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Outer Ards Seed mussel Stock Assessment survey

June/July 2017

Prepared by
AFBI Fisheries and Aquatic Ecosystems Branch
2017

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Introduction

The June/July 2017 seed mussel stock assessment survey was undertaken by the Agri-Food and Biosciences Institute on the 13th of June and the 3rd of July on-board the DAERA Fisheries Protection Vessel (FPV) Queen of Ulster and on the 7th of July on-board the AFBI Research Vessel Corystes. The current seed mussel stock assessment methodology has two stages. The first stage uses acoustic surveys and dredge tows. If significant amounts of juvenile *Mytilus edulis* are found, a second towed camera stage is undertaken to build on the initial ground truthing. The purpose of the June/July 2017 seed mussel stock assessment survey was to undertake acoustic and dredge surveys within areas identified within the Spring 2017 Seed mussel stock assessment survey as potential seed mussel beds and also to undertake further video surveys if large mussel beds are identified. The areas covered within this survey are shown in Figure 1, and are the previously fished areas of Burial Island, Skullmartin and the Feathers. The results of all of these surveys are detailed within the paragraphs below.

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

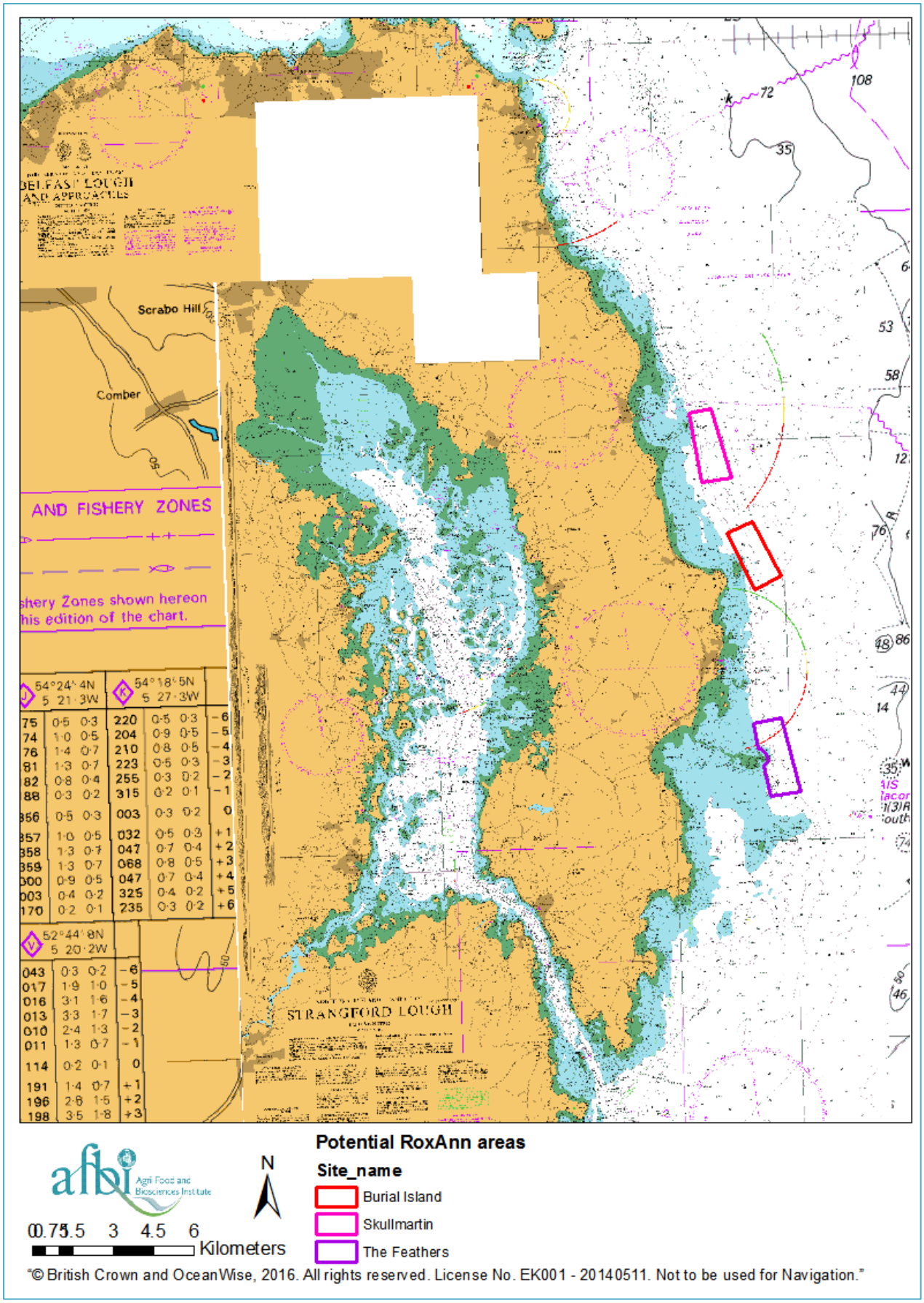


Figure 1: Survey locations for the spring 2017 seed mussel stock assessment.

Materials and Methods

- *Survey methods*

Acoustic Survey

RoxAnn acoustic ground discrimination system (AGDS) data were collected aboard the DAERA FPV Queen of Ulster on the 13th of June 2017, using a 200 kHz transducer. Data were collected at a save rate of 1s. Track spacing was approximately 100 m for Skulmartin, Burial Island and the Feathers.

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

1. Data artefacts (caused by bubbles beneath transducer) and data from all turns at the end of survey lines removed.
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 for Skullmartin, Burial Island and The Feathers, 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.

Dredge survey

The dredge survey was undertaken onboard the DAERA FPV Queen of Ulster on the 3th of July 2017, with three AFBI staff members onboard collecting samples and directing sampling effort.

