

OUTER ARDS SEED MUSSEL STOCK ASSESSMENT MAY 2016

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Introduction

The May 2016 seed mussel stock assessment survey was undertaken by the Agri-Food and Biosciences Institute on the 16th of May 2016 onboard the DAERA Fisheries Protection Vessel (FPV) Banrion Uladh. The current seed mussel stock assessment methodology has two stages. The first stage uses dredge tows only. If there are any significant amounts of juvenile *Mytilus edulis* present, a second acoustic and towed camera stage is undertaken to build on the initial ground truthing and provide a total area required for accurate stock assessment calculations. Previous surveys undertaken by AFBI in April 2016 identified two areas of potential seed mussel beds. The aim of the May 2016 survey was to undertake further acoustic and dredge surveys within these areas to enable the boundaries of these beds to be mapped and also to carry out dredge tows in areas not investigated in the previous survey. The areas covered within the May 2016 survey are shown in Figure 1, namely Donaghadee Sound, Craigbrain (the southern section of the survey area), Burial Island and the Feathers. The results of these surveys are detailed within the paragraphs below.

All care was taken to avoid areas within Craigbrain and Burial Island determined to contain live *Modiolus modiolus* within previously AFBI surveys.

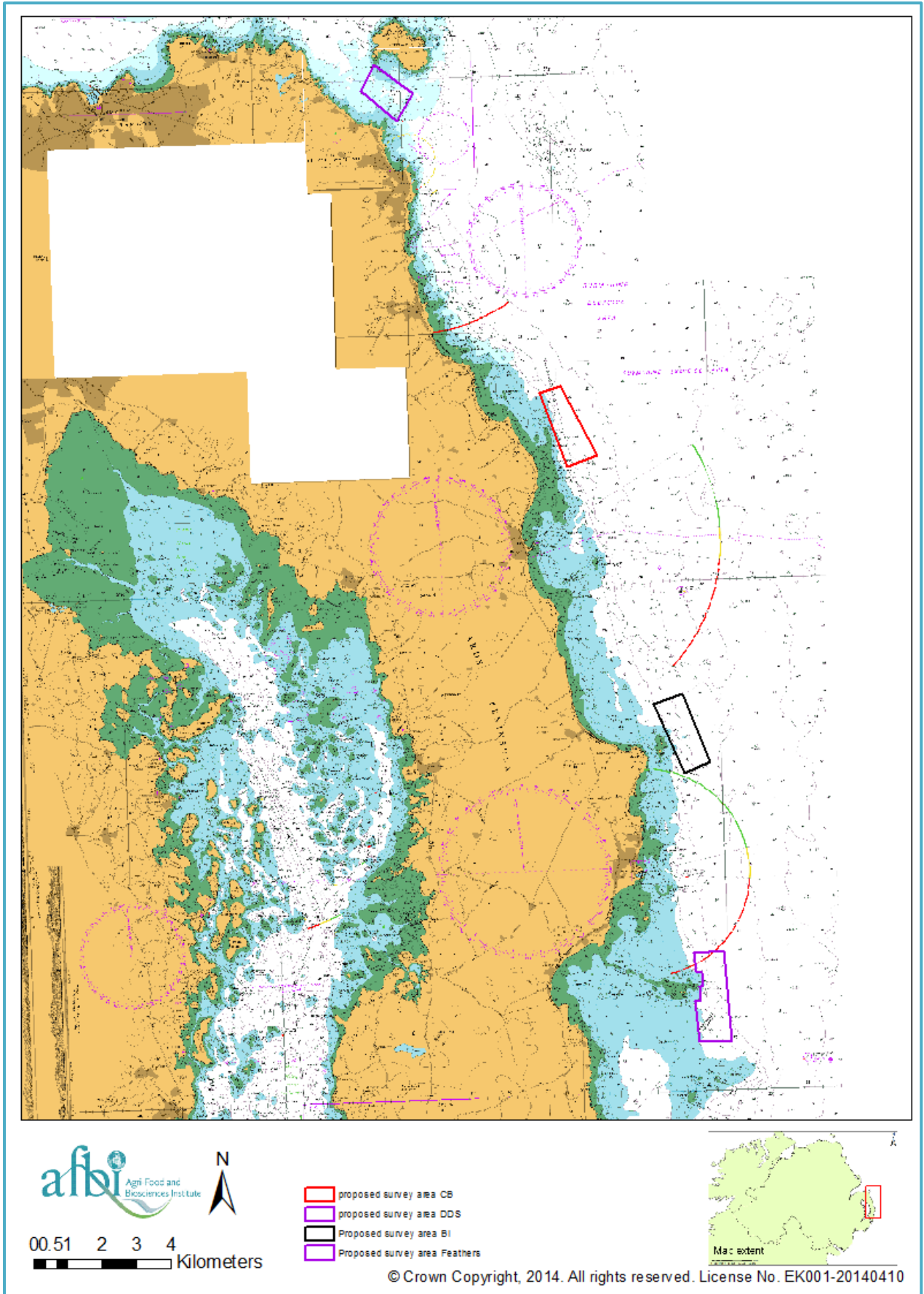


Figure 1: Survey locations for the May 2016 seed mussel stock assessment.

Materials and Methods

- *Survey methods*

The dredge survey was undertaken onboard the DAERA FPV Banrion Uladh, with four AFBI staff members onboard collecting samples and directing sampling effort. RoxAnn acoustic ground discrimination system (AGDS) data were also collected aboard the DAERA FPV Banrion Uladh using a 200kHz transducer. Data were collected at a save rate of 1s. Track spacing was approximately 100m.

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.

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 100m with inverse distance weighting method (to the power of 2), with a resulting grid cell size of 10 m². 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 data did not support classification to more than six classes at The Feathers or more than five classes at Burial Island. The classified raster grid was then converted to a shapefile for calculation of areas.

- *Laboratory Analysis*

Samples collected during the dredge survey 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)



Figure 2: Photograph showing the mussel dredge used during the May 2016 survey.

Results

Donaghadee Sound

Four dredge tows were undertaken within the area of Donaghadee Sound known to have previously yielded seed mussels (Figure 3). Large adult mussels were found within one of these tows (Figures 3 and 4, Tables 1 - 3).

- *Shellfish Processing*

The summary results from the mussel sample processing for the dredge tow that yielded mussels are shown in Tables 2 and 3 and the size class distributions of mussels are shown within Figure 5. As can be seen from Figure 5 the majority of the mussels found were within the 65.1 – 70.0 mm size range. As can be seen from Figure 4 and Table 2 the percentage waste contained within this sample was 58%.

Table 2: Seed mussel sample processing summary data: Donaghadee Sound 16/05/16

Total sample weight (kg)	1.04
Shellfish weight (kg)	0.43
% Waste	58.269
Pieces per kilo	48

Table 3: Seed mussel length measurement summary data: Donaghadee Sound 16/05/16.

Mussel length measurements (mm)				
Mean	Median	SD	min	max
66.027	66.37	4.068	57.33	72.08

SD= Standard Deviation from the mean

Craigbrain

Three dredge tows were undertaken within the area of Craigbrain (Figure 6). No seed mussel was found within any of these tows (Table 1).

Table 1: Dredge information from the 16th of May 2016 Outer Ards dredge survey. Only the dredge Tows whose contents were composed of greater than 15% mussels are shown as red lines on the corresponding maps (Figure 3: Donaghadee Sound, Figure 6: Craigbrian, Figure 7: Burial Island and Figure 11: The Feathers).

