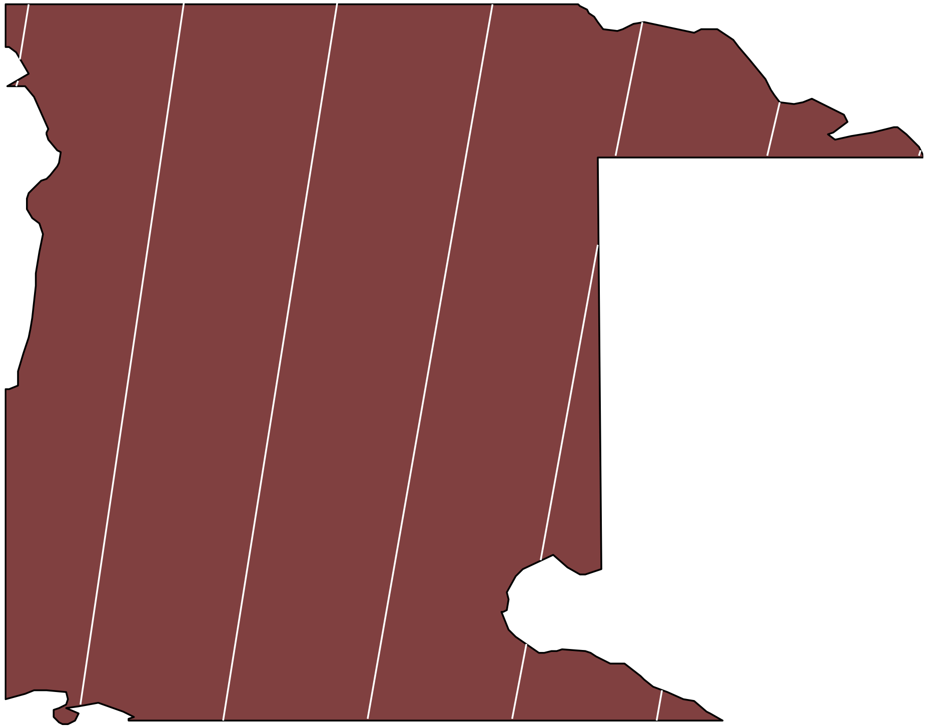
List of samplers:
    x-coord  y-coord

  Sampler 1
    13.01531 38.38697
    13.42268 40.50286
    --
  Sampler 2
    13.39908 38.10642
    13.87349 40.50415
    --
  Sampler 3
    13.80871 37.97715
```

```
    14.32381 40.50361
    --
  Sampler 4
    14.24981 38.01595
    14.7736 40.50127
    --
  Sampler 5
    14.70244 38.10955
    15.14446 40.15572
    --
  Sampler 6
    15.14351 38.14344
    15.57299 40.07424
    --
  Sampler 7
    15.59805 38.23773
    15.60012 38.24718
    --
    15.6068 38.27762
    15.89481 39.54745
    --
```

Block C Outside

Replica 1



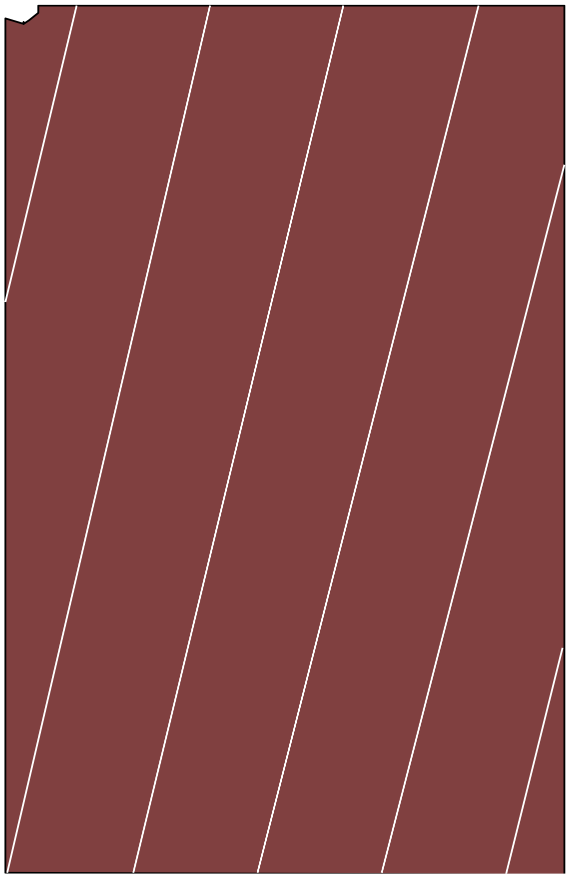
```
Type of sampler:    Line
Number of samplers: 7

List of samplers:
    x-coord  y-coord

  Sampler 1
    9.560506 40.91383
    9.565968 40.95135
    --
    9.584505 41.07817
    9.632352 41.40178
    --
  Sampler 2
    9.934251 37.24886
    10.54804 41.40981
    --
  Sampler 3
```

```
  10.78122 37.16034
  11.46234 41.4104
  --
Sampler 4
  11.64014 37.16588
  12.37492 41.40359
  --
Sampler 5
  12.49745 37.16503
  12.57397 37.61717
  --
  12.65868 38.10596
  13.00225 39.9734
  --
  13.10535 40.50086
  13.2655 41.29308
  --
Sampler 6
  13.35292 37.15803
  13.38505 37.33654
  --
  14.00608 40.50418
  14.07408 40.82191
  --
Sampler 7
  14.9048 40.50024
  14.91256 40.53444
  --
```

Block D
Replica 1