Dredging was conducted using a custom oyster dredge (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 7th of July 2017. Camera footage of the seabed was collected with a towed epibenthic video sledge equipped with an Osprey video camera, coupled with two halogen lights, strip and point lasers for scaling, and a USBL system (Figure 3). Camera tows were between 1 and 2 km in length, towed at a speed of 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) Mussels 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 June/July 2017 survey.

Figure 3: Photograph showing the AFBI camera sledge used during the July 2017 surveys. This photograph was taken during the June 2016 survey.

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.

Twelve dredge tows were undertaken on the 3rd of July 2017 within the area of Skullmartin known to have previously yielded seed mussels (Figure 5). Mussels were found within seven of these tows (Figures 5, 6 and 7, and Tables 1 - 3). As can be seen with Figure 5 mussels were confined to the dredges undertaken within RoxAnn Cluster 2 (orange areas on Figure 5) and RoxAnn Cluster 3 (Green areas on Figure 5). 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 and the size class distributions for mussels within each of the dredges are shown within Figure 7. The mussel length data was then grouped per RoxAnn cluster. Figure 8 shows the size class distributions for mussels found within each RoxAnn cluster. As can be seen from Figure 8 the majority of the mussels found within the Skullmartin area were within the 30.1 - 35.0 mm size class. No mussels greater than 40.0 mm were found within RoxAnn Cluster 3, whilst mussels were found within the 55.1 – 60.0 mm size class within RoxAnn cluster 2. As can be seen from Table 2 the percentage waste (by weight) contained within these samples ranged from 63 % to 95%.

The video survey was planned based on the findings of the RoxAnn and dredge surveys. The towed video survey transects undertaken within the area of Skullmartin on the 7th of July 2017 are shown on Figure 9. Figure 10 shows the habitats identified along these tows. Percentage cover of blue mussels (*Mytilus edulis*) and abundance of blue mussels and starfish (*Asterias rubens*) was determined as per Turner *et al* (2016) (shown in Figures 11 and 12 respectively).

Burial Island

The processed RoxAnn cluster map for Burial Island 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 all six of these clusters.

