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Executive summary

The Summer 2019 seed mussel survey was undertaken by the Agri-Food and Biosciences Institute (AFBI) within July 2019 and August 2019. Three areas were investigated at this time, namely Skullmartin, Burial Island and The Feathers. Surveys undertaken within these areas included:

- RoxAnn acoustic surveys,
- Dredge surveys,
- Towed epibenthic video sledge surveys

This report details the methodologies used within these surveys and the subsequent results. The main findings are summarised below, and are discussed in detail within sections 1 – 4 of this report.

Introduction

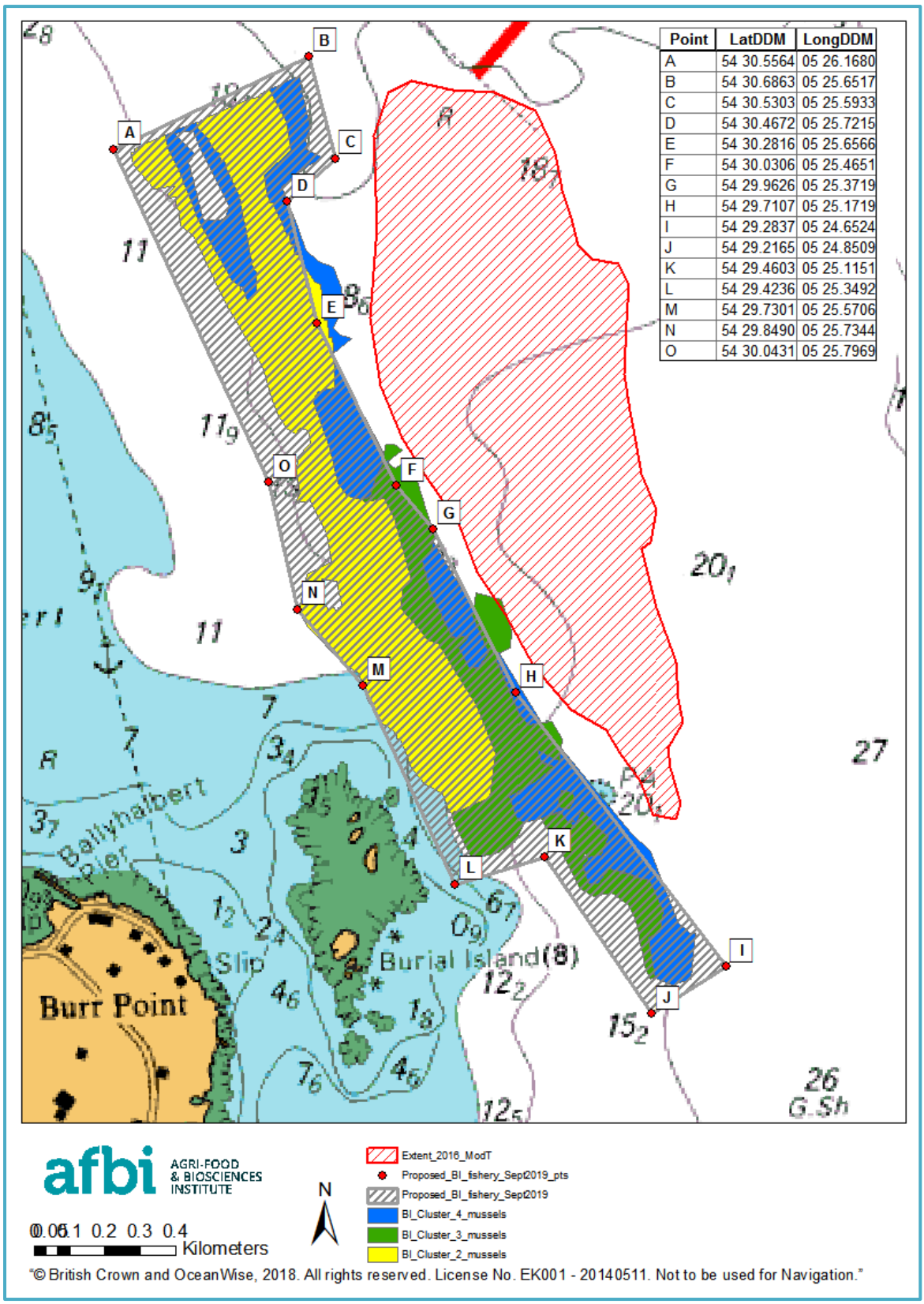
The Summer 2019 seed mussel stock assessment survey was undertaken by AFBI on the 26th of July 2019 and the 20th and 23rd of August 2019 onboard the DAERA Fisheries Protection Vessel (FPV) Queen of Ulster. The purpose of the Summer 2019 seed mussel stock assessment survey was to undertake acoustic, dredge and towed video surveys within the areas of Burial Island and The Feathers which had previously been fished and also, to monitor the development of the area of Skullmartin which was found to contain small quantities of seed mussel in 2017 and 2018.

Results and Discussion

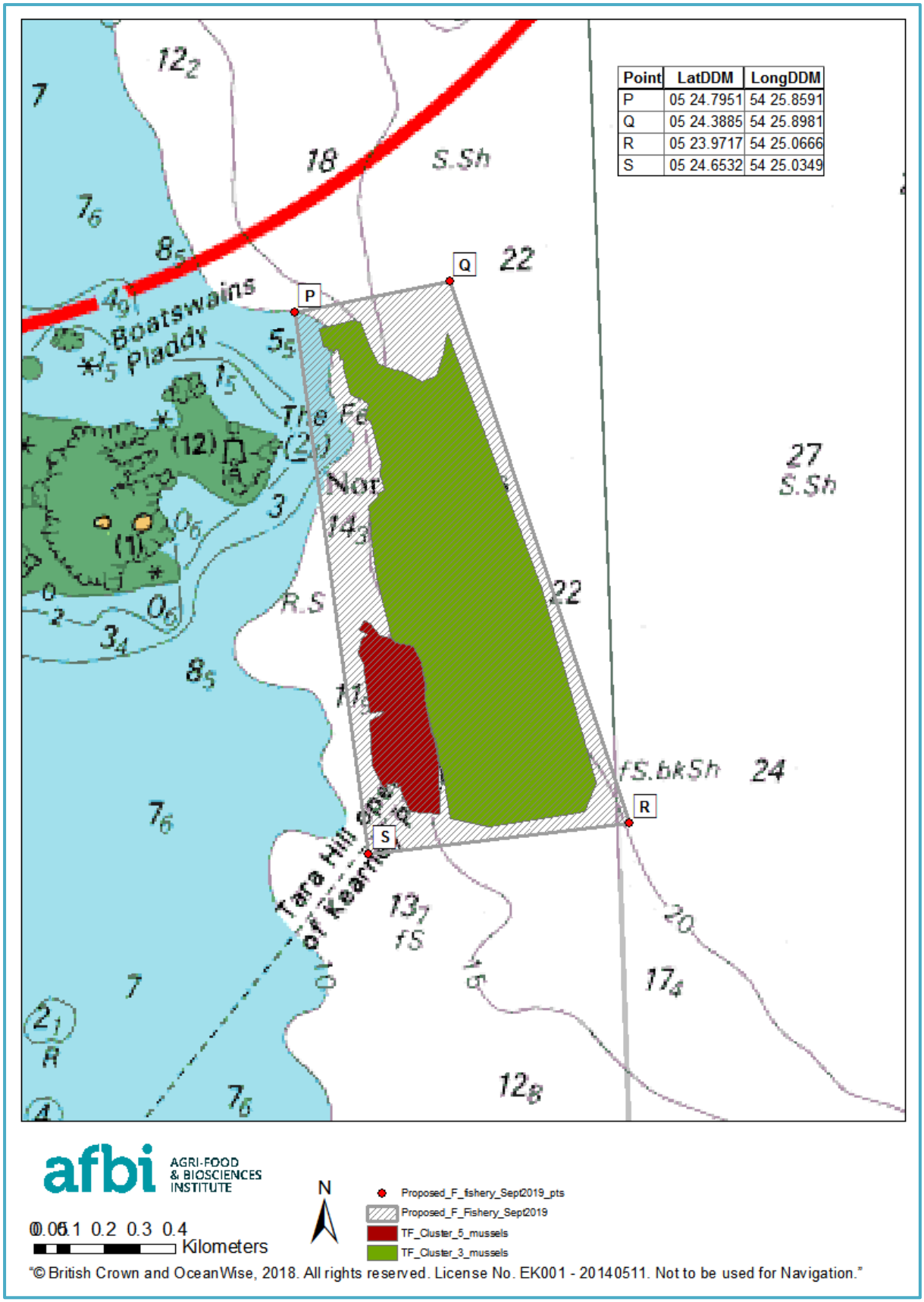
Following acoustic and ground truthing surveys (dredge and towed video) seed mussel beds were identified within the area of Burial Island (Figure 31) and the area of The Feathers (Figure 34). In order to determine the stock of seed mussels present within these areas, calculations as per Strong and Service (2011) were applied. From this it was determined that the Burial Island Seed Fishery Area, as shown within Figure 31 (and map 1 below), contains approximately **700** tonnes of seed mussel and The Feathers Seed Fishery Area, as shown within Figure 34 (and map 2 below), contains approximately **1000** tonnes of seed mussel. It is therefore recommend that these areas be opened to fishing on the next suitable tide.

It should be noted that the values stated above are estimates. These approximate tonnages come with the following caveats;

1. **The calculations as per Strong and Service (2011) utilise percentage waste which is based on the weight of the mussels subtracted from the total weight of the sample. If very small mussels are present within the beds the overall biomass of these mussels will be small in relation to the weight of the sample waste i.e. everything that wasn't mussels (predominately pebbles and cobbles). Therefore the waste on the beds may be an overestimation, which will in turn reduce the tonnage of mussels produced by the calculation.**



Map 1: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Burial Island, highlighting the area of Cluster 4 (blue area on map), Cluster 3 (green area on map) and Cluster 2 (yellow area on map) that represents seed mussel. The proposed fishery area is shown by the grey hashed area on the map. The red hashed area indicates the area previously identified as *M. modiolus* bed.



Map 2: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of The Feathers, highlighting the area of Cluster 5 (red area on map) and Cluster 3 green area on map) that represents seed mussel. The proposed fishery area is shown by the grey hashed area on the map.

1. Introduction

The Summer 2019 seed mussel stock assessment survey was undertaken by the Agri-Food and Biosciences Institute (AFBI) on the 26th of July 2019 and the 20th to the 23rd of August 2019 onboard the DAERA Fisheries Protection Vessel (FPV) Queen of Ulster. The current seed mussel stock assessment methodology has two stages. The first stage uses acoustic and dredge tows. If there are any significant amounts of juvenile *Mytilus edulis* present, a second towed camera stage is undertaken to build on the initial ground truthing. The purpose of the Summer 2019 seed mussel stock assessment survey was to undertake acoustic, dredge and video surveys within the areas of Burial Island and The Feathers which had previously been fished and also, to monitor the development of the area of Skullmartin which was found to contain small quantities of seed mussel in 2017 and 2018. The areas covered within the Summer 2019 survey are shown in Figure 1. The results of all of these surveys are detailed within the paragraphs below.

All care was taken to avoid the area of Burial Island previously identified as *Modiolus modiolus* habitat.

2. Materials and Methods

- *Survey methods*

RoxAnn acoustic ground discrimination system (AGDS) data were collected aboard the DAERA FPV Queen of Ulster on the 26th of July 2019, using a 200 kHz transducer. Data were collected at a save rate of 1s. Track spacing was approximately 100 m for all three areas investigated.

The following data processing was completed for the RoxAnn data obtained:

1. Data artefacts removed (caused by bubbles beneath transducer) and data from all turns at the end of survey lines.
2. E1 ("roughness") and E2 ("hardness") standardised by dividing each value by the 95th percentile of the range of values. Additionally a variability index, which shows how variable particular seabed areas are, was calculated by measuring the variability between sequential E1 and E2 datapoints. This was generated by square-rooting the absolute value of the next data point minus the current data point for each of E1 and E2, then adding these together. This provides a measure of along-track data variability for E1 and E2. These data were then plotted in ArcGIS as a point shapefile in UTM Zone 30N projection.
3. E1 (standardised) and E2 (standardised) were interpolated using ArcGIS 10.3 Spatial Analyst using a smooth circular search neighbourhood of 100 m, with inverse distance weighting method (to the power of 2), with a resulting grid cell size of 10 m^2. The resulting grids were clipped by an extent mask to constrain the final grids to the limits of the survey lines.

The clipped and interpolated E1 and E2 grids were then subjected to IsoCluster unsupervised image classification, with a number of classes trialled. The minimum class size (number of cells) used in the IsoCluster routine was 2. The addition of the depth grid was also trialled in the classification (i.e. E1, E2 and depth, or E1 and E2). The classified raster grid was then converted to a shapefile for calculation of areas.

The dredge surveys were undertaken onboard the DAERA FPV Queen of Ulster on the 20th of August 2019, with three AFBI staff members onboard collecting samples and directing sampling effort.

Dredging was conducted using a custom oyster dredge measuring 1.5m x 0.5m (Figure 2). Dredge sampling was in accordance with AFBI Standard Operating Procedures (SOP) "Collection and recording of Benthic dredge samples". Samples collected were logged into the AFBI laboratory upon return as per SOP MARISM015 and processed in accordance with SOP MARISM019 and SOP MARISM020.

Towed Video Survey

The video survey was undertaken onboard the DAERA FPV Queen of Ulster on the 23rd of August 2019. Camera footage of the seabed was collected with a towed epibenthic video sledge equipped with an Osprey video camera, coupled with halogen lights and lasers for scaling (Figure 3). The video sledge was operated in accordance with AFBI SOP MARISM043 and was towed at a speed of approximately 0.5-0.8 knots. The camera provides a large and stable field of view which (under perfect conditions) can display a clear and unambiguous picture of the seabed for the assessment of seed mussel presence. All of the footage has been interpreted following NMBAQC Guidelines (Turner *et al* 2016) by experienced AFBI staff members who have undertaken video surveys of the seed mussel beds within previous years.

- *Laboratory Analysis*

Samples collected during the dredge and grab surveys were processed as per SOP MARISM019 and MARISM020 the main elements of which are summarised very briefly below:

1) Whole sample weighed
2) Mussel removed from the sample and weighed
3) Waste calculated from above values
4) Mussels in 1 kg were counted
5) Sixty mussels selected for length analysis (more if two or more size classes were present)

3. Results

Skullmartin

The processed RoxAnn cluster map for Skullmartin is shown in Figure 4. As can be seen from Figure 4, five distinct clusters were identified for this area. The dredge survey was then planned to provide representative sampling of all five of these clusters (Figure 5).

Ten dredge tows were undertaken on the 20th of August 2019 within the area of Skullmartin known to have previously yielded seed mussels (Figure 6). Mussels (accounting for greater than 10% of dredge contents) were found within seven of these tows (Figures 6, 7, 8 and 9, and Tables 1, 2 and 3).

The summary results from the mussel sample processing for the dredge tows undertaken within the area of Skullmartin are shown in Tables 2 and 3. The size class distributions for mussels within the dredge Tows are shown within Figure 9. As can be seen from Figure 9 two different settlements of mussels were found within this area. The majority of mussels found within Tows 32, 33, 34 and 37 were within the 30-35 mm length category whilst the majority of mussels present within Tows 35, 36 and 38 greater than 50 mm in length. **As can be seen from Table 2 the percentage waste (by weight) contained within these samples was high, ranging from 53% to 88%.**

The video survey for this area was planned based on the findings of the RoxAnn, and dredge surveys. Figure 10 shows the location of the video tows undertaken within the area of Skullmartin. Figure 11 shows the mussel coverage identified along these tows. Percentage cover of blue mussels (*Mytilus edulis*) was determined as per Turner *et al* (2016) (shown in Figure 12).

Burial Island

The processed RoxAnn cluster map for Burial Island is shown in Figure 13. As can be seen from Figure 13, five distinct clusters were identified for this area. The dredge survey was then planned to provide representative sampling of all five of these clusters (Figure 14).

Twelve dredge tows were undertaken on the 20th of August 2019 within the area of Burial Island known to have previously yielded seed mussels (Figure 15). Mussels (accounting for

greater than 10% of dredge contents) were found within five of these tows (Figures 15, 16 and 17 and Tables 1, 4 and 5).

The summary results from the mussel sample processing for the dredge tows undertaken within the area of Burial Island are shown in Tables 4 and 5. The size class distributions for mussels within the dredge Tows are shown within Figure 17. As can be seen from Figure 17 two different settlements of mussels were found within this area. The majority of mussels found within Tows 24, and 26 were within the 30-40 mm length categories whilst Tow 25 contained larger mussels within the 45-55 mm size range. Tows 27 and 28 contained a wide range of different sized mussels. **As can be seen from Table 4 the percentage waste (by weight) contained within these samples was high, ranging from 47% to 88%.**

The video survey for this area was planned based on the findings of the RoxAnn, and dredge surveys. Figure 18 shows the location of the video tows undertaken within the area of Burial Island. Figure 19 shows the mussel coverage identified along these tows. Percentage cover of blue mussels (*Mytilus edulis*) was determined as per Turner *et al* (2016) (shown in Figure 12).