```
Type of sampler:    Line
Number of samplers: 6

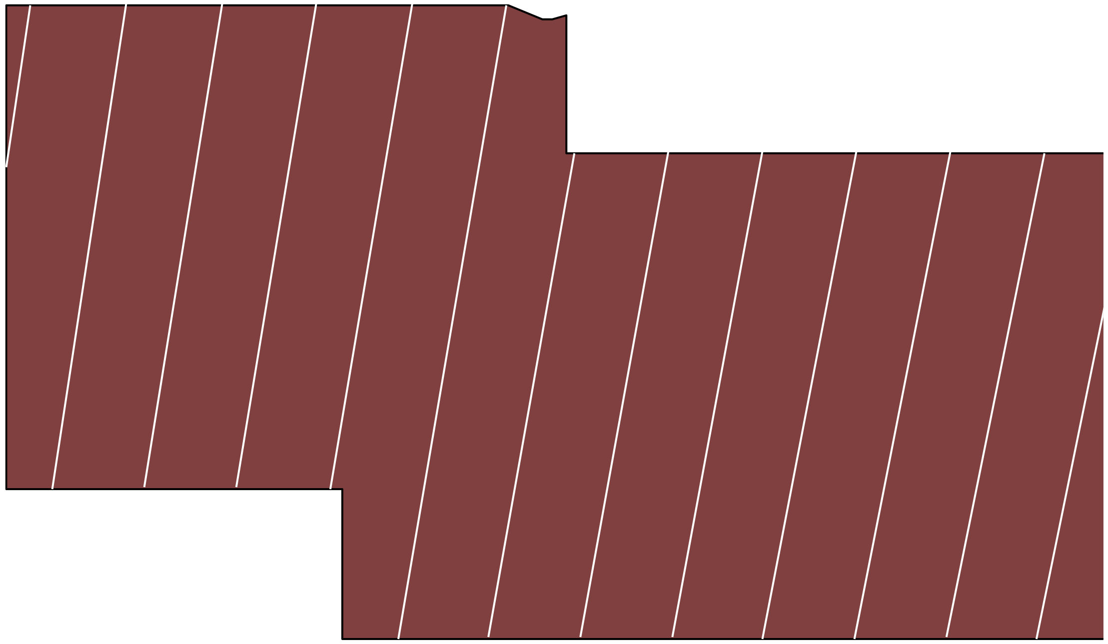
List of samplers:
    x-coord  y-coord

  Sampler 1
    16.99523 37.41394
    17.38004 39.00059
    --
```

```
Sampler 2
  17.00678 34.3518
  18.09791 39.00041
  --
Sampler 3
  17.67921 34.35719
  18.81542 39.0007
  --
Sampler 4
  18.35003 34.35862
  19.5325 39.00116
  --
Sampler 5
  19.01911 34.35612
  19.99946 38.14407
  --
Sampler 6
  19.68634 34.34971
  19.99092 35.56245
  --
```

Block E Inside

Replica 1



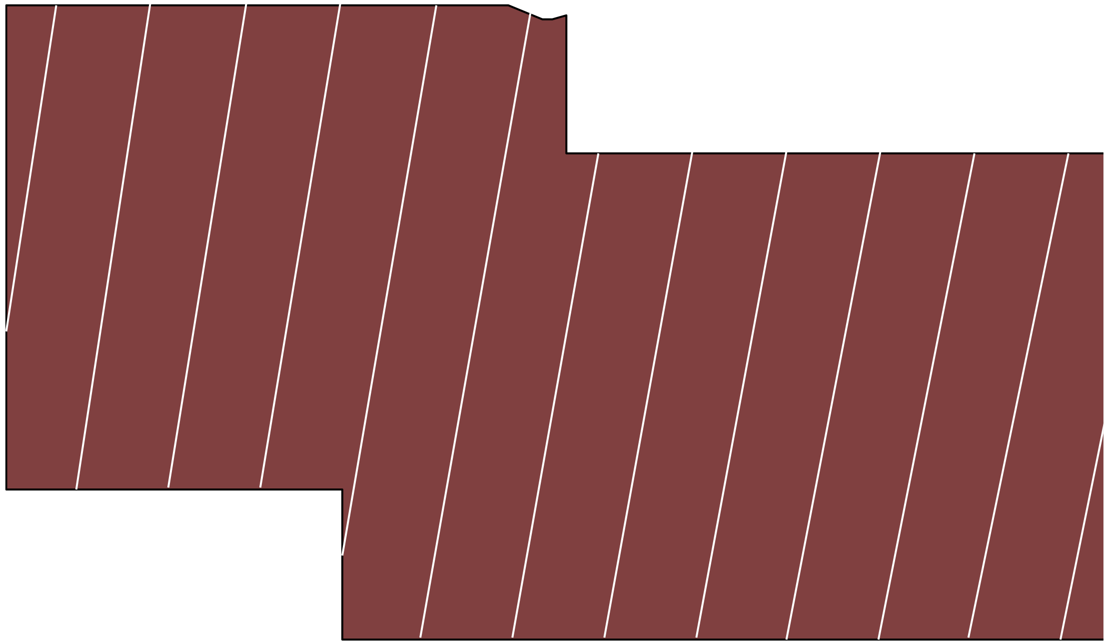
```
Type of sampler:    Line
Number of samplers: 13

List of samplers:
    x-coord  y-coord

  Sampler 1
    11.49819 36.43717
    11.60826 37.16
    --
  Sampler 2
    11.70383 35.00112
    12.03354 37.16295
    --
  Sampler 3
    12.11667 35.00232
    12.45843 37.16433
```

```
  --
Sampler 4
  12.5291 35.00206
  12.88289 37.16414
  --
Sampler 5
  12.94108 35.00036
  13.30689 37.16238
  --
Sampler 6
  13.2443 34.33183
  13.7304 37.15906
  --
Sampler 7
  13.65293 34.33374
  14.03096 36.50027
  --
Sampler 8
  14.06109 34.33424
  14.45135 36.50306
  --
Sampler 9
  14.46877 34.33332
  14.87127 36.50431
  --
Sampler 10
  14.87593 34.33099
  15.29067 36.50402
  --
Sampler 11
  15.2833 34.33136
  15.70953 36.50218
  --
Sampler 12
  15.69049 34.33211
  16.1281 36.50016
  --
Sampler 13
  16.09713 34.33143
  16.39742 35.80554
  --
```

Replica 2



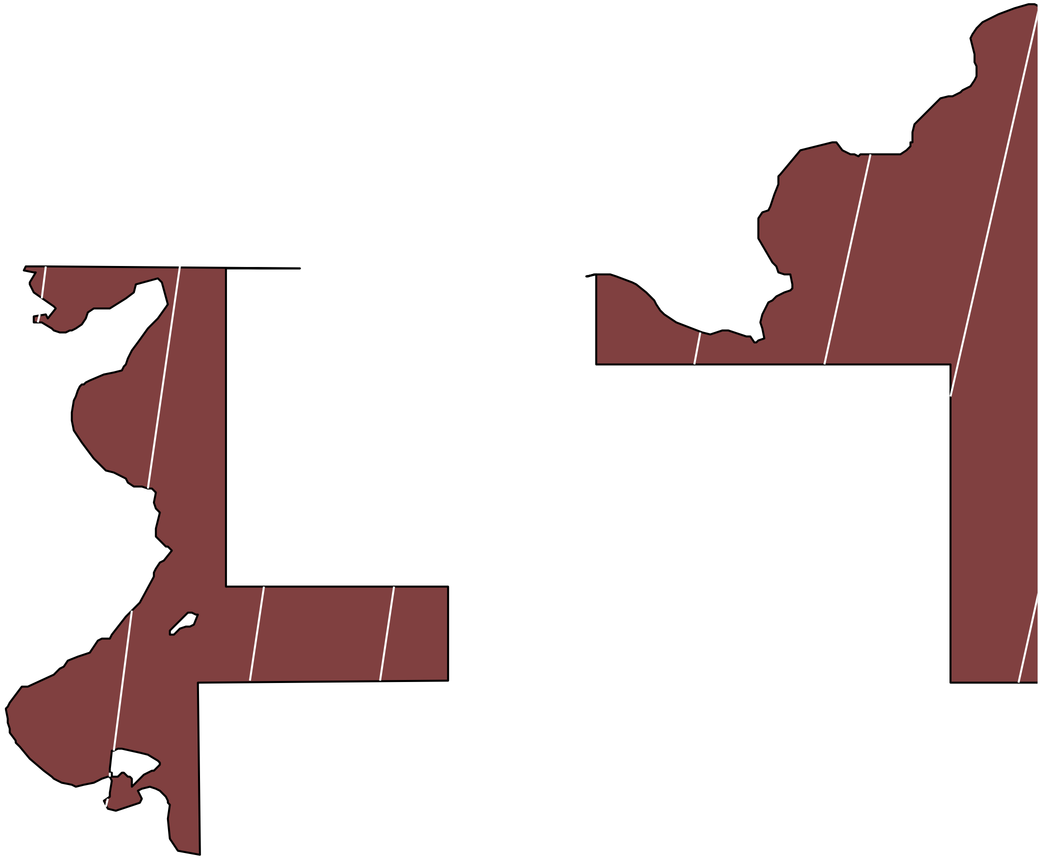
```
Type of sampler:    Line
Number of samplers: 13

List of samplers:
    x-coord  y-coord

  Sampler 1
    11.49822 35.7009
    11.71867 37.16092
    --
  Sampler 2
    11.81101 35.00157
    12.14386 37.16346
    --
  Sampler 3
    12.22375 35.00239
    12.56864 37.16443
```

