Outer Ards Seed mussel Stock Assessment survey

Summer 2018

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Completed by: A. Boyd, H. Cromie, E. O'Kane, R. O'Loughlin

Date/initials: AB 30/8/18

Approved by: M. Service

Date/initials: MS 30/8/18

Further information

Agri-Food and Biosciences Institute (AFBI)

Fisheries & Aquatic Ecosystems Branch

Coastal Zone Science Group

Newforge Lane

Belfast

BT9 5PX

Tel: 028-90255472

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with the dredges undertaken on the 25th of July and the video tows undertaken on the 5th of July 2018. All red lines on the above map indicate the presence of seed mussels. **58**

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Executive summary

The Summer 2018 seed mussel survey was undertaken by AFBI on several occasions between the 22nd of May and the 25th of July 2018. Two areas were investigated at this time, namely Burial Island and The Feathers. Surveys within these areas included:

- RoxAnn acoustic surveys,
- Dredge surveys,
- Towed epibenthic dredge 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 2018 seed mussel stock assessment surveys were undertaken by AFBI on the 22nd and 26th of May 2018 and the 23rd and 25th of July 2018 onboard the DAERA Fisheries Protection Vessel (FPV) Queen of Ulster and on the 5th of July 2018 onboard the AFBI Research Vessel (RV) Corystes. The purpose of these surveys was to undertake acoustic and dredge surveys within the areas of Burial Island and the Feathers which had been identified as seed mussel beds in 2017 and subsequently fished.

During the first part of the surveys, undertaken in May 2018, a seed mussel bed was identified at Burial Island. Whilst no seed mussels were found within the dredge survey of The Feathers undertaken in May 2018, small seed mussels were observed during the video tows undertaken in July 2018. AFBI were advised by DAERA that the first suitable seed fishing tides towards the end of 2018 (as identified by the BGMCF) were within the first few weeks of September 2018. This therefore meant that there would be several months between the May RoxAnn survey and the potential first opening of any identified seed mussel beds. Bearing this in mind, along with the presence of previously unseen mussels within the video Tows undertaken within the area of the Feathers, it was decided to undertake further RoxAnn and dredge surveys.

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

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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 <u>approximately</u> **450** tonnes of seed mussel and The Feathers Seed Fishery Area, as shown within Figure 34 (and map 2 below), contains <u>approximately</u> **200** 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. **Very small seed mussels (10-20 mm) were found within both seed beds. The dredge samples were collected on the 25th of July. As the first suitable fishing tide is in September these small mussels will have increased in size/biomass between the time of survey and the opening of the fishery. A more accurate estimate of the total tonnage on the site will not be able to be made until the fishery opens.**

2. **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. Small mussels were present within both beds. The overall biomass of these mussels is 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 bed may have been overestimated, which will in turn reduce the tonnage of mussels produced by the calculation.**

3. **There was no evidence of newly settled seed mussel during the May dredge surveys. This could indicate that the dredge used may not be efficient in fishing for very small seed mussel, which would result in an underestimation of the tonnage of seed mussel on the beds.**

Points	Lat DDM	Long DDM
BI_A	54 30.3476	05 25.7031
BI_B	54 30.2154	05 25.6061
BI_C	54 30.0306	05 25.4651
BI_D	54 29.9605	05 25.3691
BI_E	54 29.7143	05 25.1766
BI_F	54 29.4927	05 24.8882
BI_G	54 29.2776	05 24.7205
BI_H	54 29.2185	05 24.8593
BI_I	54 29.3646	05 24.9568
BI_J	54 29.4496	05 25.0992
BI_K	54 29.4309	05 25.1430
BI_L	54 29.3810	05 25.1147
BI_M	54 29.3104	05 25.2642
BI_N	54 30.3135	05 25.9486

Descript
- AFBI 80m buffer
- AFBI mod/seed boundary
- Proposed BI_fishery_2018_pts
- Proposed BI_fishery_2018
- BI_Iso_6_Cluster_4_mussels
- BI_Iso_6_Cluster_2_mussels

Map 1: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of Burial Island, highlighting the area of Cluster 4 (light blue area on map) and Cluster 2 (dark blue area on map) that represents seed mussel. The proposed fishery area is shown by the grey hashed area on the map. The pink line indicates the 80 m buffer which has previously been applied to safeguard the *M. modiolus* bed.

Point	Lat DDM	Long DDM
F_A	54 25.6150	05 24.7287
F_B	54 25.6199	05 24.2047
F_C	54 24.9851	05 24.0178
F_D	54 24.9700	05 24.7296

0.00 75 0.15 0.225 0.3 Kilometers

● Proposed_Feathers_fishery_2018_pts
▨ Proposed_Feathers_fishery_2018
▮ Feathers_Iso_5_Cluster_5_mussels
▮ Feathers_Iso_5_Cluster_3_mussels

Map 2: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of The Feathers, highlighting the area of Cluster 5 (pink area on map) and Cluster 3 orange area on map) that represents seed mussel. The proposed fishery area is shown by the black hashed area on the map.

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1. <u>Introduction</u>

The Summer 2018 seed mussel stock assessment survey was undertaken by the Agri-Food and Biosciences Institute (AFBI) on the 22nd and 26th of May 2018 and the 23rd and 25th of July 2018 onboard the DAERA Fisheries Protection Vessel (FPV) Queen of Ulster and on the 5th of July 2018 onboard the AFBI Research Vessel (RV) Corystes. 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 2018 seed mussel stock assessment survey was to undertake acoustic and dredge surveys within the areas of Burial Island and the Feathers which had been identified as seed mussel beds in 2017 and subsequently fished.

During the first part of the surveys, undertaken in May 2018, a seed mussel bed was identified at Burial Island. Whilst no seed mussels were found within the dredge survey of The Feathers undertaken in May 2018, small seed mussels were observed during the video tows undertaken in July 2018. AFBI were advised by DAERA that the first suitable seed fishing tides towards the end of 2018 (as identified by the BGMCF) were within the first few weeks of September 2018. This therefore meant that there would be several months between the May RoxAnn survey and the potential first opening of any identified seed mussel bed(s). Bearing this in mind, along with the presence of previously unseen mussels within the video Tows undertaken within the area of the Feathers, it was decided that in order to accurately ascertain the boundaries and tonnages of seed mussels present within the areas of Burial Island and The Feathers further RoxAnn and dredge surveys needed to be undertaken. As described above, these were completed at the end of July 2018.

The areas covered within the Summer 2018 surveys 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 22nd of May 2018, using a 200 kHz transducer. This survey was repeated on the 23rd of July 2018 to ascertain if the very small seed mussels (<5 mm) that were observed during the May dredge surveys had grown and caused the expansion of previously identified seed beds. During both surveys data were collected at a save rate of 1s. Track spacing was approximately 100 m for both areas investigated.

The following data processing was completed for all 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 26th of May and the 25th of July 2018, with two AFBI staff members onboard collecting samples and directing sampling effort on both occasions.

On both occasions dredging was conducted using a custom oyster dredge measuring approximately 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 AFBI RV Corystes on the 5th of July 2018. Camera footage of the seabed was collected with a towed epibenthic video sledge equipped with a Konsberg video camera, coupled with halogen lights and point lasers for scaling (Figure 3). The ship's navigation system was used for positioning. 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 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

Burial Island

May 2018 Surveys

The processed RoxAnn cluster map for Burial Island for the May 2018 survey 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 24th of May 2018 within the area of Burial Island known to have previously yielded seed mussels (Figure 6). Mussels (accounting for greater than 10% of dredge contents) were found within four of these tows (Figures 6, 7 and 8), and Tables 1 - 3). As can be seen within Figure 6, mussels were confined to the dredges undertaken within RoxAnn Cluster 3 (light blue cluster in Figure 6) and Cluster 2 (green cluster in Figure 6).

The summary results from the mussel sample processing for the dredge tow undertaken within the area of Burial Island that yielded mussels are shown in Tables 2 and 3 and the size class distribution of mussels are shown within Figure 8. As can be seen from Figure 8 within Tows 21, 23 and 24 the most frequently observed size class of mussels was between 40 – 45 mm, whilst in Tow 22 the most frequently observed size class was 35 – 40 mm. As can be seen from Table 2 the percentage waste (by weight) contained within the samples was lower in Tows 21 and 22 (with observed wastes of 32.77% and 24.96% respectively) than in Tows 23 and 24 which had observed percentage wastes of 50.69% and 50.81% respectively.

Towed Video Survey

The video survey for this area was planned based on the findings of the RoxAnn and dredge surveys carried out in May 2018. Three video tows were proposed within this area as shown in Figure 9. Due to the presence of static fishing gear in the area only one video tow was able to be successfully executed (Figure 10). Figure 11 show the habitats identified along this tow. Percentage cover of blue mussels (*Mytilus edulis*) was determined as per Turner *et al.* 2016 (Figure 12).

July 2018 Surveys

The processed RoxAnn cluster map for Burial Island for the July 2018 survey is shown in Figure 13. As can be seen from Figure 13, six distinct clusters were identified for this area. The

dredge survey was then planned to provide representative sampling of the clusters in the area where mussels were found during the May surveys (Figure 14).

Eight dredge tows were undertaken on the 25th of July 2018 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 seven of these tows (Figures 15, 16 and 17, and Tables 4 - 6). As can be seen within Figure 15, mussels were confined to the dredges undertaken within RoxAnn Cluster 4 (light blue cluster in Figure 15) and Cluster 2 (dark blue cluster in Figure 15).

The summary results from the mussel sample processing for the dredge tows undertaken within the area of Burial Island that yielded mussels are shown in Tables 5 and 6 and the size class distribution of mussels are shown within Figure 17. Several of the Tows yielded two distinct size classes of mussels. In these instances, 60 mussels from each size class were selected for measurement. As can be seen from Figure 17 four of the six dredge tows from which samples were taken contained two size classes of mussels, one within mussels ranging from 10 mm to 20 mm and one with mussels ranging from 40 mm to 60 mm.

The Feathers
May 2018 Surveys

The processed RoxAnn cluster map for The Feathers for the May 2018 survey is shown in Figure 18. As can be seen from Figure 18, 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 19).

Fifteen dredge tows were undertaken on the 24th of May 2018 within the area of The Feathers known to have previously yielded seed mussels (Figure 20). Mussels (accounting for greater than 10% of dredge contents) were not found within any of these tows (Table 1). However it should be noted that weather conditions were such at the time of survey that the dredge may not have been fishing efficiently.

Towed Video Survey

The video survey for this area was planned based on the findings of the RoxAnn and dredge surveys carried out in May 2018. Three video tows were proposed within this area as shown in Figure 21. Due to the presence of static fishing gear in the area only two video tows were able to be successfully executed (Figure 22). Figure 23 show the habitats identified along this

tow. Percentage cover of blue mussels (*Mytilus edulis*) was determined as per Turner *et al.* 2016 (Figure 12).

July 2018 Surveys

The processed RoxAnn cluster map for The Feathers for the July 2018 survey is shown in Figure 24. As can be seen from Figure 24, five distinct clusters were identified for this area. The dredge survey was then planned to provide representative sampling of the clusters in the area where mussels were found during the towed video survey (Figure 25).

Ten dredge tows were undertaken on the 25th of July 2018 within the area of The Feathers known to have previously yielded seed mussels (Figure 26). Mussels (accounting for greater than 10% of dredge contents) were found within five of these tows (Figures 26, 27 and 28, and Tables 4, 7 and 8). As can be seen within Figure 26, mussels were confined to the dredges undertaken within RoxAnn Cluster 3 (orange cluster in Figure 26) and Cluster 5 (pink cluster in Figure 26).

The summary results from the mussel sample processing for the dredge tows undertaken within the area of The Feathers that yielded mussels are shown in Tables 7 and 8 and the size class distribution of mussels are shown within Figure 28. One of the Tows undertaken within the area of The Feathers yielded two distinct size classes of mussels. In this instance, 60 mussels from each size class were selected for measurement. As can be seen from Figure 28 the majority of the seed mussels found in this area were within the 10 mm to 20 mm size class.

4. **Discussion**

Burial Island

Following acoustic and ground truthing surveys (dredge and towed video) undertaken between May and July 2018 an area of seed mussels was identified within the area of Burial Island (Figure 29). The area identified as Cluster 4 was found to correspond to seed mussel and a proportion of the area identified as Cluster 2 was also found to contain seed mussel (Figure 30). It is believed that Cluster 4 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 2 does not contain blue mussels but the horse mussel *Modiolus modiolus*. Mussel tonnages were calculated for the area of Clusters 2 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 (pink line in Figure 31) applied since the 2015 Seed mussel stock Assessments to allow protection of the adjacent *Modiolus modiolus* beds.

During the video survey an area of sand eel habitat was also identified (the southern portion of Cluster 1, Figure 29). Therefore the seed mussel fishery area has been drawn so as to avoid this habitat.

From all the information collected during the Summer 2018 (May to July) surveys (utilising the calculations, as per Strong and Service, 2011) we can therefore approximate that the Burial Island Seed Fishery Area, as shown within Figure 31, contains approximately **450 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.**

The approximate tonnage stated above comes with the following caveats;

4. **Two distinct size classes of seed mussel were found within this bed (highlighting two separate settlements). Average values, in relation to mussel biomass etc, were utilised when undertaking the calculation of tonnage on the bed. The dredge samples were collected on the 25th of July, as the first suitable fishing tide is in September the small mussels will have increased in size/biomass between the time of survey and the opening of the fishery. A more accurate estimate of the total tonnage on the site will not be able to be made until the fishery opens.**

5. **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. As average values were used the more recently settled mussels (within the small size class) whose biomass was small in relation to the sample waste, i.e. everything that wasn't mussels, (predominately pebbles and cobbles) will have reduced the proportion of mussels (by weight) within the collected sample. Therefore the waste on the bed may have been overestimated, which will in turn reduce the tonnage of mussels produced by the calculation.**

6. **There was no evidence of newly settled seed mussel at this site during the May dredge survey. This could indicate that the dredge used may not be efficient in fishing for very small seed mussel, which would result in an underestimation of the tonnage of seed mussel on the bed.**

The Feathers

Following acoustic and ground truthing surveys (dredge and towed video) undertaken between May and July 2018 an area of seed mussels was identified within the area known as The Feathers (Figure 32). The area identified as Cluster 3 was found to correspond to seed mussel and a proportion of the area identified as Cluster 5 was also found to contain seed mussel (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 2018 (May to July) 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 <u>approximately</u> 200 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.

The approximate tonnage stated above comes with the following caveats;

1. **The seed mussel found within this bed was very small (primarily within the 10 – 20 mm size class). The dredge samples were collected on the 25th of July. As the first suitable fishing tide is in September these small mussels will have increased in size/biomass between the time of survey and the opening of the fishery. A more accurate estimate of the total tonnage on the site will not be able to be made until the fishery opens.**

2. **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. As the mussels within this bed were very small their overall biomass was small in relation to the sample waste, i.e. everything that wasn't mussels, (predominately pebbles and cobbles). Therefore the waste on the bed may have been overestimated, which will in turn reduce the tonnage of mussels produced by the calculation.**

3. **There was no evidence of seed mussel at this site during the May dredge survey. This could indicate that the dredge used may not be efficient in fishing for very small seed mussel, which would result in an underestimation of the tonnage of seed mussel on the bed**

Tables

Table 1: Dredge information from the 24th of May 2018 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: Burial Island and Figure 20: The Feathers).

Tow No.	Date	Location	Depth start	Depth end	Tow Length (m)	Description	Est % fill	Mussel
1	24/05/2018	Feathers	14	14.4	191	Kelp and some urchins	<5%	N
2	24/05/2018	Feathers	14.1	12.8	247	Kelp and a few cobbles	<5%	N
3	24/05/2018	Feathers	14	18.1	236	Kelp	<5%	N
4	24/05/2018	Feathers	22.8	22.9	202	Kelp and dead shell	<5%	N
5	24/05/2018	Feathers	21.8	22.9	211	Kelp	<5%	N
6	24/05/2018	Feathers	19	21.8	231	Kelp and one velvet crab	<5%	N
7	24/05/2018	Feathers	17.2	19	212	Broken shell	<5%	N
8	24/05/2018	Feathers	20.2	20.9	193	Kelp, one cobble	<5%	N
9	24/05/2018	Feathers	24.2	24.8	249	Pebbles and dead shell	<5%	N
10	24/05/2018	Feathers	26.5	26.8	240	Kelp, pebbles, cobbles, dead shell	<5%	N
11	24/05/2018	Feathers	22.7	23.9	239	Cobbles and pebbles	<5%	N
12	24/05/2018	Feathers	25.2	25.2	110	Pebbles and dead shell	<5%	N
13	24/05/2018	Feathers	23.5	22.3	251	Kelp, dead shell	<5%	N
14	24/05/2018	Feathers	19.4	18.8	234	Kelp	<5%	N
15	24/05/2018	Feathers	24.7	23.6	209	Kelp	<5%	N
16	24/05/2018	Burial Island	19.2	19.9	251	Kelp and broken shell	<5%	N
17	24/05/2018	Burial Island	18.5	17.2	167	Kelp, dead and broken shell	5%	N
18	24/05/2018	Burial Island	19.3	18.1	204	Broken shell	<5%	N
19	24/05/2018	Burial Island	22.4	23.3	238	Dead broken shell	30%	N
20	24/05/2018	Burial Island	23.9	23.5	241	Dead Modiolus shell and brittle stars	65%	N
21	24/05/2018	Burial Island	16.9	16.9	57	Mussel	10%	Y
22	24/05/2018	Burial Island	17.8	18.6	190	Mussel	40%	Y
23	24/05/2018	Burial Island	17.9	17.5	224	Kelp and mussel	20%	Y
24	24/05/2018	Burial Island	19	18.7	173	Dead Modiolus shell and mussel	10%	Y
25	24/05/2018	Burial Island	16.1	15	222	Kelp	<5%	N

Table 2: Mussel sample processing summary data: Burial Island 24/05/18

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 21	5.05	3.40	32.77	159.65
Tow 22	10.10	7.58	24.96	160.26
Tow 23	7.85	3.87	50.69	119.44
Tow 24	8.86	4.36	50.81	229.11

Table 3: Mussel length measurement summary data: Burial Island 24/05/18

Tow No.	Mussel length measurements (mm)				
	Median	Mean	SD	min	max
Tow 21	45.61	46.92	8.08	23.73	62.70
Tow 22	41.73	44.84	7.48	36.08	64.34
Tow 23	45.43	46.86	6.72	37.08	63.98
Tow 24	40.86	40.90	4.96	30.23	60.84

SD= Standard Deviation from the mean

Table 4: Dredge information from the 25th of July 2018 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 15: Burial Island and Figure 26: The Feathers).