Eleven dredge tows were undertaken on the 3rd of July 2017 within the area of Burial Island known to have previously yielded seed mussels (Figure 14). Mussels were found within seven of these tows (Figures 14, 15 and 16, and Tables 1, 4 and 5). As can be seen with Figure 14

mussels were confined to the dredges undertaken within RoxAnn Cluster 2 (light blue areas on Figure 14) and RoxAnn Cluster 3 (orange areas on Figure 14). 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 16. The mussel length data was then grouped per RoxAnn cluster. Tow 20 spanned three clusters and so was not included within these length frequency histograms. Figure 17 shows the size class distributions for mussels found within each RoxAnn cluster. As can be seen from Figure 17 the majority of mussels found within this area were within the 30.1 – 35.0 mm size class. Mussels larger than 50.0 mm in length were found within RoxAnn cluster 3 but not within RoxAnn cluster 2. As can be seen from Table 4 the percentage waste (by weight) contained within these samples ranged from 45% to 83%.

The video survey for this area was planned based on the findings of the RoxAnn and dredge surveys. The towed video survey transects undertaken within the area of Burial Island on the 7th of July are shown on Figure 18. Figure 19 shows the habitats identified along these tows. Percentage cover of blue mussels (*Mytilus edulis*) and abundance of blue mussels and starfish (*Asterias rubens*) was determined as per Turner *et al* (2016) (shown in Figures 11 and 12 respectively).

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.

Eleven dredge tows were undertaken on the 3rd of July 2017 within the area of The Feathers known to have previously yielded seed mussels (Figure 21). Mussels were found within four of these tows (Figures 21, 22 and 23 and Tables 1, 6 and 7). As can be seen with Figure 21 mussels were confined to the dredges undertaken within RoxAnn Cluster 2 (orange areas on Figure 21) and RoxAnn Cluster 5 (dark blue areas on Figure 21). 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 mussels within each of the dredges are shown within Figure 23. The mussel length data was then grouped per RoxAnn cluster. Figure 24 shows the size class distributions for mussels found within each RoxAnn cluster. As can be seen from Figure 24 the majority of the mussels found within this area were within the 25.1 – 30.0 mm and 30.1 – 35.0 mm size classes. As can be seen from Table 6 the percentage waste (by weight) contained within these samples ranged from 35% to 78%.

The video survey for this area was planned based on the findings of the RoxAnn and dredge surveys. The towed video survey transects undertaken within the area of The Feathers on the 7th of July 2017 are shown on Figure 25. Figure 26 shows the habitats identified along these tows. Percentage cover of blue mussels (*Mytilus edulis*) and abundance of blue mussels and starfish (*Asterias rubens*) was determined as per Turner *et al* (2016) (shown in Figures 11 and 12 respectively).

Table 1: Dredge information from the 3rd of July 2017 Outer Ards dredge survey.

Tow No.	Location	Depth start (m)	Depth end (m)	Description	Est % fill	Mussel
T1	The Feathers			NA	0	N
T2	The Feathers		21.5	Dredge almost empty	<1	N
T3	The Feathers	16.5	15.1	Dredge filled with fine sand which washed out as being brought onboard.	<1	N
T4	The Feathers	24.4	26.6	Dead shells and crabs	<5	N
T5	The Feathers	24.6	24	Mussels with a few cobbles	80	Y
T6	The Feathers	22.4	21.2	Seed mussels with some mud	85	Y
T7	The Feathers	22	20.6	mussels and a few cobbles	50	Y
T8	The Feathers	26.1	26.1	Broken dead shells and pebbles	25	N
T9	The Feathers	23.4	22.8	cobbles with barnacles	<5	N
T10	The Feathers	20.7	20	Cobbles and crabs	<5	N
T11	The Feathers	17	18.1	mussels with gravel and pebbles	50	Y
T12	The Feathers	14.7	13.1	cobbles with kelp	<5	N
T13	Burital Island	28	27.3	Shell gravel with cobbles and pebbles	<10	N
T14	Burital Island	26	25.8	Brittlestars and dead modiolus shell	50	N
T15	Burital Island	17.6	20.6	Dredge almost empty	<1	N
T16	Burital Island	17.8	19.6	Seed mussel, pebbles and shell gravel	50	Y
T17	Burital Island	25.3	23.7	Seed mussels with a few pebbles	50	Y
T18	Burital Island	18.9	19.7	Mussels and mud	80	Y
T19	Burital Island	19		Mussels and mud	60	Y
T20	Burital Island	22.5	22.4	Mussels, shell gravel and brittlestars	85	Y
T21	Burital Island	19.8	20.6	Mussels and dead shells	50	Y
T22	Burital Island	20.3	21.8	Mussels and shell gravel	50	Y
T23	Burital Island	16.2	17		<5	N
T24	Skullmartin	16.5	17.5	Dead shell	<5	N
T25	Skullmartin	20.7	19	Seed mussel and shell gravel	33	Y
T26	Skullmartin	22.3	22.7	Seed mussel and shell gravel	40	Y
T27	Skullmartin	22.8	23	Mussel with shell gravel and cobbles	45	Y
T28	Skullmartin	24.5	24	cobbles and pebbles	20	N