```
  --
Sampler 4
  12.63607 35.00176
  12.99298 37.16383
  --
Sampler 5
  12.99978 34.69944
  13.41685 37.16167
  --
Sampler 6
  13.3504 34.33246
  13.83331 37.12069
  --
Sampler 7
  13.75891 34.33401
  14.14011 36.50114
  --
Sampler 8
  14.16695 34.33414
  14.56038 36.50354
  --
Sampler 9
  14.57449 34.33285
  14.98017 36.50438
  --
Sampler 10
  14.98151 34.33016
  15.39943 36.50368
  --
Sampler 11
  15.38903 34.33169
  15.81814 36.50145
  --
Sampler 12
  15.79608 34.33207
  16.23681 36.50017
  --
Sampler 13
  16.20257 34.33102
  16.39709 35.29184
  --
```

Block E Outside
Replica 1



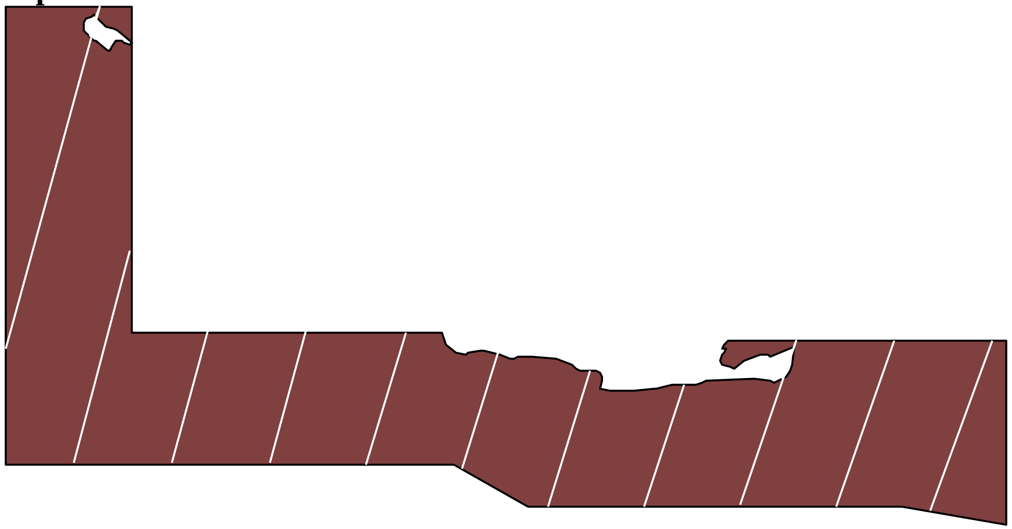
```
Type of sampler:    Line
Number of samplers: 8

List of samplers:
    x-coord  y-coord

  Sampler 1
    10.22965 36.78713
    10.23601 36.83441
    --
```

```
  10.25153 36.94931
  10.28019 37.15974
  --
Sampler 2
  10.68608 33.50823
  10.69342 33.56721
  --
  10.71082 33.70618
  10.71519 33.74099
  --
  10.73392 33.88929
  10.85599 34.82986
  --
  10.96924 35.66475
  11.18465 37.16266
  --
Sampler 3
  11.66469 34.35618
  11.75681 35.00135
  --
Sampler 4
  12.53475 34.35693
  12.63391 35.00177
  --
Sampler 5
  14.66404 36.50389
  14.70672 36.72401
  --
Sampler 6
  15.5556 36.50303
  15.85813 37.92529
  --
Sampler 7
  16.39893 36.28394
  16.99988 38.89605
  --
Sampler 8
  16.86717 34.35218
  16.99517 34.96301
  --
```

Block F
Replica 1



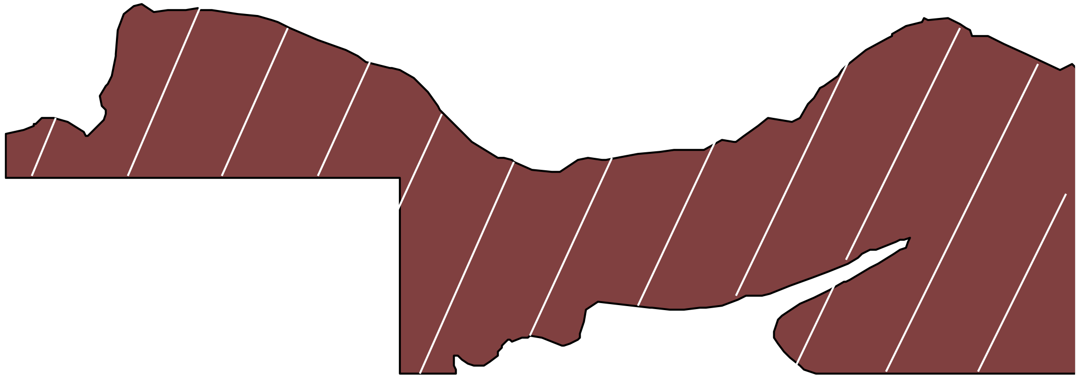
```
Type of sampler:    Line
Number of samplers: 11

List of samplers:
    x-coord  y-coord

  Sampler 1
    19.99228 35.26847
    20.74368 38.0009
    20.71822 37.91433
    20.67424 37.76387
    --
  Sampler 2
    20.99579 36.04473
    20.54453 34.35092
    --
  Sampler 3
    21.6128 35.40448
    21.3261 34.35427
    --
  Sampler 4
```

```
  22.40402 35.40516
  22.10494 34.35215
  --
Sampler 5
  23.1923 35.40013
  22.88086 34.3446
  --
Sampler 6
  23.92614 35.22568
  23.64371 34.29829
  --
Sampler 7
  24.66937 35.09556
  24.32789 34.00226
  --
Sampler 8
  25.4144 34.98318
  25.10011 34.00918
  --
Sampler 9
  26.20798 35.0239
  26.29742 35.2827
  26.31422 35.33093
  25.86917 34.01056
  --
Sampler 10
  27.09712 35.3327
  26.63484 34.00644
  --
Sampler 11
  27.87739 35.3313
  27.38487 33.9622
  --
```

Block G Inside
Replica 1



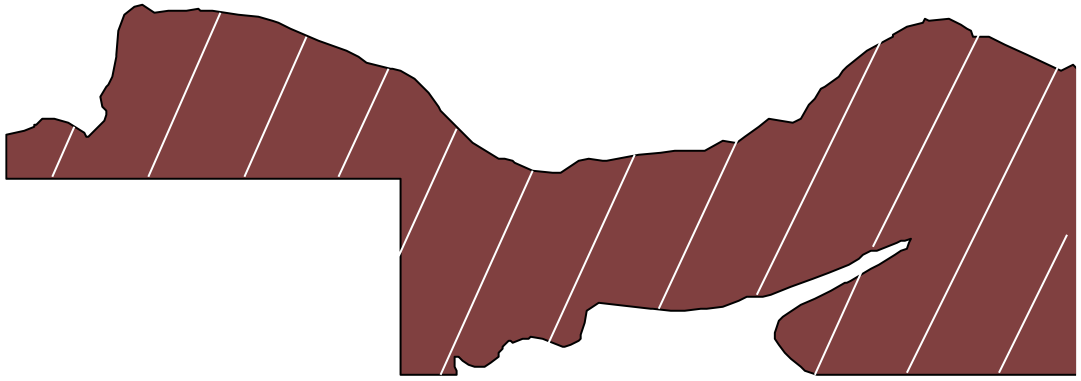
```
Type of sampler:    Line
Number of samplers: 12

List of samplers:
    x-coord  y-coord

  Sampler 1
    30.12745 36.00261
    30.25257 36.29937
    --
  Sampler 2
    30.61476 36.00594
    30.98522 36.85557
    --
  Sampler 3
    31.10038 36.0069
    31.43322 36.7583
    --
  Sampler 4
    31.5842 36.00552
    31.84346 36.58303
    --
  Sampler 5
    31.98241 35.8148
    32.21074 36.32051
```