Date	site	Tow no.	Depth Start	Depth end	% fill	Mussels present	Estimated % Mussel from observations	Photo no.	Description
16/05/2016	Burial Island	T 1	18	18	50	Y	90	4529-4535	Seed mussel and mussel mud
16/05/2016	Burial Island	T 2	20	20	50	Y	<20	4635-4546	Broken shell gravel, dead Modiolus shell, some seed mussel
16/05/2016	Burial Island	T 3	18	19	33	Y	95	4547-4550	Seed mussel, some secondary settlement of seed
16/05/2016	Burial Island	T 4	21	18	60	Y	95	4551-4555	Seed mussel, dead shells, secondary settlement of seed
16/05/2016	The Feathers	T 1	20.0	18.4	25	Y	85	4556-4565	Seed mussel, starfish, some cobbles, secondary settlement of seed
16/05/2016	The Feathers	T 2	20.0	17.1	66	Y	80	4566-4577	Seed mussel ,broken shell gravel, some cobbles, secondary settlement of seed
16/05/2016	The Feathers	T 3	20.8	18.9	25	Y	60	4578-4589	Seed mussel, cobbles, some starfish, some secondary settlement of seed
16/05/2016	The Feathers	T 4	16.3	15.4	12.5	Y	40	4590-4595	Seed mussel, lots of cobbles and pebbles
16/05/2016	Craigbrian	T 1	24	24	50	N	N/A	4596-4601	Stones, gravel, cobbles, broken shell, dead Modiolus shell
16/05/2016	Craigbrian	T 2	21	22	33	N	N/A	4602-4606	Cobbles, dead shell, flustra, dead scallop shell, dead Modiolus shell, barnacles
16/05/2016	Craigbrian	T 3	25	25	70	N	N/A	4607-4611	Dead modiolus shell, dead shell, lots of brittle stars, dead scallop shell.
16/05/2016	Donaghadee Sound	T 1	12.4	13.3	10	N	N/A	4612-4618	Weed, cobbles, pebbles
16/05/2016	Donaghadee Sound	T 2	8.3	9.5	40	N	N/A	4619-4624	Weed, cobbles, pebbles
16/05/2016	Donaghadee Sound	T 3	11.2	12.0	25	Y	N/A	4625-4634	Adult mussels, cobbles, weed
16/05/2016	Donaghadee Sound	T 4	7.3	10.5	40	N	N/A	4635-4641	Weed, cobbles, stones

Burial Island

Four dredge tows were undertaken within the area of Burial Island known to have previously yielded seed mussel (Figures 7 to 9). Mussels were found within all of the dredge tows, however one of these tow contained less than 20% mussels (Figure 8, and Tables 1, 4 and 5). The processed RoxAnn cluster map for Burial Island is shown in Figure 10. As can be seen from Figure 10, five distinct clusters were identified for this area.

- *Shellfish Processing*

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 and the size class distributions for mussels within each of the dredges are shown within Figure 9. As can be seen from Figure 9 the majority of the mussels found within Tows 2 – 4 were within the 45.1 – 50.0 mm size class, whilst the majority of mussels measured within Tow 1 were within the 35.1 - 40.0 mm size class. As can be seen from Table 4 the percentage waste contained within these samples ranged from 41 % to 87 %.

Table 4: Seed mussel sample processing summary data: Burial Island 16/05/16

Tow No.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
T1	18.35	7.66	58.24	198
T2	17.69	2.35	86.72	168
T3	16.39	9.31	43.20	171
T4	15.92	9.47	40.53	180

Table 5: Seed mussel length measurement summary data: Burial Island 16/05/16

Tow No.	Mussel length measurements (mm)				
	Median	Mean	SD	min	max
T1	42.74	42.599	4.573	30.11	51.96
T2	47.31	46.945	4.124	37.54	57.40
T3	46.28	45.966	3.681	38.87	55.71
T4	45.26	45.575	3.955	35.83	55.26

SD= Standard Deviation from the mean

The Feathers

Four dredge tows were undertaken within the area of the Feathers known to have previously yielded seed mussel (Figure 11). Mussels were found within all these tows (Figures 11 - 13 and Tables 1, 6 and 7). The processed RoxAnn clusters for this area are shown in Figure 14. As can be seen from Figure 14, five distinct clusters were identified for this area.

- *Shellfish Processing*

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 and the size class distributions for seed mussels within each of the dredges are shown within Figure 13. As can be seen from Figure 13 the majority of the mussels found within these Tows were within the 40.1-45.0 mm size class. As can be seen from Figure 12 and Table 6, the percentage waste contained within all of the samples ranged from 48 to 88%.

Table 6: Mussel sample processing summary data: The Feathers 16/05/16.

Tow No.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
T1	11.655	6.020	48.348	202
T2	18.505	8.540	53.850	203
T3	11.915	2.630	77.927	204
T4	14.880	1.770	88.105	188

Table 7: Mussel length measurement summary data: The Feathers 16/05/16.

Tow No.	Mussel length measurements (mm)				
	Median	Mean	SD	min	max
T1	44.440	43.858	3.581	34.570	51.030
T2	43.935	43.953	3.452	35.790	51.520
T3	43.630	43.012	3.811	28.940	50.380
T4	43.105	42.916	5.133	30.580	53.690

SD= Standard Deviation from the mean

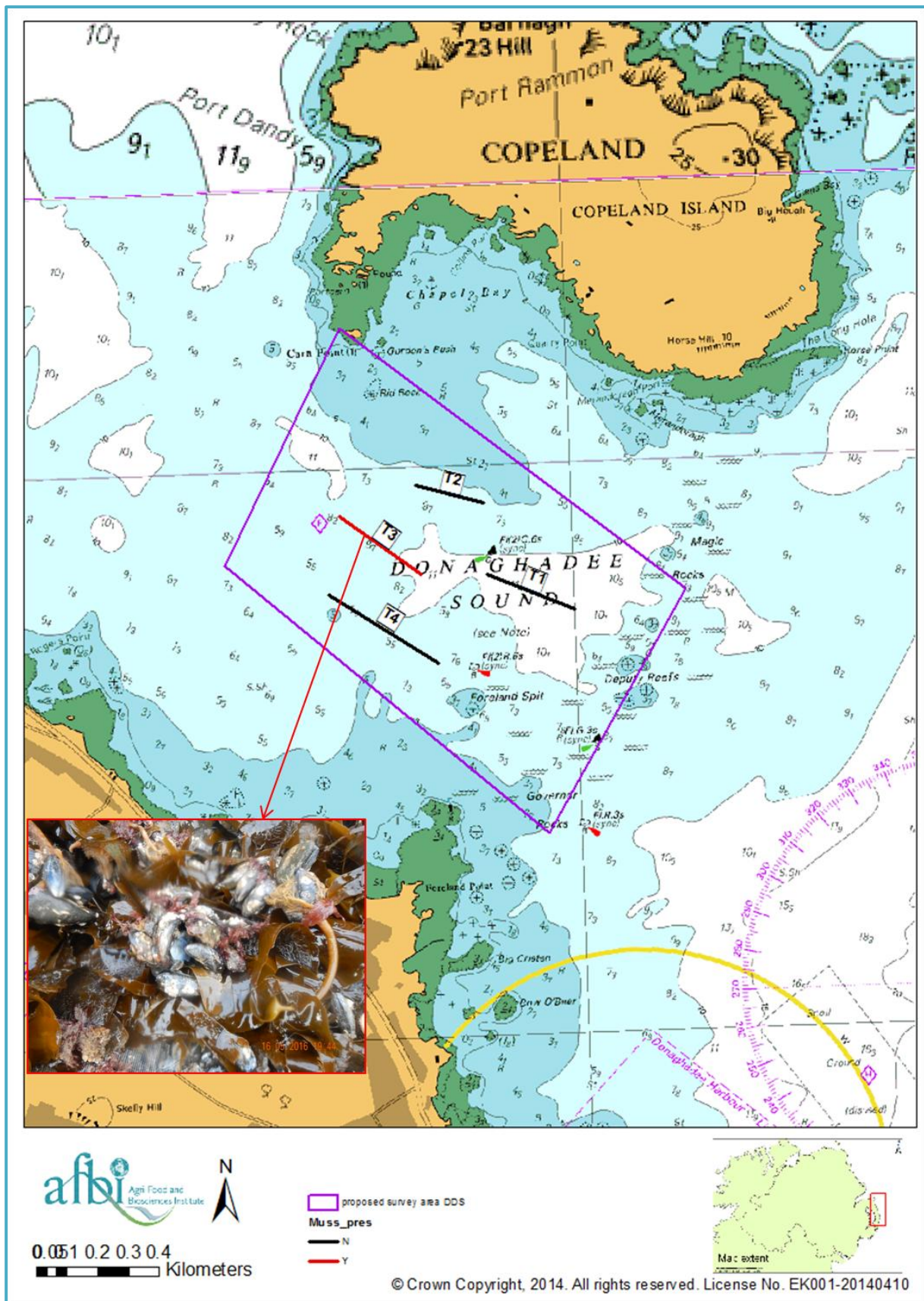


Figure 3: Location of Dredge Tows undertaken within Donaghadee Sound during the May 2016 seed survey. Dredges within which mussels were found are coloured red.