Tow No.	Date	Location	Depth start	Depth end	Tow Length (m)	Description	Est % fill	Mussel >10%
1	25/07/2018	Feathers	21.8	19.8	225	Cobbles	<5%	N
2	25/07/2018	Feathers	19.5	18.3	205	Seed mussel, cobbles with seed attached.	20%	Y
3	25/07/2018	Feathers	18.3	17.1	268	Seed mussel, two size classes, large number of velvet crabs.	30%	Y
4	25/07/2018	Feathers	16.2	16.8	260	Seed mussel, shell gravel, pebbles, cobbles.	15%	Y
5	25/07/2018	Feathers	17.6	16.2	276	Cobbles, pebbles, seed mussels attached to cobbles and loose.	15%	N
6	25/07/2018	Feathers	18.9	18	287	Cobbles with seed attached, sand and gravel.	1%	N
7	25/07/2018	Feathers	20	18.8	216	Cobbles with attached seed	1%	N
8	25/07/2018	Feathers	19.7	19.3	301	Cobbles and seed mussel, some seed attached to cobbles	10%	Y
9	25/07/2018	Feathers	22.4	22.1	398	Cobbles with some seed attached	<5%	N
10	25/07/2018	Feathers	22.5	20.3	346	Cobbles with mussel attached and loose seed.	10%	Y
11	25/07/2018	Burial Island	18.4	16.9	119	Cobbles	10%	N
12	25/07/2018	Burial Island	16.6	15.9	143	Mussel	20%	Y
13	25/07/2018	Burial Island	15.3	13.8	123	Mussel	1%	Y
14	25/07/2018	Burial Island	16.4	15.4	45	Mussel (old) with some seed	<1%	Y
15	25/07/2018	Burial Island	22.3	25.5	192	Sand/gravel, mussel seed	30%	Y
16	25/07/2018	Burial Island	24.6	21.6	340	Mussel, mainly two size classes, some old.	50%	Y
17	25/07/2018	Burial Island	20.7	22.2	440	Mussel	70%	Y
18	25/07/2018	Burial Island	21.5	21.2		Failed dredge	0%	N
19	25/07/2018	Burial Island	21.7	20.6	308	Pebbles and gravel, shell, seed mussel	30%	Y

Table 5: Mussel sample processing summary data: Burial Island 25/07/18

Tow No.	Total sample weight (kg)	Shellfish weight (kg)	% Waste by weight	Pieces per kilo
Tow 12*	8.98	3.85	55.90	294
Tow 14	1.35	1.00	28.14	236
Tow 15	15.28	4.036	73.586	204
Tow 16*	11.76	7.632	35.102	510
Tow 17*	9.39	7.143	23.93	451
Tow 19	10.525	0.468	95.554	7790

*Two size classes were present but results are shown for the sample as a whole.

Table 6: Mussel length measurement summary data: Burial Island 25/07/18

Tow No.	Mussel length measurements				
	Median	Mean	SD	min	max
Tow 12*	28.35	29.74	16.16	9.43	54.84
Tow 14	14.24	27.74	21.69	8.45	64.93
Tow 15	44.66	44.50	4.71	35.04	54.69
Tow 16*	37.14	34.04	13.47	12.12	62.07
Tow 17*	28.34	34.11	16.78	13.61	65.62
Tow 19	15.54	15.50	1.89	11.68	19.93

*Two size classes were present but results are shown for the sample as a whole.

SD= Standard Deviation from the mean

Table 7: Mussel sample processing summary data: The Feathers 25/07/18

Feathers	Total sample weight (kg)	Shellfish weight (kg)	% Waste by weight	Pieces per kilo
Tow 2	13.78	4.85	64.79	4146
Tow 3*	12.86	7.38	42.60	1325
Tow 4	11.87	0.80	93.28	4561
Tow 6	4.38	0.11	97.59	6361
Tow 8	11.32	3.83	66.19	4131
Tow 10	7.48	1.28	82.88	4418

*Two size classes were present but results are shown for the sample as a whole.

Table 8: Mussel length measurement summary data: The Feathers 25/07/18

Tow No.	Mussel length measurements				
	Median	**Mean**	**SD**	**min**	**max**
Tow 2	16.07	15.93	2.35	9.77	20.13
Tow 3*	31.16	32.82	16.35	12.12	56.99
Tow 4	14.76	14.71	2.30	9.87	19.72
Tow 6	14.26	14.32	1.69	9.90	18.82
Tow 8	16.19	15.68	2.16	9.75	20.16
Tow 10	15.95	15.86	1.97	11.23	19.23

*Two size classes were present but results are shown for the sample as a whole.

SD= Standard Deviation from the mean

Figures
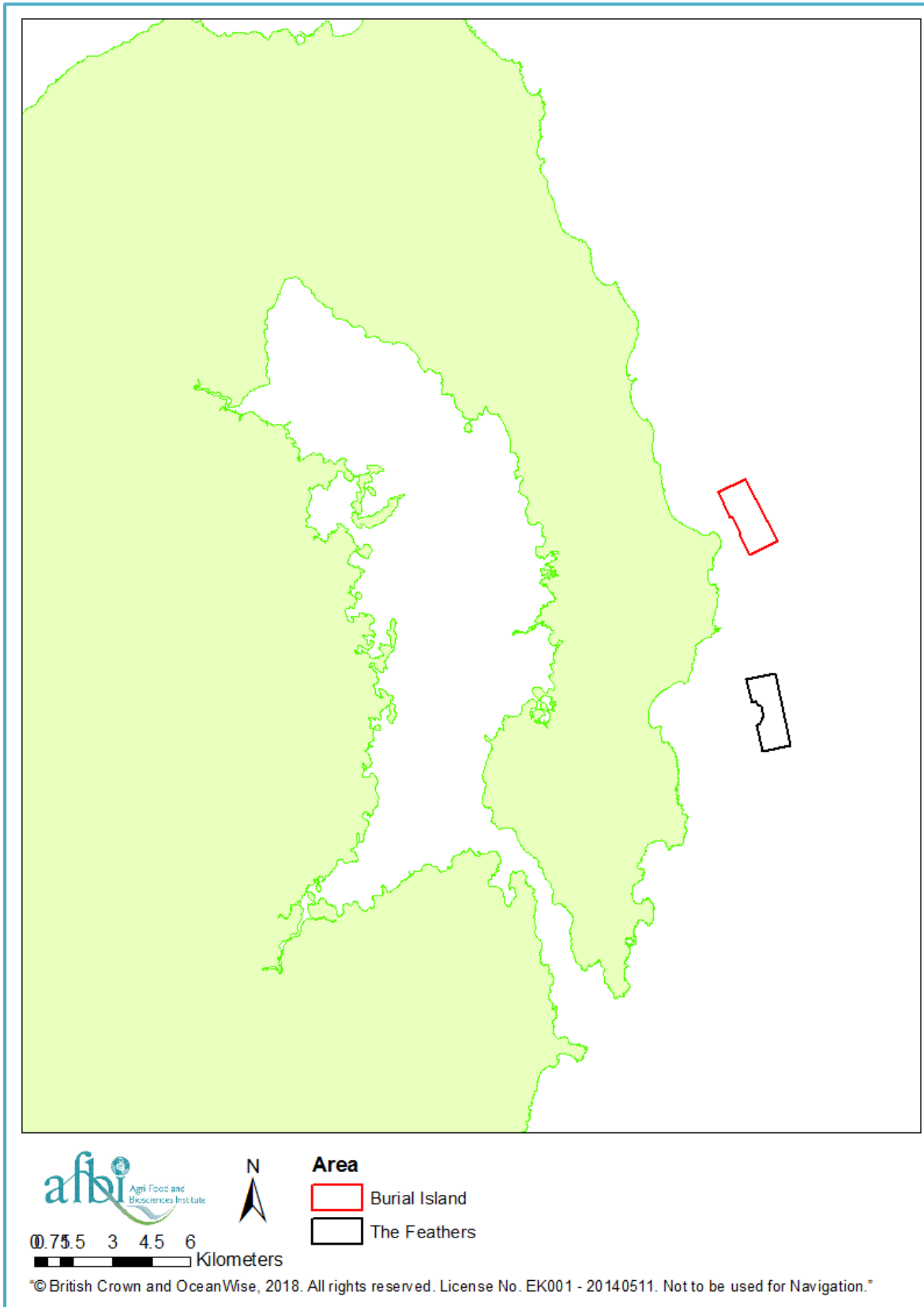
Figure 1: Survey locations for the summer 2018 seed mussel survey.

Figure 2: Photograph showing the dredge used during the Summer 2018 surveys.