```
  --
Sampler 6
  32.1033 35.00274
  32.58182 36.07371
  --
Sampler 7
  32.66039 35.18964
  33.0778 36.10291
  --
Sampler 8
  33.20689 35.34762
  33.60078 36.18983
  --
Sampler 9
  33.70345 35.39466
  34.2952 36.62401
  --
Sampler 10
  34.01064 35.03942
  34.21204 35.46787
  --
  34.26602 35.5811
  34.84439 36.75436
  --
Sampler 11
  34.46584 35.00799
  35.2377 36.58011
  --
Sampler 12
  34.93491 35.00922
  35.37702 35.91199
  --
```

Replica 2



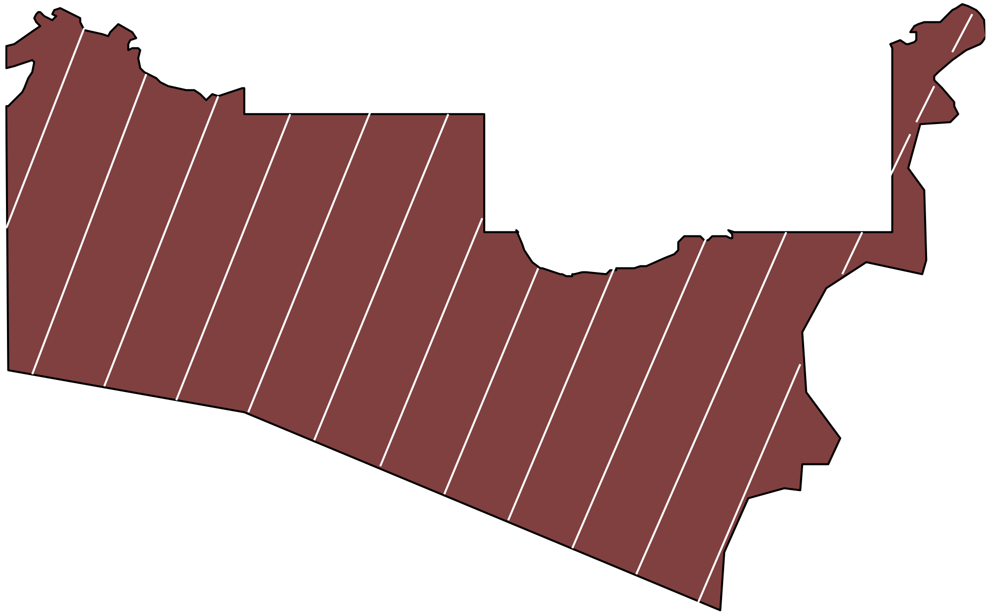
```
Type of sampler:    Line
Number of samplers: 12

List of samplers:
    x-coord  y-coord

  Sampler 1
    30.23274 36.00353
    30.34095 36.25941
    --
  Sampler 2
    30.71969 36.00634
    31.08625 36.84394
    --
  Sampler 3
    31.20493 36.0068
    31.52138 36.71913
    --
  Sampler 4
    31.68836 36.00491
    31.93812 36.5595
    --
  Sampler 5
    31.98222 35.58056
    32.28148 36.24625
    --
  Sampler 6
    32.20571 35.00281
    32.67057 36.04028
    --
```

```
Sampler 7
  32.75224 35.1659
  33.1891 36.11847
  --
Sampler 8
  33.30463 35.33722
  33.71515 36.21163
  --
Sampler 9
  33.81202 35.40797
  34.44761 36.72012
  --
Sampler 10
  34.09634 35.00546
  34.3488 35.54019
  --
  34.39999 35.64682
  34.93476 36.72702
  --
Sampler 11
  34.56726 35.00845
  35.34062 36.57863
  --
Sampler 12
  35.0358 35.00919
  35.37761 35.70861
  --
```

Block G Outside
Replica 1



```
Type of sampler:    Line
Number of samplers: 12

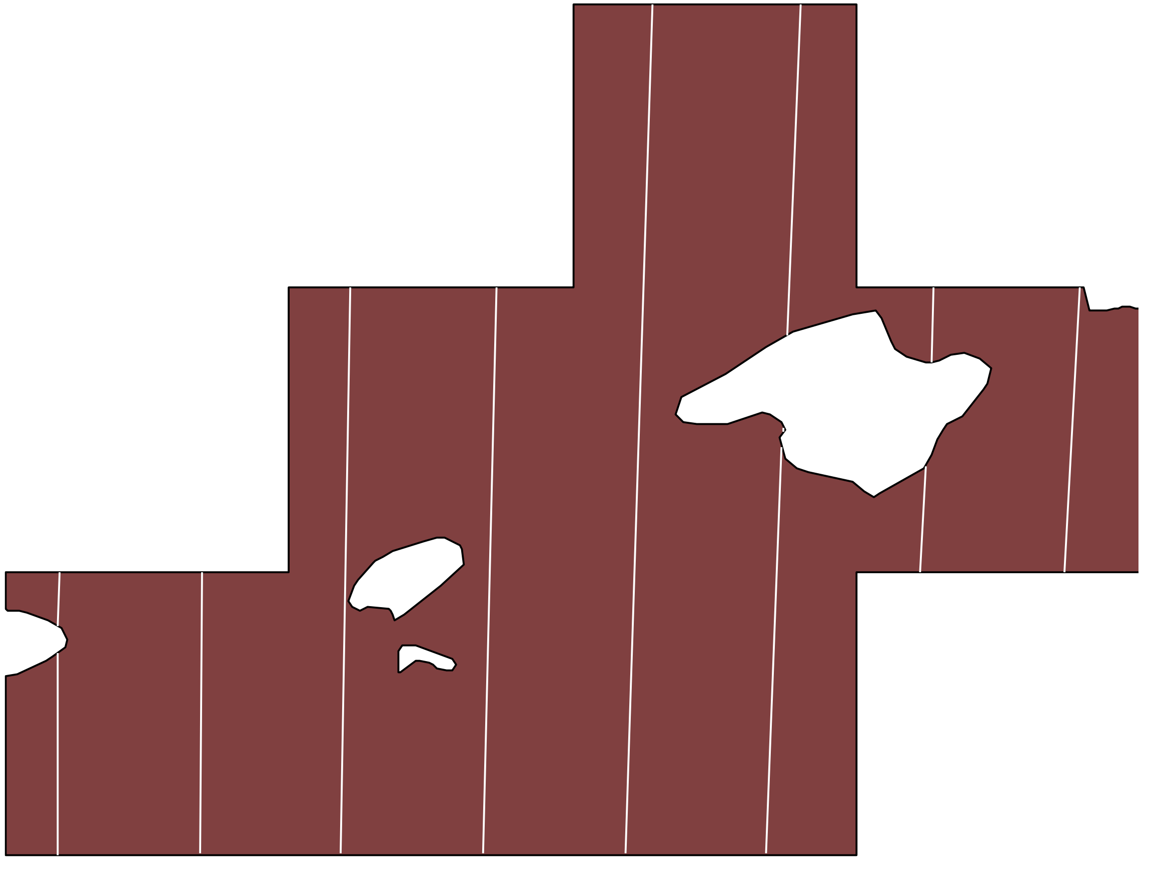
List of samplers:
    x-coord  y-coord

  Sampler 1
    27.99538 35.04269
    28.64548 36.72043
    --
  Sampler 2
    28.20618 33.81857
    29.16701 36.33489
    --
  Sampler 3
    28.8167 33.71346
    29.76643 36.1538
```