Tow No.	Location	Depth start (m)	Depth end (m)	Description	Est % fill	Mussel
T29	Skullmartin	24	25.1	cobbles and pebbles	<10	N
T30	Skullmartin	21.8	21.5	Mussels, dead shell and mud	40	Y
T31	Skullmartin	19.7	18.7	Mussels and mud	90	Y
T32	Skullmartin	18.7	22.9	Mussels, dead shell and mud	90	Y
T33	Skullmartin	17.9	18.6	Cobbles and mussels	15	Y
T34	Skullmartin	17.8	16.1	Dead shell and shell gravel	33	N
T35	Skullmartin	17.1	16.6	pebbles	20	N

Table 2: Mussel sample processing summary data: Skullmartin 03/07/17

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 25	11.48	2.37	79.38	369
Tow 26	7.62	0.42	94.55	619
Tow 27	11.94	1.65	86.18	613
Tow 30	14.95	5.08	65.99	278
Tow 31	20.68	7.21	65.14	265
Tow 32	18.63	6.80	63.49	192
Tow 33	9.51	0.99	89.58	197

Table 3: Mussel length measurement summary data: Skullmartin 03/07/17

Tow No.	Mussel length measurements (mm)				
	Median	**Mean**	**SD**	**min**	**max**
Tow 25	32.89	32.56	3.28	21.81	39.58
Tow 26	29.29	29.14	3.08	22.45	35.66
Tow 27	30.51	30.71	3.87	18.72	39.37
Tow 30	40.10	40.07	5.32	25.77	53.10
Tow 31	37.02	37.33	6.69	20.26	53.99
Tow 32	34.14	39.29	10.91	23.92	59.65
Tow 33	35.46	40.90	10.60	25.04	59.04

SD= Standard Deviation from the mean

Table 4: Mussel sample processing summary data: Burial Island 03/07/17

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 16	12.13	2.06	83.02	395
Tow 17	16.85	7.84	53.47	422
Tow 18	16.05	8.53	46.85	192
Tow 19	17.40	9.51	45.33	224
Tow 20	17.01	5.80	65.93	132
Tow 21	9.99	5.35	46.43	391
Tow 22	14.06	3.43	75.57	643

Table 5: Mussel length measurement summary data: Burial Island 03/07/17

Tow No.	Mussel length measurements				
	Median	Mean	SD	min	max
Tow 16	31.93	31.85	2.98	24.75	39.48
Tow 17	32.68	32.66	3.17	26.64	40.93
Tow 18	33.46	39.00	10.85	25.50	59.80
Tow 19	33.28	37.97	10.62	23.82	64.79
Tow 20	43.90	45.55	11.93	28.78	66.15
Tow 21	31.27	33.92	8.14	20.90	58.83
Tow 22	30.38	29.95	6.40	16.70	46.91

SD= Standard Deviation from the mean

Table 6: Mussel sample processing summary data: The Feathers 03/07/17

Tow no.	Total sample weight (kg)	Shellfish weight (kg)	% Waste	Pieces per kilo
Tow 5	13.35	5.47	59.06	606
Tow 6	11.55	7.51	35.02	296
Tow 7	11.82	6.17	47.82	467
Tow 11	12.99	2.86	78.00	589

Table 7: Mussel length measurement summary data: The Feathers 03/07/17

Tow No.	Mussel length measurements				
	Median	Mean	SD	min	max
Tow 5	29.03	29.04	3.21	20.77	36.39
Tow 6	35.60	36.04	6.46	20.41	59.73
Tow 7	30.81	30.70	3.60	21.63	38.17
Tow 11	30.23	29.87	2.90	22.56	36.86