The Feathers

The processed RoxAnn cluster map for The Feathers is shown in Figure 20. As can be seen from Figure 20, five distinct clusters were identified for this area. The dredge survey was then planned to provide representative sampling of all five of these clusters (Figure 21).

Sixteen dredge tows were undertaken on the 20th of August 2019 within the area of The Feathers known to have previously yielded seed mussels (Figure 22). Mussels (accounting for greater than 10% of dredge contents) were found within three of these tows (Figures 22, 23 and 24 and Tables 1, 6 and 7).

The summary results from the mussel sample processing for the dredge tows undertaken within the area of The Feathers are shown in Tables 6 and 7. The size class distributions for mussels within the dredge Tows are shown within Figure 24. As can be seen from Figure 24 the majority of the mussels found within all Tows 6 and 11 were within the 15-25 mm length categories, whilst the majority of mussel found with Tow 7 were within the 30-35 mm length category. **As can be seen from Table 6 the percentage waste (by weight) contained within these samples ranged from 27% to 62%.**

The video survey for this area was planned based on the findings of the RoxAnn, and dredge surveys. Figure 25 shows the location of the video tows undertaken within the area of The Feathers. Figure 26 shows percentage coverage of mussels identified along this tow. Percentage cover of blue mussels (*Mytilus edulis*) was determined as per Turner *et al* (2016) (shown in Figure 12).

4. Discussion

Skullmartin

Following acoustic and ground truthing surveys (dredge and towed video) undertaken between July and August 2019 an area of seed mussels was identified within the area of Skullmartin (Figure 27). A proportion of the areas identified as Cluster 2, 3 and 4 were found to correspond to seed mussels (Figure 28).

From the Towed video footage it could be seen that coverage of mussels within this area was very sporadic and this was substantiated by the dredge survey results as the percentage waste within all samples was high (ranging from 53% to 88%).

As this is the first sign of the reestablishment of this once large seed mussel bed (in 2006 approximately 3,900 tonnes of mussels were harvested from Skullmartin (McQuaid *et al* 2007)) we would not recommend opening this bed at this time. We propose to undertake further acoustic, dredge and video surveys during 2020 to monitor the development of the seed mussel bed within this area.

Burial Island

Following acoustic and ground truthing surveys (dredge and towed video) undertaken between July and August 2019 an area of seed mussels was identified within the area of Burial Island (Figure 29). A proportion of the areas identified as Cluster 2, 3 and 4 were found to correspond to seed mussels (Figure 30). **It is believed that Cluster 3 contains the more dense areas of seed mussel.** In order to determine the stock of seed mussels present within the Burial Island area, the following calculations, as per Strong and Service (2011) were applied:

Stock Assessment Calculations

1) Tow length was calculated from start and stop positions.
2) Tow area was calculated from dredge mouth width x tow length.
3) Dredge percentage 'fill' was assessed in situ – this was converted to a weight based on the volume held within a full dredge.
4) The mussel biomass (as determined from samples processed in the laboratory) is multiplied by the dredge fill. This mussel dredge biomass is then divided by the tow area (to give a biomass per m^2) and multiplied by the acoustic area (classified mussel strata) to give a tonnage.

5) As step 4 uses biomass from highly cleaned and sorted mussels, a site waste value has been included to better represent the actual weights likely to be recovered by industry.

All tonnages were adjusted according to published dredge efficiency values (Dolmer *et al.*, 1999).

It has been well document from previous surveys that the outer portion of Cluster 3 does not contain blue mussels but the horse mussel *Modiolus modiolus*. Mussel tonnages were calculated for the area of Clusters 2, 3 and 4 determined to contain mussels and a mussel Fishery box was assigned to this region (Figure 31).

It should be noted that the seaward edge of the Fishery area has been constrained by an 80 m buffer applied since the 2015 Seed mussel stock Assessments to allow protection of the adjacent *M. modiolus* beds.

Based on the information collected during the Summer 2019 (July and August) surveys (utilising the calculations, as per Strong and Service, 2011) we have approximated that The Burial Island Seed Fishery Area, as shown within Figure 31, contains approximately 700 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.

The Feathers

Following acoustic and ground truthing surveys (dredge and towed video) undertaken between July and August 2019 an area of seed mussels was identified within the area of The Feathers (Figure 32). A proportion of the areas identified as Cluster 3 and 5 were found to correspond to seed mussels (Figure 33). **It is believed that Cluster 3 contains the more dense areas of seed mussel.** In order to determine the stock of seed mussels present within The Feathers area, the calculations outlined above, as per Strong and Service (2011), were applied. All tonnages were adjusted according to published dredge efficiency values (Dolmer *et al.*, 1999).

Mussel tonnages were calculated for the area of Clusters 3 and 5 determined to contain mussels and a mussel Fishery box was assigned to this region (Figure 34).

Based on the information collected during the Summer 2019 (July and August) surveys (utilising the calculations, as per Strong and Service, 2011) we have approximated that The Feathers Seed Fishery Area, as shown within Figure 34, contains approximately 1,000 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.

It should be noted that the values stated above are estimates. These approximate tonnages come with the following caveats;

1. **The calculations as per Strong and Service (2011) utilise percentage waste which is based on the weight of the mussels subtracted from the total weight of the sample. If very small mussels are present within the beds the overall biomass of these mussels will be small in relation to the weight of the sample waste i.e. everything that wasn't mussels (predominately pebbles and cobbles). Therefore the waste on the beds may be an overestimation, which will in turn reduce the tonnage of mussels produced by the calculation.**

Tables

Table 1: Dredge information from the 20th of August 2019 Outer Ards dredge survey. Only the dredge Tows whose contents were composed of greater than 10% mussels are shown as red lines on the corresponding maps (Figure 6: Skullmartin, Figure 15: Burial Island and Figure 22: The Feathers).

Tow_No	Date	Location	Depth start	Depth end	Tow Length (m)	Est % fill	Mussel >10%	Sample description
T01	20.08.19	The Feathers	11.6	12	360	<5	N	Kelp with cobbles and crabs
T02	20.08.19	The Feathers	15.4	15.2	301	<5	Y	Kelp with cobbles and crabs
T03	20.08.19	The Feathers	20.1	16.6	301	<10	N	Cobbles with barnacles and seed mussel
T04	20.08.19	The Feathers	10	9.1	213	<10	N	Kelp with crabs
T05	20.08.19	The Feathers	11.2	11	352	<5	N	Kelp with crabs
T06	20.08.19	The Feathers	14.6	14.4	352	70%	Y	seed mussel cobbles and shell gravel
T07	20.08.19	The Feathers	16.2	17.1	364	50%	Y	seed mussels with a few cobbles
T08	20.08.19	The Feathers	22.6	23.1	265	<10	N	Kelp with cobbles and crabs
T09	20.08.19	The Feathers	24.1	24.7	305	<10	N	Dead shells and shell gravel
T10	20.08.19	The Feathers	22.1	22.7	356	<10	N	Cobbles and crabs
T11	20.08.19	The Feathers	18.6	18.8	288	80%	Y	Seed mussels
T12	20.08.19	The Feathers	21.1	22.8	297	<5	N	cobbles and dead shell
T13	20.08.19	The Feathers	11.3	10.5	378	<10	N	Red algae with dead shells
T14	20.08.19	The Feathers	17.3	20.1	512	<5	N	dead shells and crabs
T15	20.08.19	The Feathers	21.3	22.1	171	<10	N	sand/shell gravel
T16	20.08.19	The Feathers	24.0	23.7	440	<5	N	cobbles and red weed
T17	20.08.19	Burial Island	19.0	19.1	350	<10	N	shell gravel and dead shell
T18	20.08.19	Burial Island	19.1	19.8	173	15%	N	shell gravel and dead shell with red algae
T19	20.08.19	Burial Island	19.4	18.7	302	10%	N	shell gravel and dead shell with echinus
T20	20.08.19	Burial Island	18.3	20.2	366	10%	N	gravelly sand/shell gravel
T21	20.08.19	Burial Island	25.4	27.7	461	10-15%	N	shell gravel and dead shell with large cobbles
T22	20.08.19	Burial Island	27.5	26.4	407	70%	N	Brittle stars and *Modiolus* shell

Tow_No	Date	Location	Depth start	Depth end	Tow Length (m)	Est % fill	Mussel >10%	Sample description
T23	20.08.19	Burial Island	14.9	17.6	325	<5	N	Gravelly sand with crabs and red algae
T24	20.08.19	Burial Island	21.9	22.2	351	70%	Y	shell gravel/dead shell with mussels
T25	20.08.19	Burial Island	22.0	21.3	315	60%	Y	mussels and dead shell
T26	20.08.19	Burial Island	22.9	23.0	270	60%	Y	mussels and shell gravel
T27	20.08.19	Burial Island	17.6	20.3	341	20%	Y	Mussels and dead shell
T28	20.08.19	Burial Island	23.2	23.5	429	70%	Y	Mussels with shell gravel and dead shell
T29	20.08.19	Skullmartin	20.1	18.6	378	60%	N	shell gravel and broken shell
T30	20.08.19	Skullmartin	19.5	17.6	329	40%	N	shell gravel and broken shell
T31	20.08.19	Skullmartin	16.2	16.8	353	30%	N	shell gravel and broken shell
T32	20.08.19	Skullmartin	18.5	20.3	343	30%	Y	shell gravel and broken shell
T33	20.08.19	Skullmartin	19.9	23.9	409	30%	Y	mussels and shell gravel
T34	20.08.19	Skullmartin	22.7	21.6	334	30%	Y	mussels and shell gravel
T35	20.08.19	Skullmartin	23.9	23.0	248	45%	Y	mussel, shell gravel and broken shell
T36	20.08.19	Skullmartin	21.1	21.0	265	70%	Y	mussel, shell gravel and broken shell
T37	20.08.19	Skullmartin	24.1	24.3	342	10%	Y	cobbles with some mussels
T38	20.08.19	Skullmartin	23.7	25.7	379	75%	Y	mussels and shell gravel

Table 2: Mussel sample processing summary data: Skullmartin 20/08/19

Tow No.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 32	4.32	0.52	87.87	446.56
Tow 33	5.50	1.15	79.02	508.67
Tow 34	7.61	1.31	82.77	309.16
Tow 35	11.32	2.06	81.81	183.19
Tow 36	17.70	5.90	66.66	112.71
Tow 37	4.83	1.44	70.07	299.17
Tow 38	15.39	7.21	53.15	96.81

Table 3: Mussel length measurement summary data: Skullmartin 20/08/19

Tow No.	Mussel length measurements (mm)				
	Median	**Mean**	**SD**	**min**	**max**
Tow 32	32.57	31.23	4.70	17.80	40.40
Tow 33	33.55	34.06	2.75	29.56	41.72
Tow 34	34.83	35.12	4.76	21.91	48.34
Tow 35	46.64	42.85	9.28	22.98	55.61
Tow 36	52.12	51.72	4.60	39.49	61.91
Tow 37	34.53	35.27	4.11	28.77	51.63
Tow 38	49.53	47.93	8.25	30.32	60.42

SD= Standard Deviation from the mean

Table 4: Mussel sample processing summary data: Burial Island 20/08/19

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 24	7.95	0.97	87.82	460.74
Tow 25	10.50	5.06	51.77	132.36
Tow 26	13.91	6.07	56.35	231.63
Tow 27	3.11	1.65	46.86	161.82
Tow 28	13.11	5.15	60.70	161.75

Table 5: Mussel length measurement summary data: Burial Island 20/08/19

Tow No.	Mussel length measurements (mm)				
	Median	Mean	SD	min	max
Tow 24	33.17	32.17	4.08	18.01	39.17
Tow 25	49.39	48.10	4.14	38.19	55.93
Tow 26	38.17	38.78	5.77	27.23	57.13
Tow 27	37.54	38.36	12.70	13.89	69.41
Tow 28	43.14	45.32	11.07	28.04	68.44

SD= Standard Deviation from the mean

Table 6: Mussel sample processing summary data: The Feathers 20/08/19

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 6	8.05	3.03	62.41	759.42
Tow 7	15.09	9.19	39.13	477.00
Tow 11	10.54	7.65	27.42	1923.01

Table 7: Mussel length measurement summary data: The Feathers 20/08/19

Tow No.	Mussel length measurements (mm)				
	Median	Mean	SD	min	max
Tow 6	24.08	26.63	7.53	18.23	43.44
Tow 7	32.71	32.82	2.91	26.62	38.18
Tow 11	21.42	21.95	2.01	18.14	29.95

SD= Standard Deviation from the mean

Figures

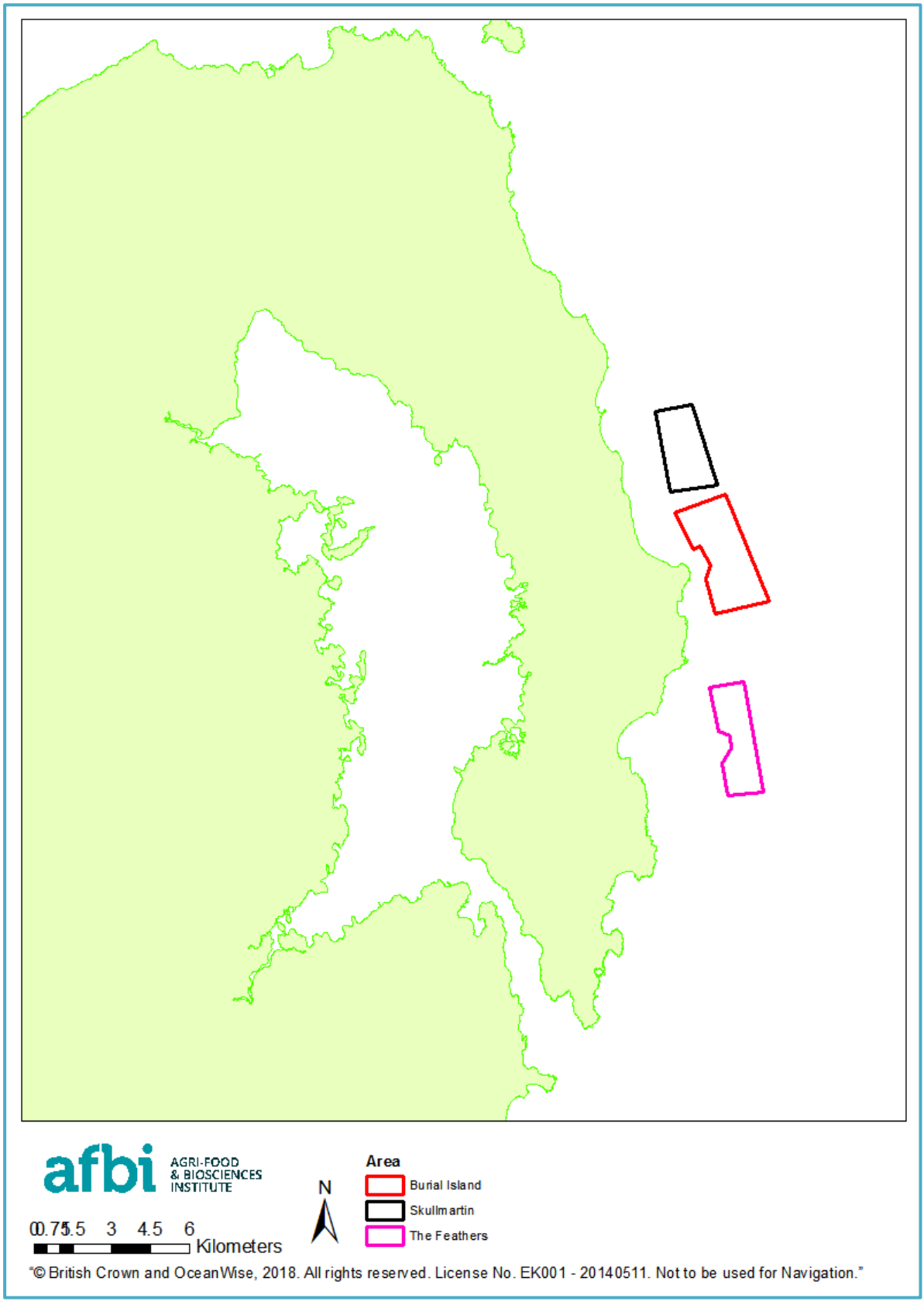


Figure 1: Locations of areas surveyed during the summer 2019 seed mussel survey.

Figure 2: Photograph showing the dredge used during the Summer 2019 survey.

Figure 3: Photograph showing the AFBI camera sledge used during the Summer 2019 surveys.