```
  --
Sampler 4
  29.42305 33.60561
  30.37481 36.00459
  --
Sampler 5
  30.02286 33.48912
  31.04449 36.0069
  --
Sampler 6
  30.57829 33.26641
  31.71081 36.00477
  --
Sampler 7
  31.12845 33.04247
  31.98337 35.12061
  --
Sampler 8
  31.67333 32.81739
  32.45857 34.71296
  --
Sampler 9
  32.21292 32.59124
  33.10311 34.70397
  --
Sampler 10
  32.7472 32.36412
  33.86797 34.96239
  --
Sampler 11
  33.27612 32.13612
  34.53642 35.00832
  --
Sampler 12
  33.79969 31.90733
  34.65871 33.89342
  --
  35.01152 34.65331
  35.18145 35.00897
  --
  35.3792 35.41487
  35.58666 35.83183
  --
  35.63479 35.92732
  35.78922 36.23064
  --
  35.93525 36.51324
  36.10314 36.83326
```

Appendix 2
Extra Tracks

Block A Inside
Replica EXTRA



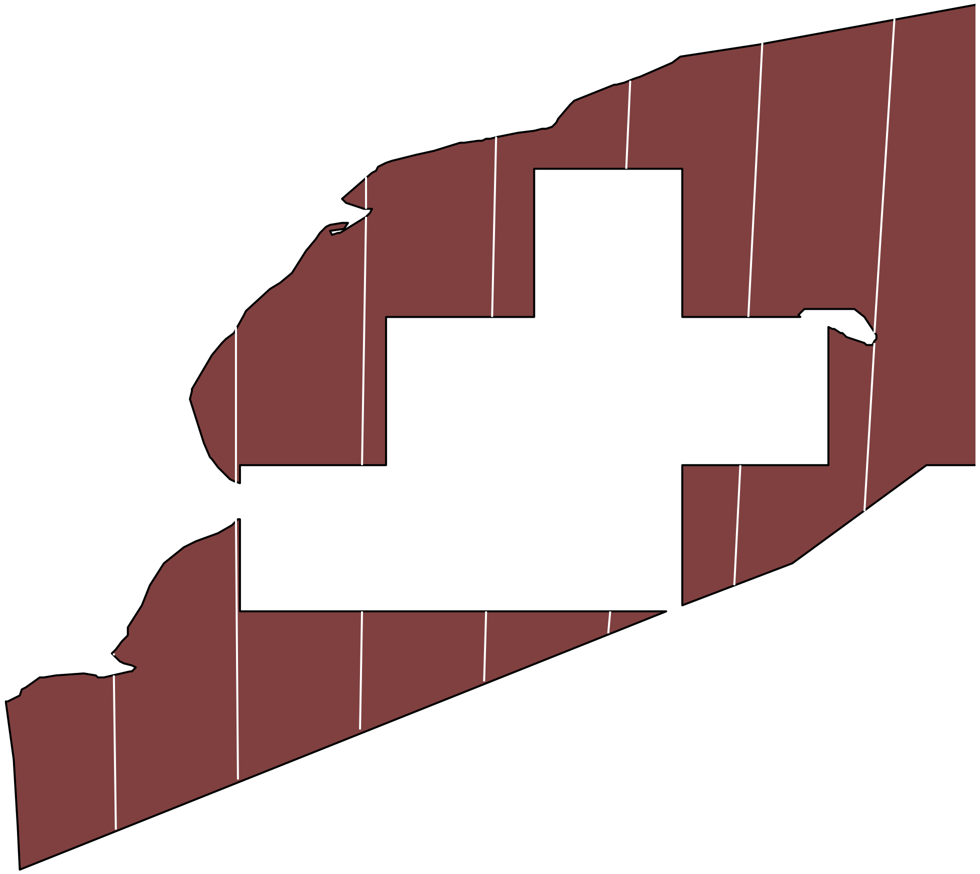
```
Type of sampler:    Line
Number of samplers: 8

List of samplers:
    x-coord  y-coord
```

```
Sampler 1
  0.1844926 38.00221
  0.1863114 38.71535
  --
  0.1865564 38.80952
  0.1870573 39.00065
  --
Sampler 2
  0.6846457 38.00674
  0.6941234 39.00091
  --
Sampler 3
  1.184813 38.00915
  1.218515 40.00074
  --
Sampler 4
  1.684943 38.00943
  1.732874 40.00084
  --
Sampler 5
  2.184982 38.00758
  2.280845 41.00088
  --
Sampler 6
  2.684878 38.0036
  2.739056 39.43603
  --
  2.741198 39.4906
  2.741976 39.51038
  --
  2.75474 39.83226
  2.802848 41.00069
  --
Sampler 7
  3.229106 39.00076
  3.246186 39.37265
  --
  3.263167 39.73563
  3.27576 40.00064
  --
Sampler 8
  3.735981 39.00084
  3.789944 40.00008
  --
```

Block A Outside

Replica EXTRA



```
Type of sampler:    Line
Number of samplers: 7

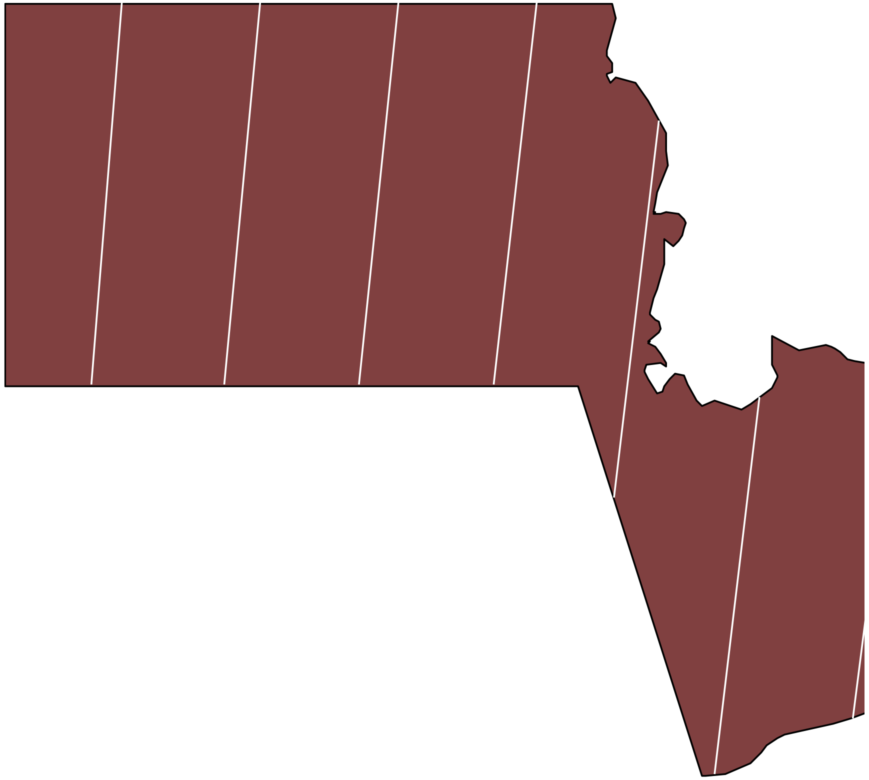
List of samplers:
    x-coord  y-coord

  Sampler 1
    -0.8409123 36.52762
```

```
  -0.8524665 37.56775
  --
  -0.8541029 37.71082
  -0.8542526 37.72385
  --
Sampler 2
  -1.500908E-02 36.86792
  -1.536776E-02 38.62295
  --
  -1.542197E-02 38.87534
  -1.565569E-02 39.92862
  --
Sampler 3
  0.818191 37.20242
  0.8270553 38.00731
  --
  0.8384944 39.00058
  0.8591916 40.68132
  --
  0.859831 40.73106
  0.8626117 40.94589
  --
Sampler 4
  1.658627 37.5309
  1.669339 38.00878
  --
  1.716842 40.00088
  1.748225 41.2157
  --
Sampler 5
  2.506225 37.85315
  2.511362 38.00421
  --
  2.621689 41.00102
  2.645937 41.60326
  --
Sampler 6
  3.361482 38.18165
  3.399953 39.00103
  --
  3.449072 40.00071
  3.546907 41.85355
  --
Sampler 7
  4.234892 38.68826
  4.303719 39.82102
  --
  4.308238 39.8932
```

4.448989 42.01894
--

Block B
Replica EXTRA



```
Type of sampler:    Line
Number of samplers: 7

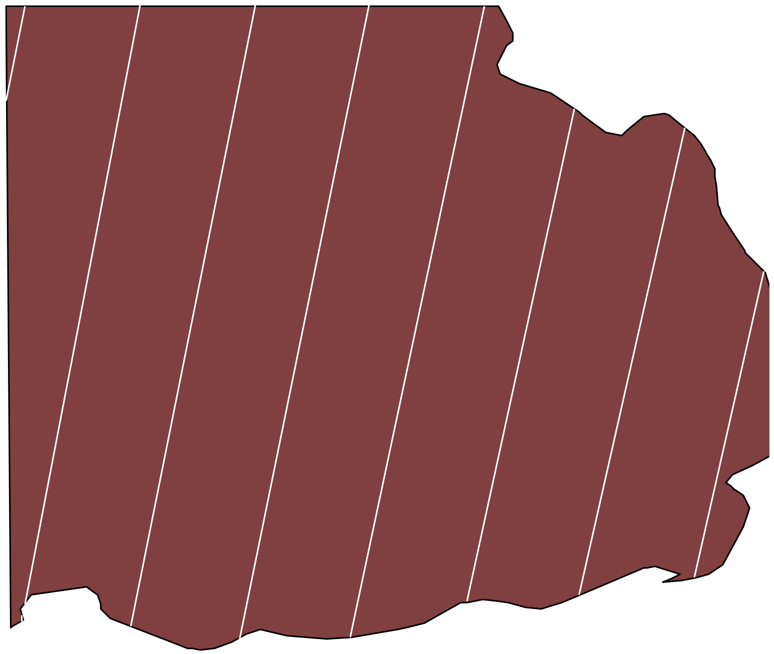
List of samplers:
    x-coord  y-coord

  Sampler 1
    5.447347 39.00512
    5.60933 41.00682
    --
  Sampler 2
```

```
  6.150287 39.00932
  6.33333 41.01072
  --
Sampler 3
  6.852707 39.00927
  7.056788 41.01003
  --
Sampler 4
  7.554461 39.00495
  7.779539 41.00477
  --
Sampler 5
  8.187911 38.41108
  8.423719 40.38527
  --
Sampler 6
  8.711481 36.96486
  8.950073 38.94177
  --
Sampler 7
  9.430215 37.26083
  9.495747 37.77501
  --
```

Block C Inside

Replica EXTRA