Figure 3: Photograph showing the AFBI camera sledge used during the Summer 2018 surveys.
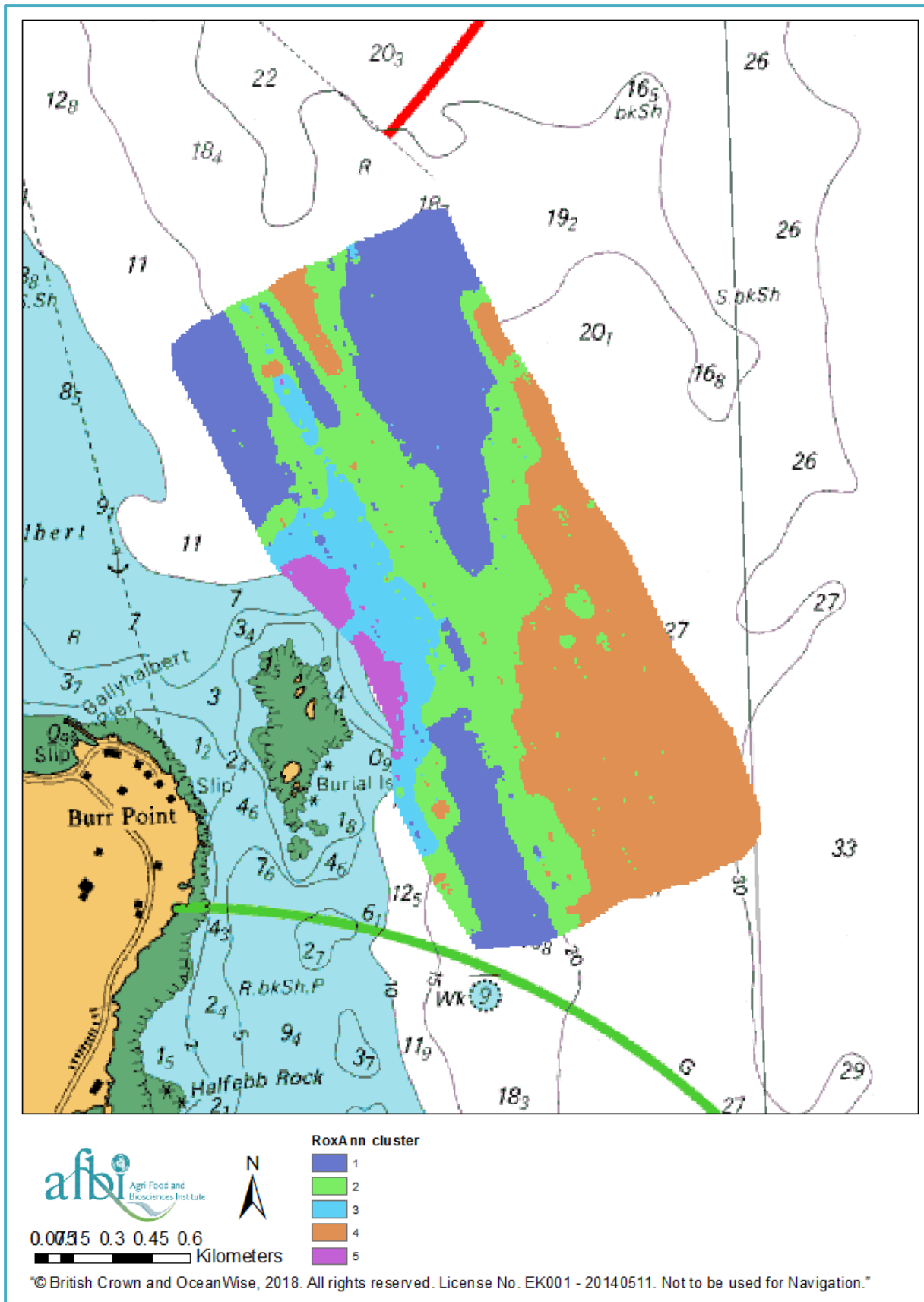
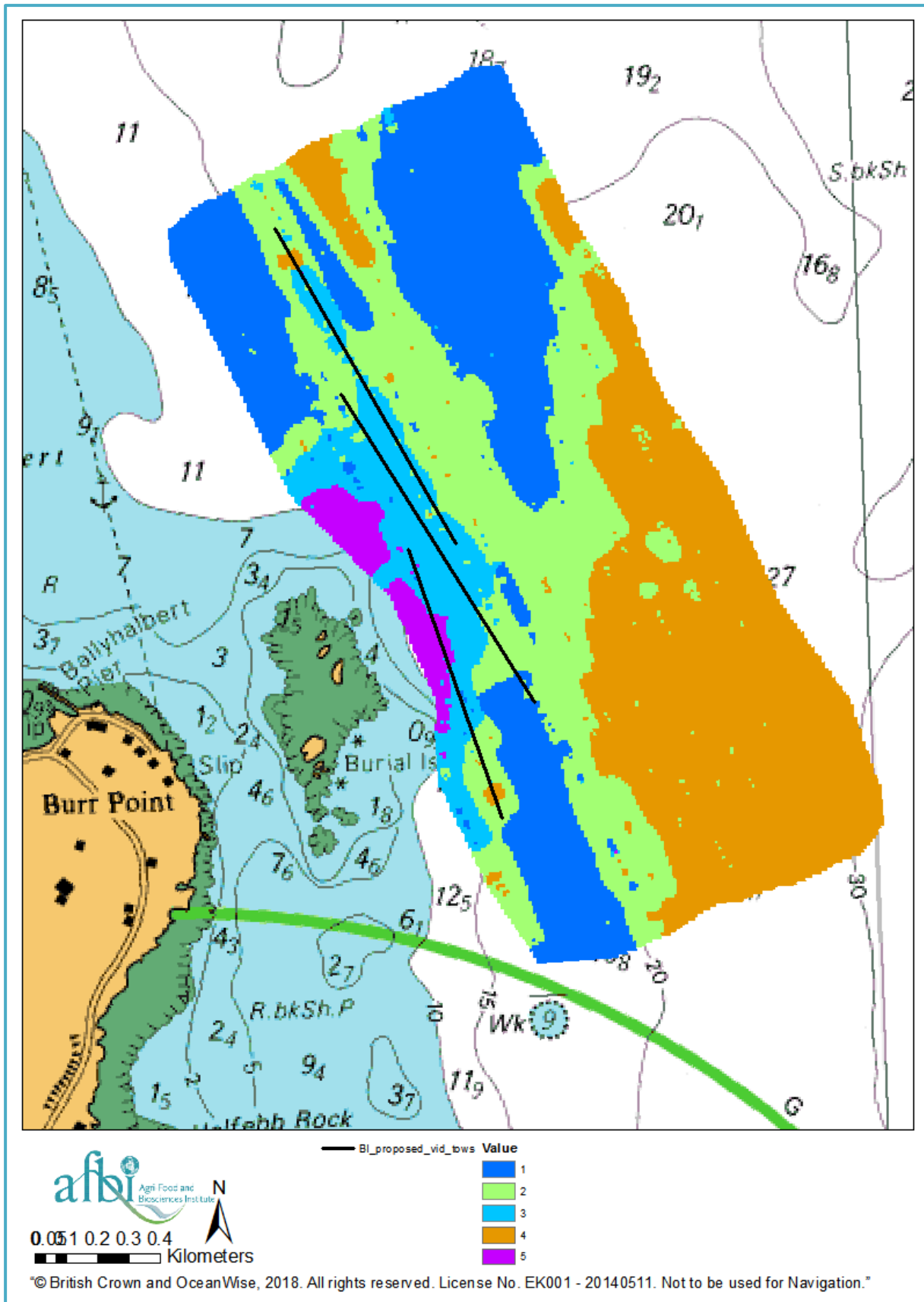**Figure 4: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of Burial Island.**
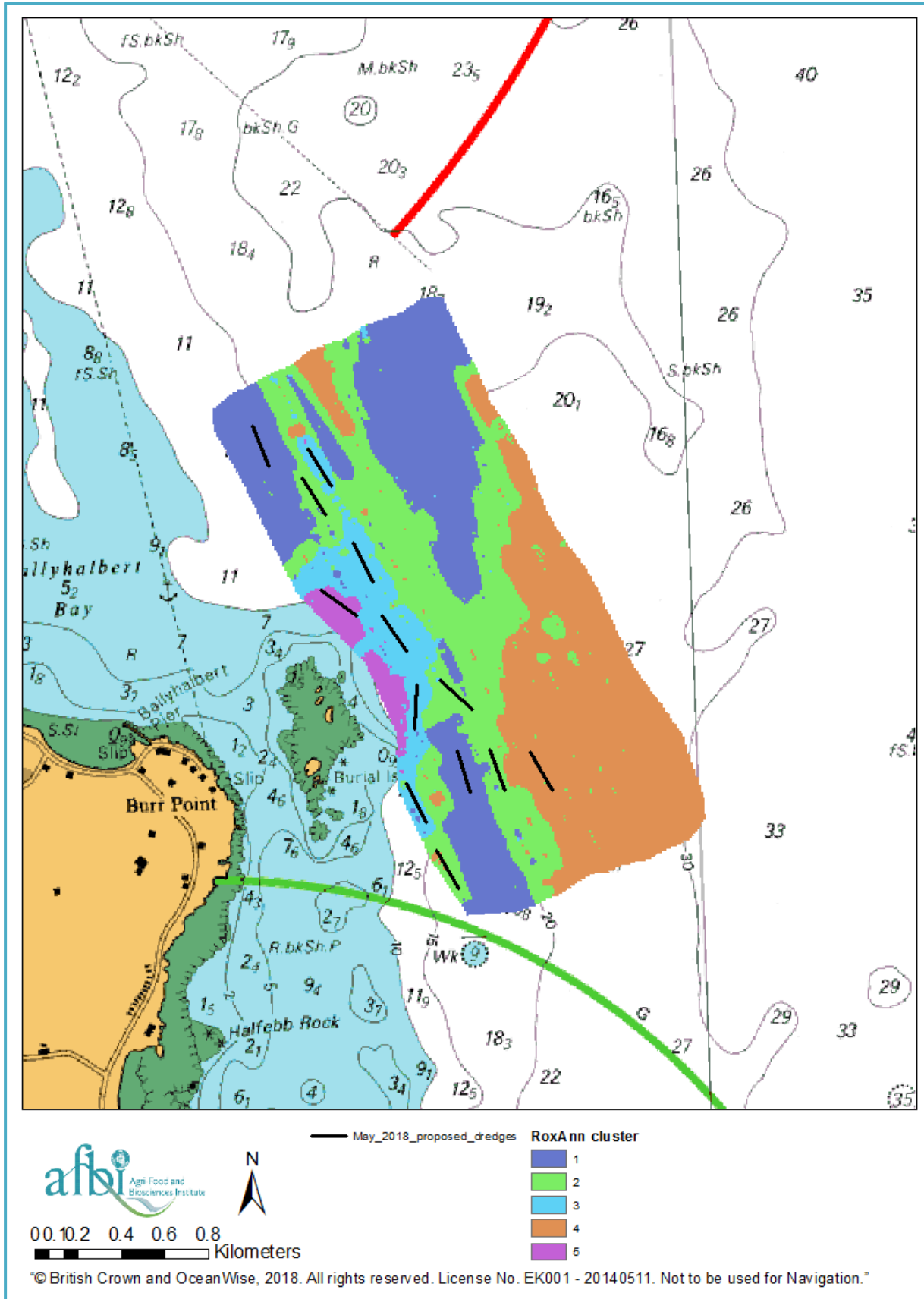
Figure 5: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of Burial Island overlaid with the proposed dredge tows.
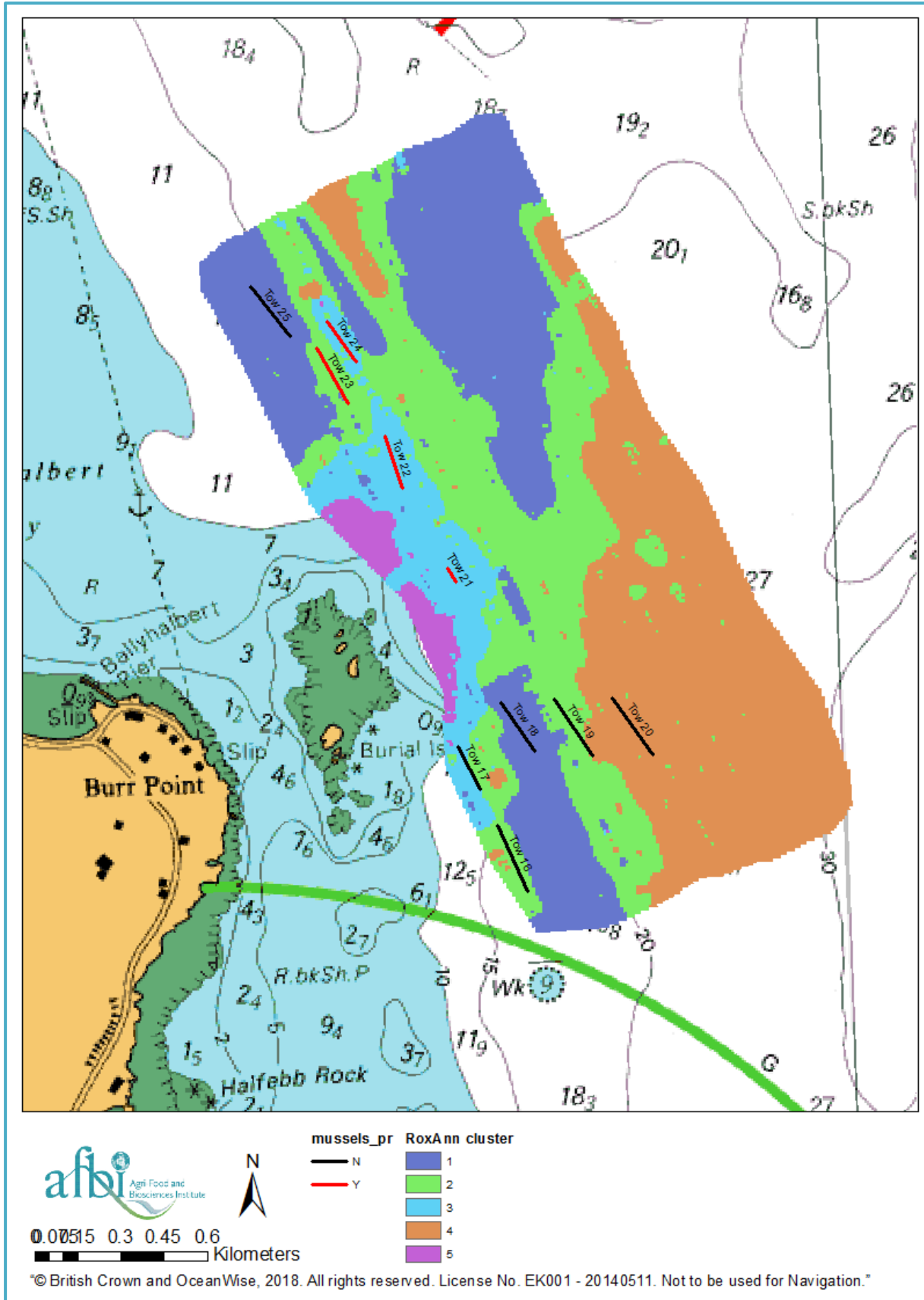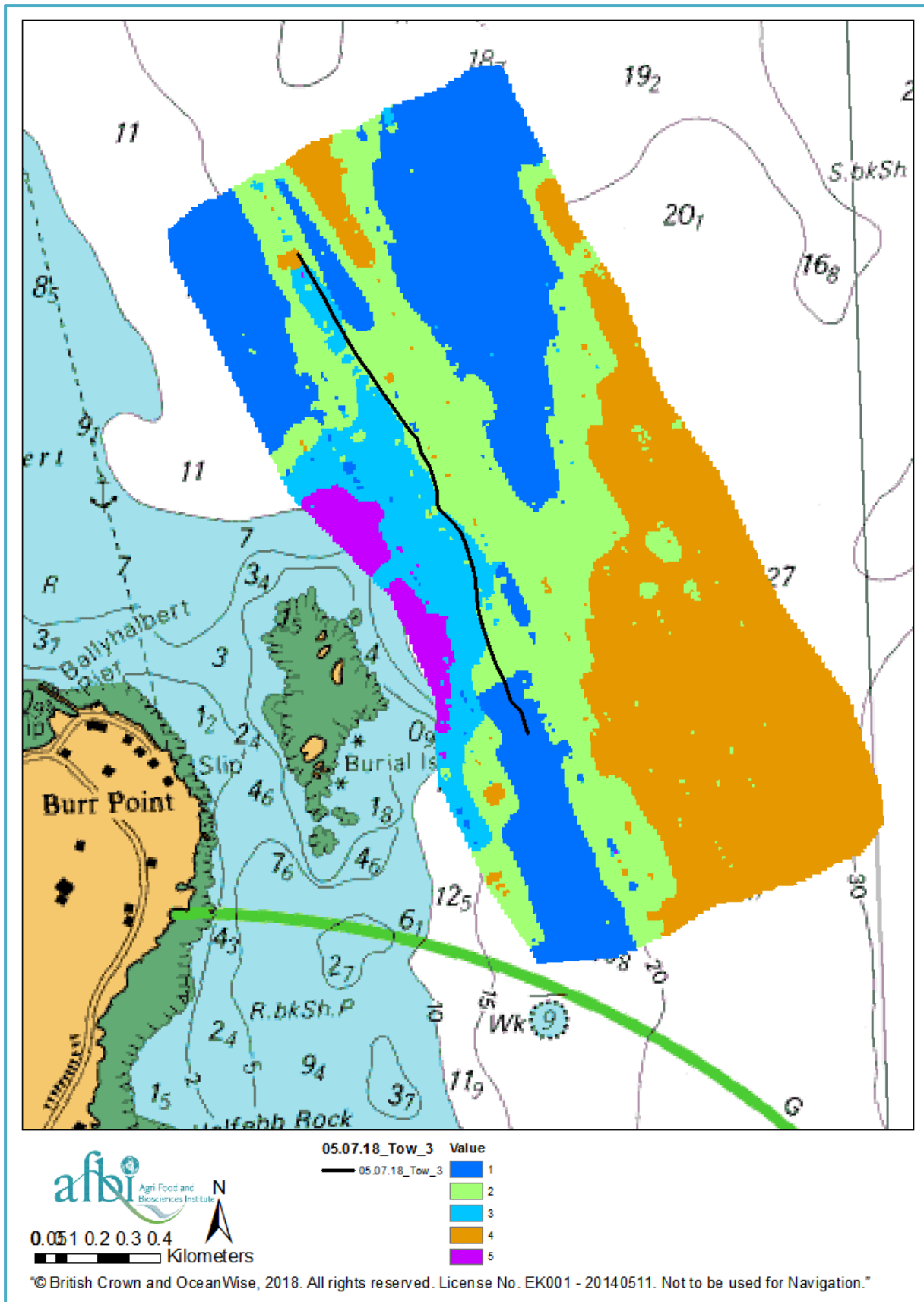
Figure 6: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of Burial Island overlaid with the dredge tows undertaken on the 24th of May 2018. Dredges within which mussels were found are coloured red.

May 2018 seed mussel survey: Burial Island Tow 21

May 2018 seed mussel survey: Burial Island Tow 22

May 2018 seed mussel survey: Burial Island Tow 23

May 2018 seed mussel survey: Burial Islands Tow 24

Figure 7: Photographs showing the contents of the dredge tow which yielded mussels undertaken within the area of Burial Island during the May 2018 seed mussel surveys.
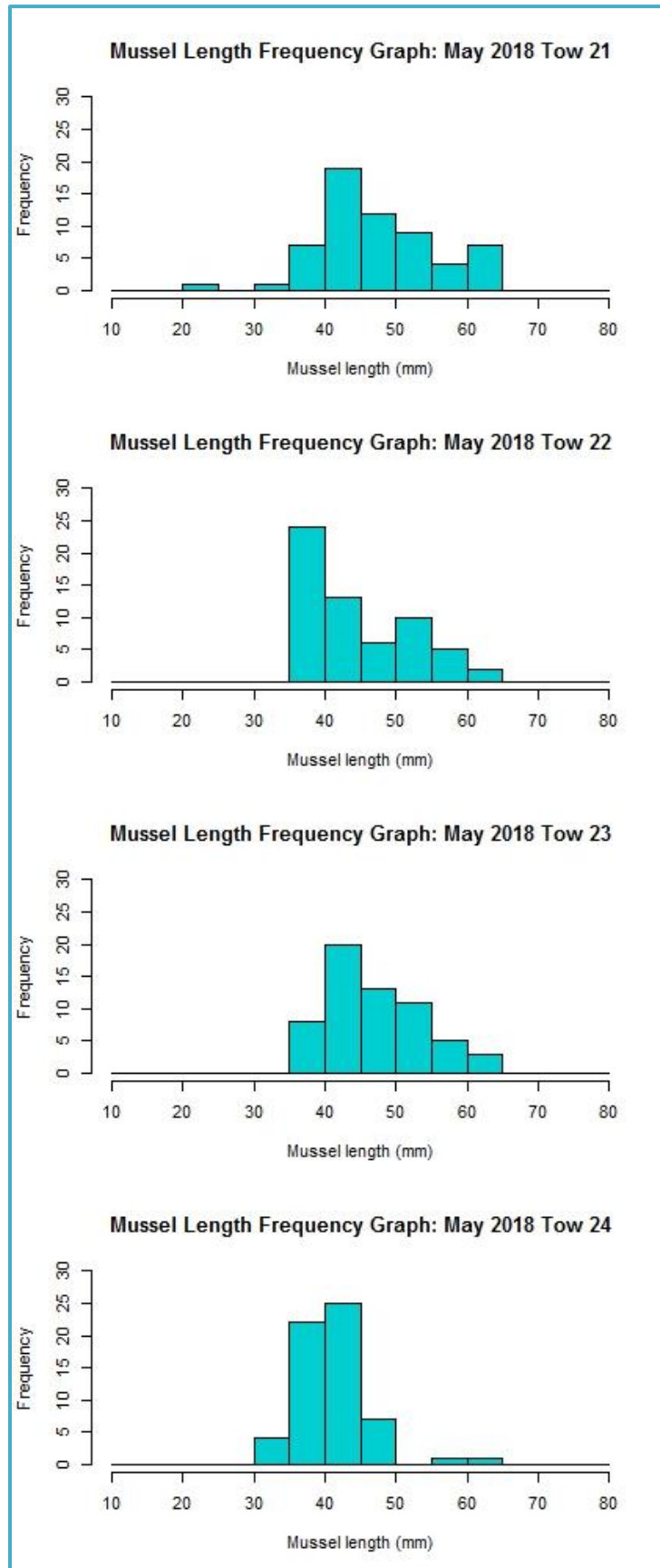
Figure 8: Length class distribution histograms for mussels found within dredge Tows undertaken within the area of Burial Island during the May 2018 seed mussel surveys.

Figure 9: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of Burial Island overlaid with the proposed video tows.