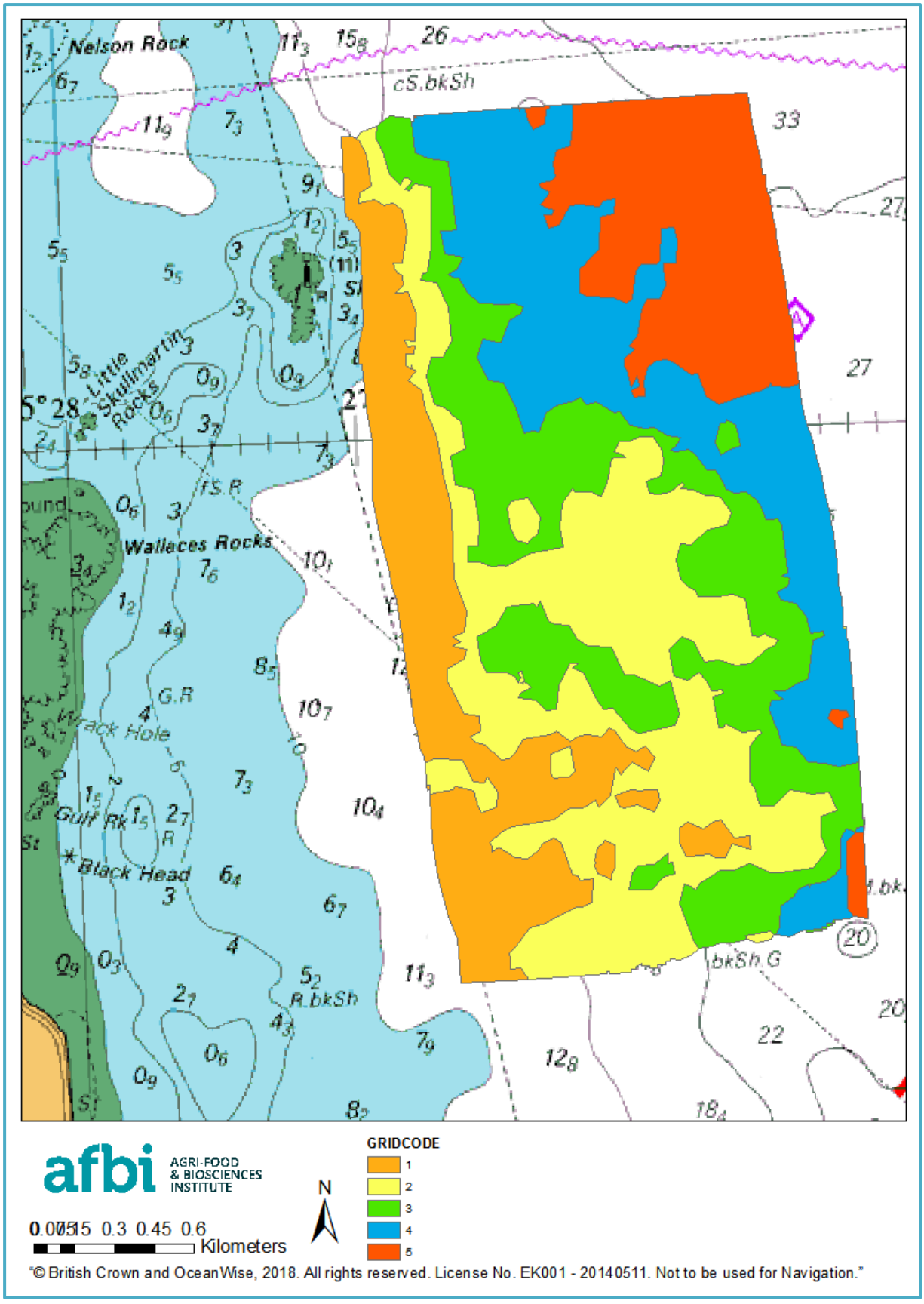


Figure 4: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Skullmartin.

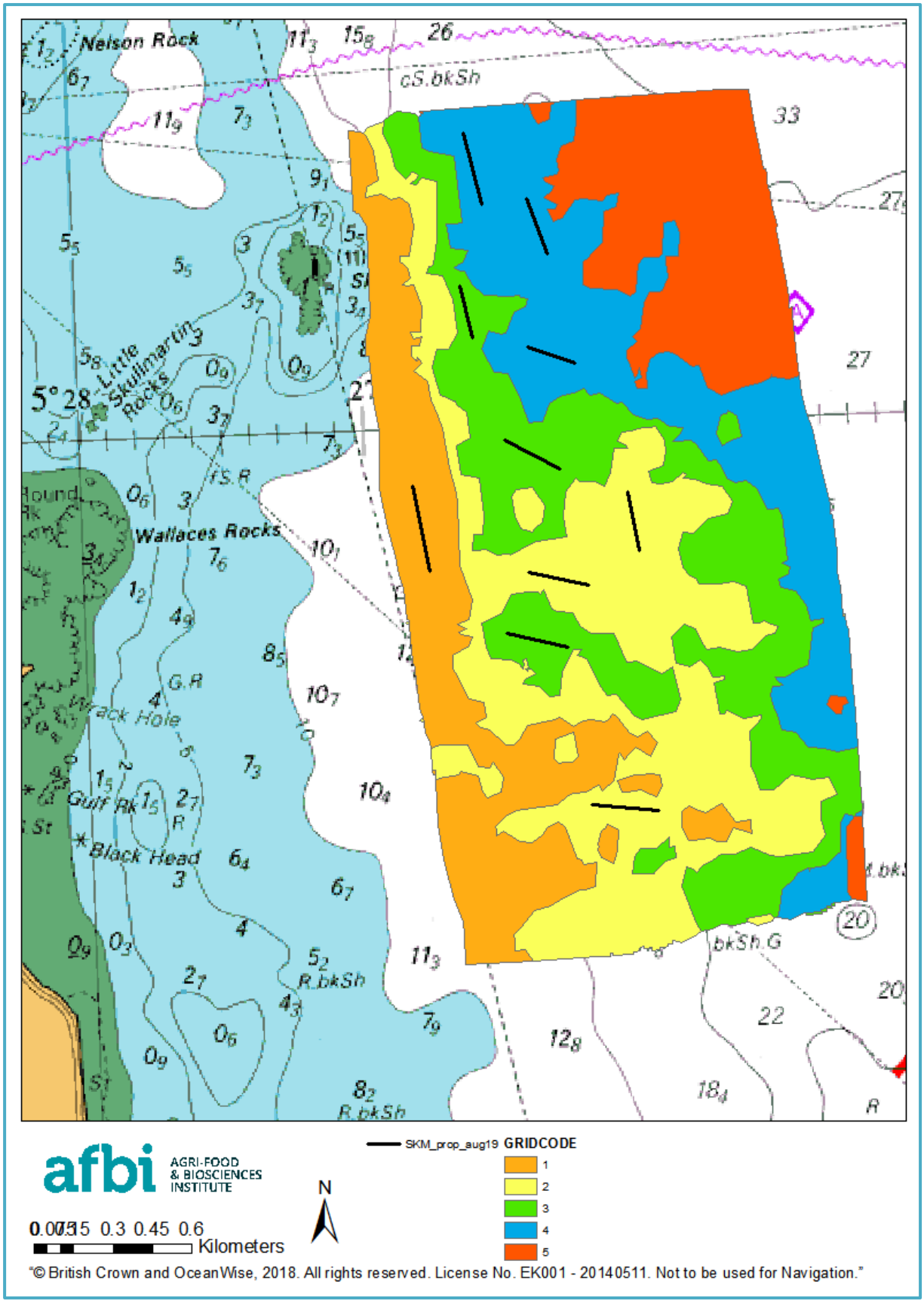


Figure 5: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Skullmartin overlaid with the proposed dredge tows.

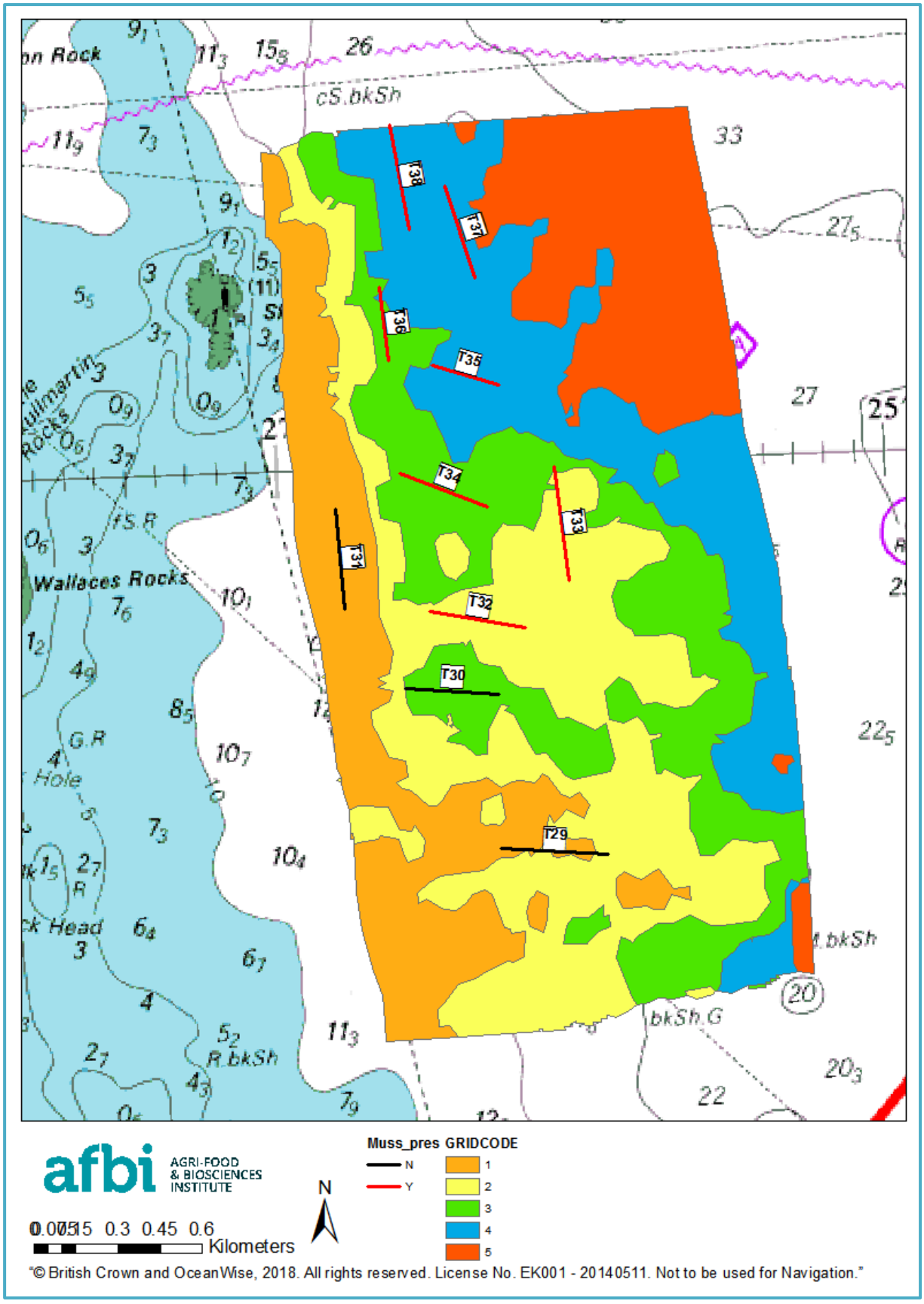


Figure 6: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Skullmartin overlaid with the dredge tows undertaken on the 20th of August 2019. Dredges within which mussels were found are coloured red.

Figure 7: Photographs showing the contents of the dredge tows 32, 33, 34 and 35 which yielded mussels undertaken within the area of Skullmartin during the August 2019 seed mussel survey.

Figure 8: Photographs showing the contents of the dredge tows 36, 37 and 38 which yielded mussels undertaken within the area of Skullmartin during the August 2019 seed mussel survey.

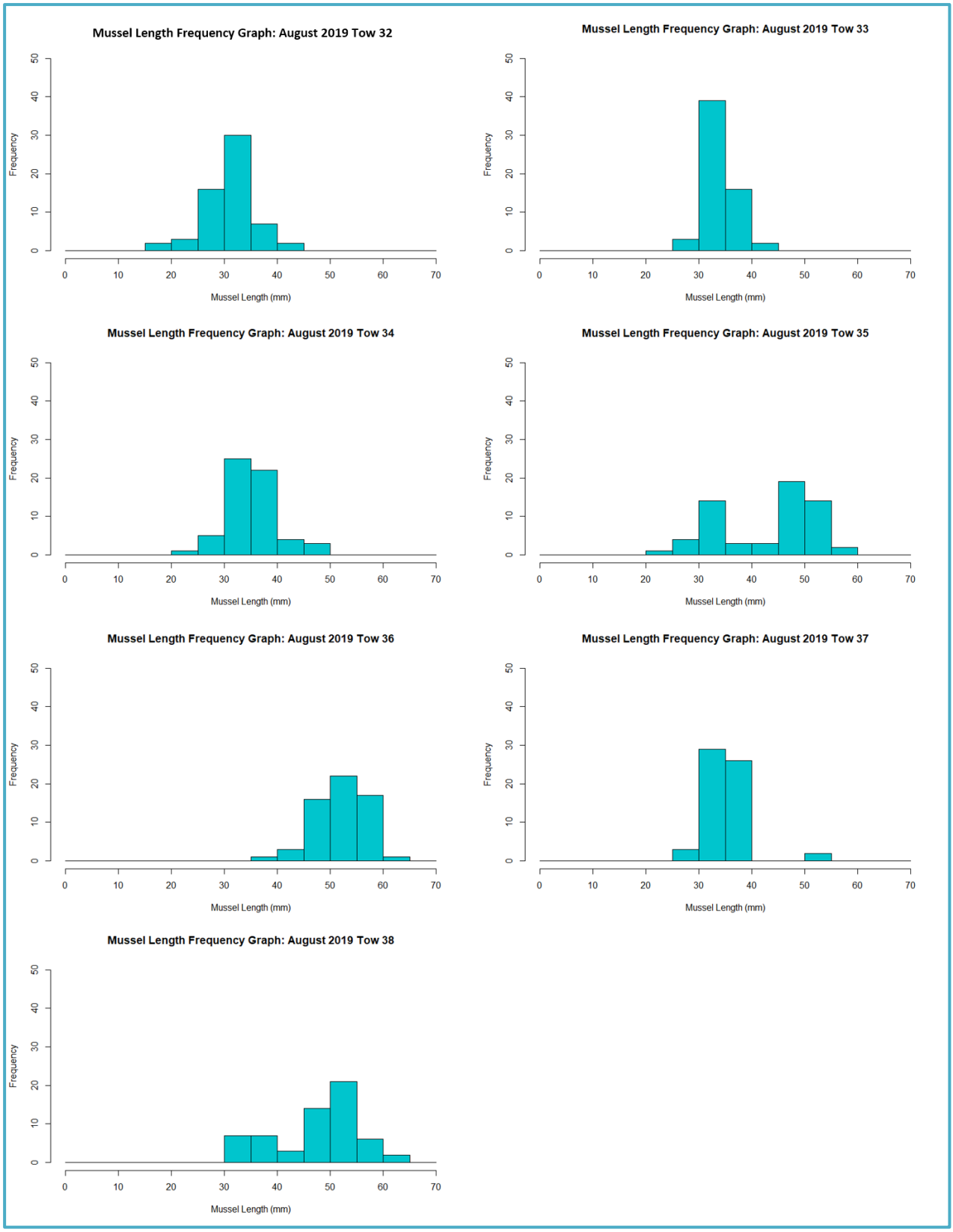


Figure 9: Length class distribution histogram for mussels found within dredge Tows undertaken within the area of Skullmartin during the August 2019 seed mussel survey.

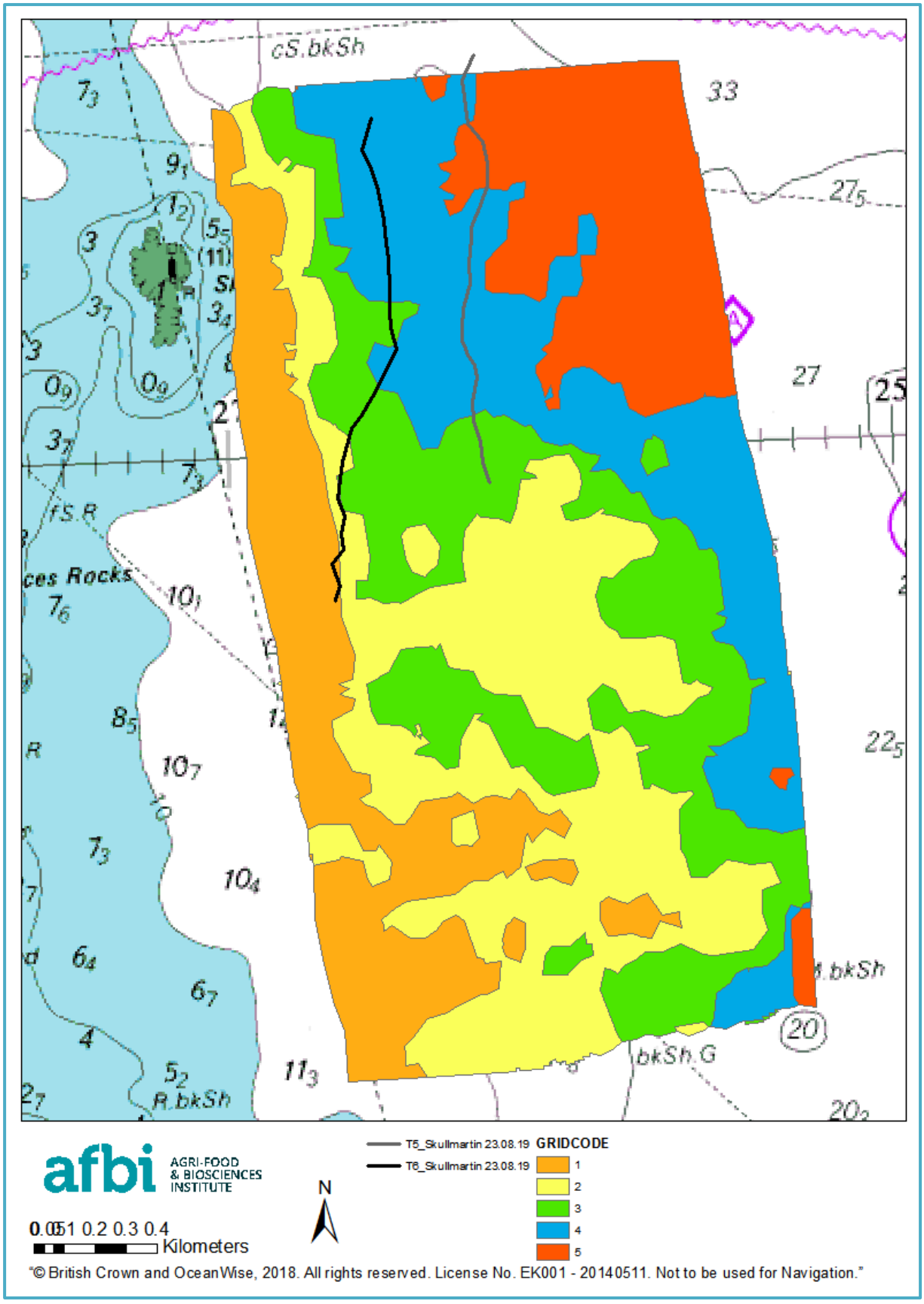


Figure 10: Location of video tows undertaken within the area of Skullmartin during the August 2019 seed mussel survey.