```
Type of sampler:    Line
Number of samplers: 8

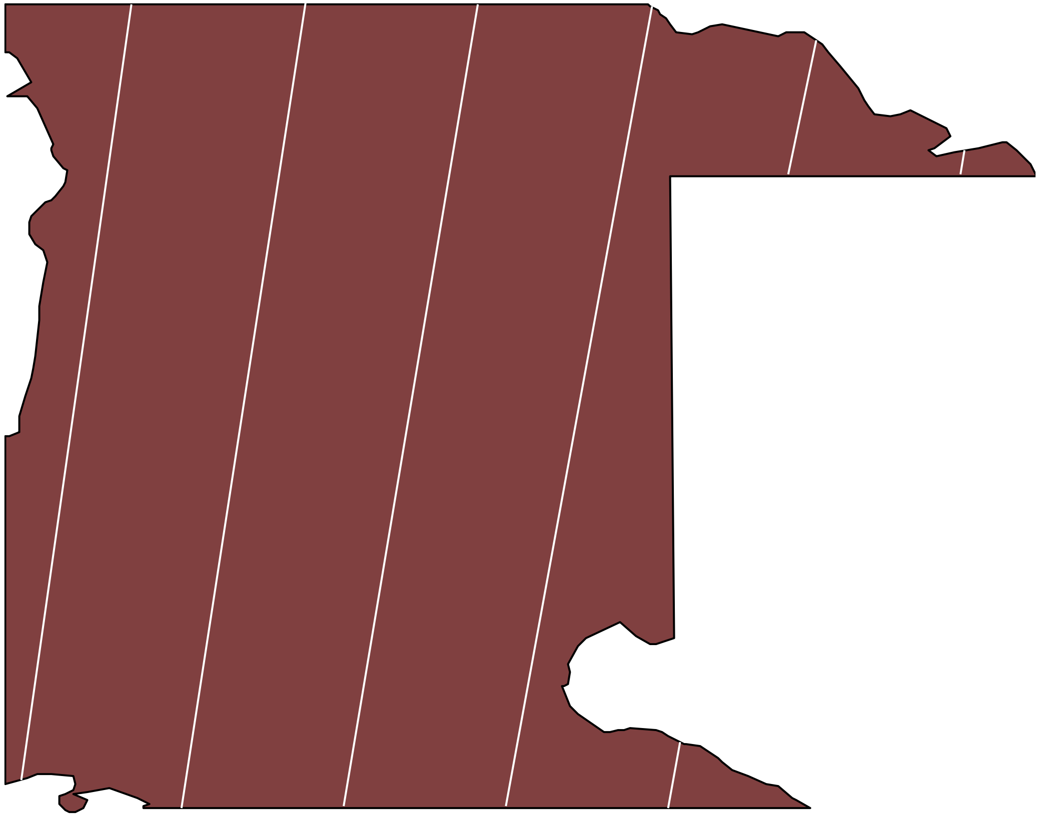
List of samplers:
    x-coord  y-coord

  Sampler 1
    13.0015 40.12481
    13.07506 40.50063
    --
  Sampler 2
    13.06031 38.08447
    13.06436 38.10685
    --
    13.07271 38.15284
    13.52622 40.50331
    --
  Sampler 3
    13.49096 38.06441
```

```
    13.97692 40.50418
    --
  Sampler 4
    13.91528 38.01372
    14.42712 40.50323
    --
  Sampler 5
    14.34955 38.01702
    14.87678 40.50047
    --
  Sampler 6
    14.81238 38.15942
    15.23305 40.0937
    --
  Sampler 7
    15.25247 38.18715
    15.66387 40.02433
    --
  Sampler 8
    15.70097 38.25218
    15.97504 39.45605
```

Block C Outside

Replica EXTRA



Type of sampler: Line
Number of samplers: 6

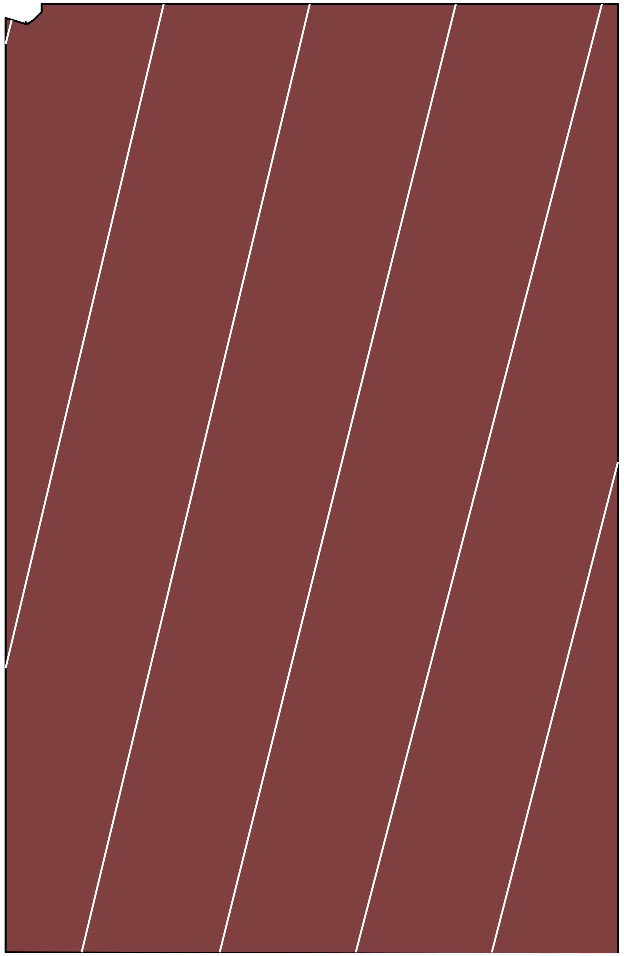
List of samplers:
    x-coord y-coord

  Sampler 1
    9.58044 37.3109
    10.16308 41.40733
    --
  Sampler 2
    10.42008 37.1598
    11.07801 41.41105
    --

```
Sampler 3
  11.27909 37.16433
  11.99135 41.40736
  --
Sampler 4
  12.1371 37.16617
  12.90155 41.39021
  --
Sampler 5
  12.99336 37.16162
  13.05426 37.50824
  --
  13.62748 40.50367
  13.77607 41.21091
  --
Sampler 6
  14.52709 40.50278
  14.55558 40.63153
  --
```

Block D

Replica EXTRA