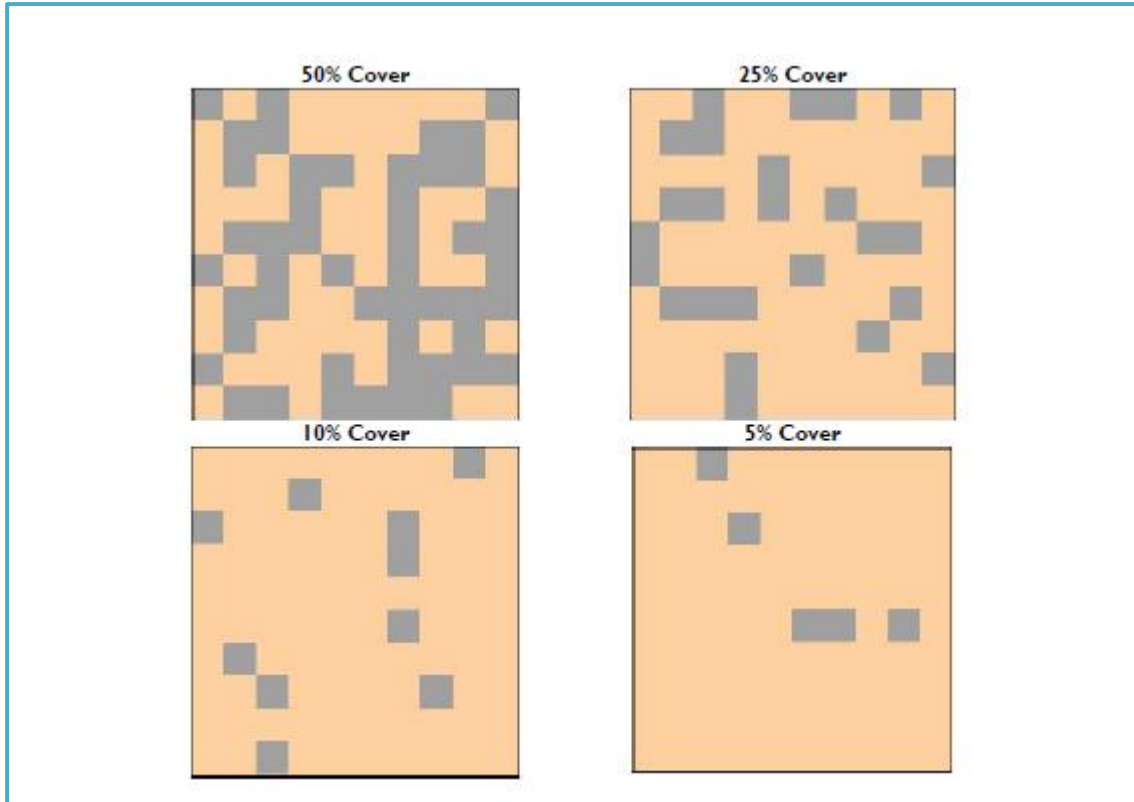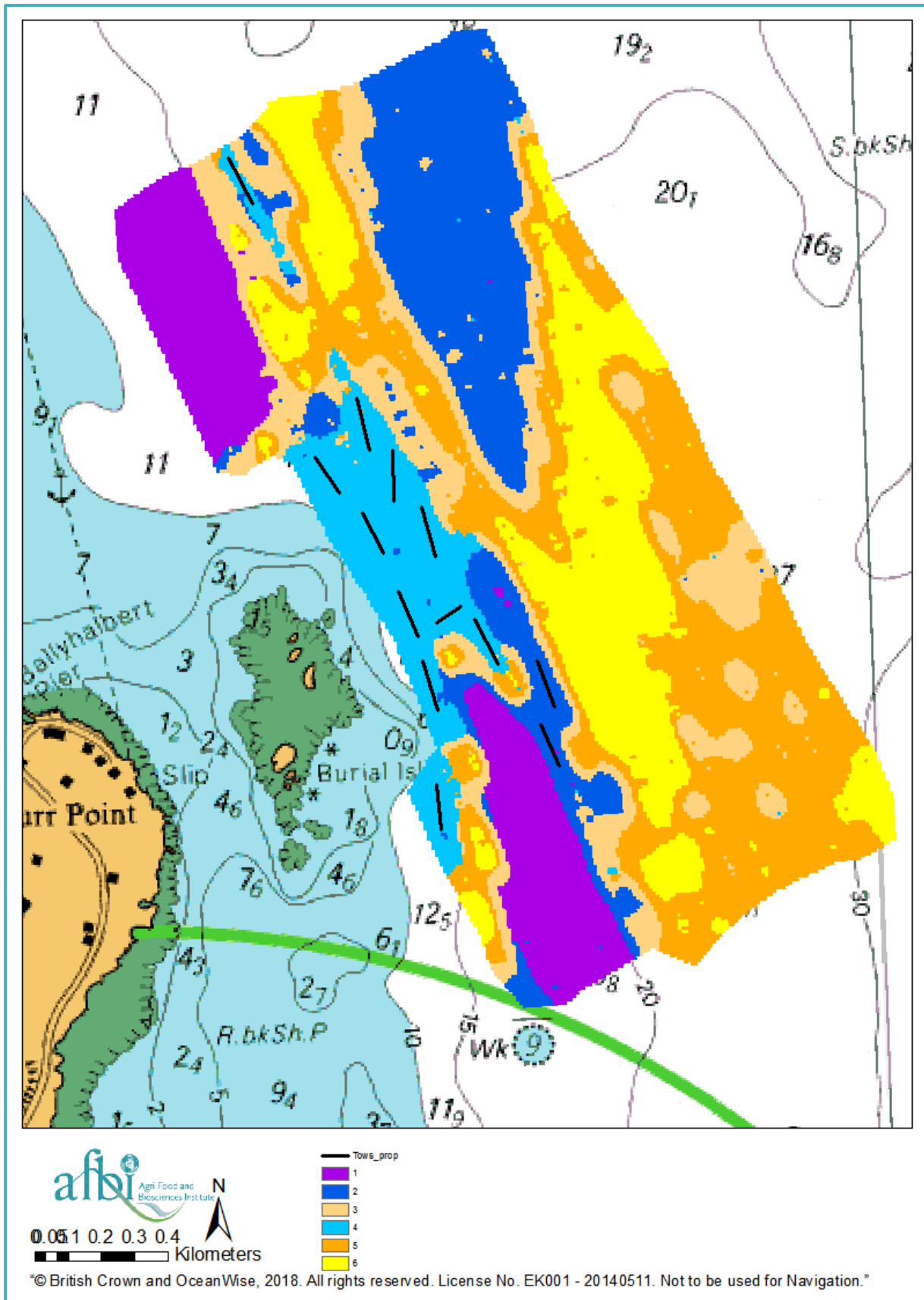**Figure 10: Location of video tow undertaken within the area of Burial Island during the July 2018 seed mussel survey.**
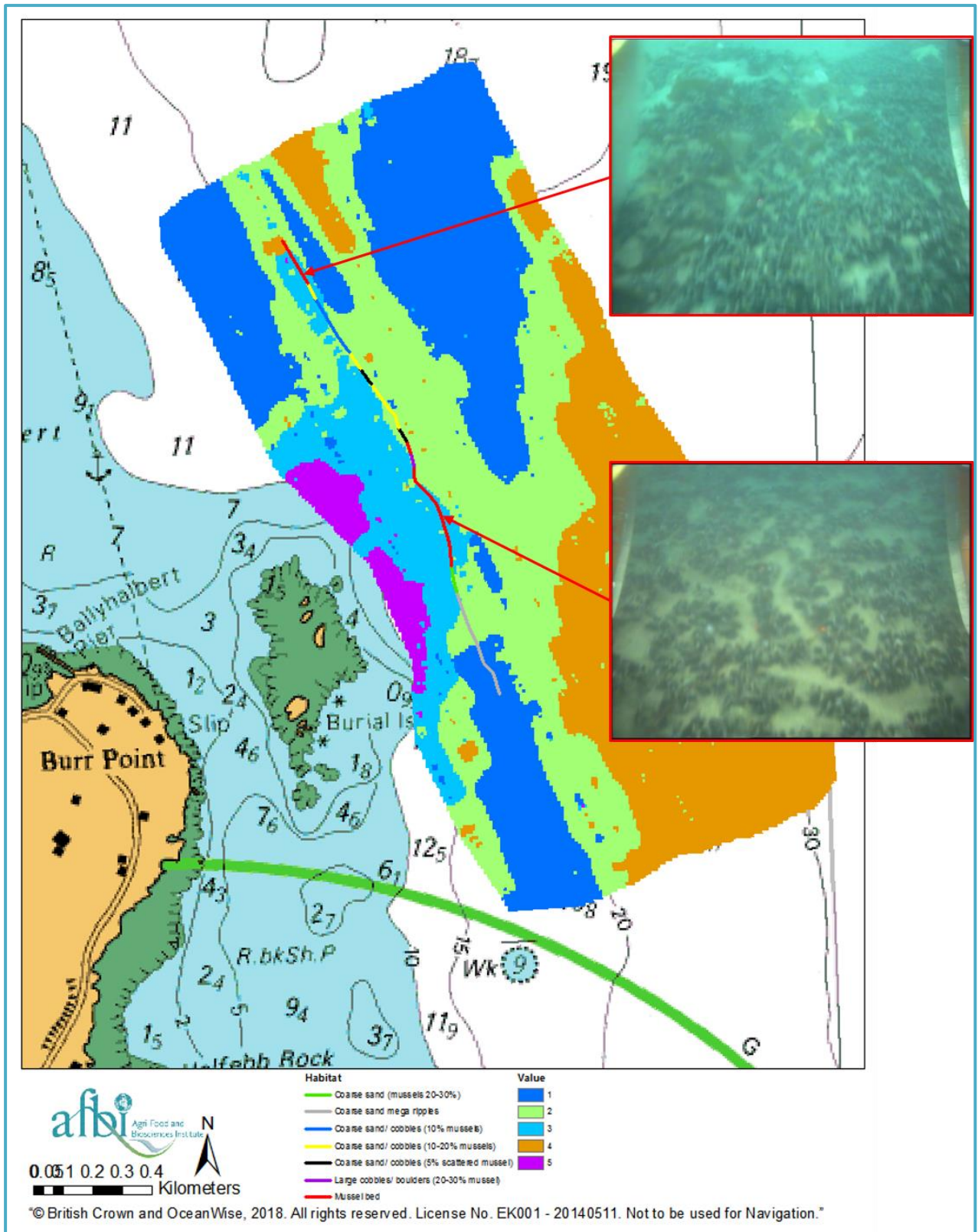
Figure 11: Location of video tow undertaken within the area of Burial Island during the July 2018 seed mussel survey showing observed habitat type.

Figure 12: Graphical illustrations to assist with estimation of percentage cover, as taken from Turner *et al* (2016) Figure 2.
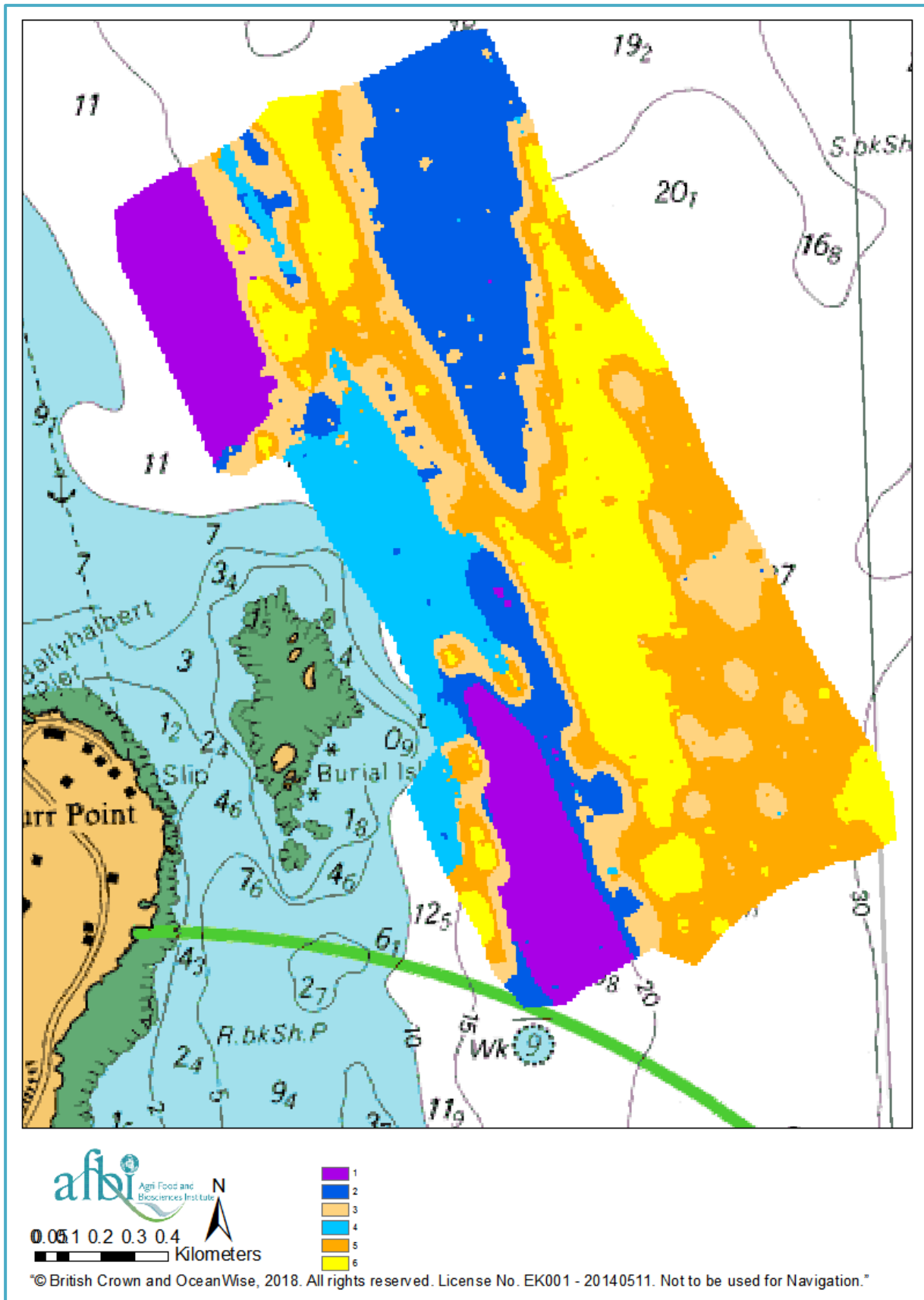
Figure 13: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of Burial Island.

Figure 14: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of Burial Island overlaid with the proposed dredge tows.
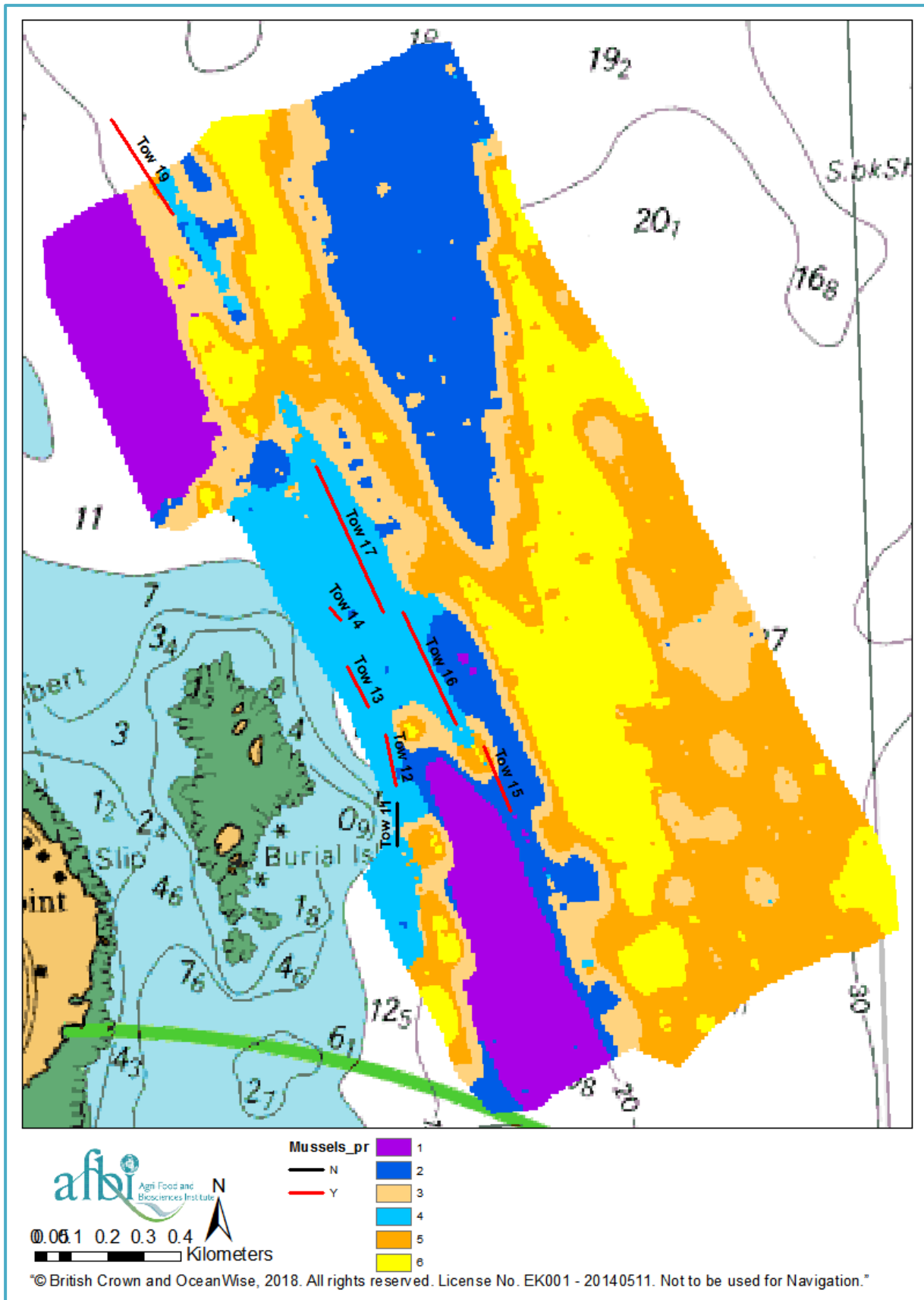
Figure 15: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of Burial Island overlaid with the dredge tows undertaken on the 25th of July 2018. Dredges within which mussels were found are coloured red.