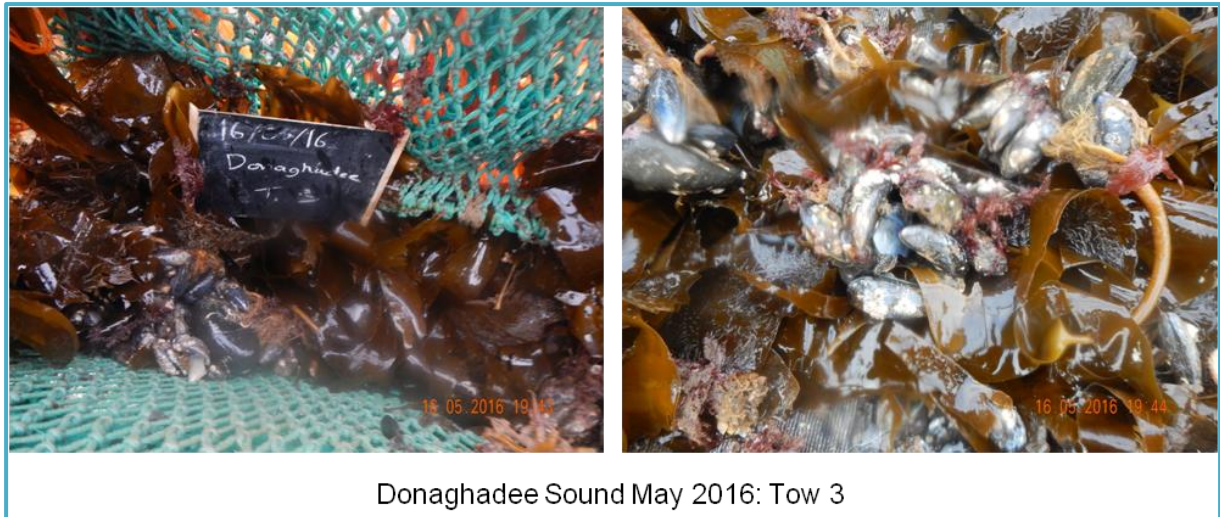


Figure 4: Photographs showing the contents of the dredge tow which yielded mussels undertaken within the area of Donaghadee Sound during the May 2016 seed mussel survey.

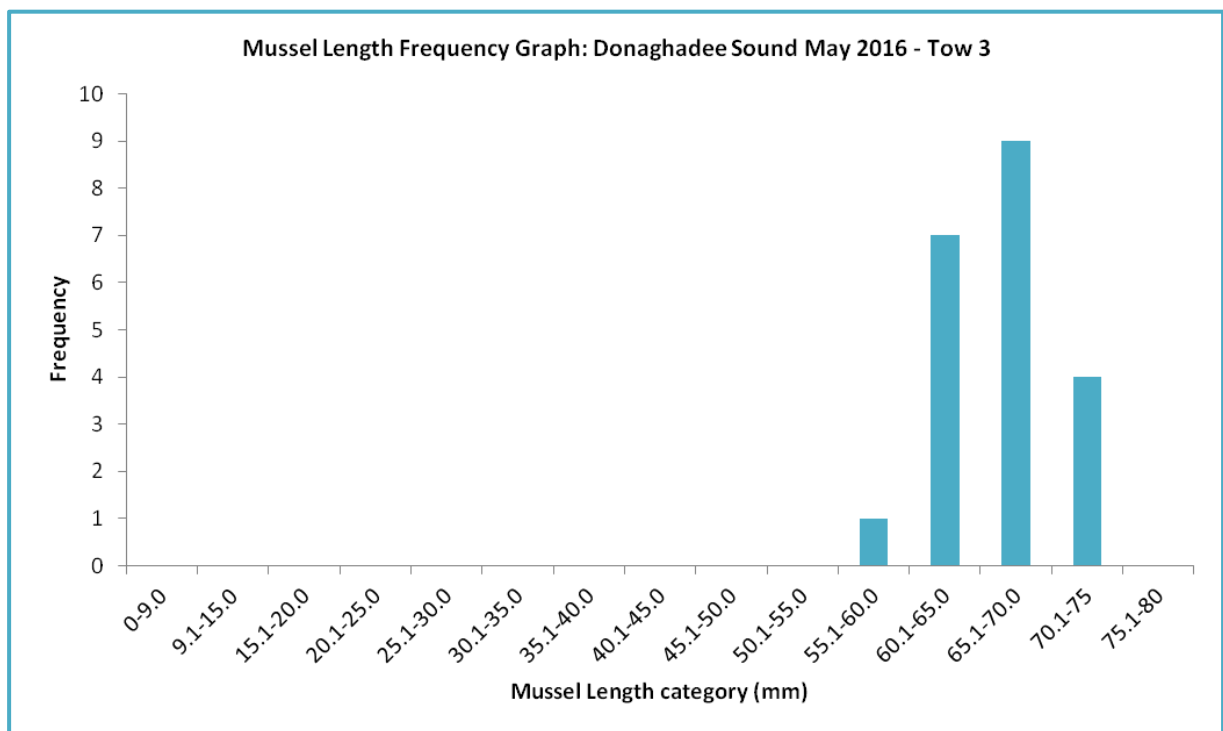


Figure 5: Length class distribution histogram for mussels found within dredge Tow 3 undertaken within the area of Donaghadee Sound during the May 2016 seed mussel survey.

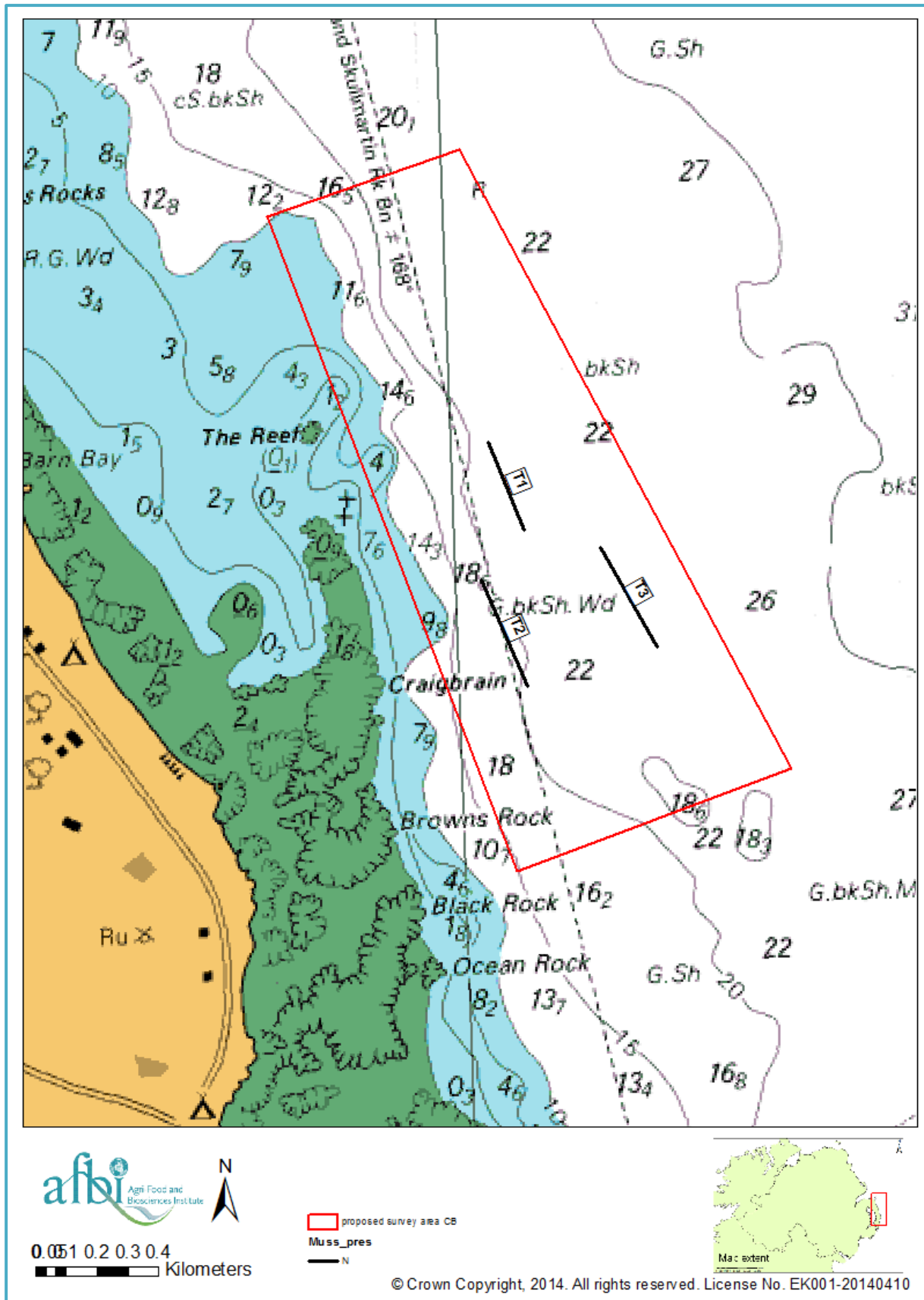


Figure 6: Location of dredge tows undertaken within the Craigbrain area during the May 2016 seed mussel survey.