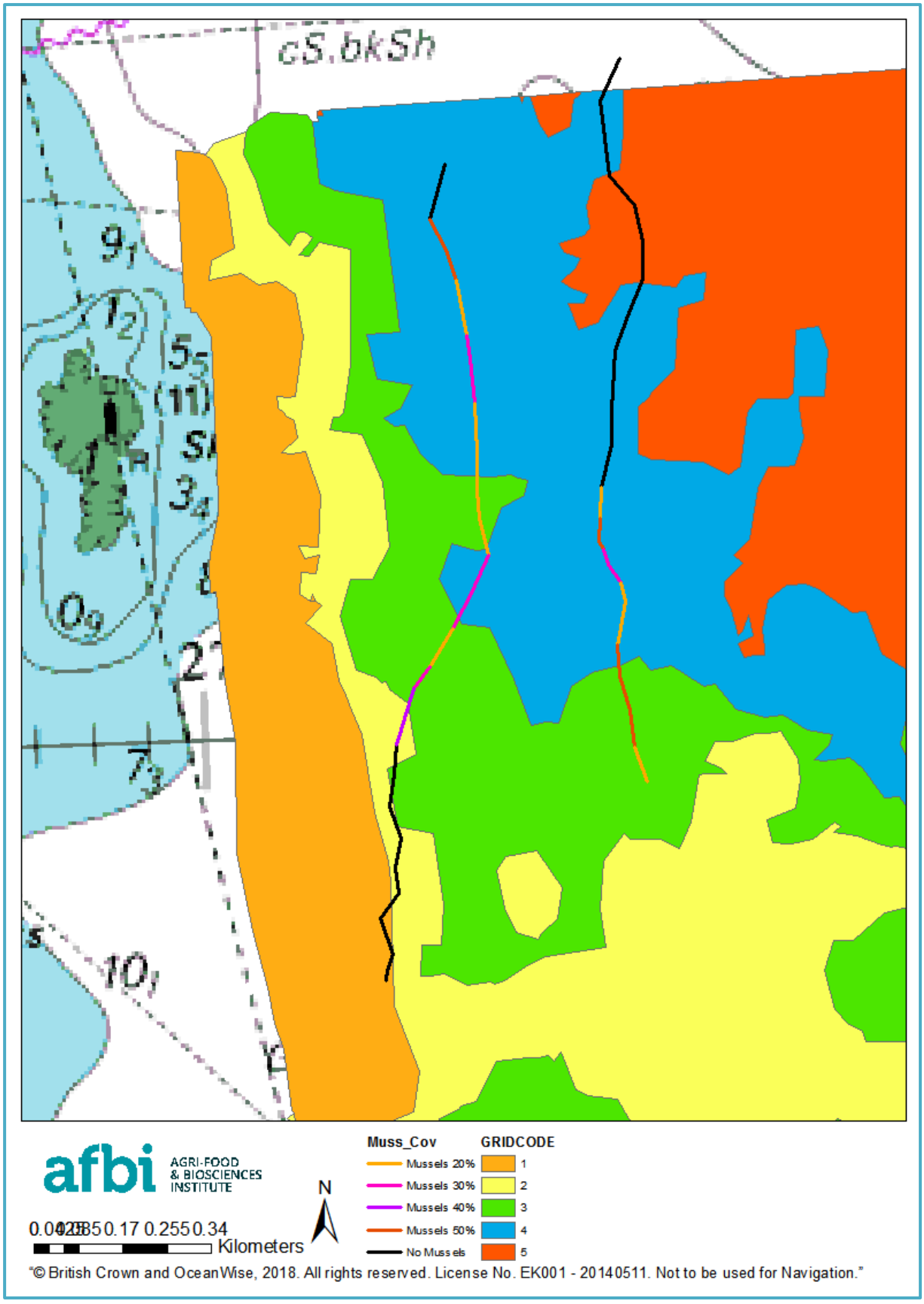


Figure 11: Location of video tows undertaken within the area of Skullmartin during the August 2019 seed mussel survey showing coverage of mussels.

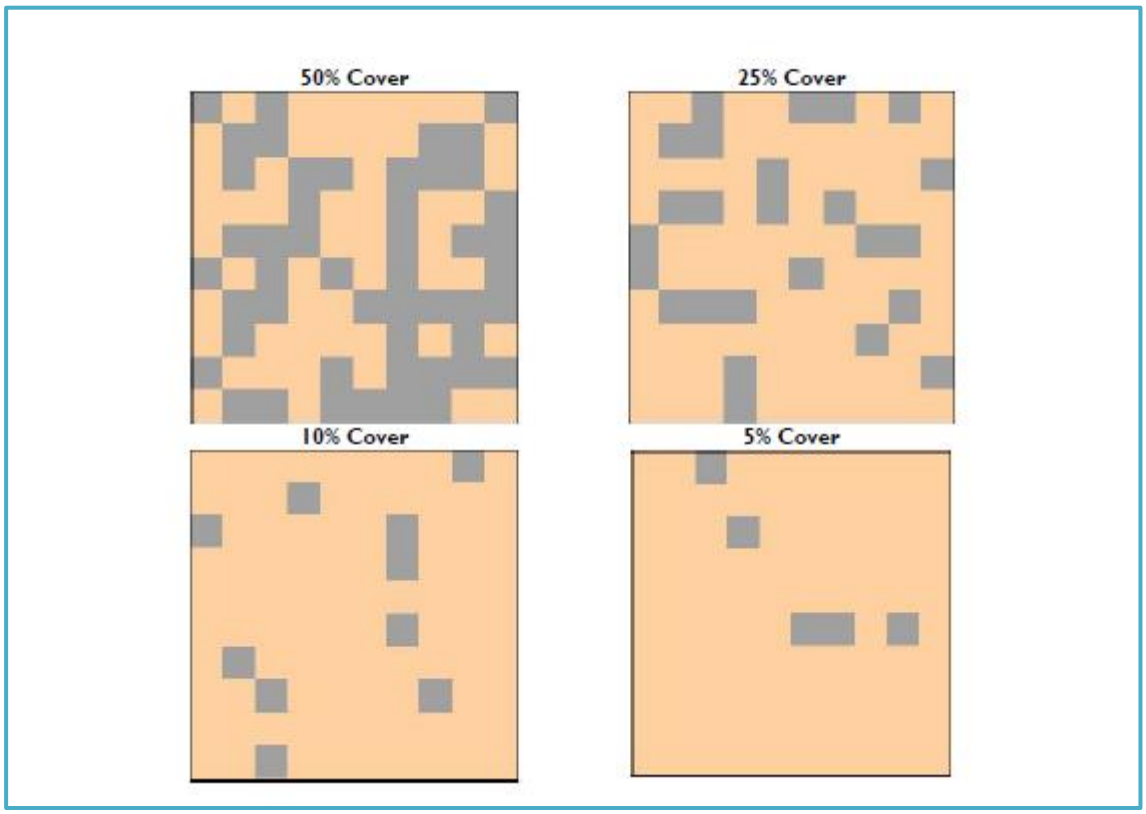


Figure 12: Graphical illustrations to assist with estimation of percentage cover, as taken from Turner et al (2016) Figure 2.

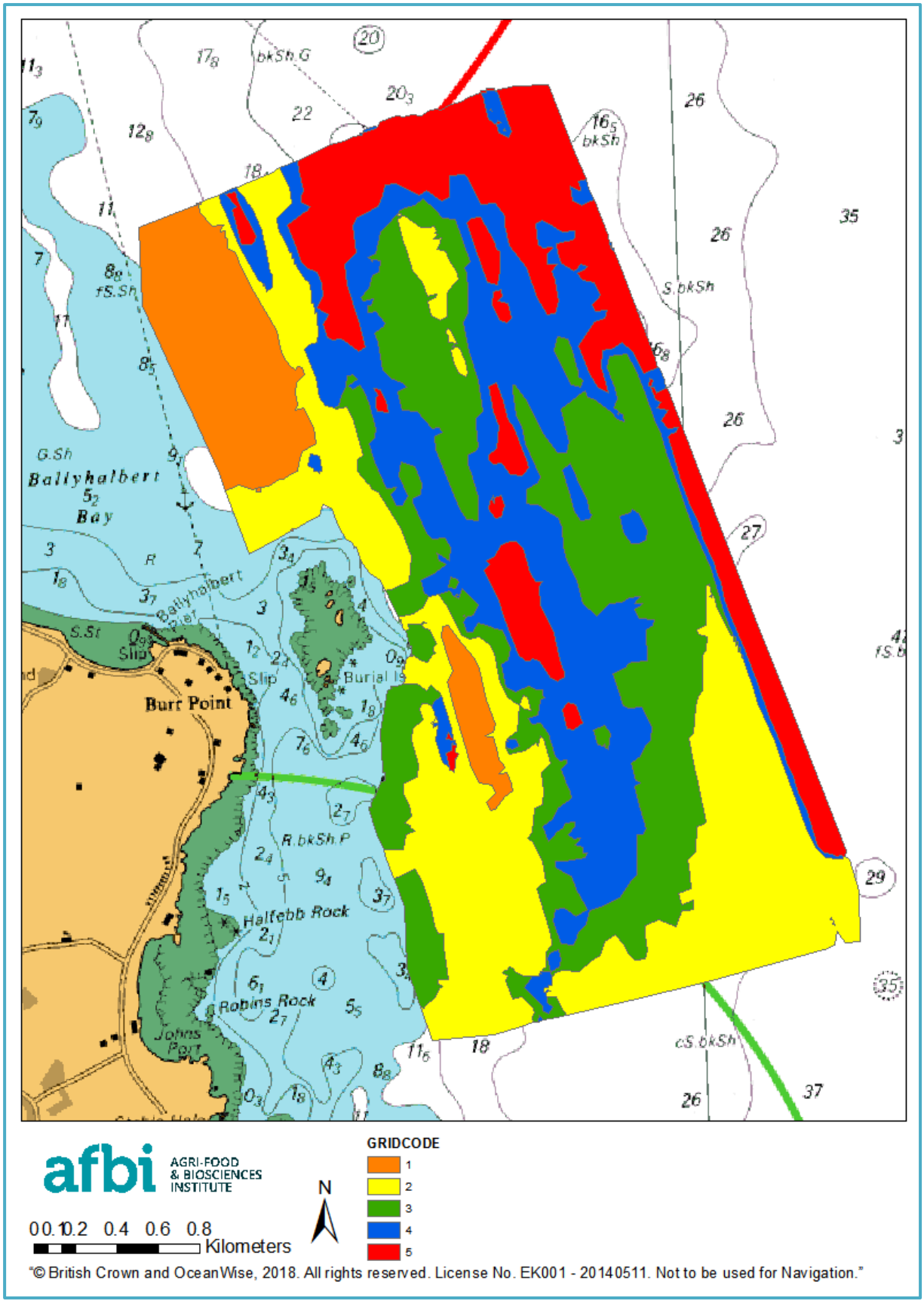


Figure 13: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Burial Island.

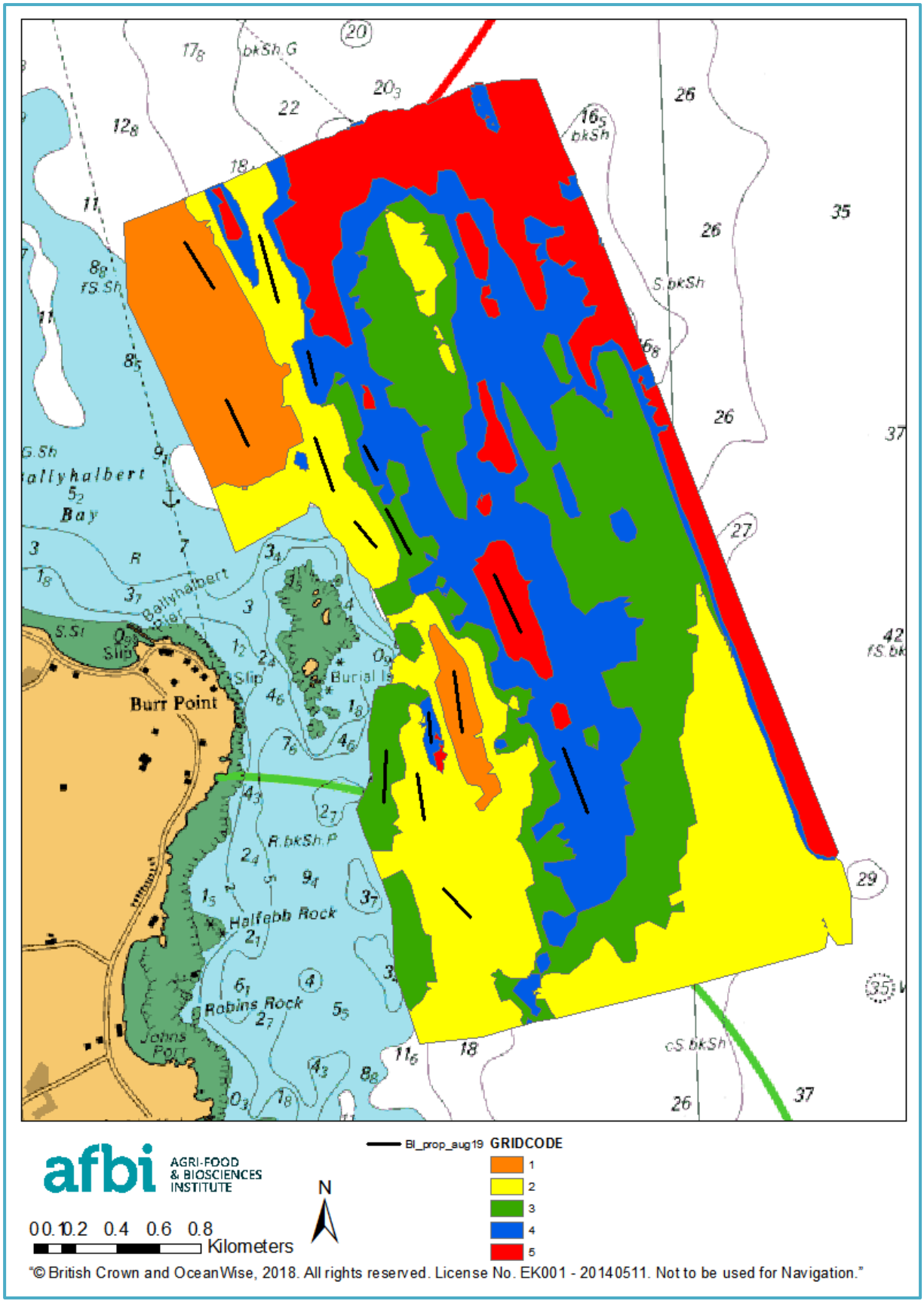


Figure 14: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Burial Island overlaid with the proposed dredge tows.