Figure 16: Photographs showing the contents of the dredge tow which yielded mussels undertaken within the area of Burial Island during the July 2018 seed mussel survey.
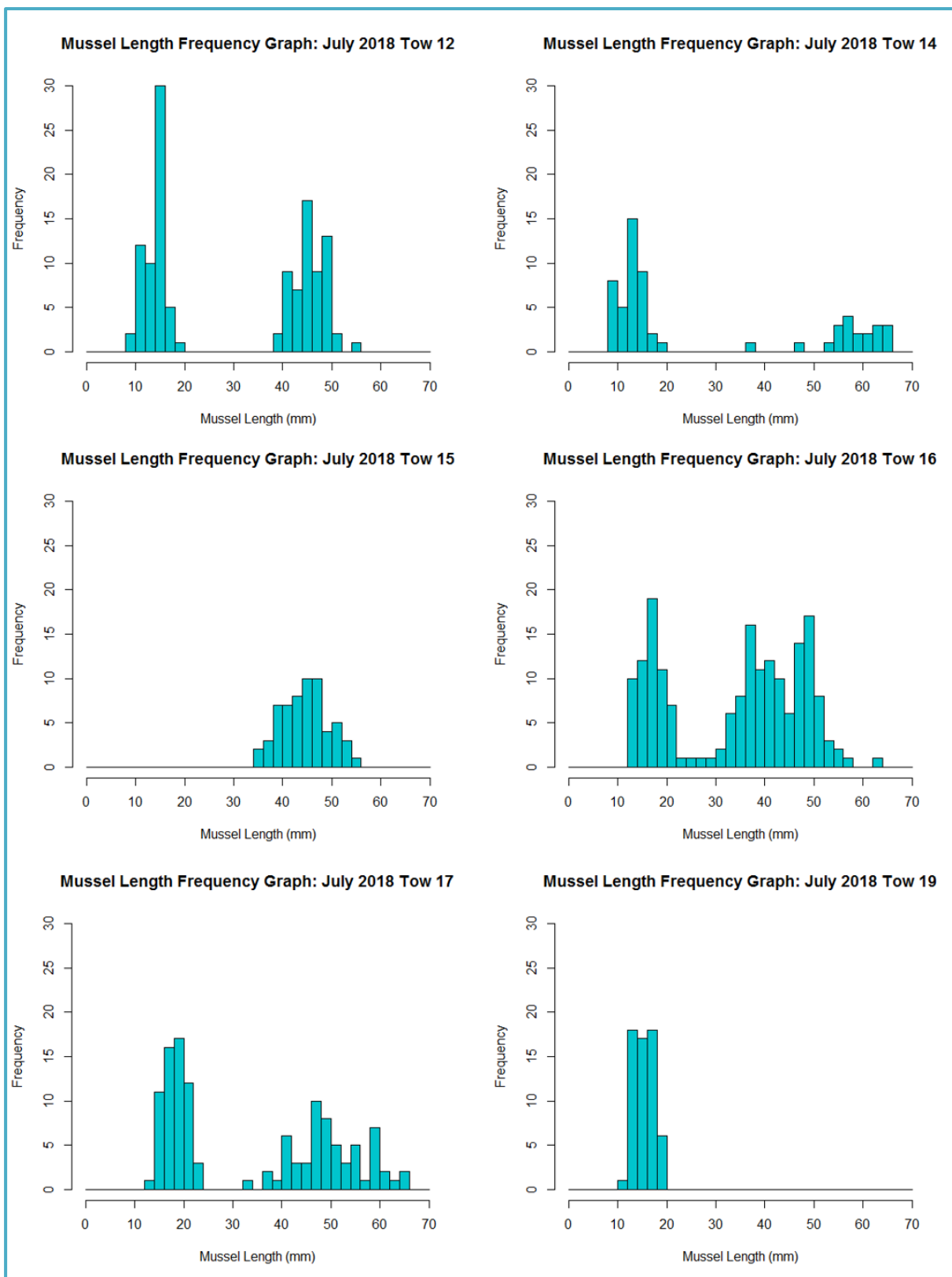
Figure 17: Length class distribution histogram for mussels found within dredge Tows undertaken within the area of Burial Island during the July 2018 seed mussel survey.
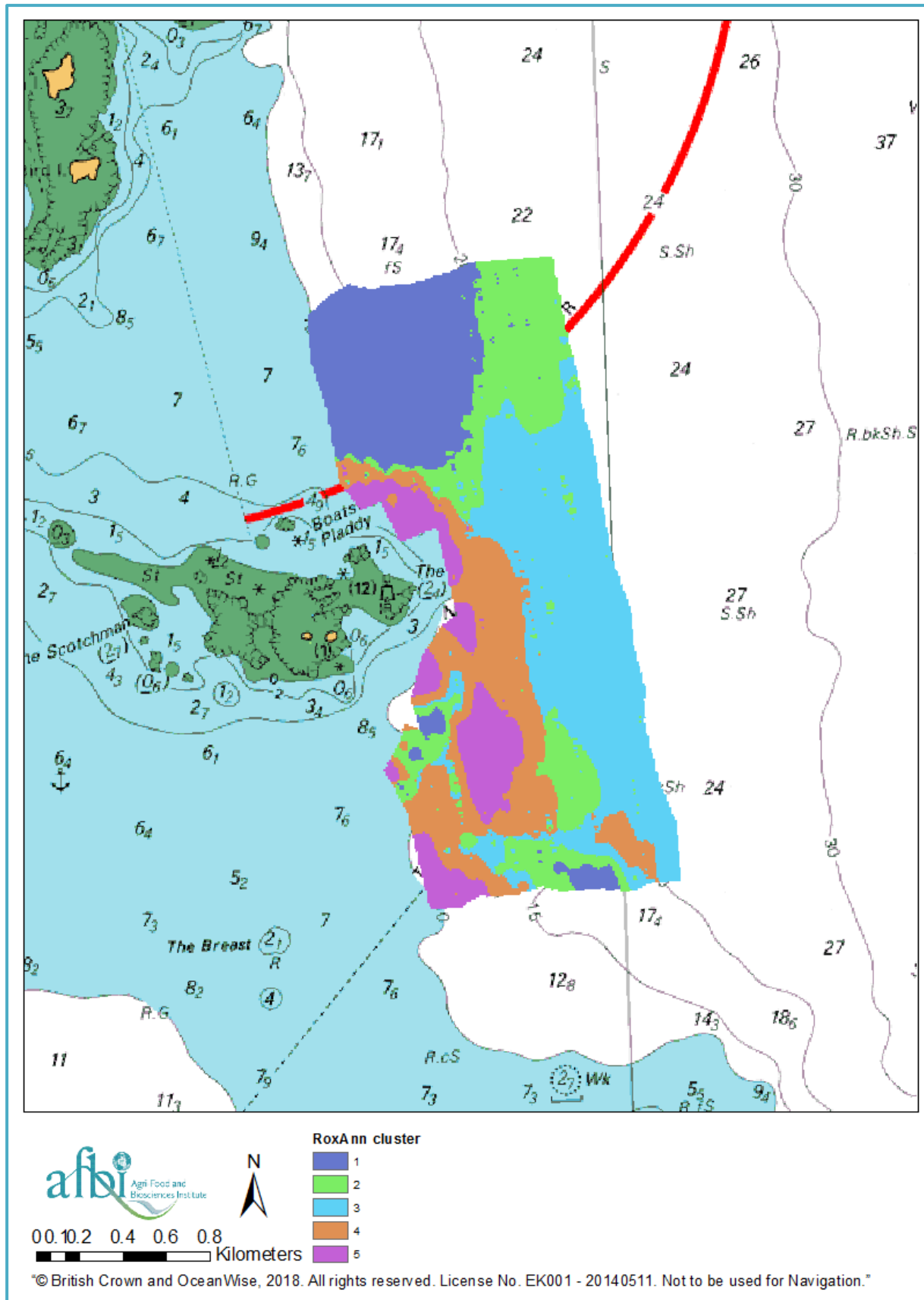
Figure 18: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of The Feathers.

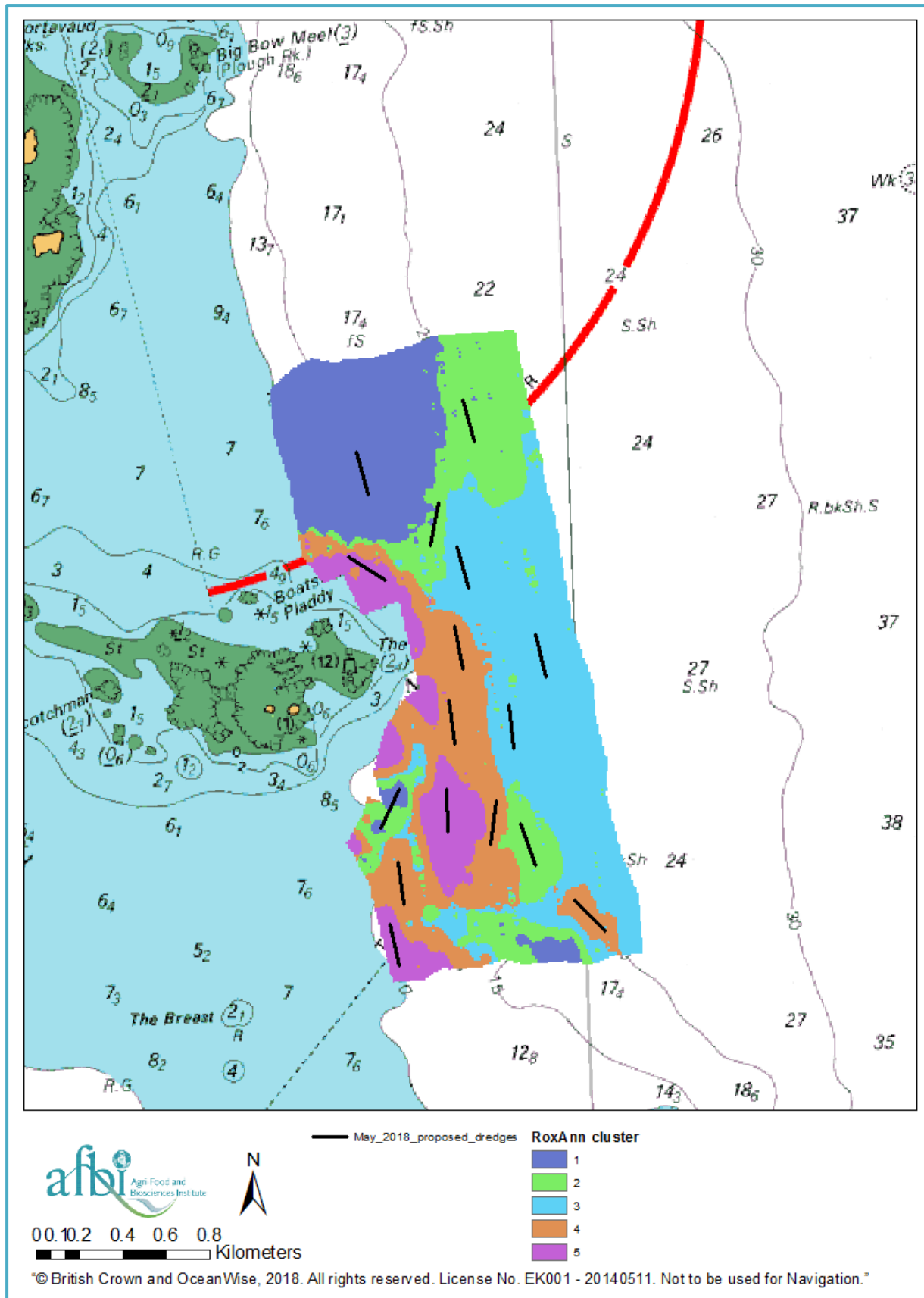**Figure 19: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of The Feathers overlaid with the proposed dredge tows.**
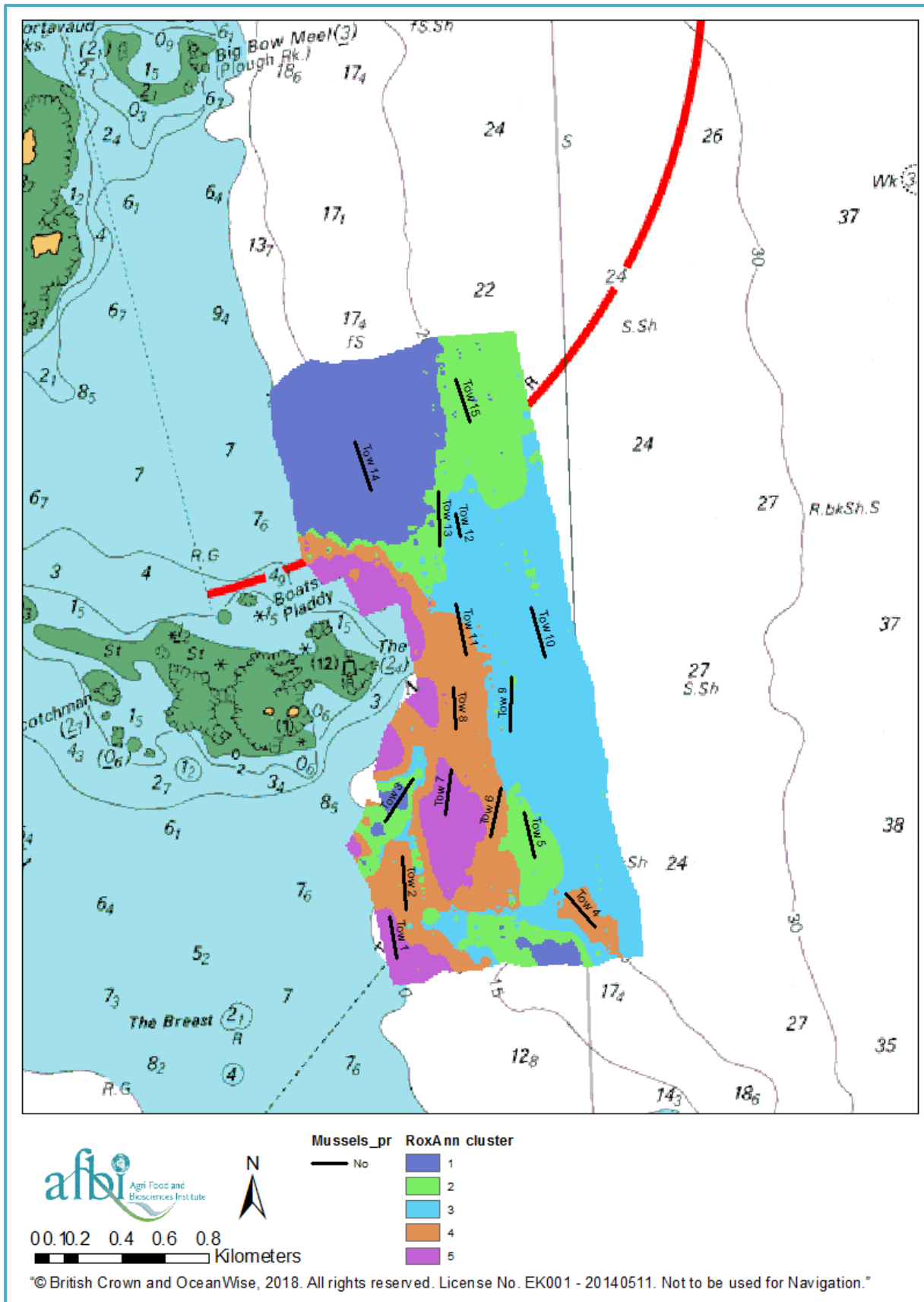
Figure 20: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of The Feathers overlaid with the dredge tows undertaken on the 24th of May 2018. Dredges within which mussels were found are coloured red.
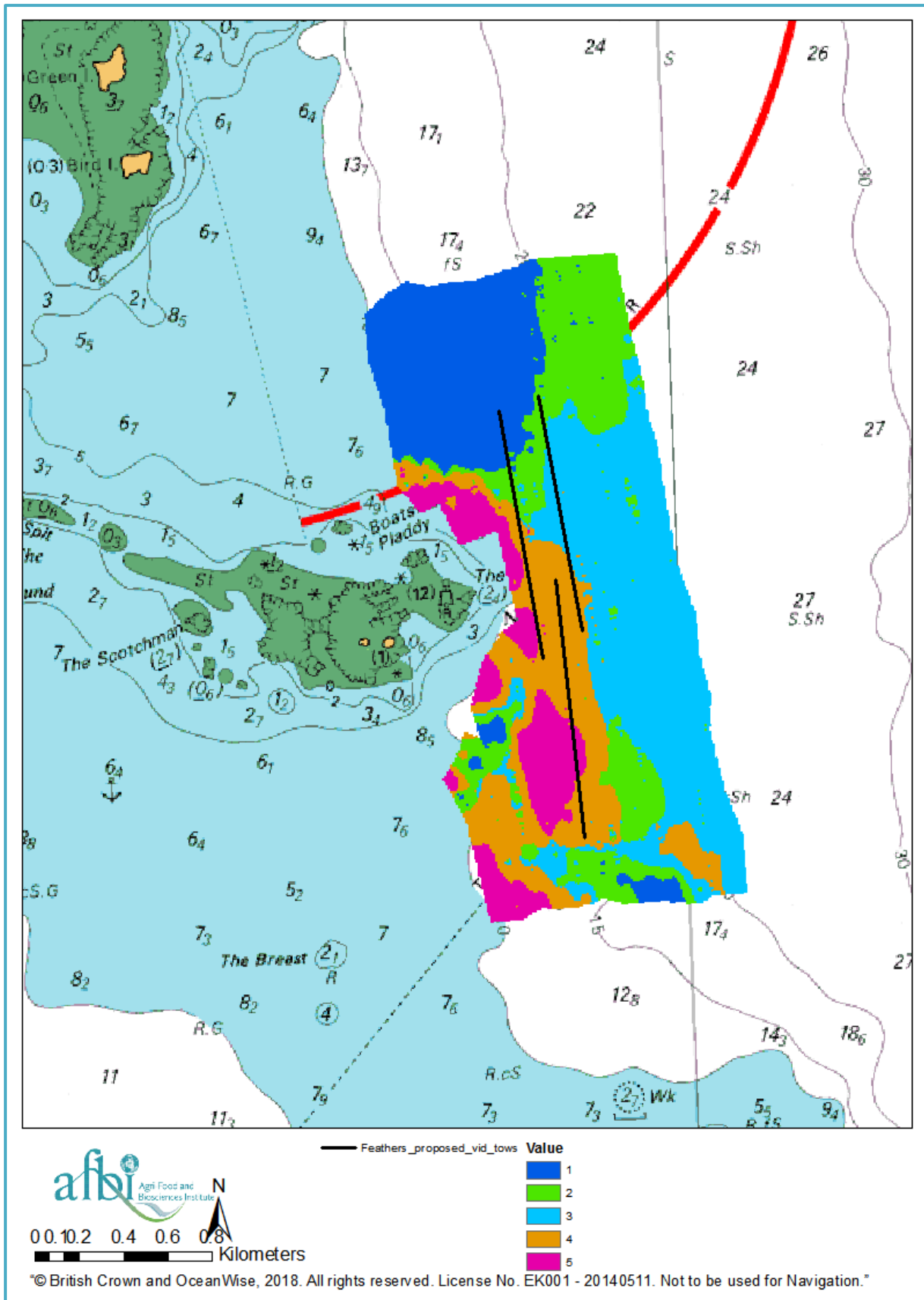
Figure 21: RoxAnn cluster map (from roughness and hardness values) from the May 2018 survey of The Feathers overlaid with the proposed video tows.
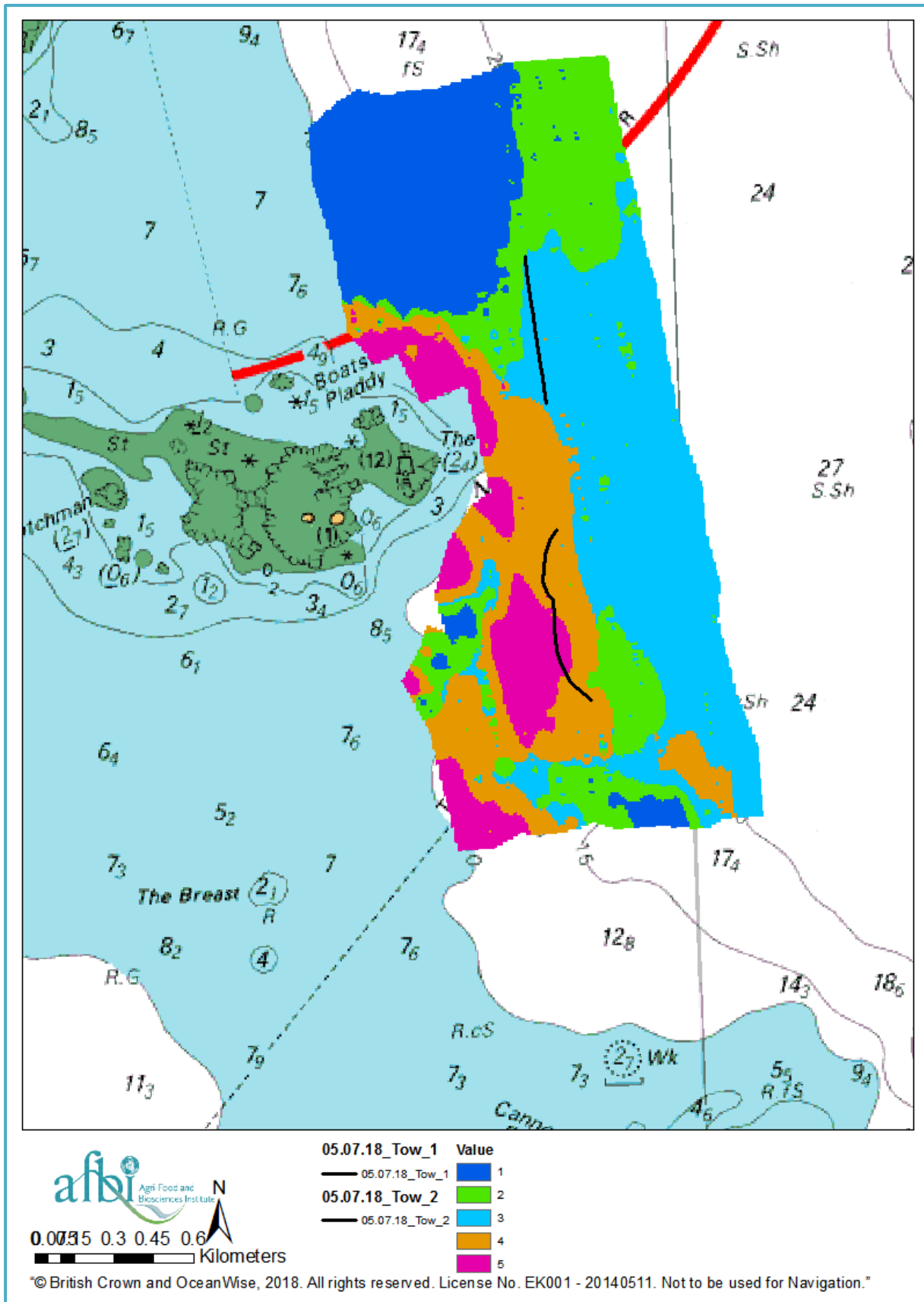
Figure 22: Location of video tows undertaken within the area of The Feathers during the July 2018 seed mussel survey.