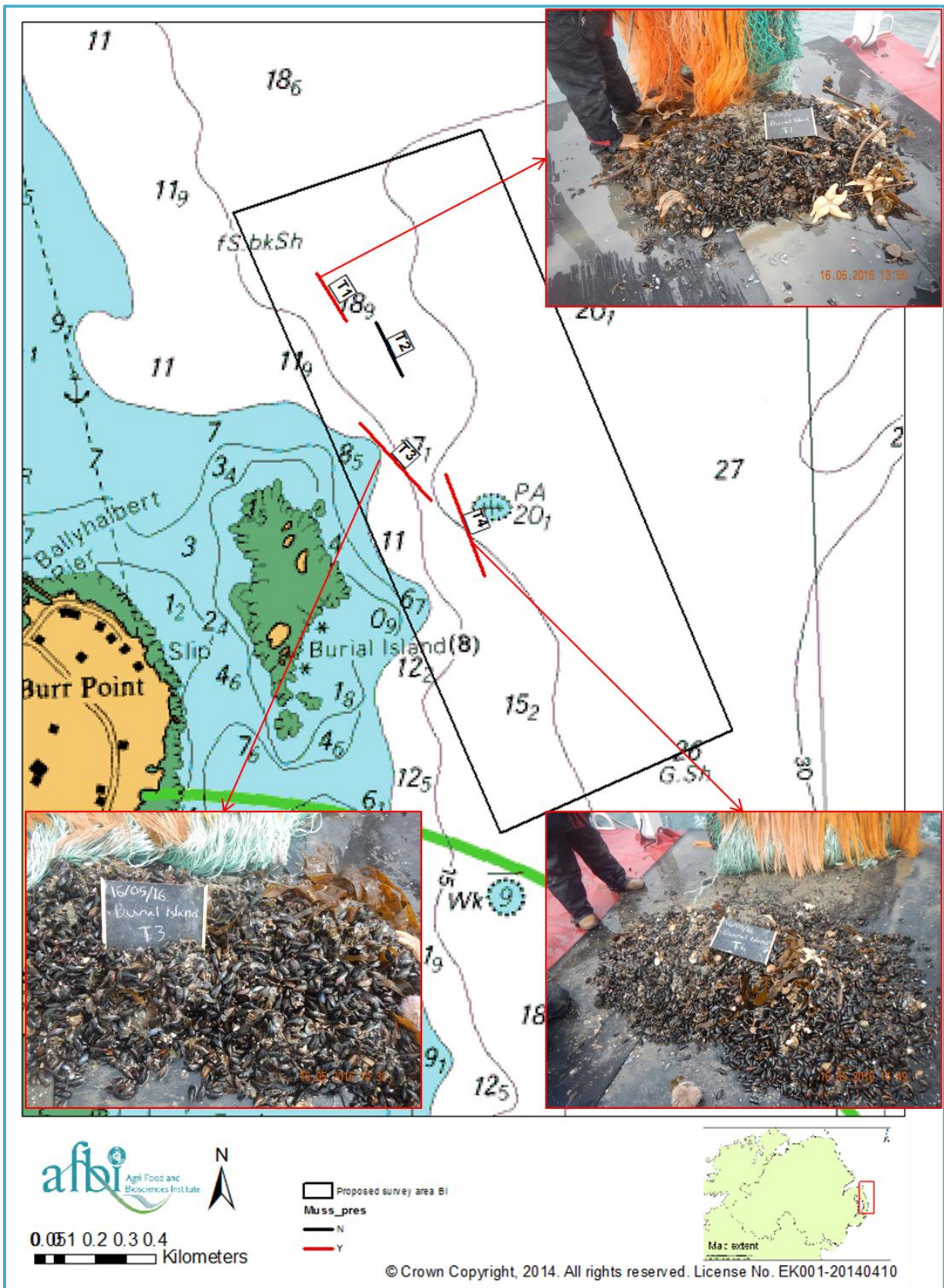


Figure 7: Location of dredge tows undertaken within the Burial Island area during the May 2016 seed mussel survey.



Figure 8: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Burial Island during the May 2016 seed mussel survey.

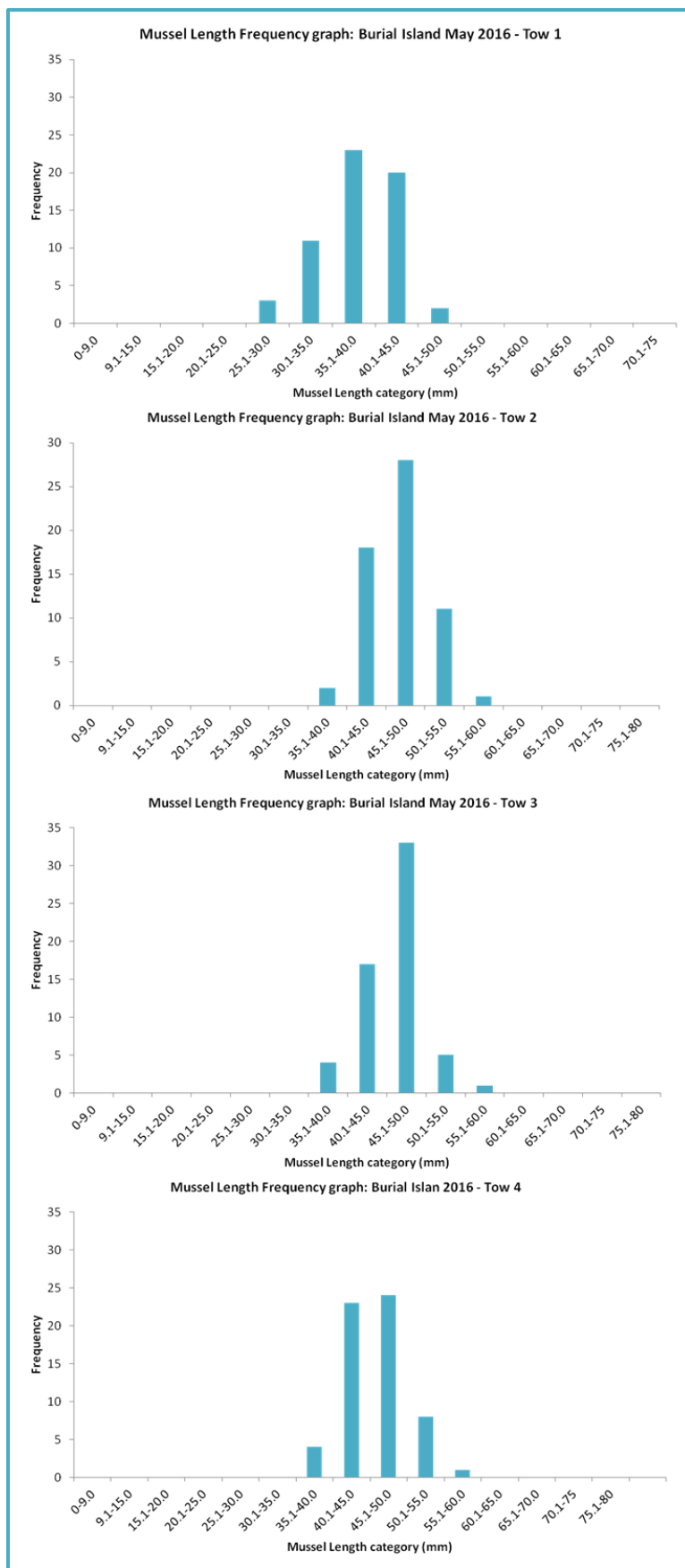


Figure 9: Length class distribution histograms for mussels found within the dredge Tows undertaken within the area of Burial Island the May 2016 seed mussel survey.