```
Type of sampler:    Line
Number of samplers: 6

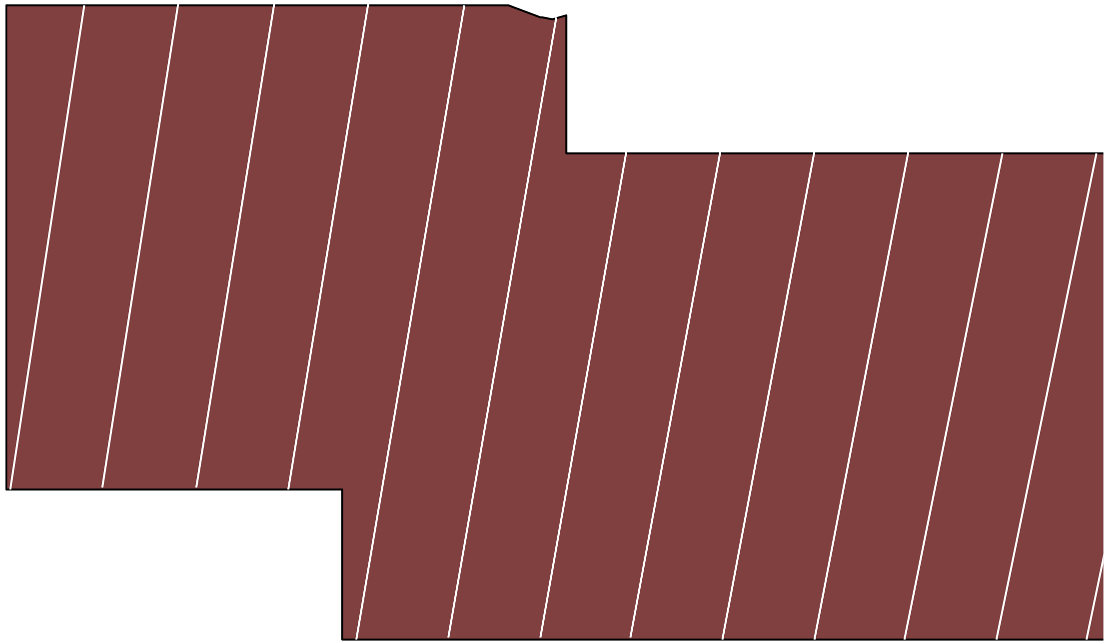
List of samplers:
    x-coord  y-coord

  Sampler 1
    16.9997 38.80339
    17.02964 38.92527
    --
  Sampler 2
```

```
    16.99184 35.74862
    17.76638 39.00064
    --
  Sampler 3
    17.36877 34.35519
    18.48418 39.00115
    --
  Sampler 4
    18.04035 34.35845
    19.20125 39.00075
    --
  Sampler 5
    18.71025 34.35776
    19.91781 39.00036
    --
  Sampler 6
    19.37835 34.35316
    19.99074 36.75779
    --
```

Block E Inside

Replica EXTRA



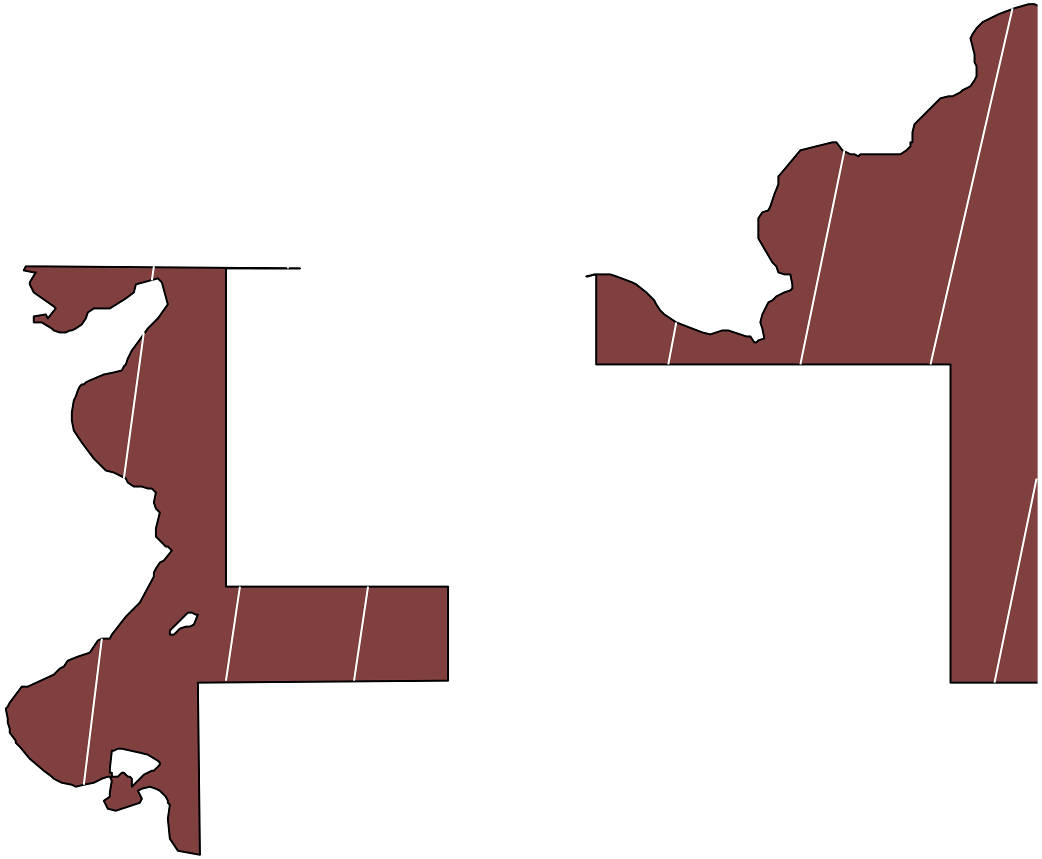
```
Type of sampler:    Line
Number of samplers: 13

List of samplers:
    x-coord  y-coord

  Sampler 1
    11.51974 35.00013
    11.84409 37.16183
    --
  Sampler 2
    11.93277 35.00196
    12.26916 37.16391
    --
  Sampler 3
    12.34538 35.00235
    12.69382 37.16442
```

```
  --
Sampler 4
  12.75757 35.0013
  13.11802 37.16336
  --
Sampler 5
  13.06208 34.33051
  13.54175 37.16073
  --
Sampler 6
  13.47091 34.33306
  13.95432 37.09969
  --
Sampler 7
  13.87928 34.33419
  14.26409 36.50201
  --
Sampler 8
  14.28718 34.3339
  14.68422 36.50394
  --
Sampler 9
  14.69457 34.3322
  15.10386 36.50434
  --
Sampler 10
  15.1017 34.33057
  15.52296 36.50319
  --
Sampler 11
  15.50912 34.33195
  15.94151 36.5005
  --
Sampler 12
  15.916 34.33191
  16.36028 36.50006
  --
Sampler 13
  16.32233 34.33044
  16.39831 34.70834
  --
```

Block E Outside
Replica EXTRA



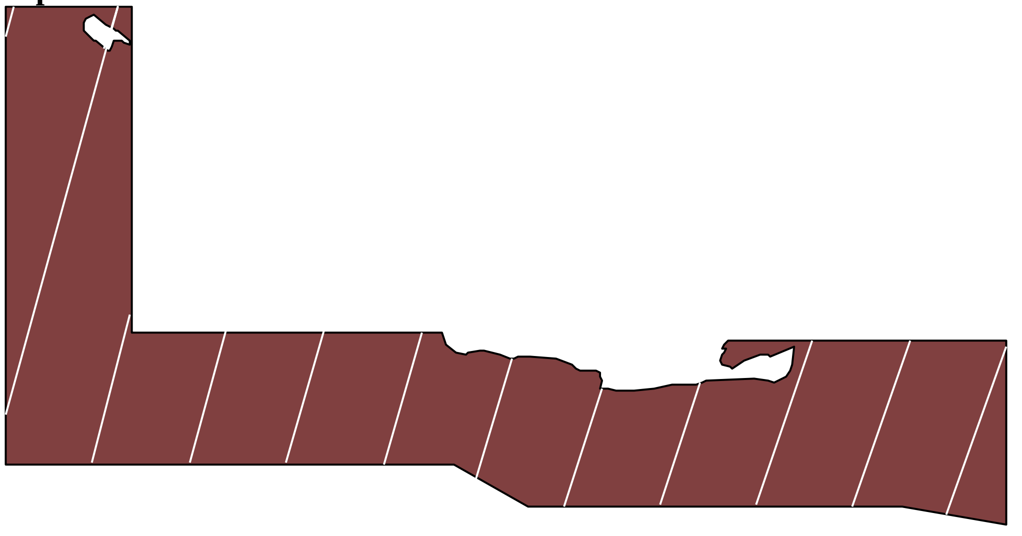
```
Type of sampler:    Line
Number of samplers: 7