SD= Standard Deviation from the mean

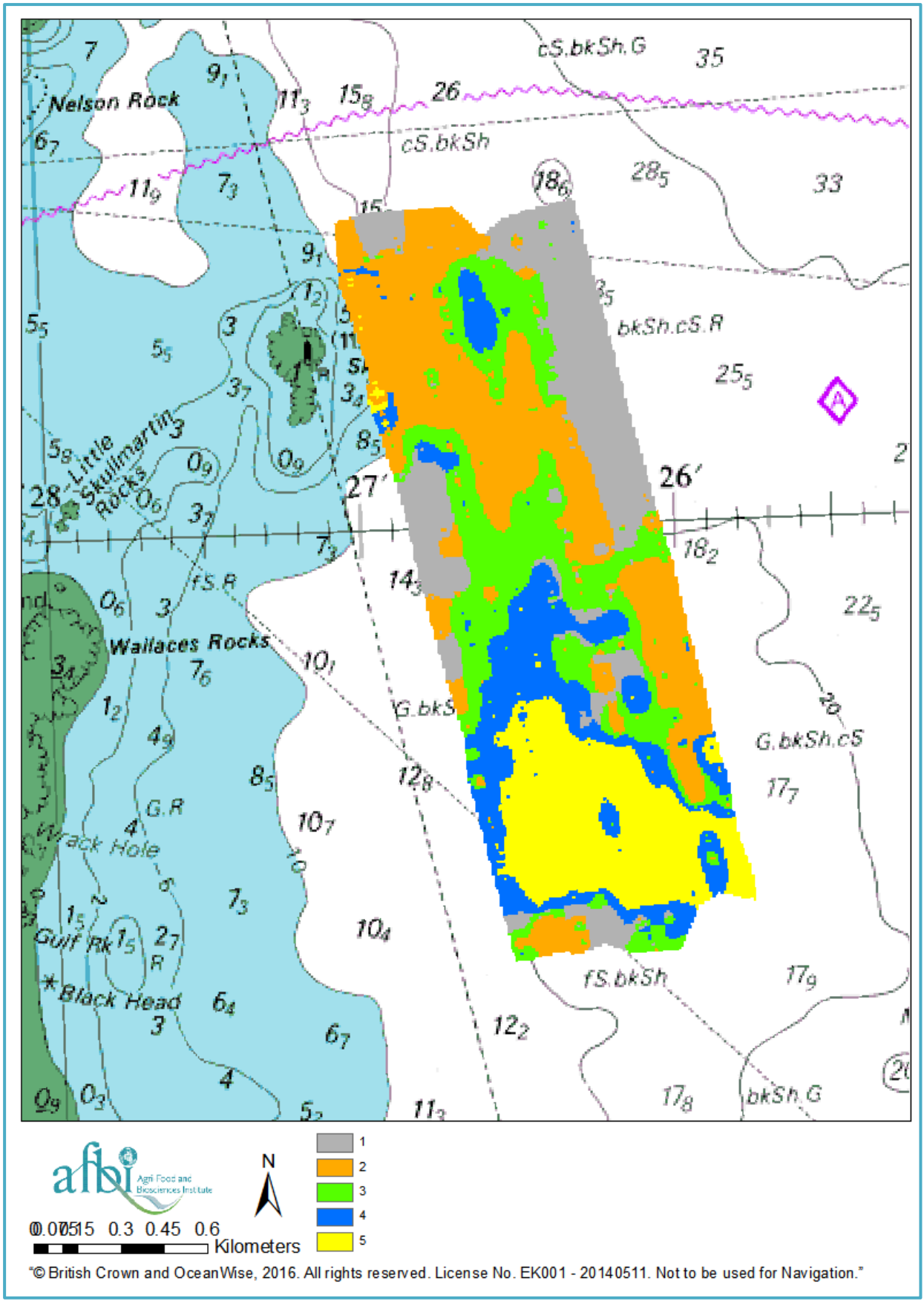


Figure 4: RoxAnn cluster map (from roughness and hardness values) from the June 2017 survey of Skullmartin.