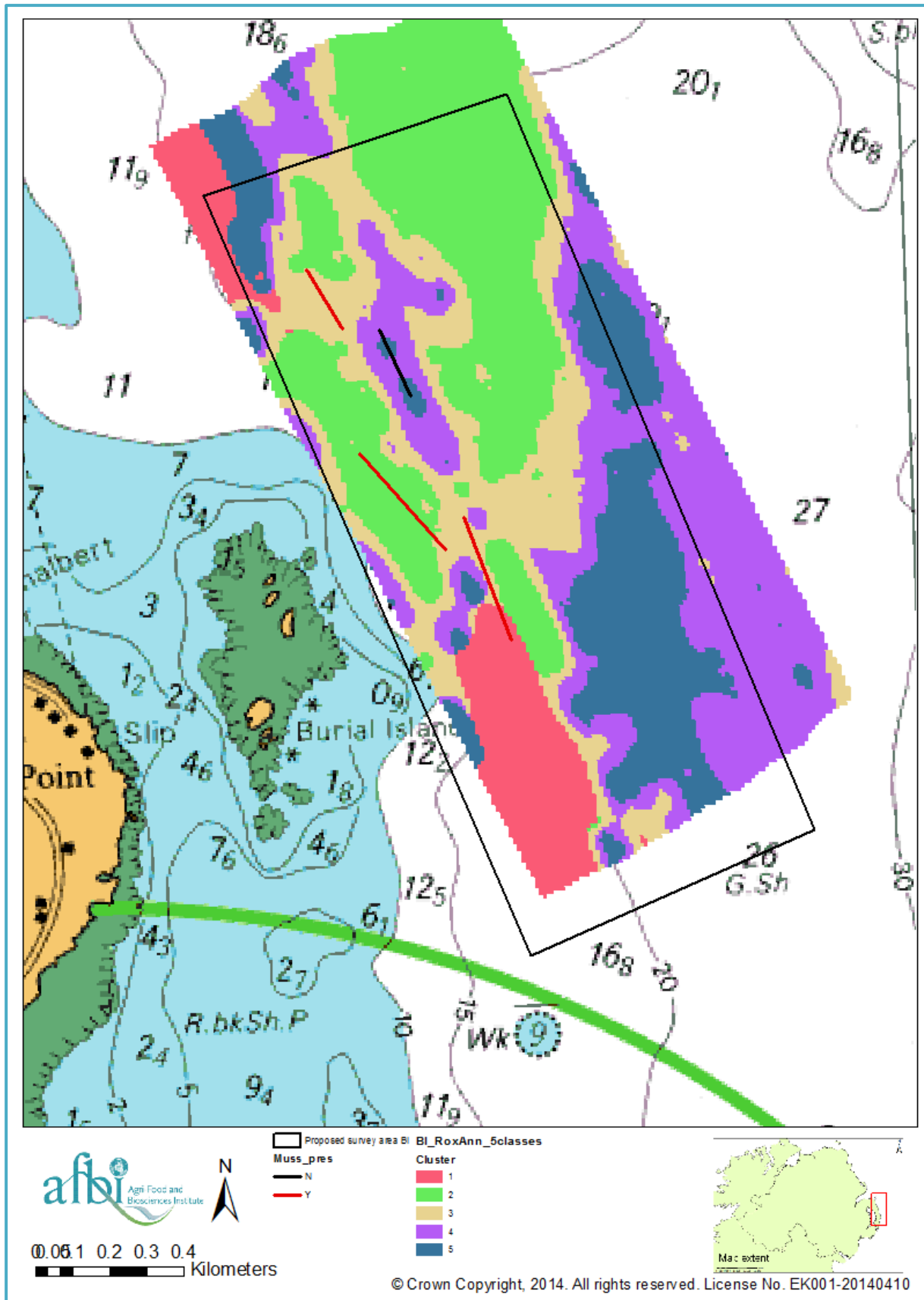


Figure 10: RoxAnn cluster map (from roughness and hardness values) from the May 2016 survey of Burial Island overlaid with the dredge Tows from the May 2016 survey.

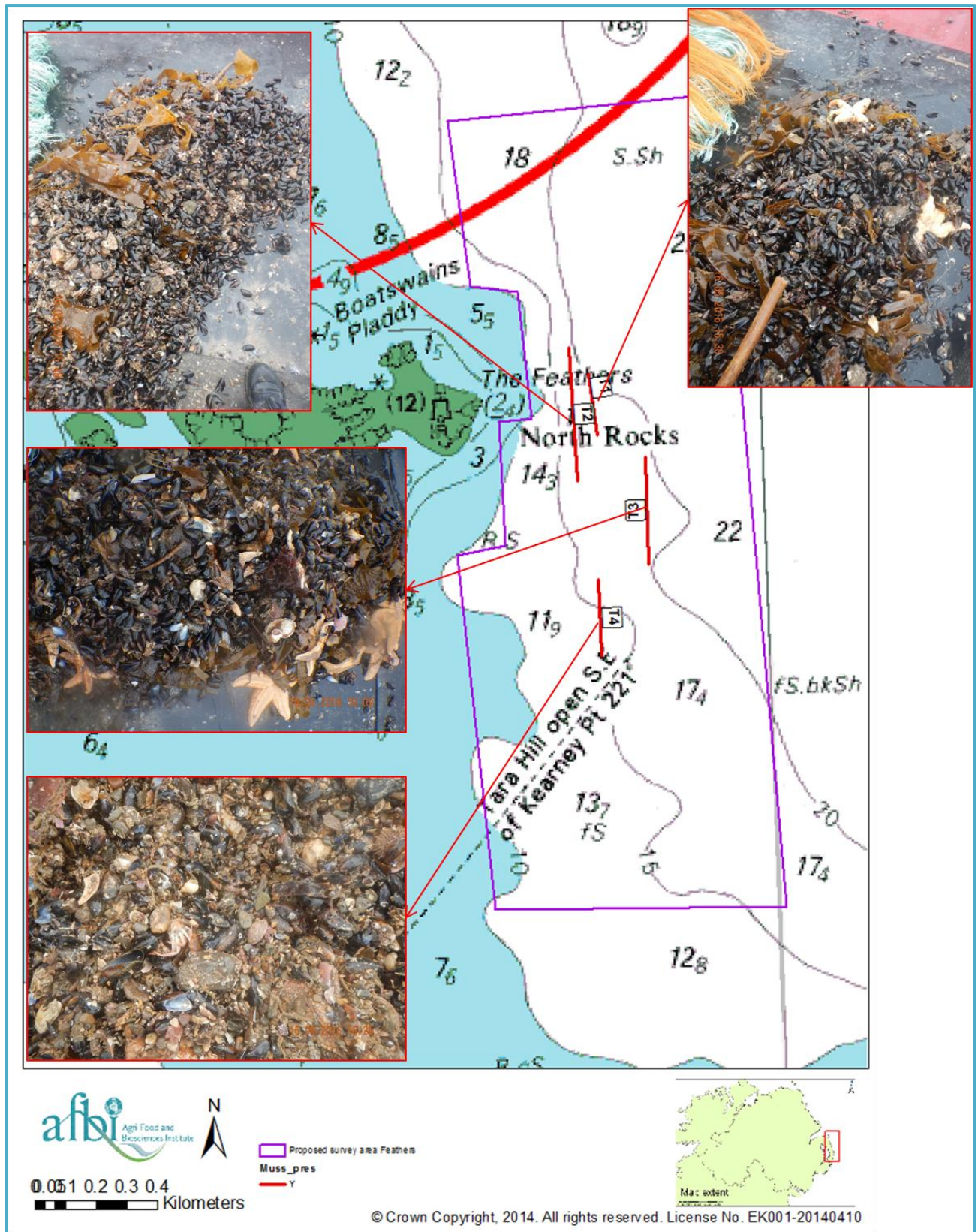


Figure 11: Location of dredge tows undertaken within the Feathers area during the May 2016 seed mussel survey.



Figure 12: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of The Feathers during the May 2016 seed mussel survey.