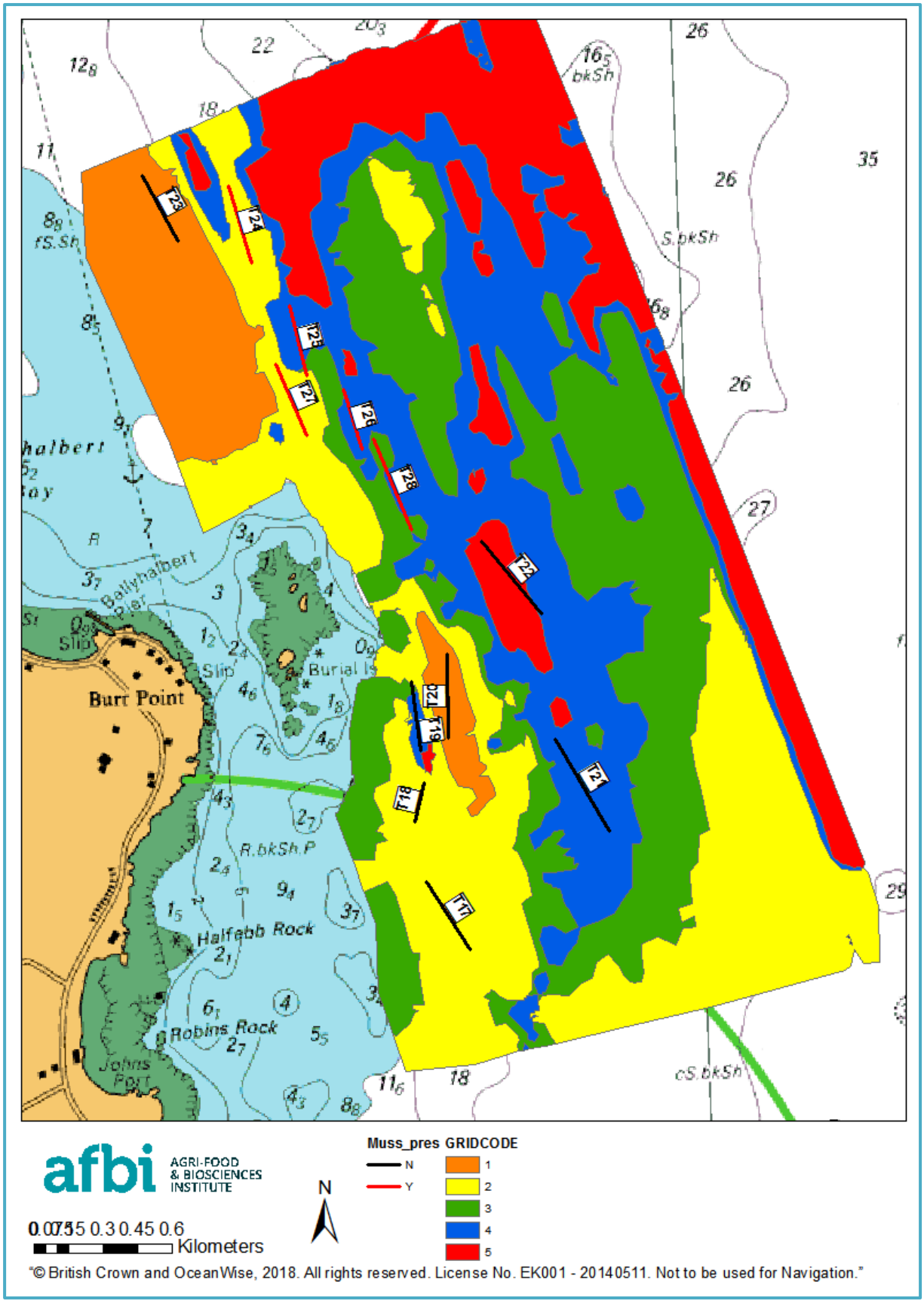


Figure 15: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of Burial Island overlaid with the dredge tows undertaken on the 20th of August 2019. Dredges within which mussels were found are coloured red.

Figure 16: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Burial Island during the August 2019 seed mussel survey.

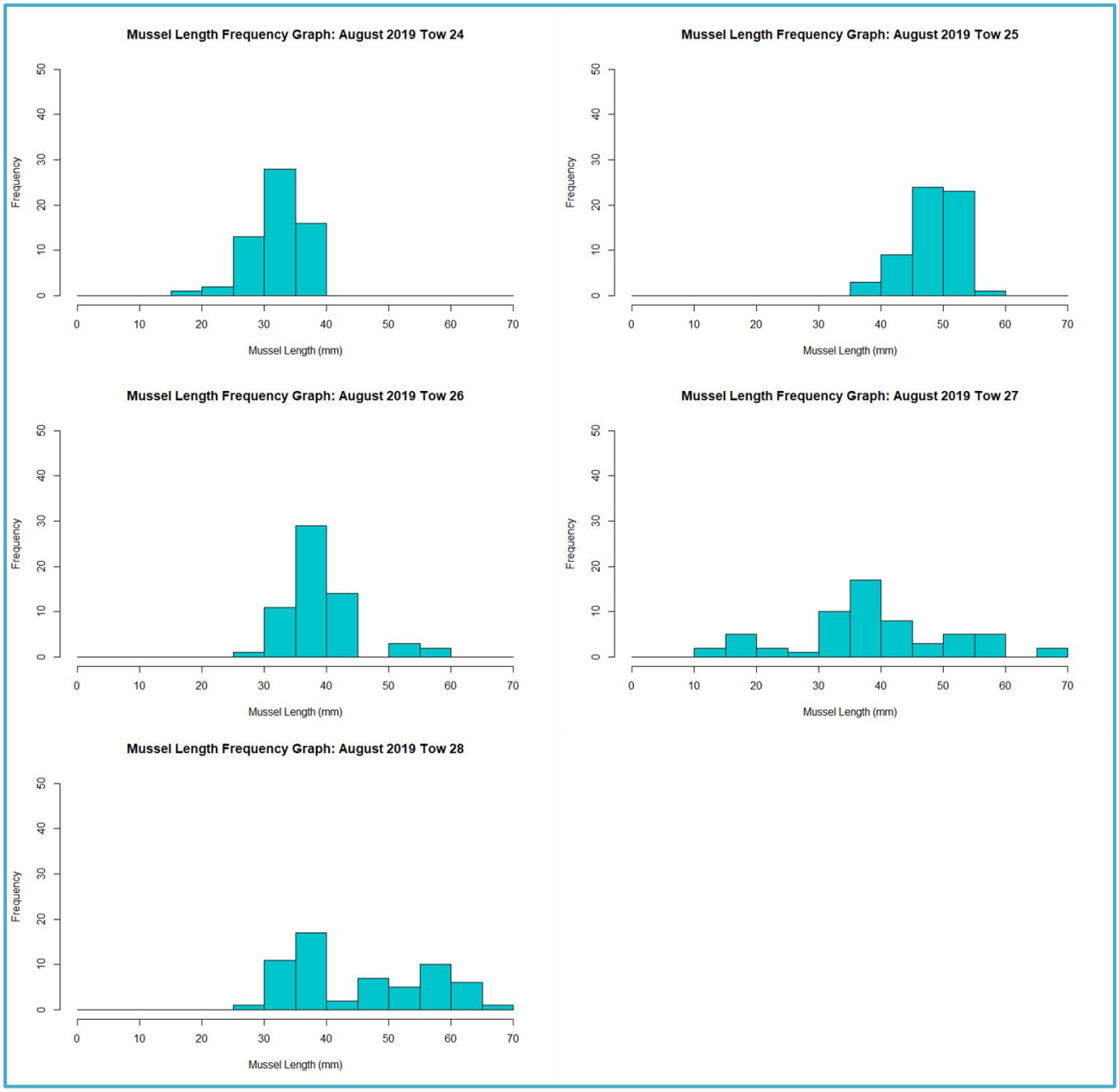


Figure 17: Length class distribution histogram for mussels found within dredge Tows undertaken within the area of Burial Island during the August 2019 seed mussel survey.

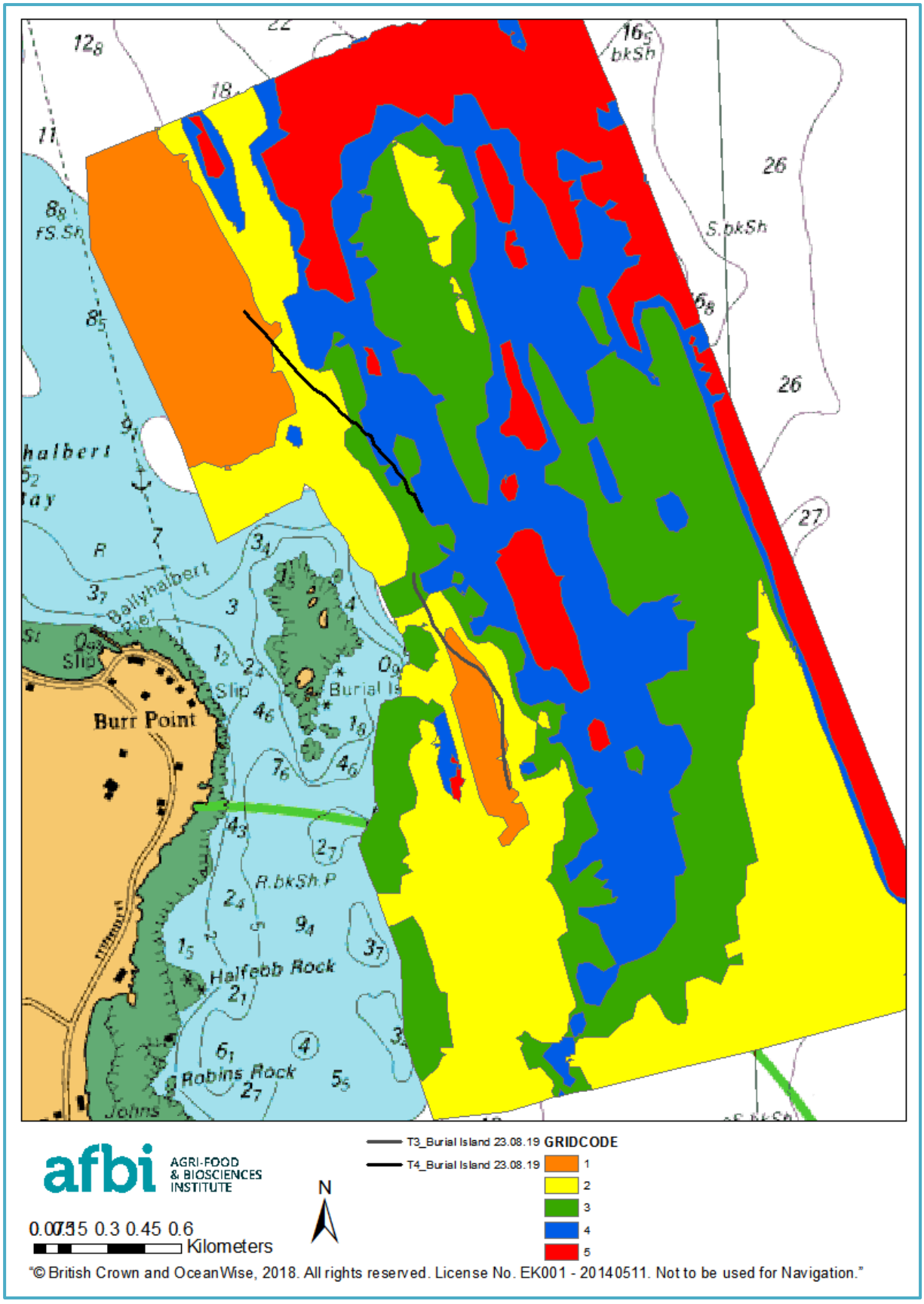


Figure 18: Location of video tows undertaken within the area of Burial Island during the August 2019 seed mussel survey.

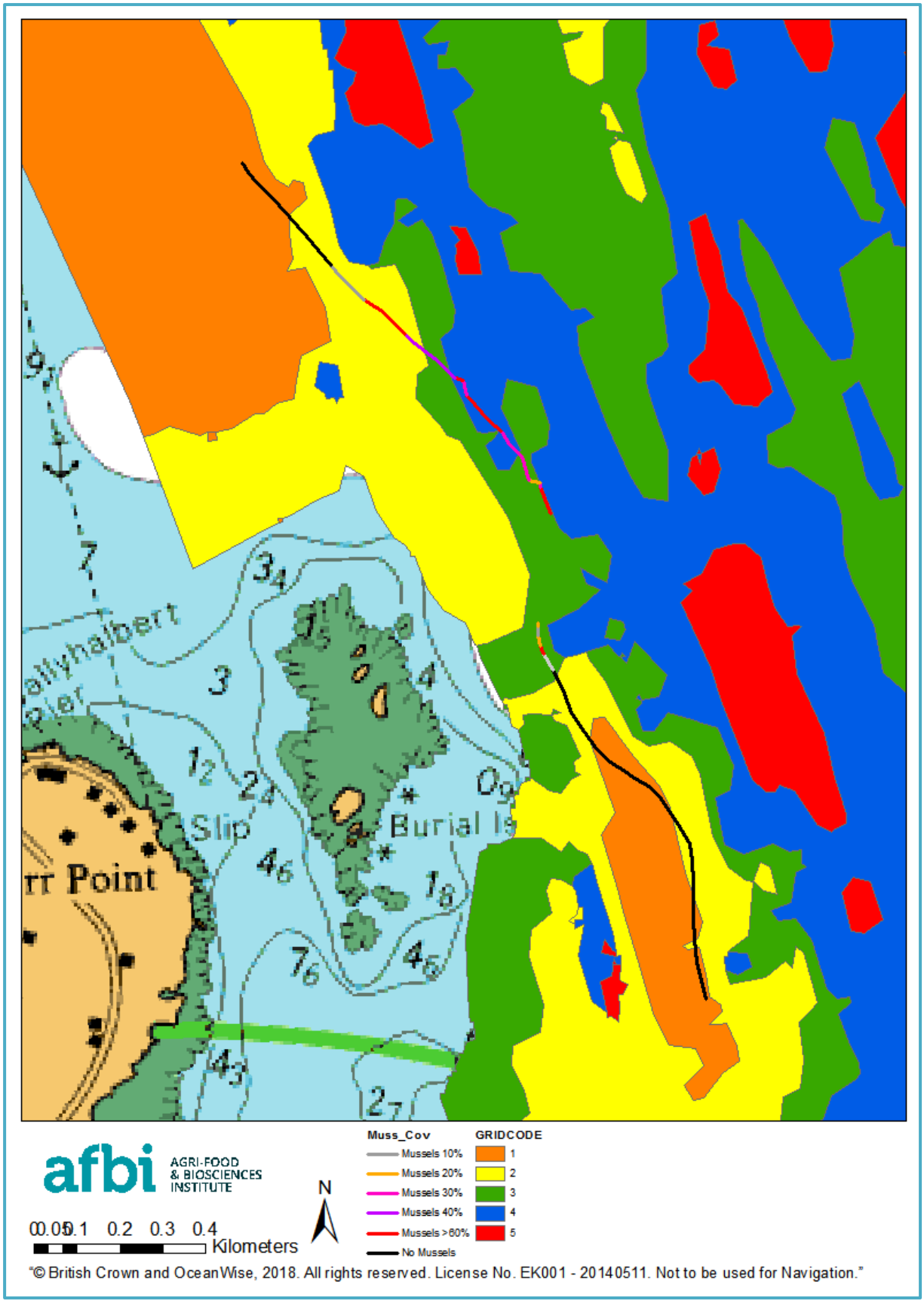


Figure 19: Location of video tows undertaken within the area of Burial Island during the August 2019 seed mussel survey showing coverage of mussels.

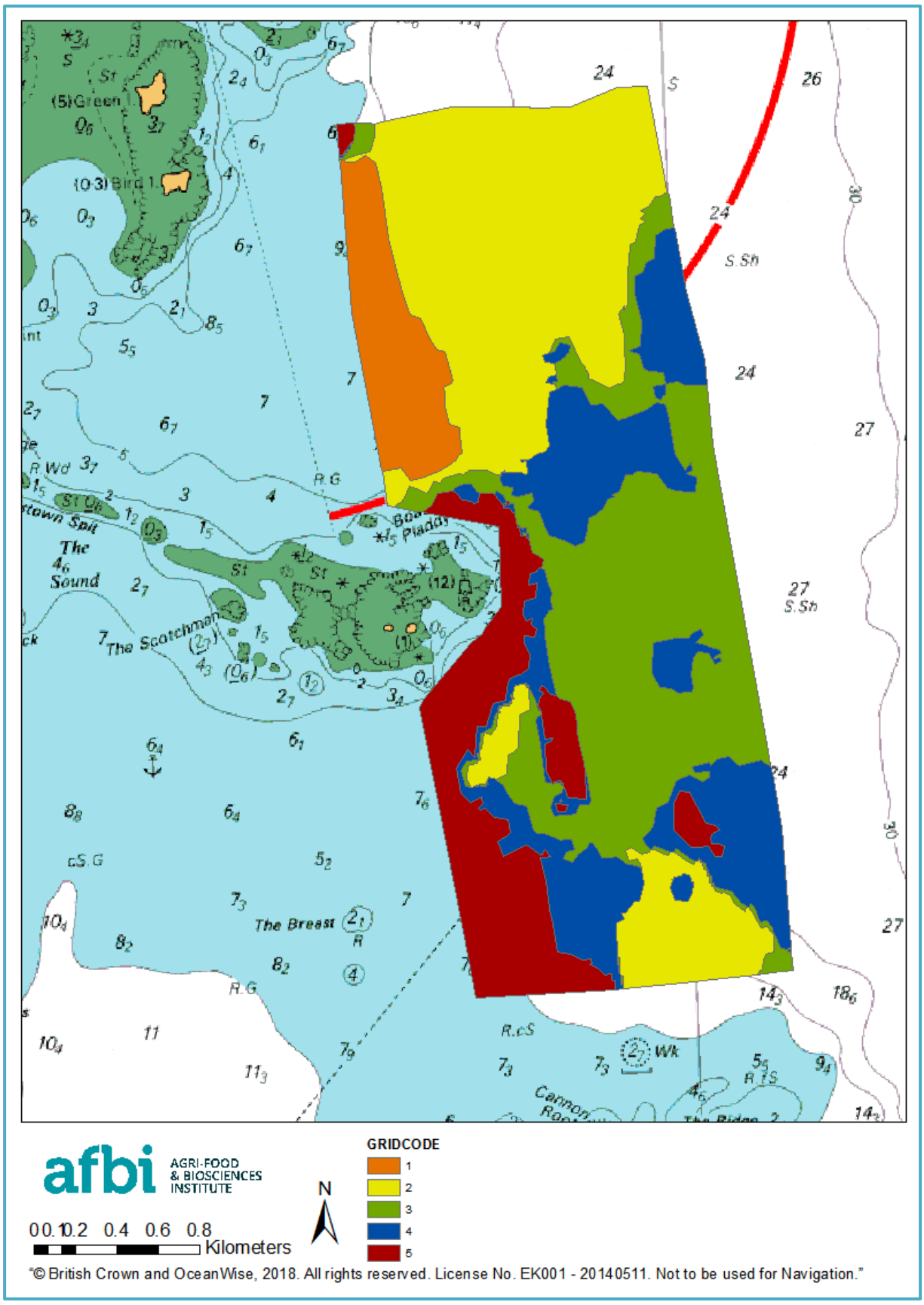


Figure 20: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of The Feathers.