Habitat

— Coarse sand (5% scattered mussel)
— Coarse sand/ cobbles (10% mussels)
— Coarse sand/ cobbles (10-20% mussels)
— Mussel bed (30-40% mussels)

Habitat

— Rippled sand
— Coarse sand/ cobbles (10% mussels)
— Coarse sand/ cobbles (5% scattered mussels)

Value

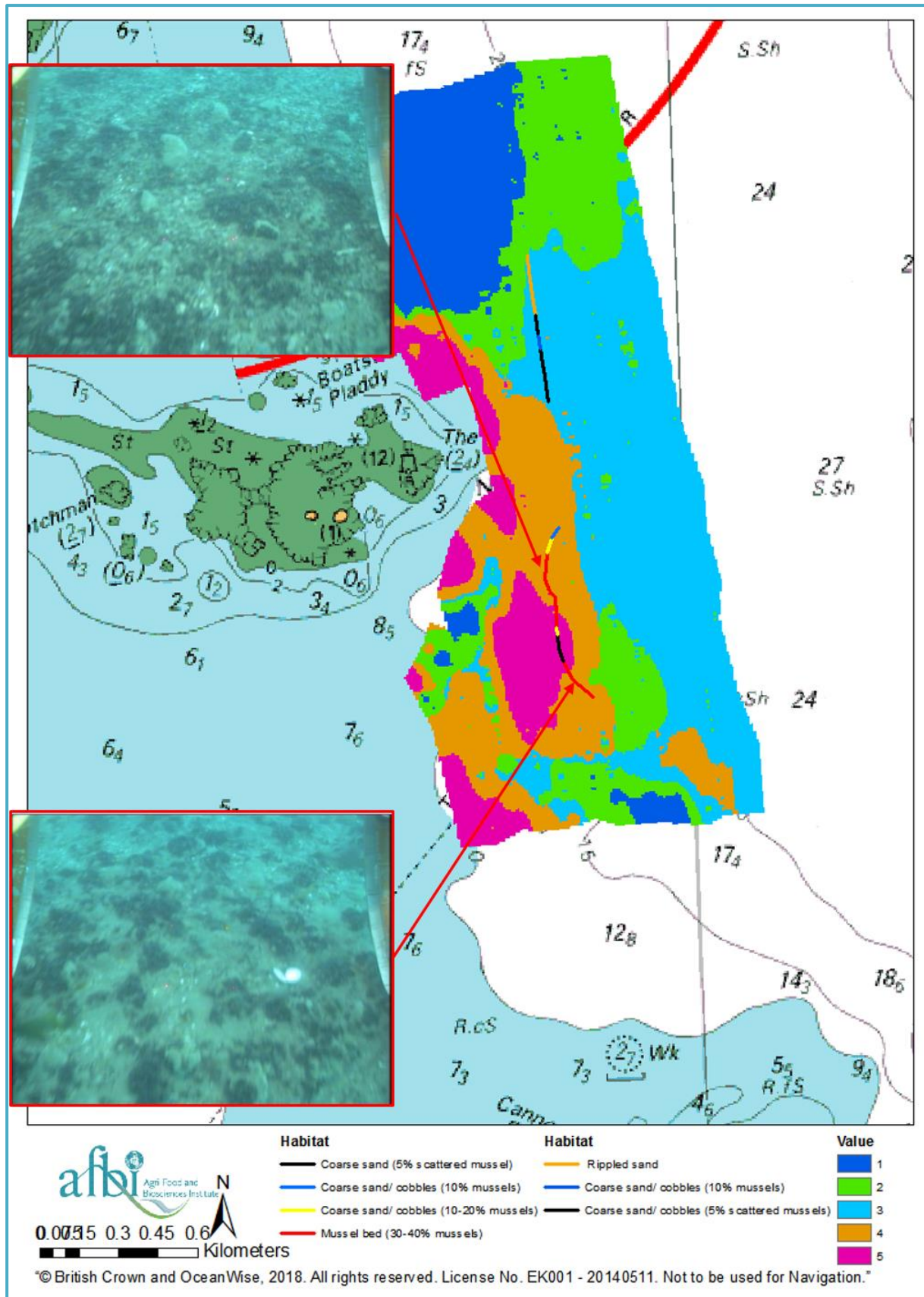■ 1
■ 2
■ 3
■ 4
■ 5

N

0.075 0.15 0.3 0.45 0.6
Kilometers

Figure 23: Location of video tows undertaken within the area of The Feathers during the July 2018 seed mussel survey showing observed habitat type.
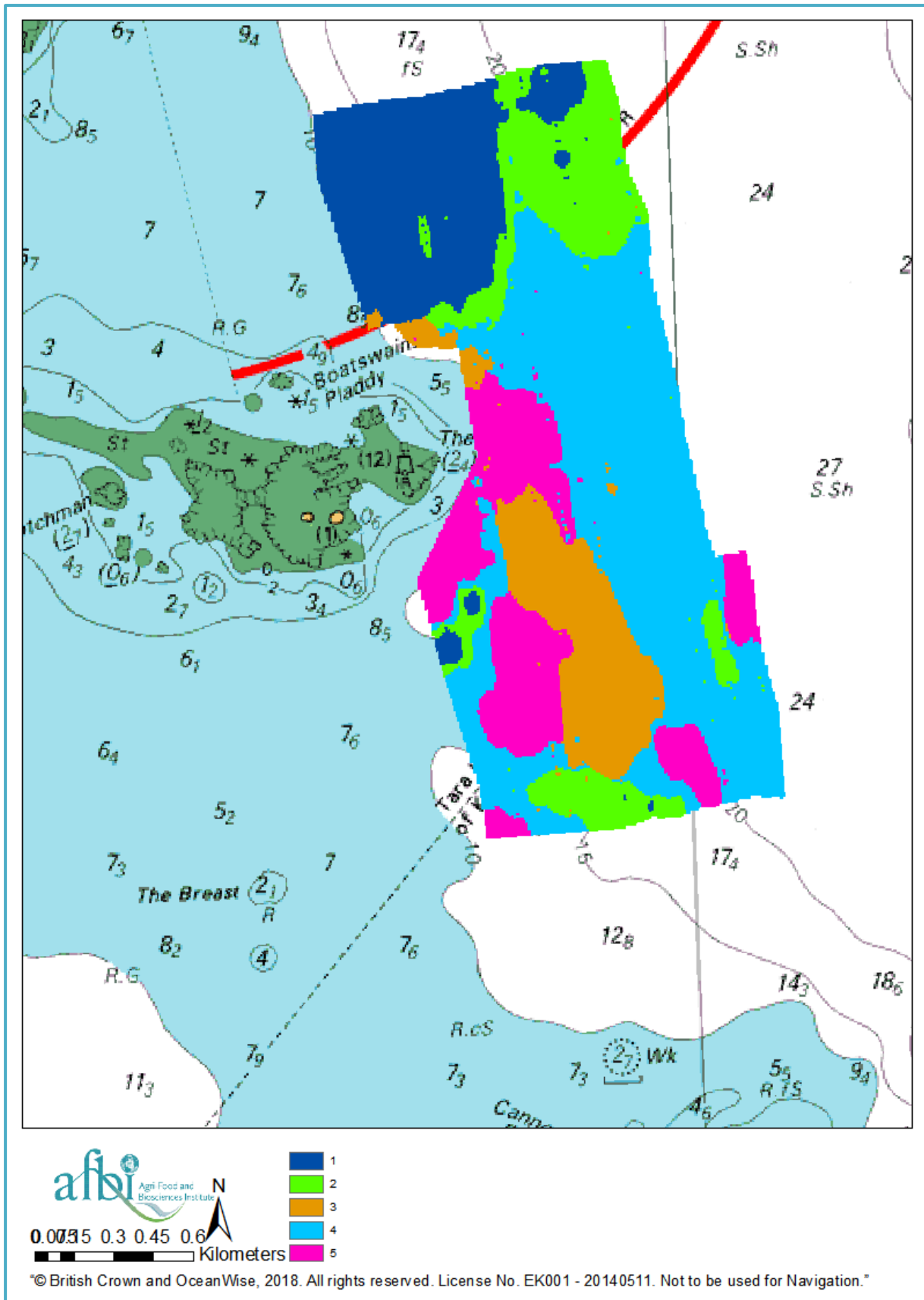
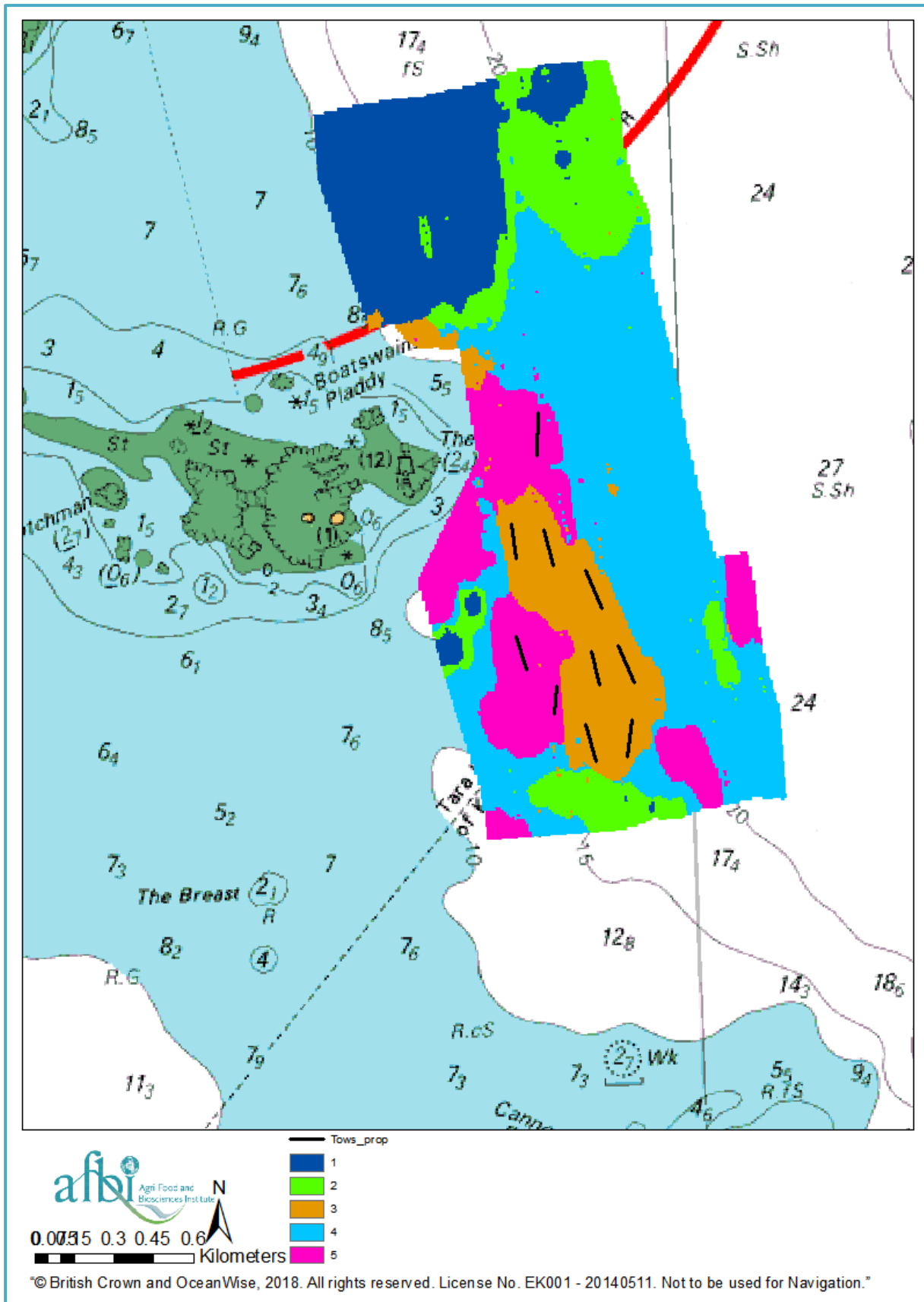**Figure 24: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of The Feathers.**