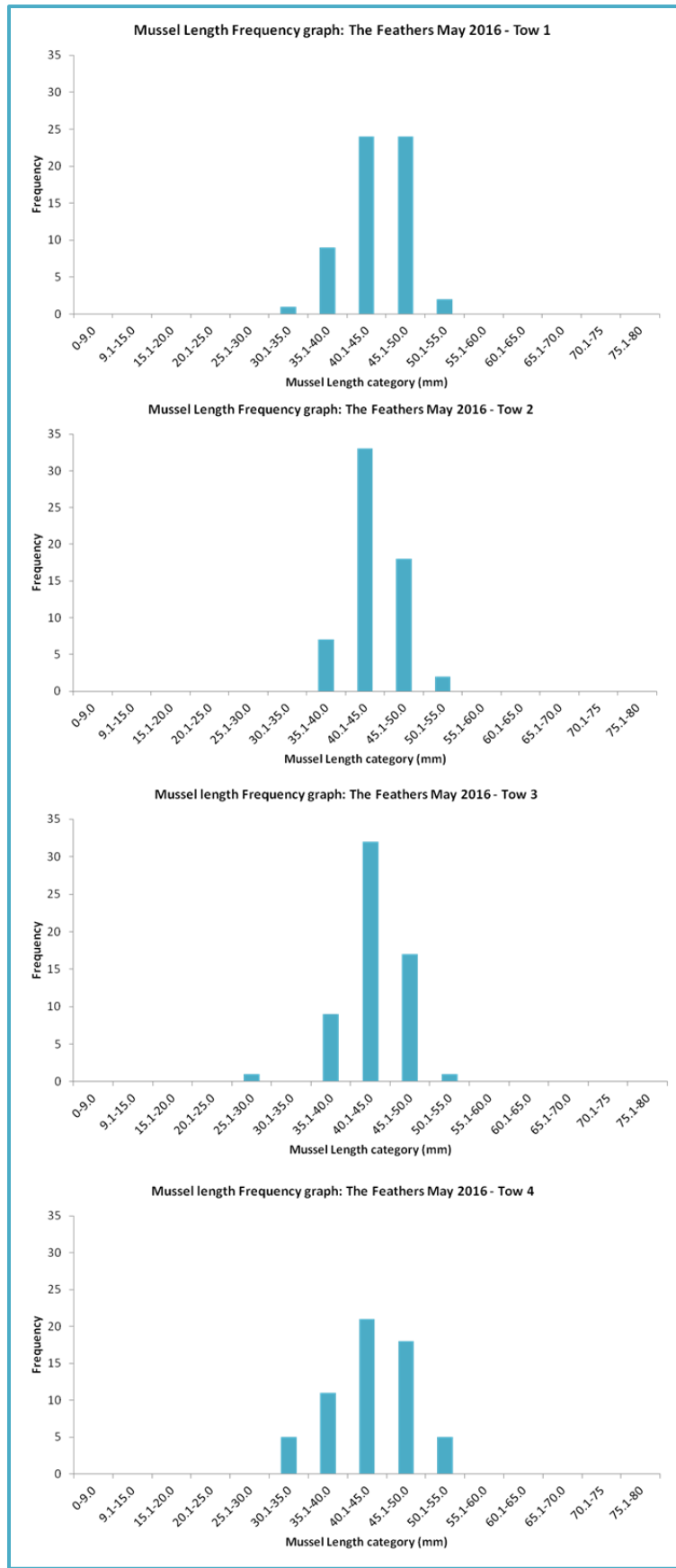


Figure 13: Length class distribution histograms for mussels found within the dredge Tows undertaken within the area of The Feathers during the May 2016 seed mussel survey.

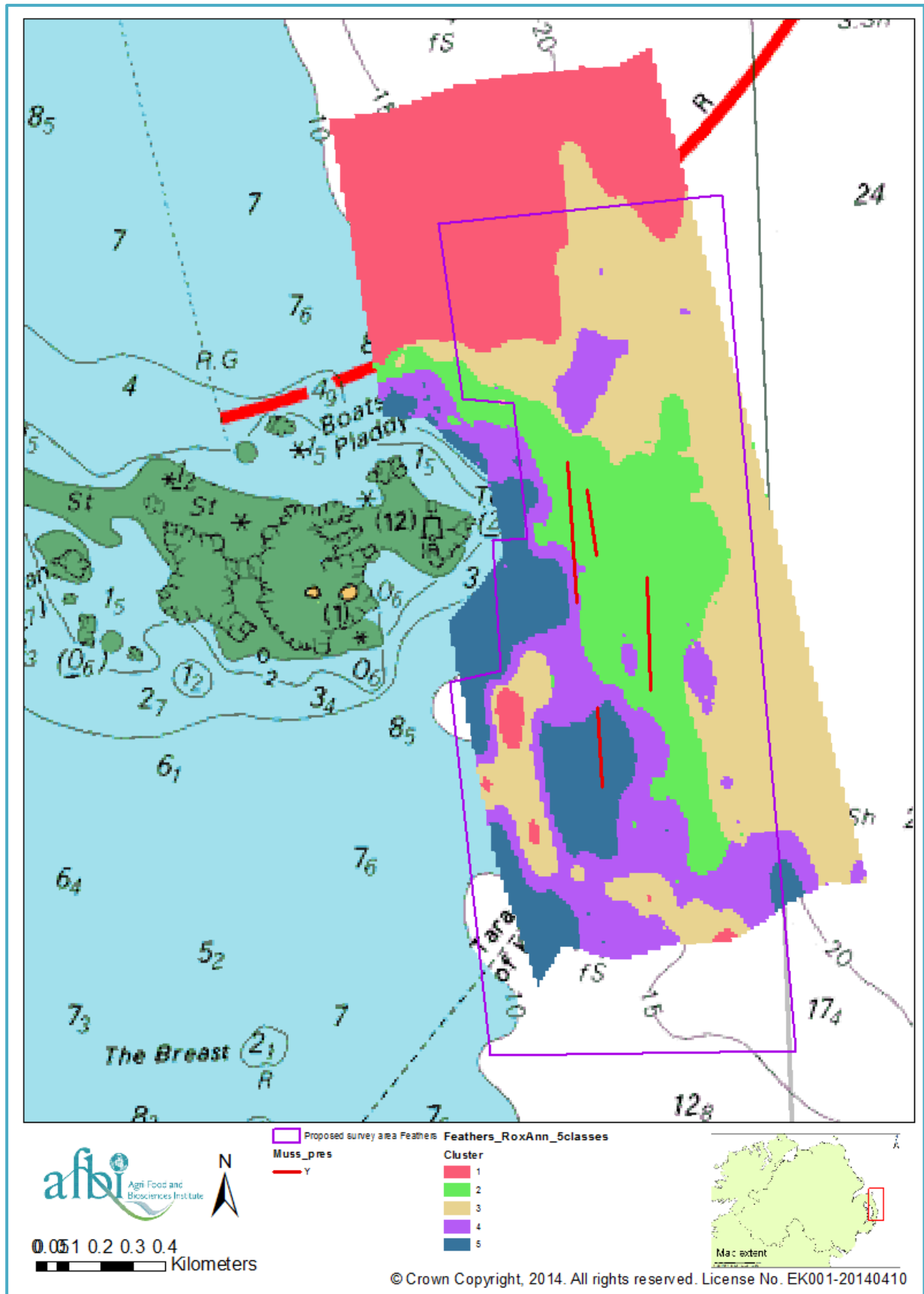


Figure 14: RoxAnn cluster map (from roughness and hardness values) from the May 2016 survey of The Feathers overlaid with the dredge Tows from the May 2016 survey.

Discussion

Burial Island

Following acoustic and ground truthing surveys (dredge and towed video) undertaken in April and May 2016 an area of seed mussels was identified within Burial Island (Figure 15). A portion of the areas identified as Cluster 2 and Cluster 3 was found to correspond to seed mussel (Figure 15). It is believed that Cluster 2 contains the more dense areas of seed mussel. Following the application of OAA (Strong and Service, 2011) the area of Clusters 2 and 3 that was required to be sampled in order to ensure accurate stock assessment calculations was determined. In order to determine the stock of seed mussels present within the Feathers 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 (1.5 m).
- 3) Dredge percentage 'fill' was assessed afloat – this was converted to a weight based on a dredge holding 250 kg when full).
- 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 m²) 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).

The ground truthing surveys determined that the outer portion of Cluster 2 did not contain mussels, which has been attributed to the depth within this region. Mussel tonnages were calculated for the area of Clusters 2 and 3 determined to contain mussels (Figure 16).

It should be noted that the seaward edge of the Fishery area (from points 2 to 3 on Figure 16) has been constrained by the buffer applied during the 2015 Assessments to allow protection of the adjacent *Modiolus modiolus* beds.