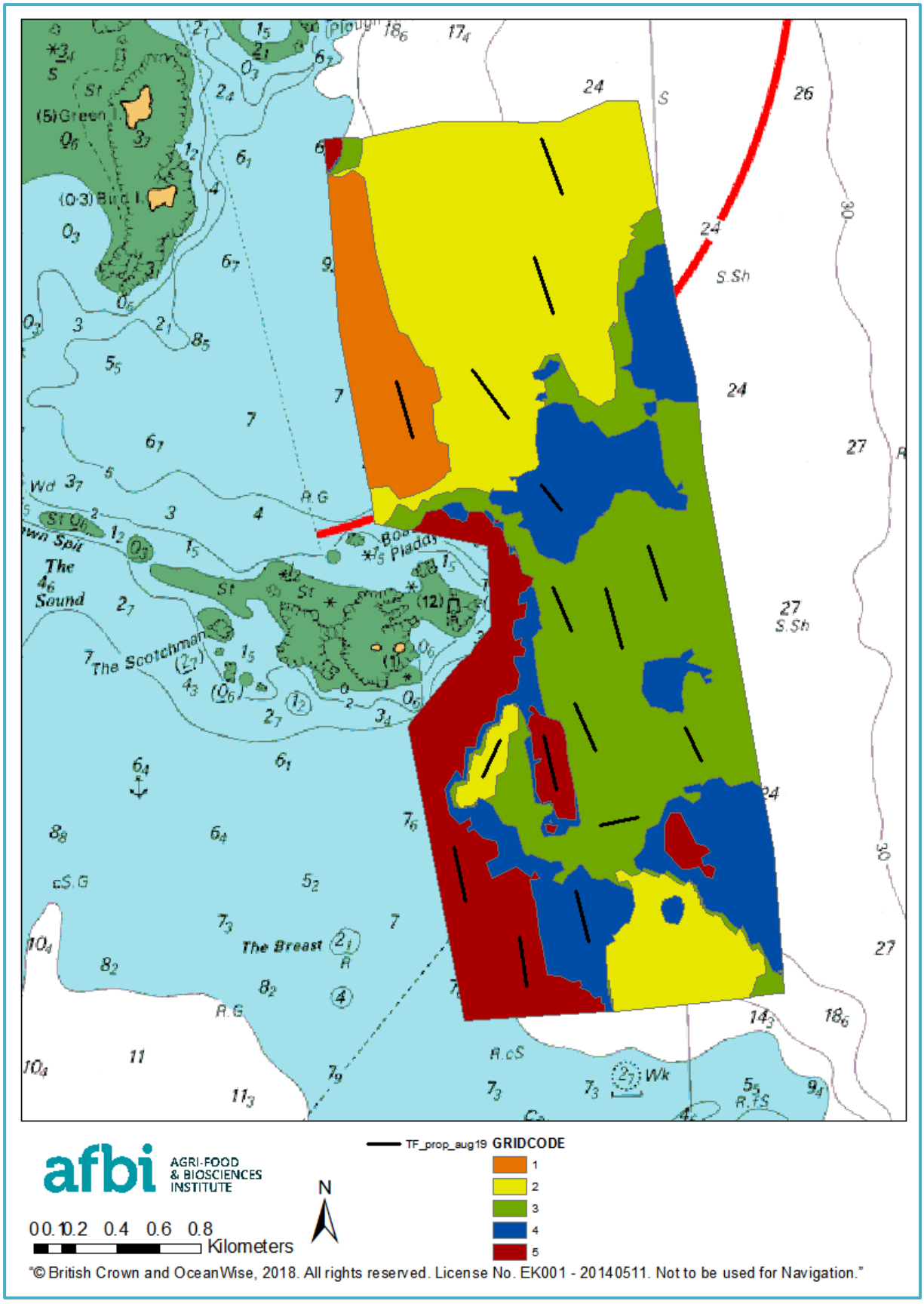


Figure 21: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of The Feathers overlaid with the proposed dredge tows.

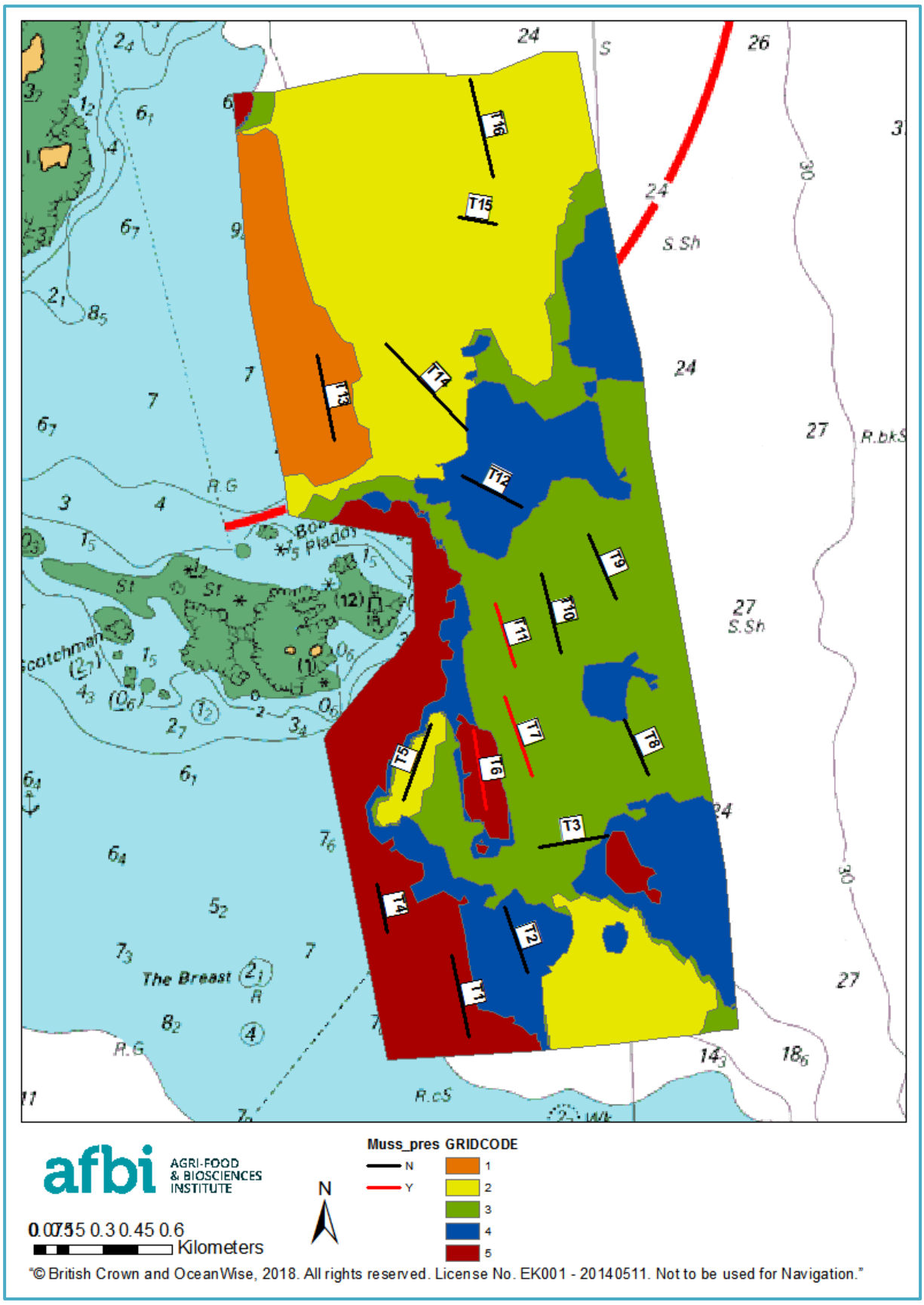


Figure 22: RoxAnn cluster map (from roughness and hardness values) from the July 2019 survey of The Feathers overlaid with the dredge tows undertaken on the 20th of August 2019. Dredges within which mussels were found are coloured red.

Figure 23: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of The Feathers during the August 2019 seed mussel survey.

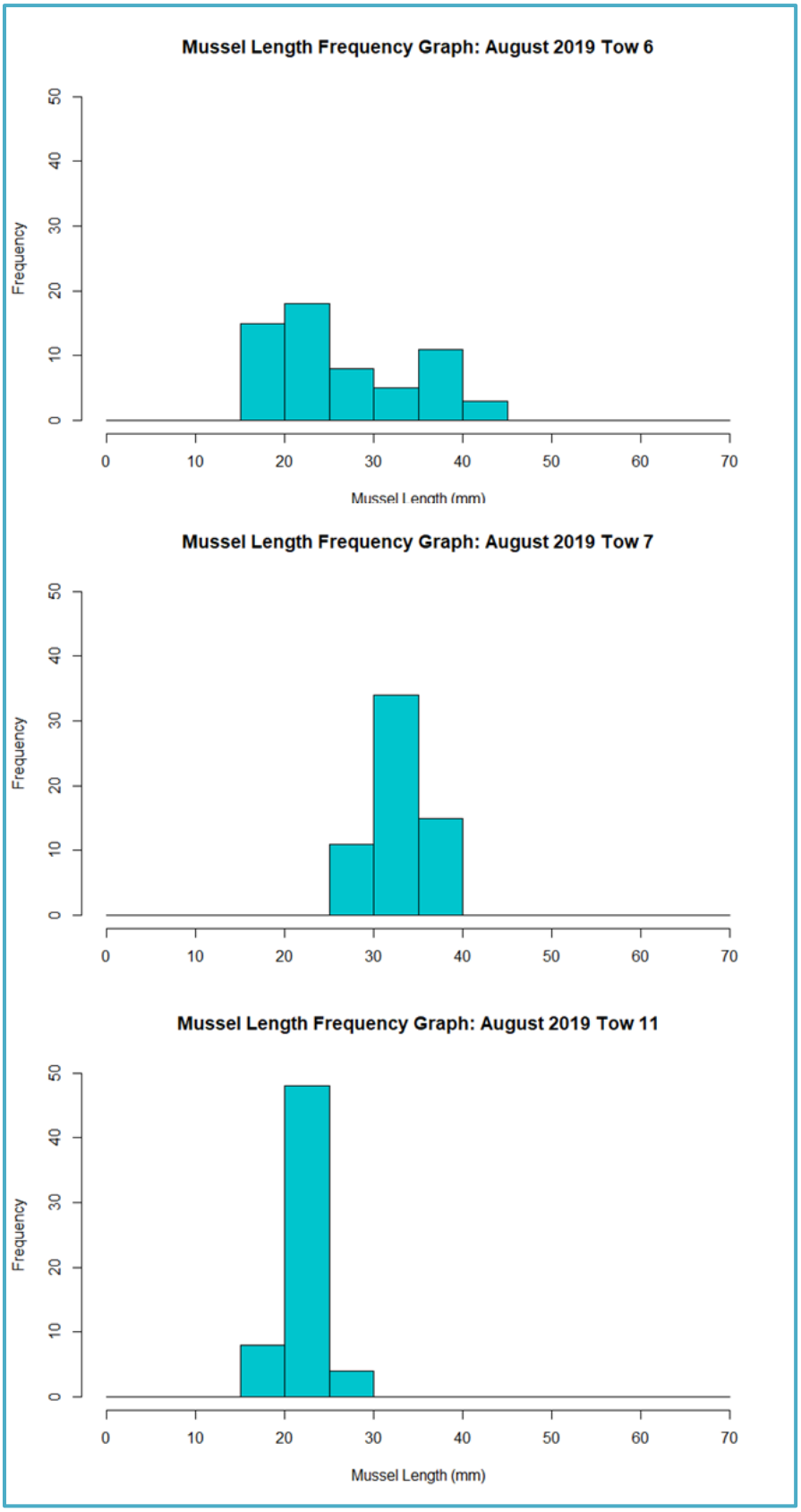


Figure 24: Length class distribution histogram for mussels found within dredge Tows undertaken within the area of The Feathers during the August 2019 seed mussel survey

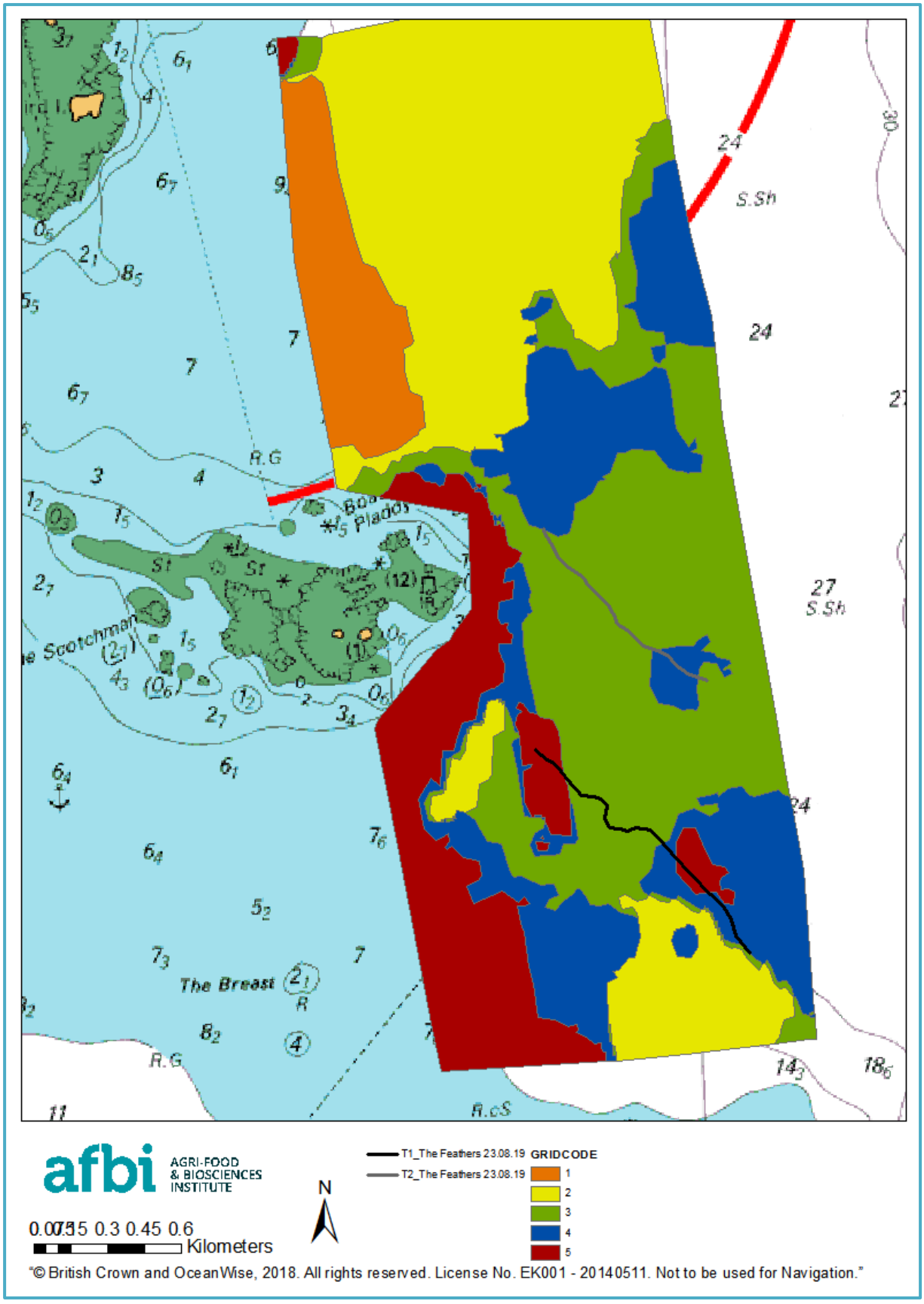


Figure 25: Location of video tows undertaken within the area of The Feathers during the August 2019 seed mussel survey.