Figure 25: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of The Feathers overlaid with the proposed dredge tows.
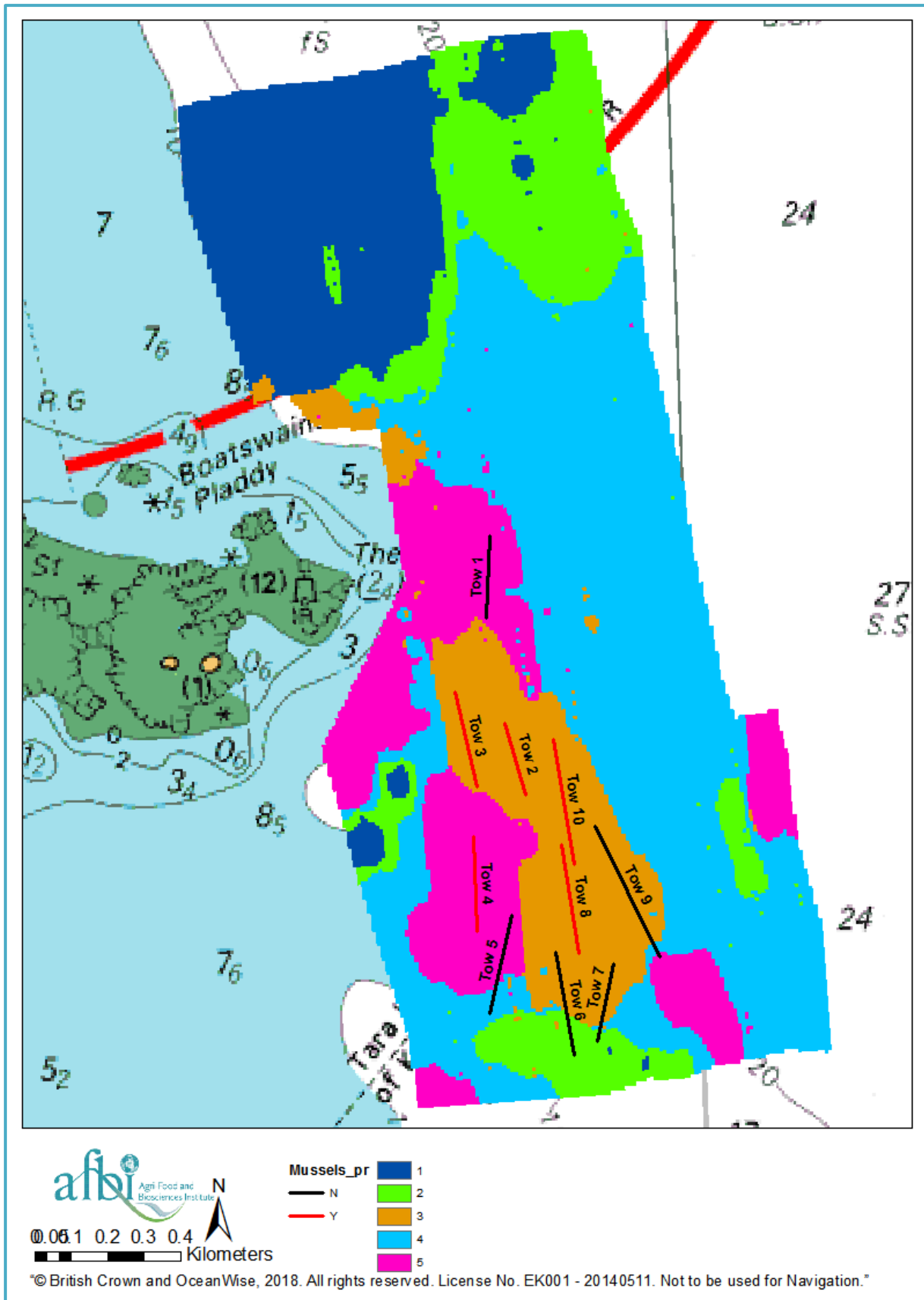
Figure 26: RoxAnn cluster map (from roughness and hardness values) from the July 2018 survey of The Feathers overlaid with the dredge tows undertaken on the 25th of July 2018. Dredges within which mussels were found are coloured red.

Figure 27: Photographs showing the contents of the dredge tow which yielded mussels undertaken within the area of The Feathers during the July 2018 seed mussel survey.
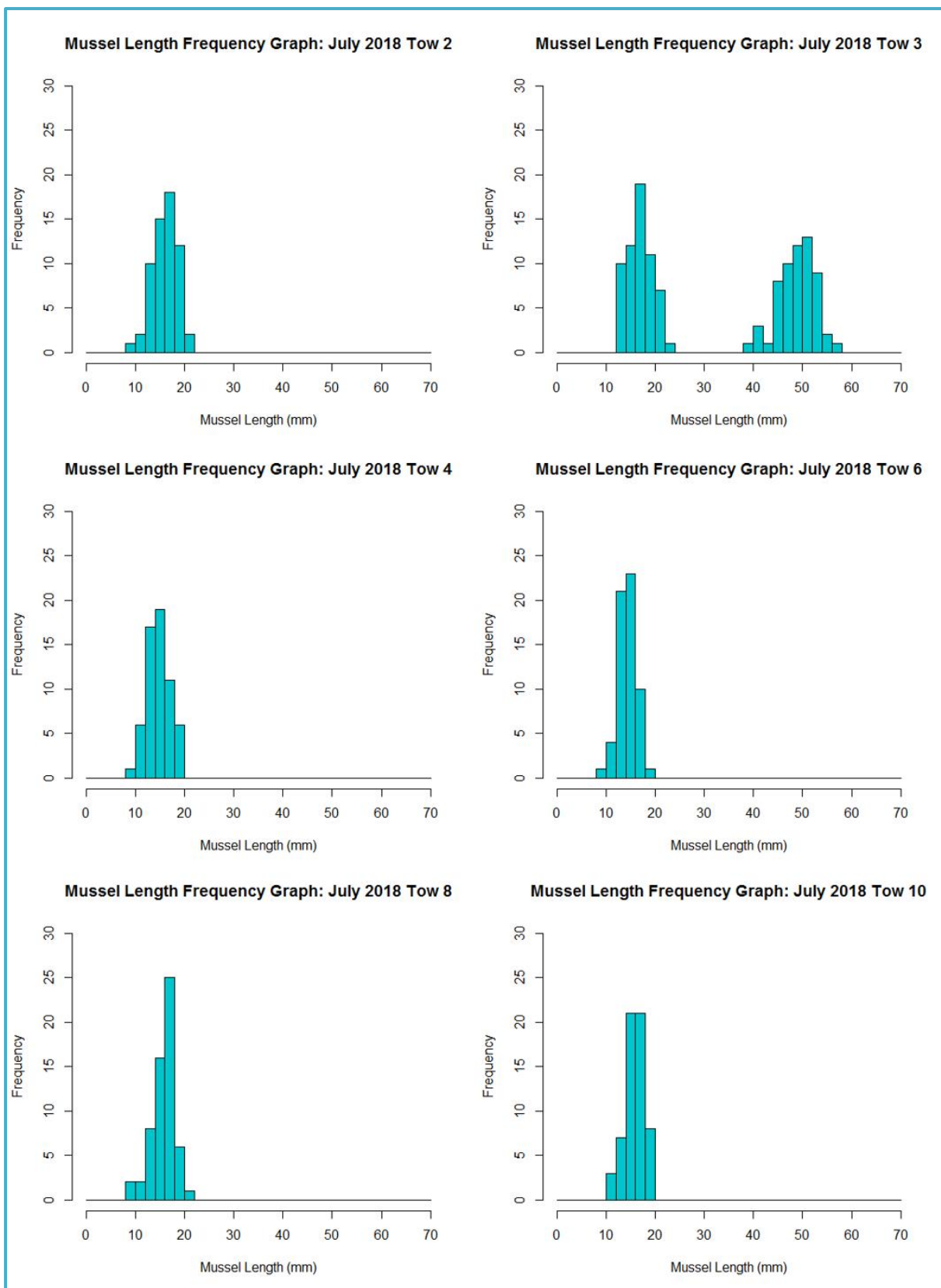
Figure 28: Length class distribution histograms for mussels found within dredge Tows undertaken within the area of The Feathers during the July 2018 seed mussel survey.
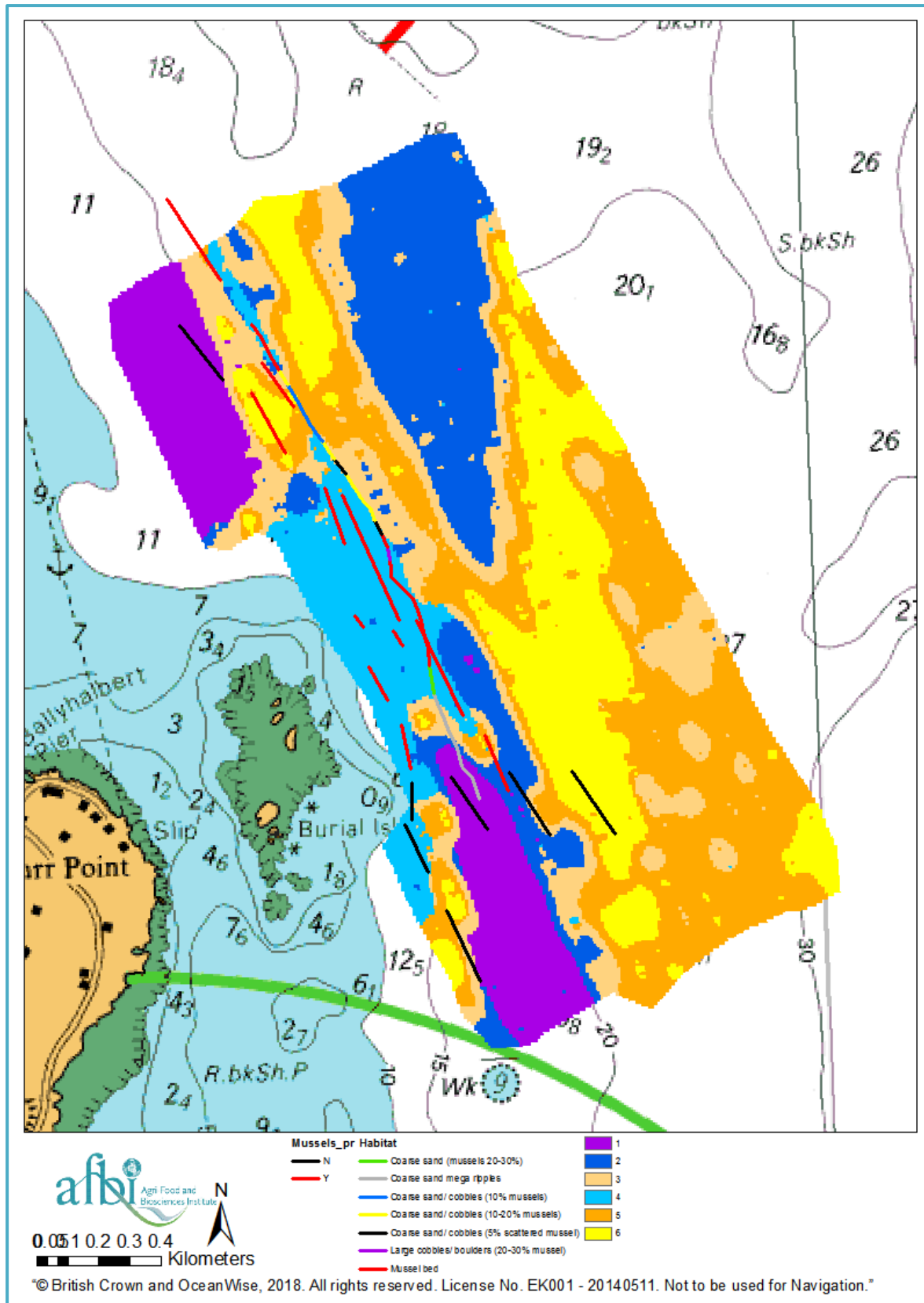
Figure 29: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of Burial Island, overlaid with the dredges undertaken on the 25th of July and the video tows undertaken on the 5th of July 2018. All red lines on the above map indicate the presence of seed mussels.
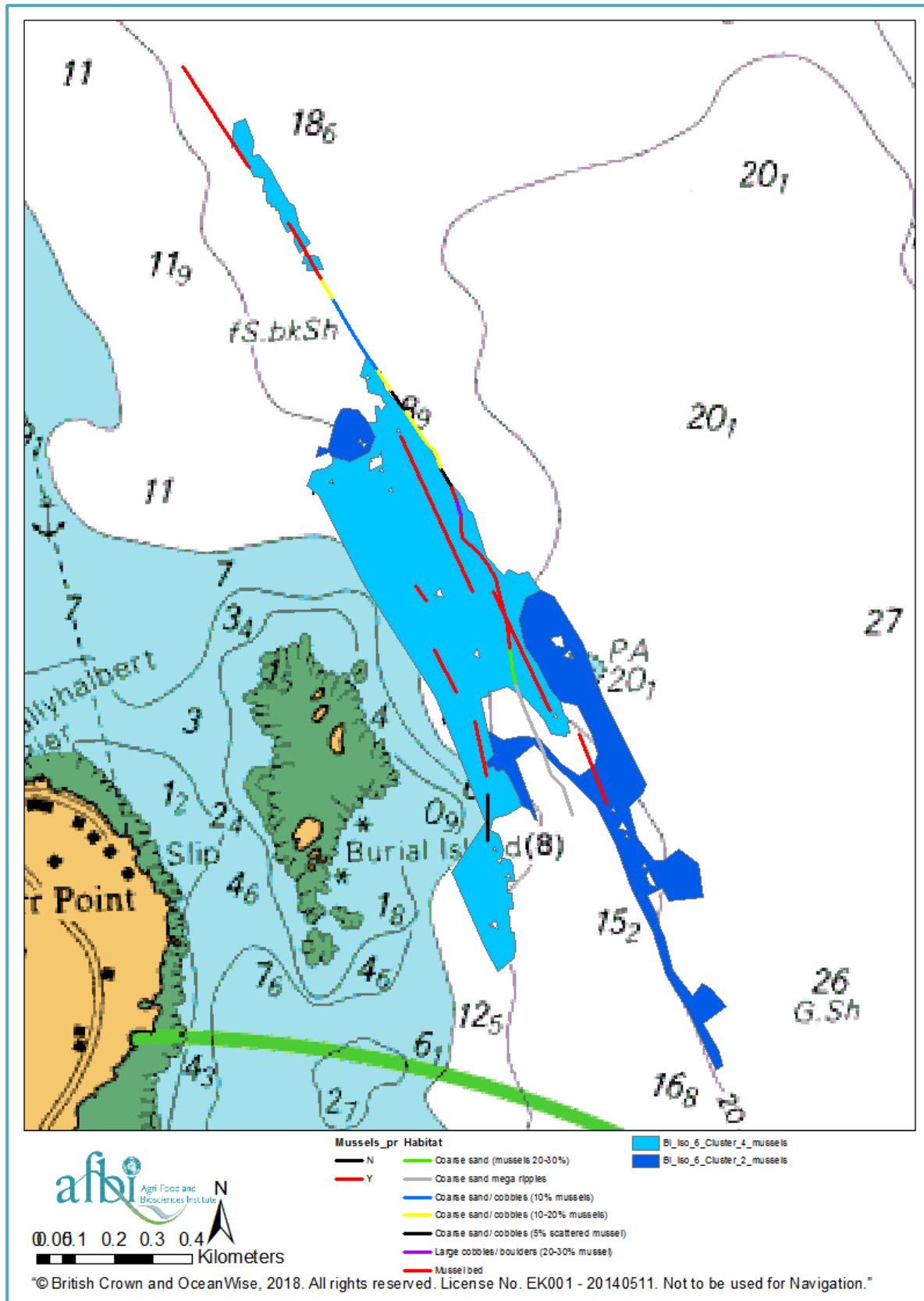
Figure 30: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of Burial Island showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 25th of July and the video tows undertaken on the 5th of July 2018. All red lines on the above map indicate the presence of seed mussels.