List of samplers:
    x-coord  y-coord

  Sampler 1
    10.53704 33.65141
    10.66232 34.64285
    --
```

```
  10.80693 35.72944
  10.94471 36.71266
  --
  10.99683 37.07237
  11.01006 37.16265
  --
Sampler 2
  11.49641 34.3553
  11.58717 35.00052
  --
  11.91301 37.15932
  11.9131 37.15987
  --
Sampler 3
  12.36683 34.35728
  12.46463 35.00219
  --
Sampler 4
  14.49154 36.50325
  14.54557 36.78487
  --
Sampler 5
  15.38357 36.50374
  15.68736 37.9479
  --
Sampler 6
  16.27373 36.50016
  16.82602 38.91357
  --
Sampler 7
  16.70039 34.35254
  16.99188 35.73102
  --
```

Block F
Replica EXTRA



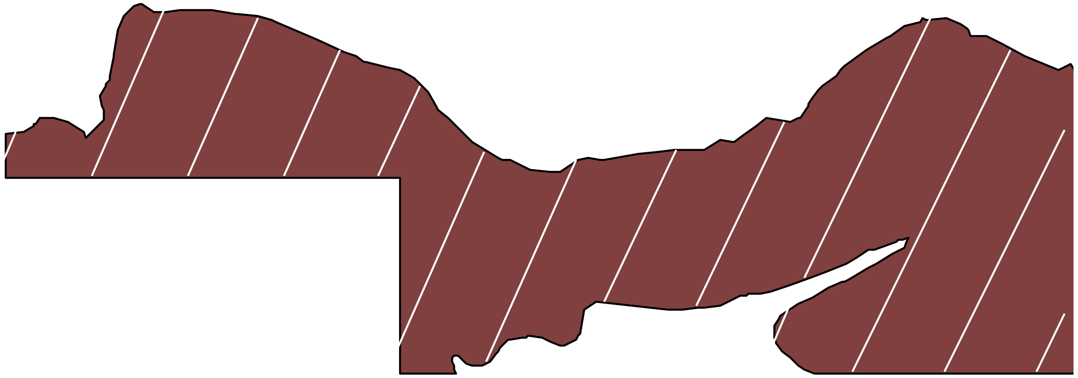
```
Type of sampler:    Line
Number of samplers: 12

List of samplers:
    x-coord  y-coord

  Sampler 1
    19.99737 37.76524
    20.06378 38.00029
    --
  Sampler 2
    19.99605 34.7347
    20.889 38.00048
    20.84027 37.83569
    20.79073 37.66676
    --
  Sampler 3
    20.99865 35.54512
    20.68254 34.35191
    --
  Sampler 4
    21.75252 35.40501
```

```
  21.46364 34.35429
  --
Sampler 5
  22.54323 35.40468
  22.24198 34.35122
  --
Sampler 6
  23.33098 35.39865
  23.01736 34.34271
  --
Sampler 7
  24.05387 35.19118
  23.7606 34.23189
  --
Sampler 8
  24.75913 34.94561
  24.46428 34.00388
  --
Sampler 9
  25.5556 34.99405
  25.23596 34.00982
  --
Sampler 10
  26.45217 35.33067
  26.00443 34.01023
  --
Sampler 11
  27.23497 35.33288
  26.76949 34.00515
  --
Sampler 12
  27.99565 35.27987
  27.51184 33.94001
  --
```

Block G Inside
Replica EXTRA



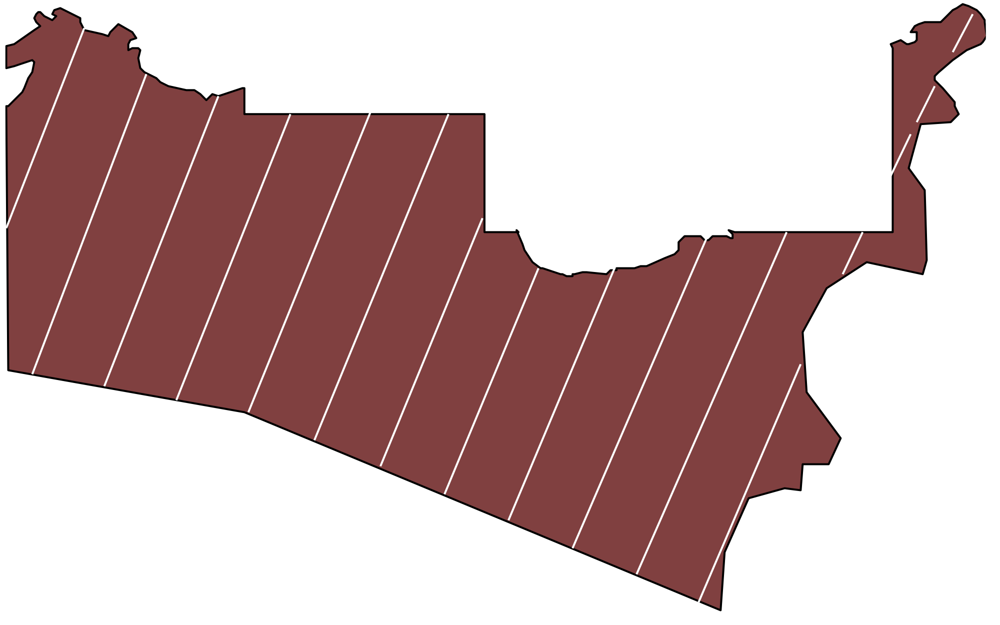
```
Type of sampler:    Line
Number of samplers: 13

List of samplers:
    x-coord  y-coord

  Sampler 1
    29.99126 36.08745
    30.051 36.23003
    --
  Sampler 2
    30.44309 36.00503
    30.80792 36.84747
    --
  Sampler 3
    30.92932 36.00682
    31.28564 36.8152
    --
  Sampler 4
    31.41378 36.00627
    31.7002 36.64722
    --
  Sampler 5
    31.8964 36.00339
    32.10334 36.4606
```

```
  --
Sampler 6
  31.98341 35.11253
  32.43634 36.12803
  --
Sampler 7
  32.43785 35.06534
  32.90295 36.09263
  --
Sampler 8
  33.04622 35.36296
  33.40846 36.14267
  --
Sampler 9
  33.5117 35.34204
  33.95837 36.28487
  --
Sampler 10
  33.89364 35.14524
  33.99073 35.353
  --
  34.05531 35.48993
  34.70366 36.81339
  --
Sampler 11
  34.29985 35.00703
  35.10093 36.64461
  --
Sampler 12
  34.76976 35.00904
  35.37698 36.24469
  --
Sampler 13
  35.23724 35.00883
  35.38005 35.30229
  --
```

Block G Outside
Replica EXTRA



```
Type of sampler:    Line
Number of samplers: 12

List of samplers:
    x-coord  y-coord

  Sampler 1
    27.99538 35.04269
    28.64548 36.72043
    --
  Sampler 2
    28.20618 33.81857
    29.16701 36.33489
    --
  Sampler 3
    28.8167 33.71346
    29.76643 36.1538
```

```
  --
Sampler 4
  29.42305 33.60561
  30.37481 36.00459
  --
Sampler 5
  30.02286 33.48912
  31.04449 36.0069
  --
Sampler 6
  30.57829 33.26641
  31.71081 36.00477
  --
Sampler 7
  31.12845 33.04247
  31.98337 35.12061
  --
Sampler 8
  31.67333 32.81739
  32.45857 34.71296
  --
Sampler 9
  32.21292 32.59124
  33.10311 34.70397
  --
Sampler 10
  32.7472 32.36412
  33.86797 34.96239
  --
Sampler 11
  33.27612 32.13612
  34.53642 35.00832
  --
Sampler 12
  33.79969 31.90733
  34.65871 33.89342
  --
  35.01152 34.65331
  35.18145 35.00897
  --
  35.3792 35.41487
  35.58666 35.83183
  --
  35.63479 35.92732
  35.78922 36.23064
  --
  35.93525 36.51324
  36.10314 36.83326
```