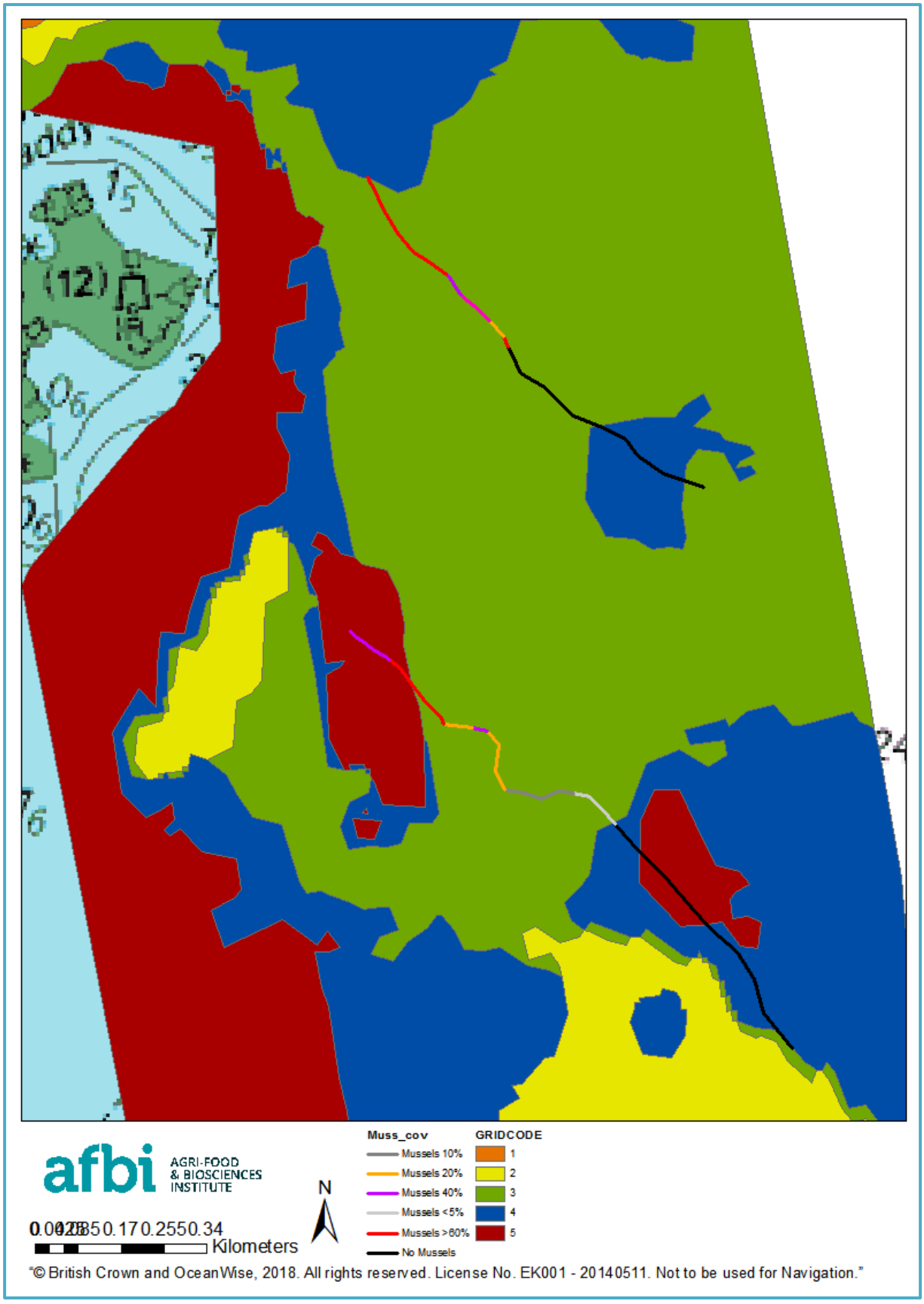


Figure 26: Location of video tows undertaken within the area of The Feathers during the August 2019 seed mussel survey showing coverage of mussels.

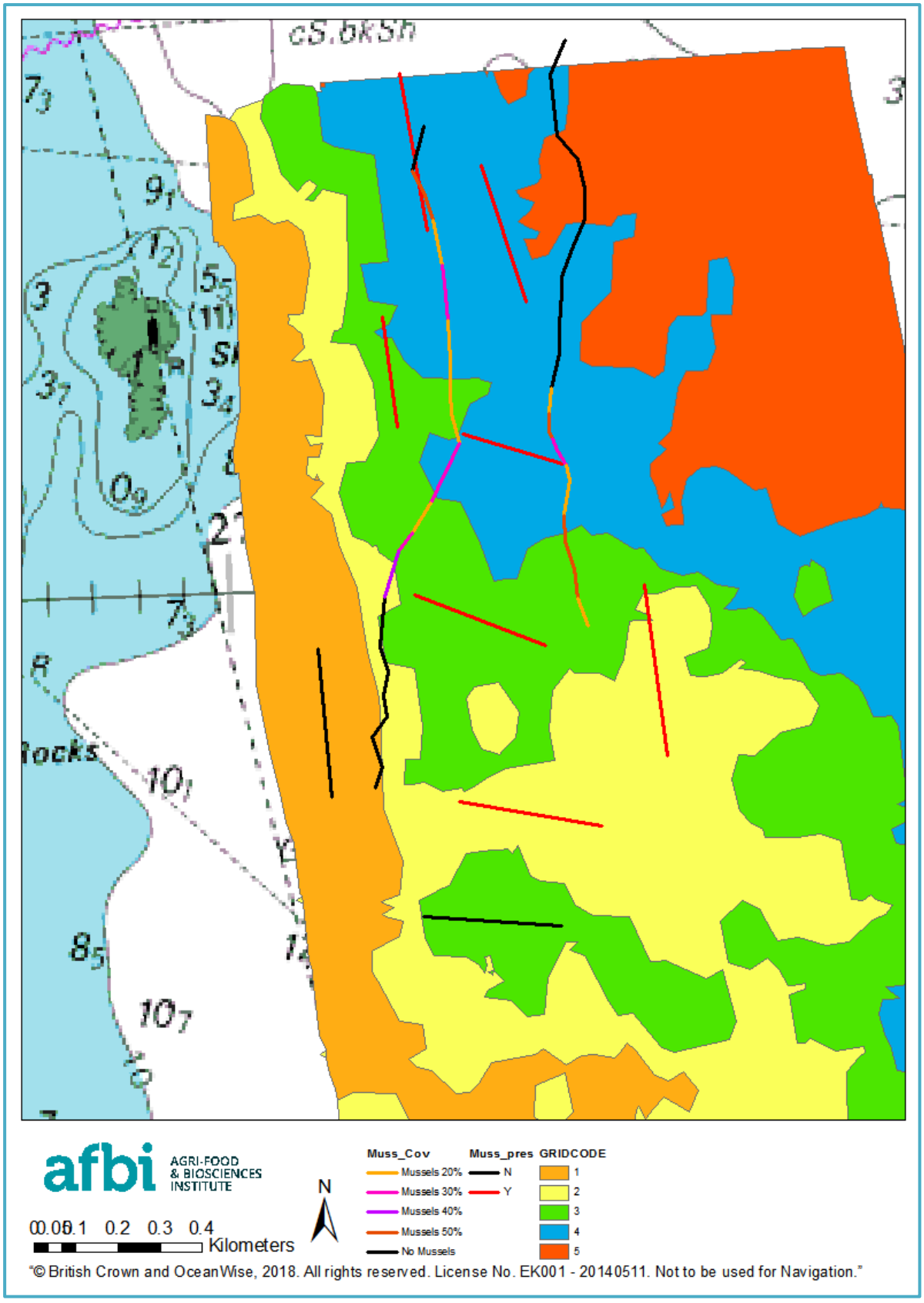


Figure 27: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Skullmartin, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

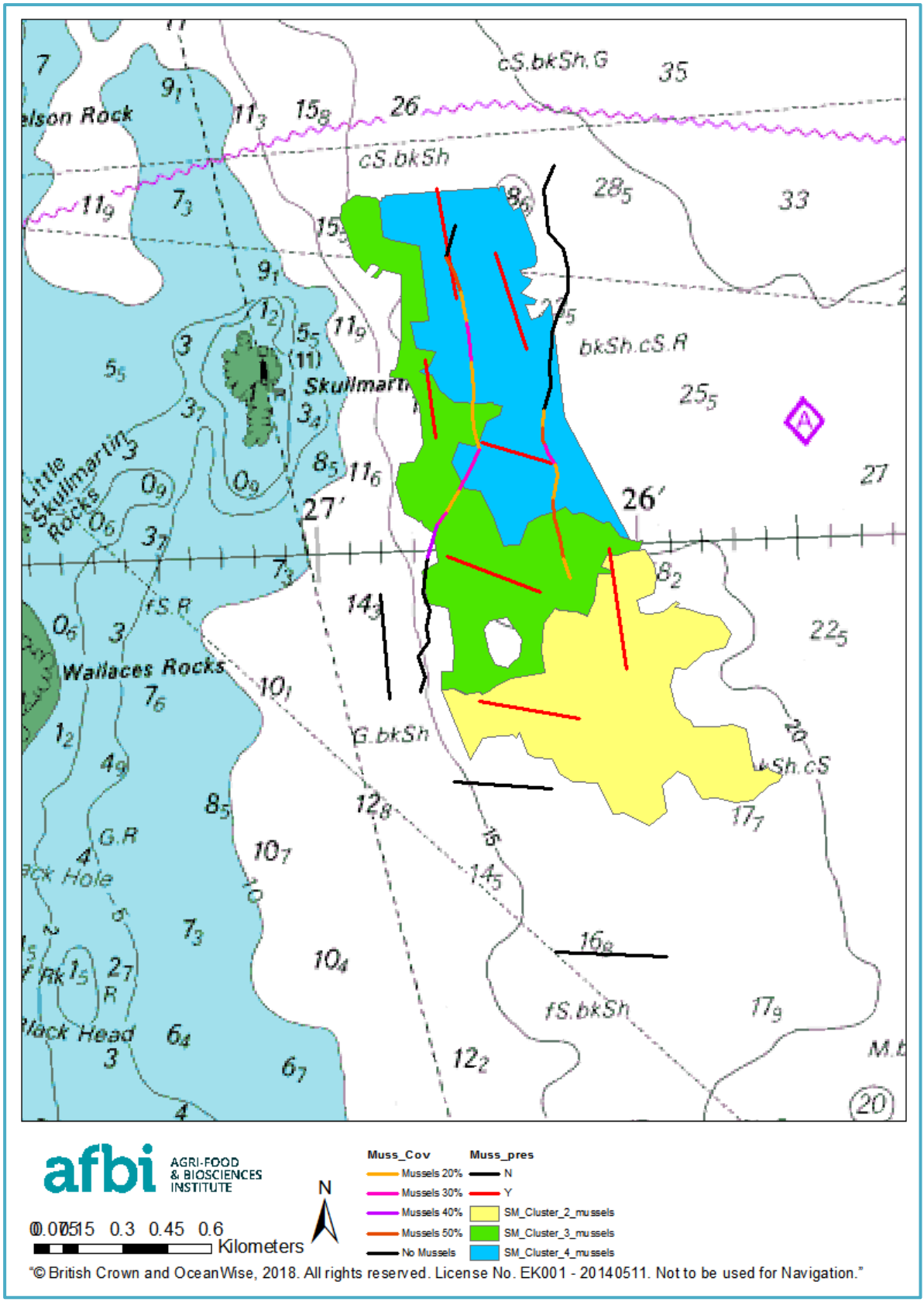


Figure 28: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Skullmartin showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

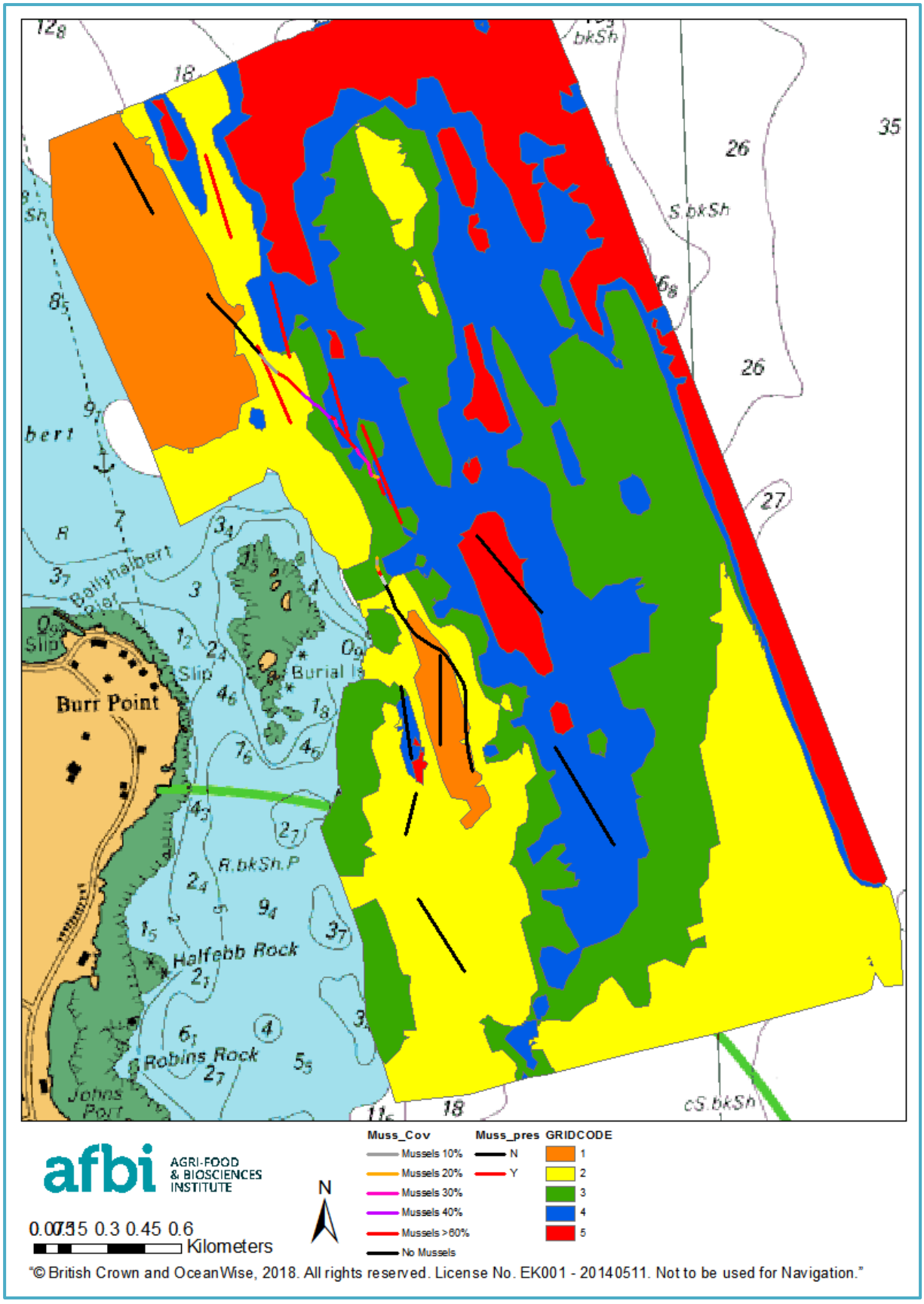


Figure 29: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Burial Island, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

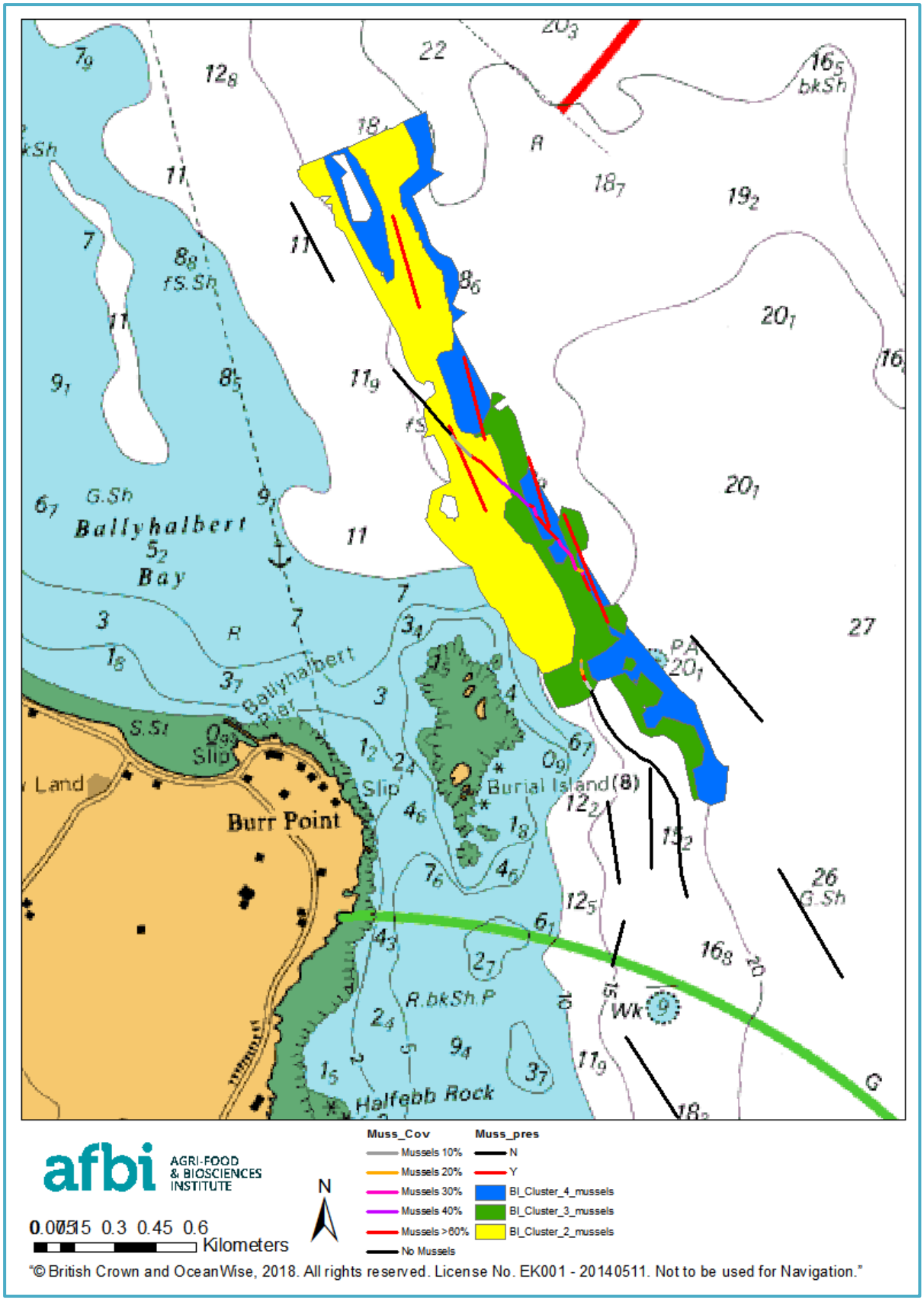


Figure 30: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Burial Island showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