From all the information collected during the April and May 2016 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 16, contains approximately 420 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 in April and May 2016 an area of seed mussels was identified within The Feathers (Figure 17). A portion of the areas identified as Cluster 2 and Cluster 4 was found to correspond to seed mussel (Figure 17). It is believed that Cluster 2 contains the more dense areas of seed mussel. Following the application of OAA (Strong and Service, 2011) the area of Clusters 2 and 4 that was required to be sampled in order to ensure accurate stock assessment calculations was determined. In order to determine the stock of seed mussels present within the Feathers area, calculations described above (as per Strong and Service, 2011) were applied.

Mussel tonnages were calculated for the area of Clusters 2 and 4 determined to contain mussels (Figure 18).

From all the information collected during the April and May 2016 surveys (utilising the calculations, as per Strong and Service, 2011) we can therefore approximate that the Feathers Seed Fishery Area, as shown within Figure 18, contains approximately 210 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.

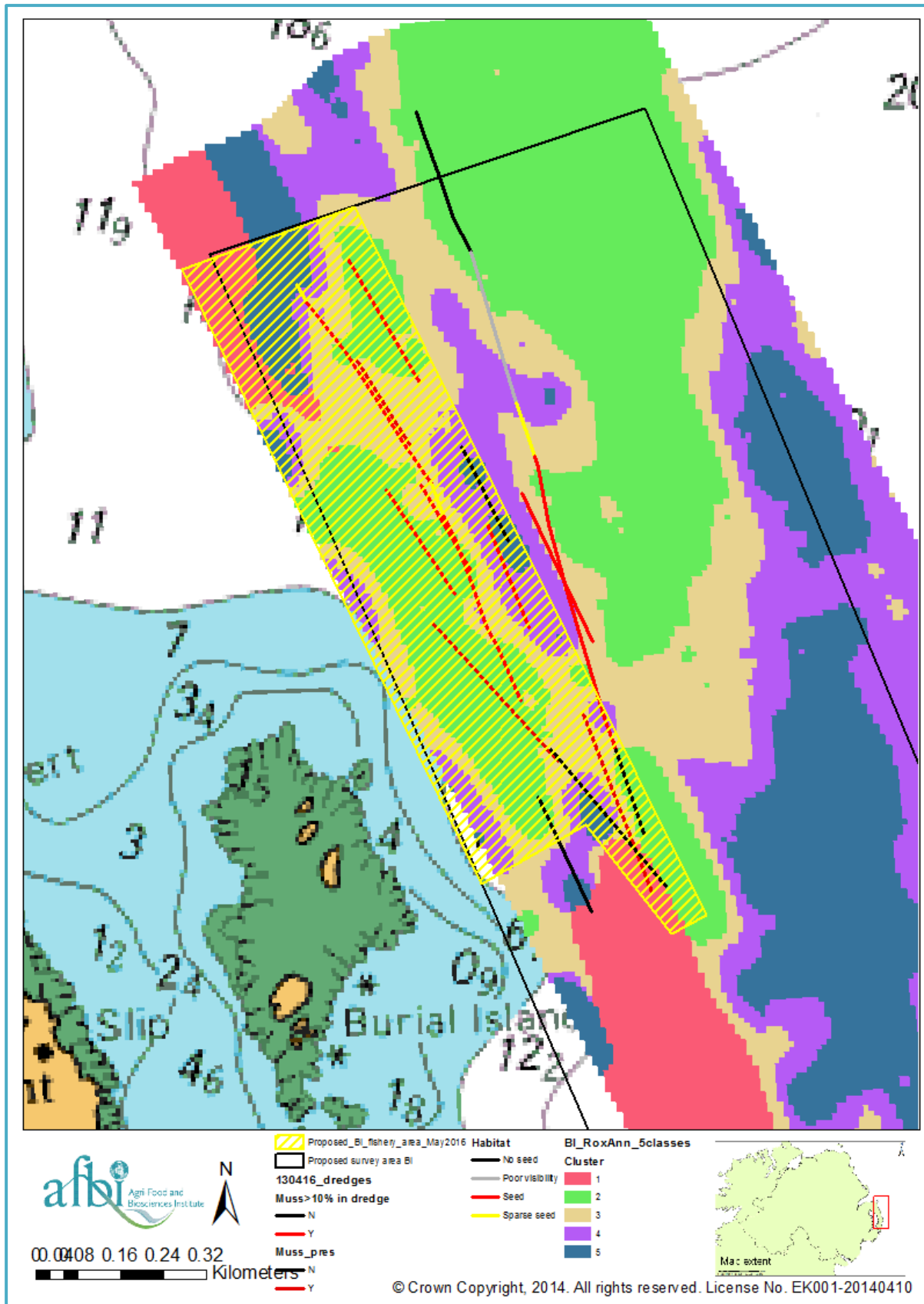


Figure 15: RoxAnn cluster map (from roughness and hardness values) from AFBI May 2016 survey of Burial Island, highlighting the area identified as containing seed mussels (Yellow hashed box on map).

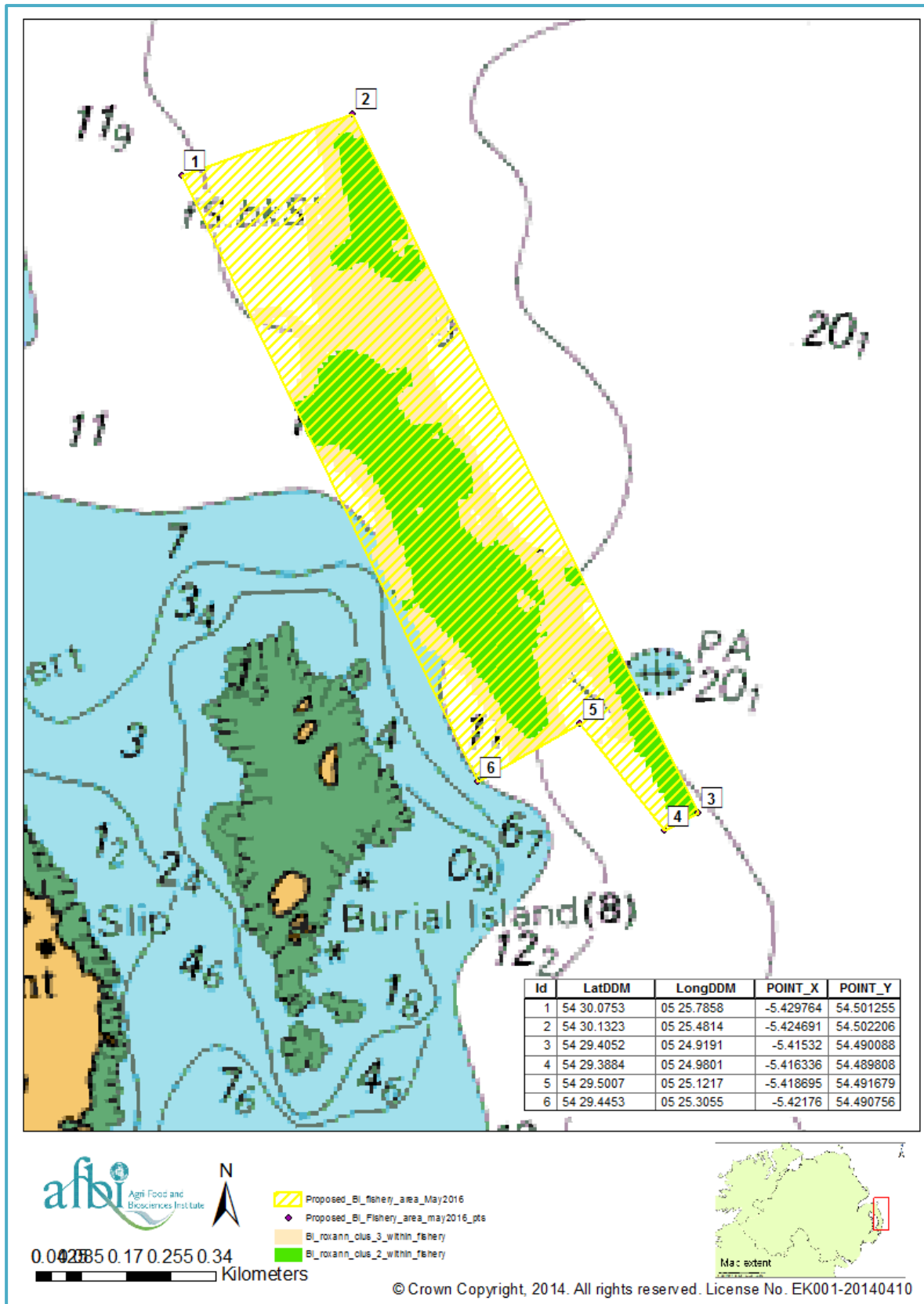


Figure 16: RoxAnn cluster map (from roughness and hardness values) from AFBI May 2016 survey of Burial Island, highlighting the area of Cluster 2 (green area on map) and Cluster 3 (light brown area on map) that represents seed mussel.