Points	Lat DDM	Long DDM
BI_A	54 30.3476	05 25.7031
BI_B	54 30.2154	05 25.6061
BI_C	54 30.0306	05 25.4651
BI_D	54 29.9605	05 25.3691
BI_E	54 29.7143	05 25.1766
BI_F	54 29.4927	05 24.8882
BI_G	54 29.2776	05 24.7205
BI_H	54 29.2185	05 24.8593
BI_I	54 29.3646	05 24.9568
BI_J	54 29.4496	05 25.0992
BI_K	54 29.4309	05 25.1430
BI_L	54 29.3810	05 25.1147
BI_M	54 29.3104	05 25.2642
BI_N	54 30.3135	05 25.9486

Descript

- AFBI 80m buffer
- AFBI mod/seed boundary
- Proposed_BI_fishery_2018_pts
- Proposed_BI_fishery_2018
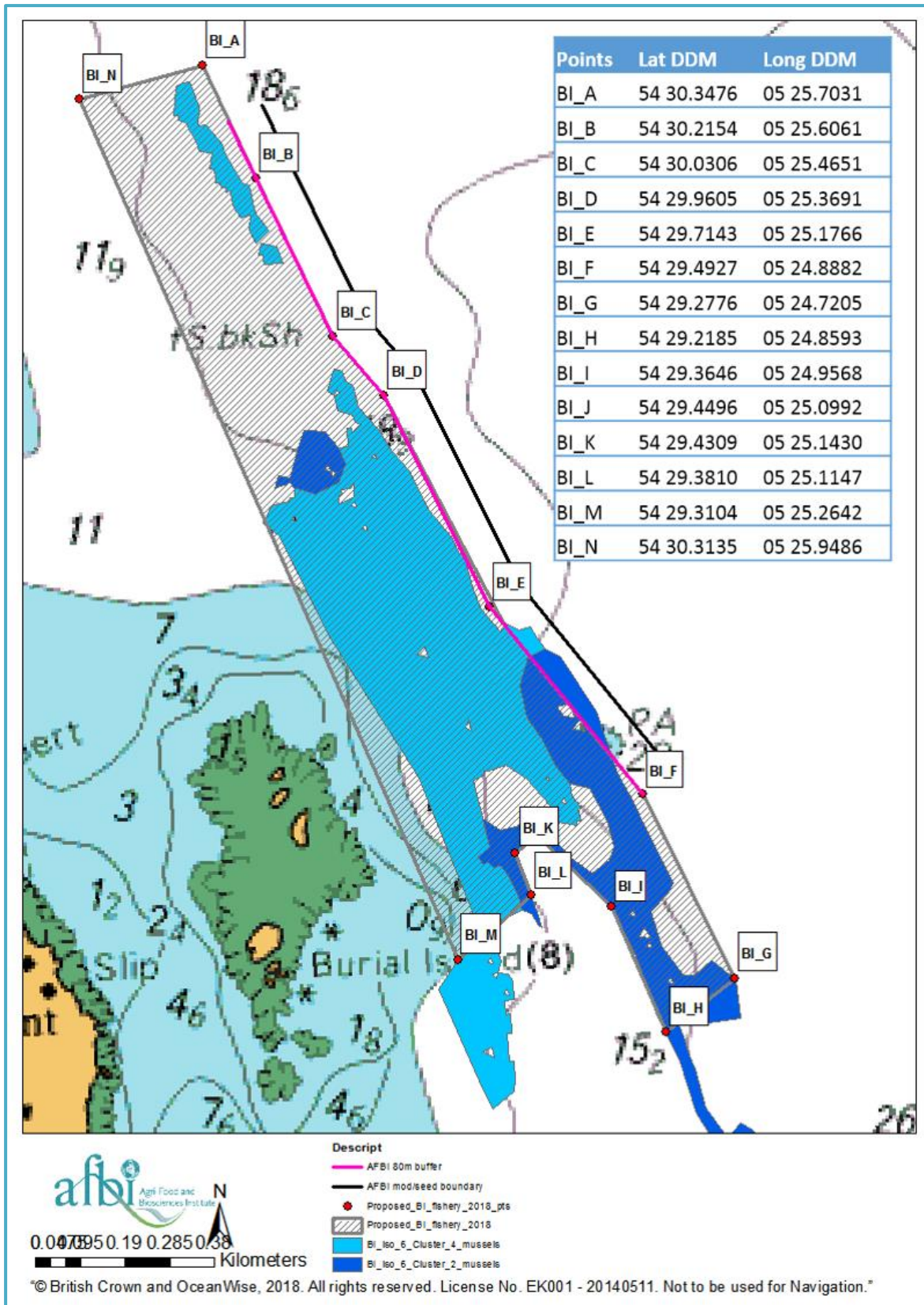- BI_Iso_6_Cluster_4_mussels
- BI_Iso_6_Cluster_2_mussels

Figure 31: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of Burial Island, highlighting the area of Cluster 4 (light blue area on map) and Cluster 2 (dark blue area on map) that represents seed mussel. The proposed fishery area is shown by the grey hashed area on the map. The pink line indicates the 80 m buffer which has previously been applied to safeguard the *M. modiolus* bed.
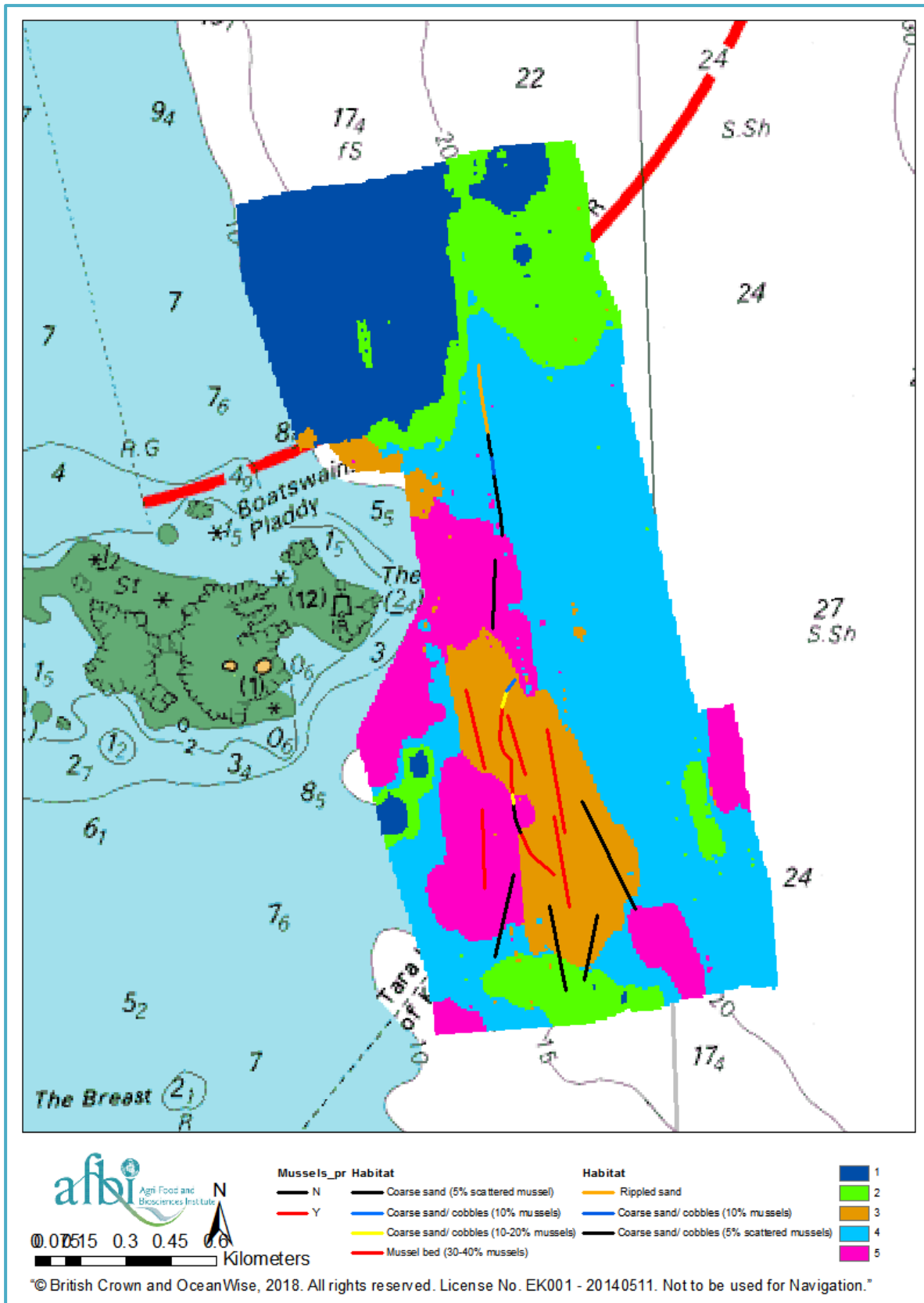
Figure 32: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of The Feathers, overlaid with the dredges undertaken on the 25th of July and the video tows undertaken on the 5th of July 2018. All red lines on the above map indicate the presence of seed mussels.
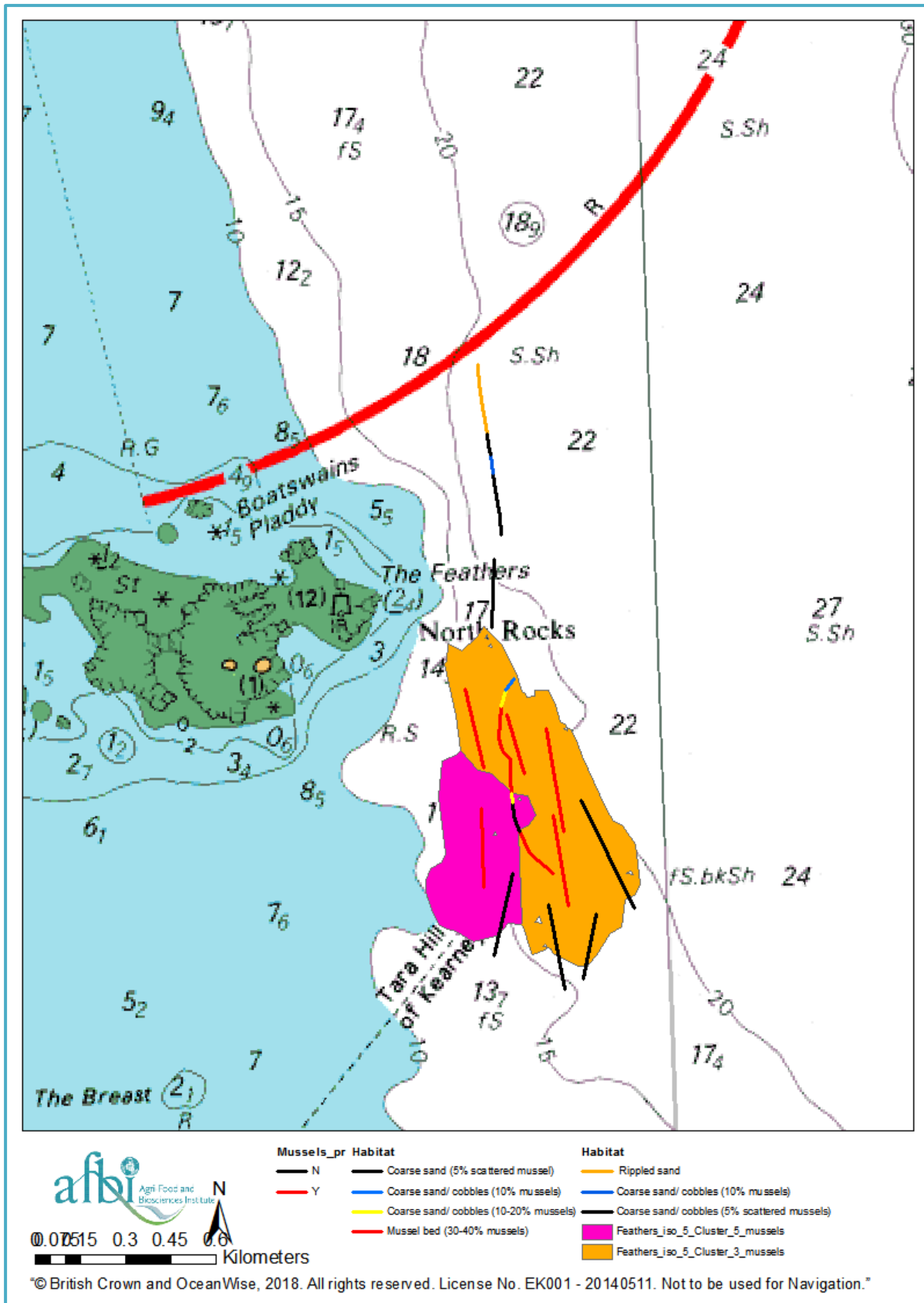
Figure 33: RoxAnn cluster map (from roughness and hardness values) from AFBI July 2018 survey of The Feathers showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 25th of July and the video tows undertaken on the 5th of July 2018. All red lines on the above map indicate the presence of seed mussels.
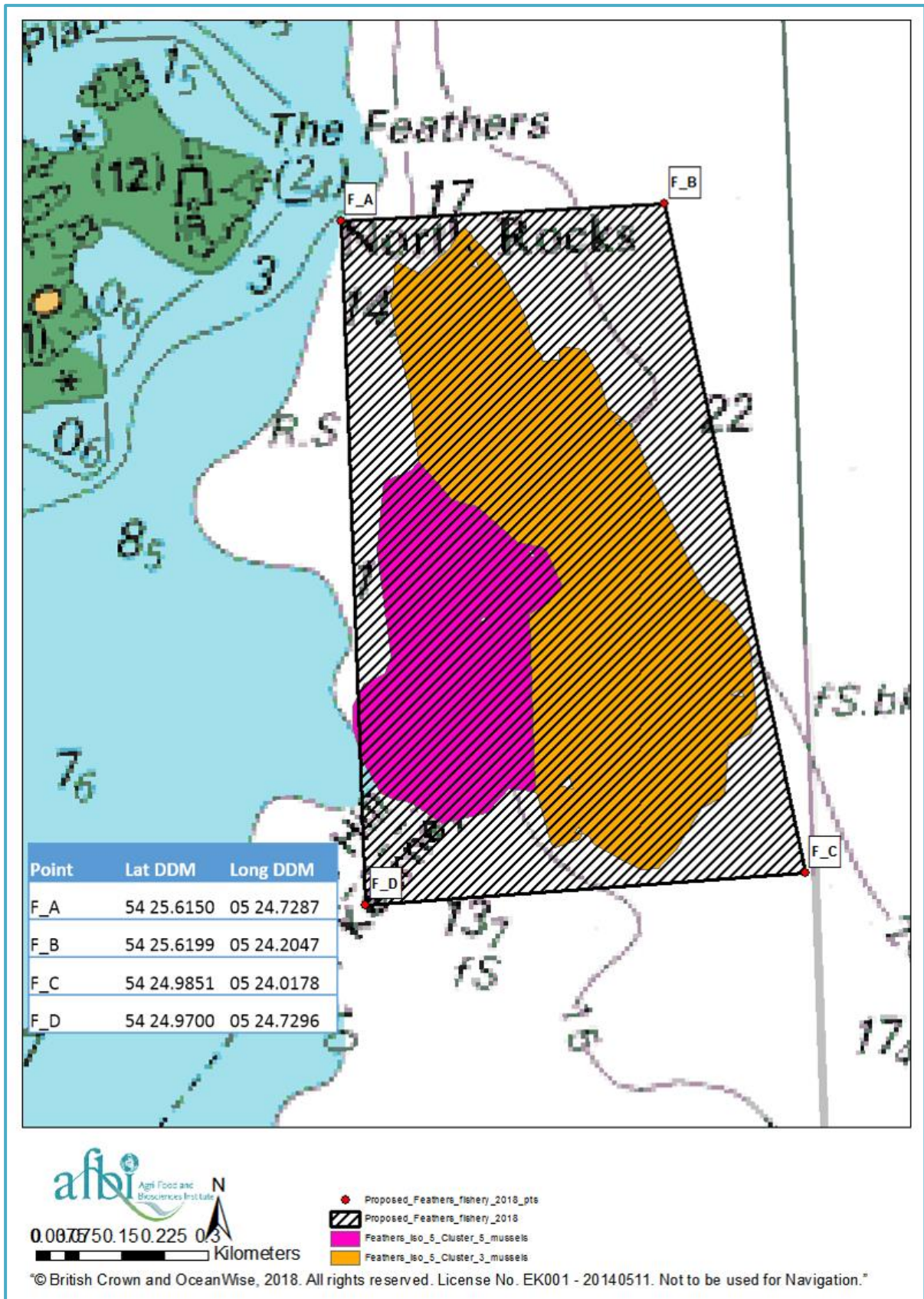
Point	Lat DDM	Long DDM
F_A	54 25.6150	05 24.7287
F_B	54 25.6199	05 24.2047
F_C	54 24.9851	05 24.0178
F_D	54 24.9700	05 24.7296

● Proposed_Feathers_fishery_2018_pts
▨ Proposed_Feathers_fishery_2018
■ Feathers_Iso_5_Cluster_5_mussels
■ Feathers_Iso_5_Cluster_3_mussels

Figure 34: RoxAnn cluster map (from roughness seed hardness values) from AFBI July 2018 survey of The Feathers, highlighting the area of Cluster 5 (pink area on map) and Cluster 3 orange area on map) that represents seed mussel. The proposed fishery area is shown by the black hashed area on the map.

References

Dolmer, P., Kristensen, P.S., and Hoffmann, E. 1999. Dredging of blue mussels (*Mytilus edulis* L.) in a Danish sound: stock sizes and fishery-effects on mussel population dynamic. Fisheries Research, 40: 73-80.

Strong, J.A. and Service, M. (2011) Using Optimum Allocation Analysis to Improve Seed Mussel Stock Assessments. *Journal of Shellfish Research* 30 (1): 1-6.

Turner, J. A., Hitchin, R., Verling, E., van Rein, H. 2016. Epibiota remote monitoring from digital imagery: Interpretation guidelines.