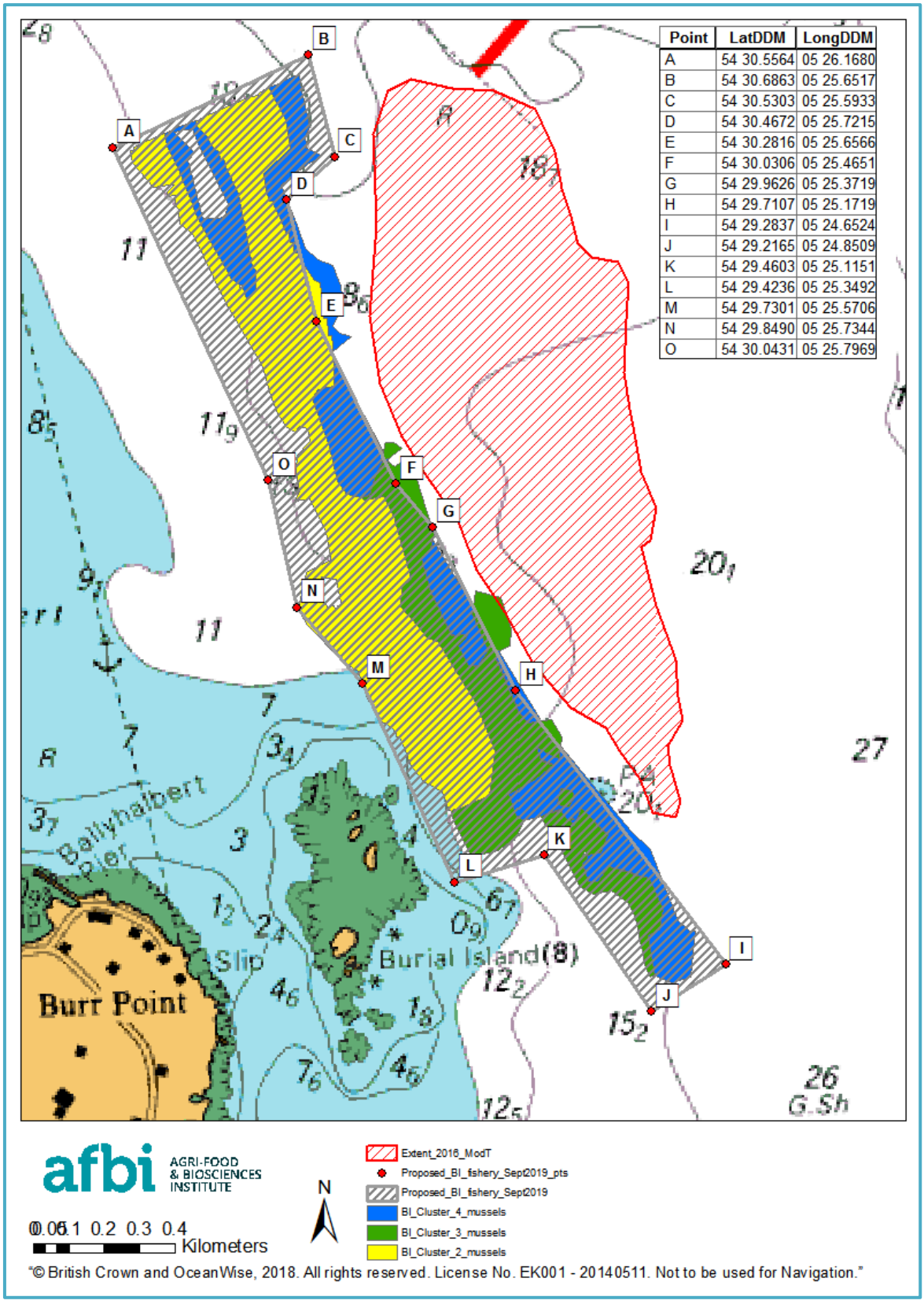


Figure 31: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of Burial Island, highlighting the area of Cluster 4 (blue area on map), Cluster 3 (green area on map) and Cluster 2 (yellow area on map) that represents seed mussel. The proposed fishery area is shown by the grey hashed area on the map. The red hashed area indicates the area previously identified as *M. modiolus* bed.

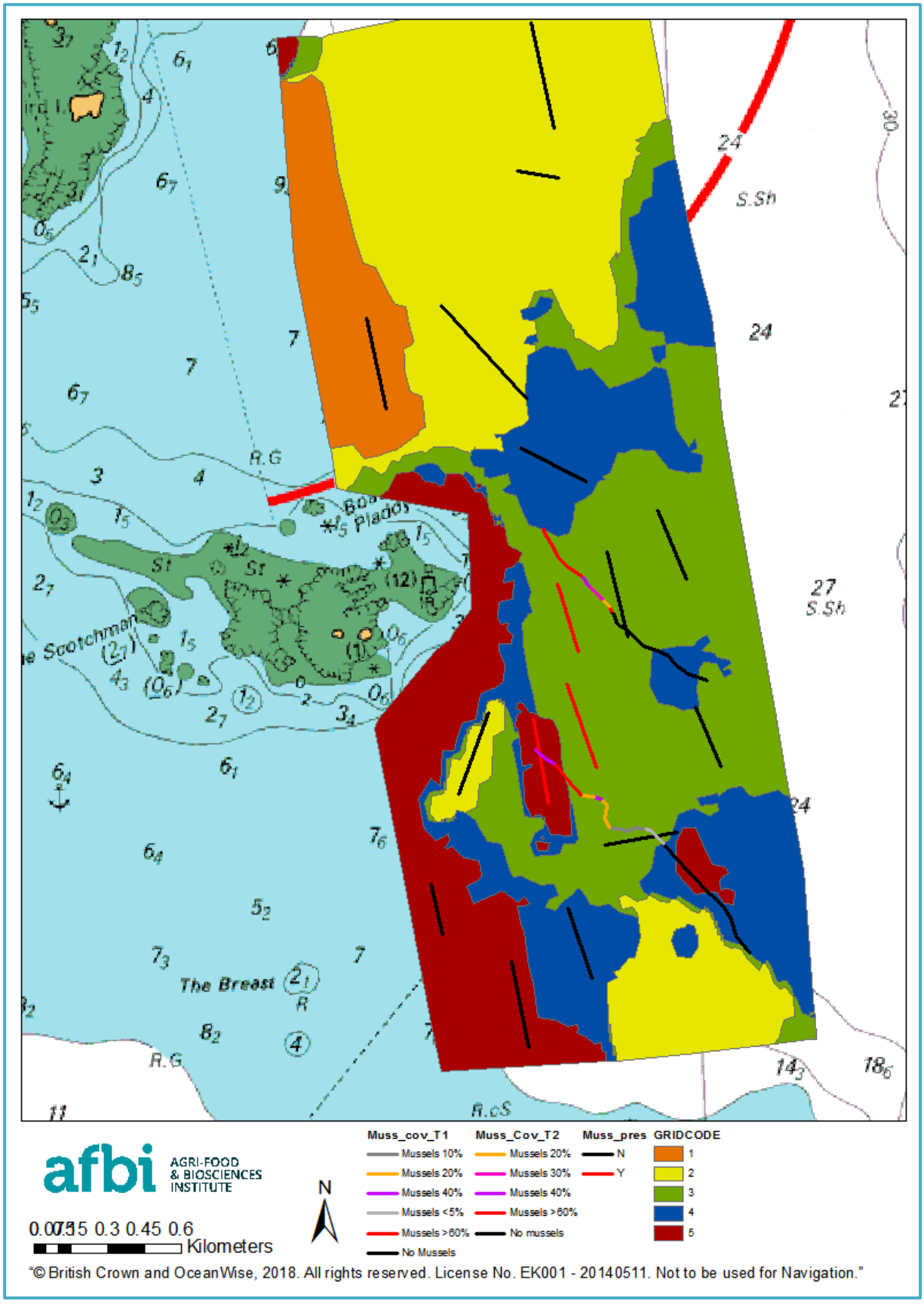


Figure 32: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of The Feathers, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

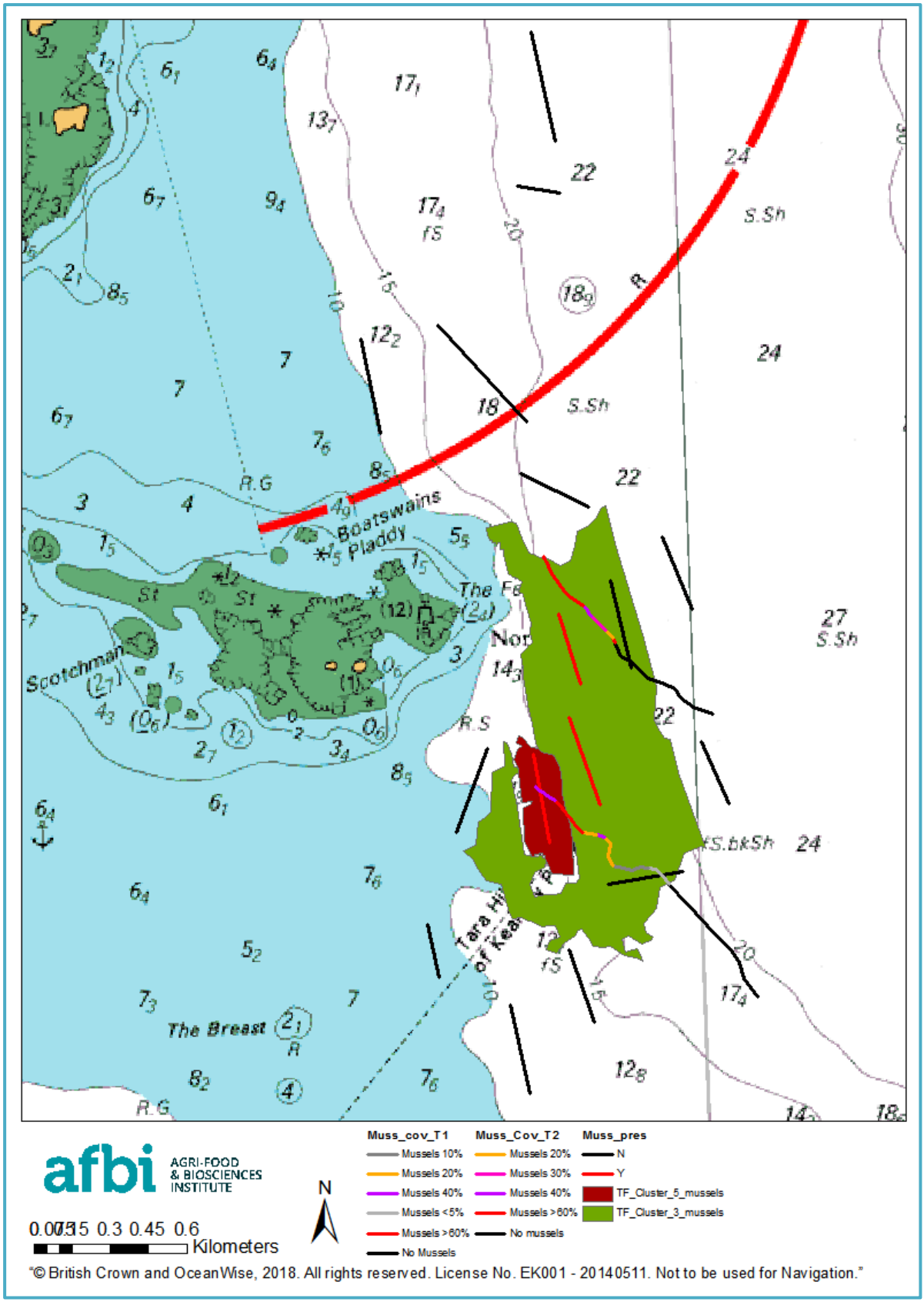


Figure 33: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of The Feathers showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 20th of August and the video tows undertaken on the 23rd of August 2019.

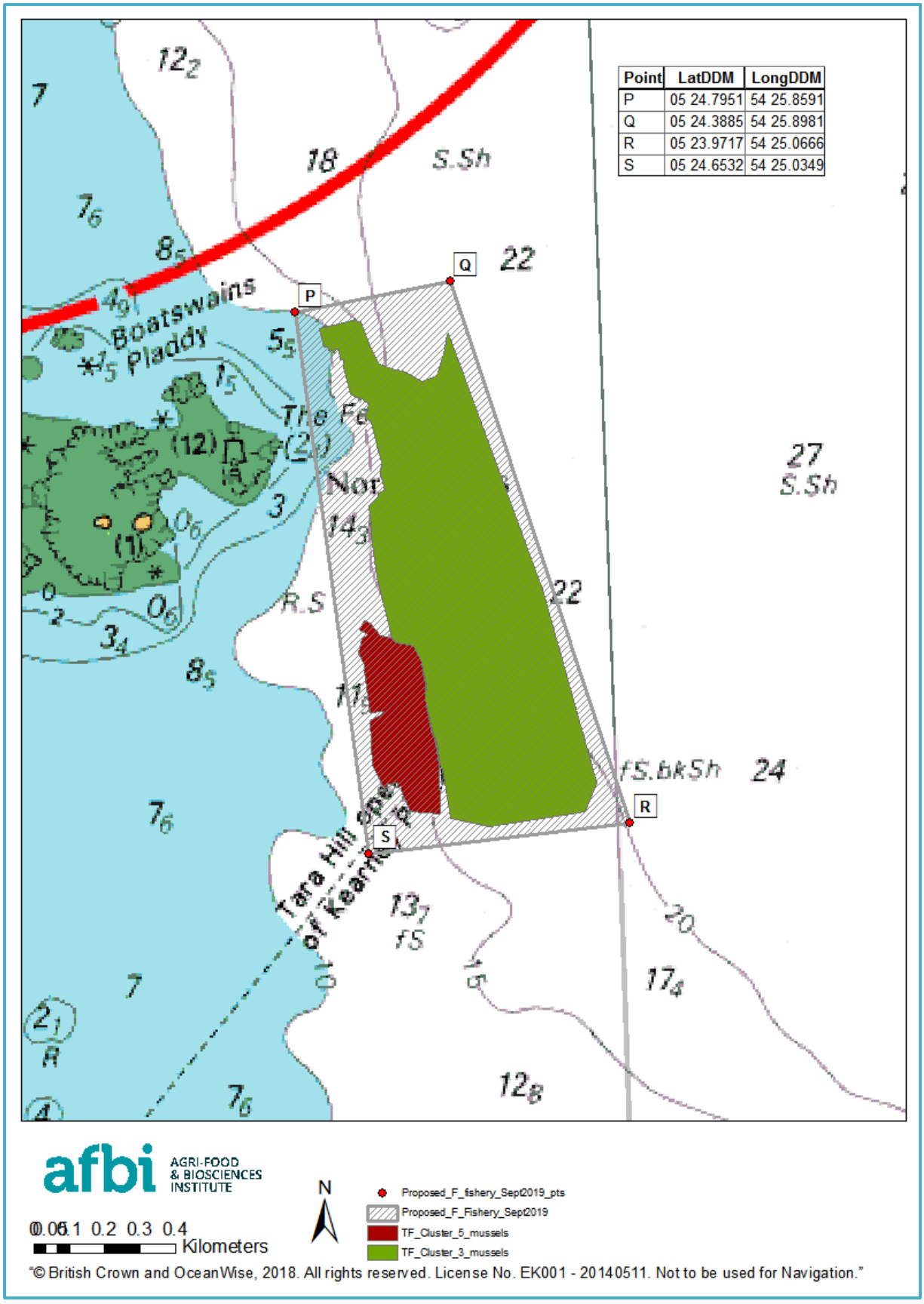


Figure 34: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2019 survey of The Feathers showing only those clusters within which mussels were found. The proposed fishery area is shown by the grey hashed area on the map.

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