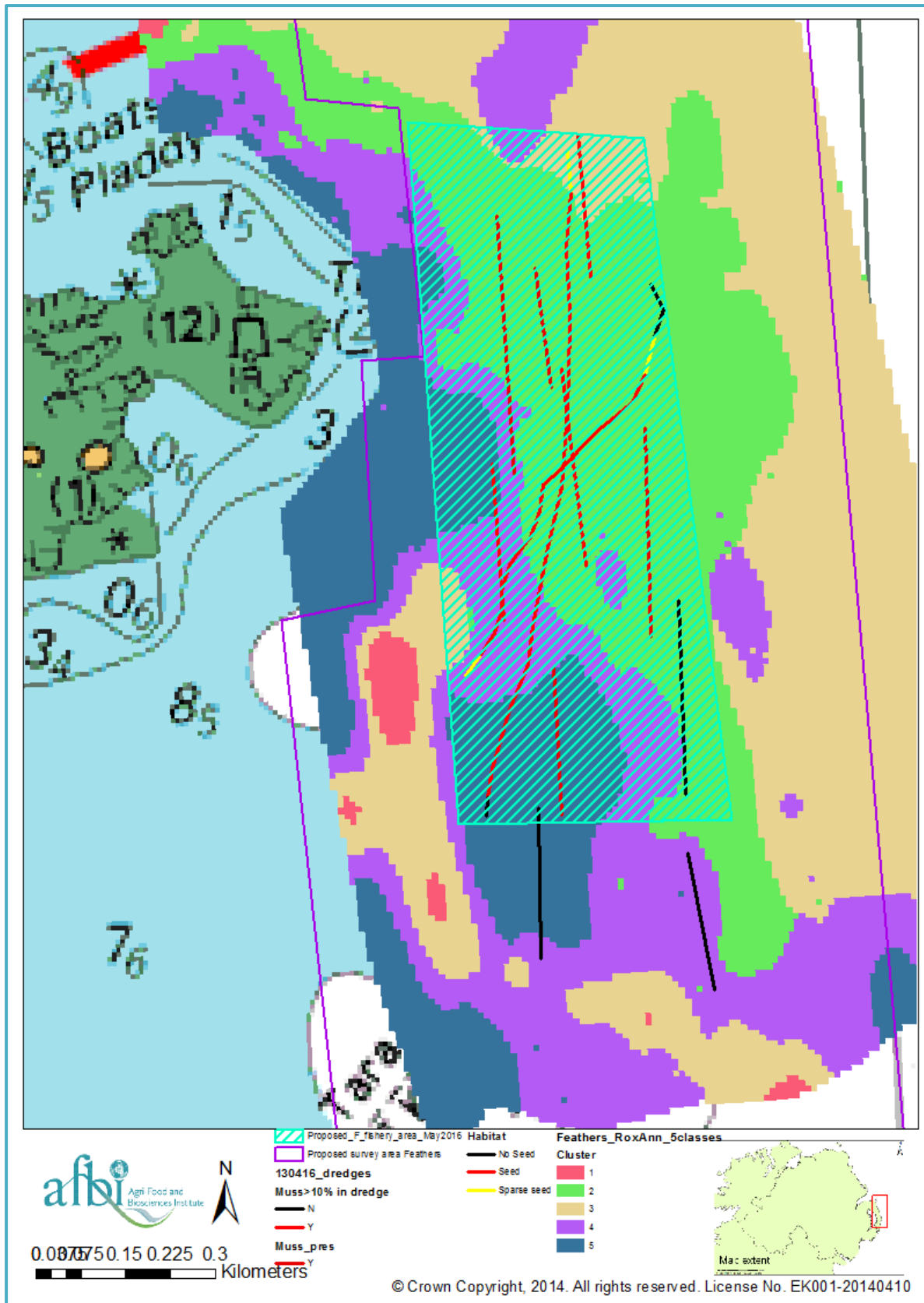


Figure 17: RoxAnn cluster map (from roughness and hardness values) from AFBI May 2016 survey of The Feathers, highlighting the area identified as containing seed mussels (turquoise hashed box on map).

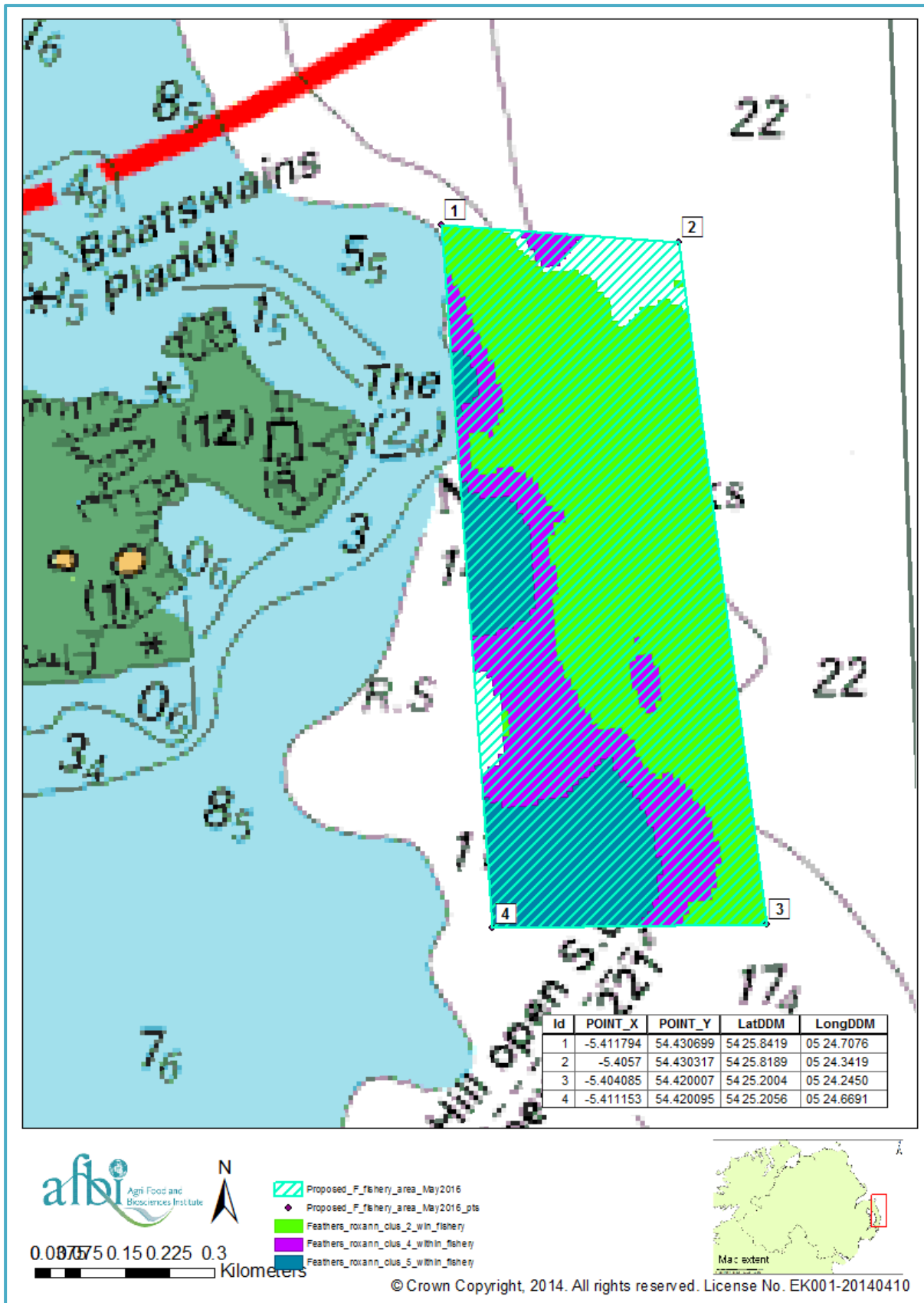


Figure 18: RoxAnn cluster map (from roughness and hardness values) from AFBI May 2016 survey of The Feathers, highlighting the area of Cluster 2 (green area on map) and Cluster 4 (purple area on map) that represents seed mussel.

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.