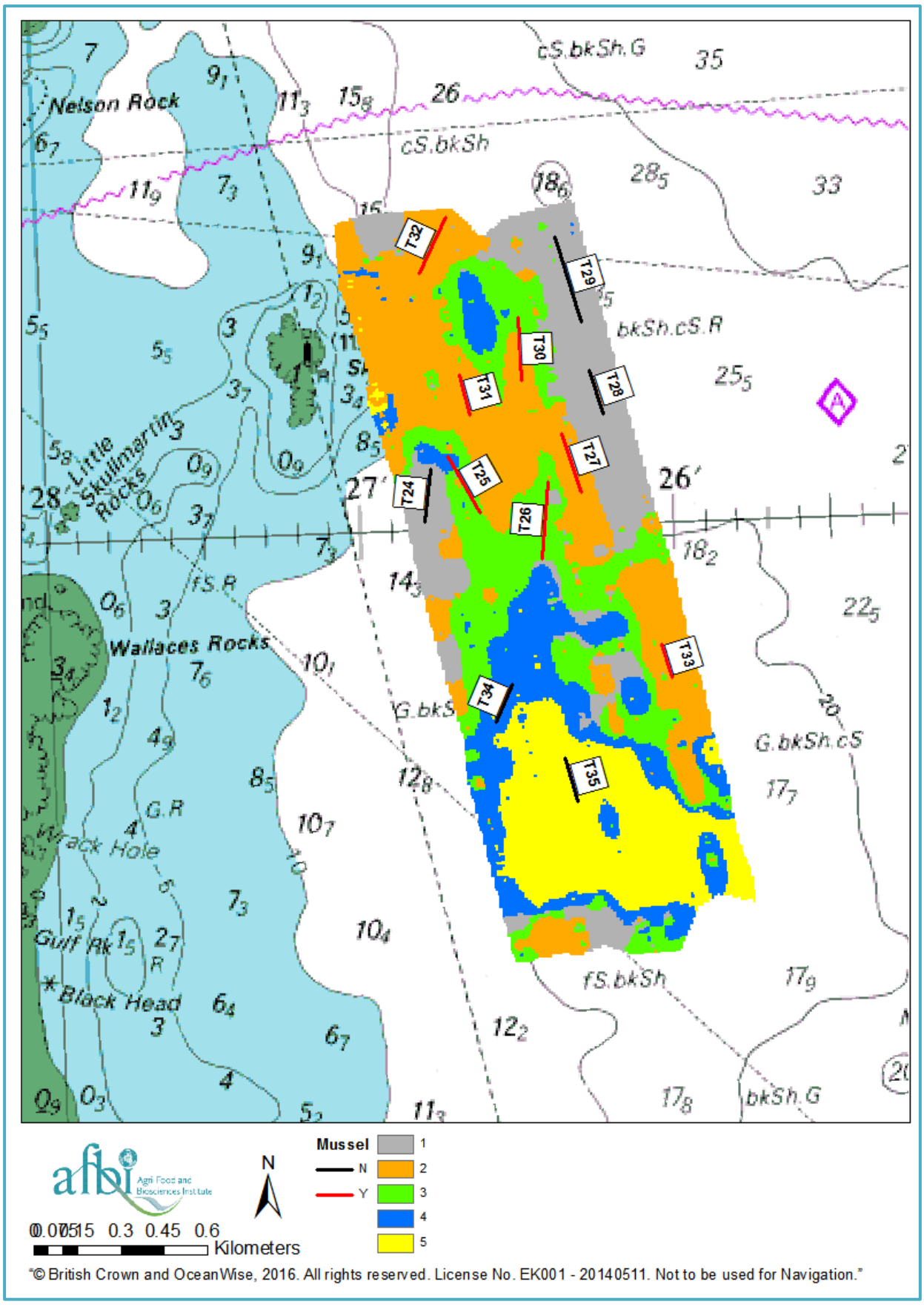


Figure 5: RoxAnn cluster map (from roughness and hardness values) from the 3rd of July 2017. Dredges within which mussels were found are coloured red.

Figure 6: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Skullmartin during the July 2017 seed mussel survey.

Figure 6 continued: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Skullmartin during the July 2017 seed mussel survey.

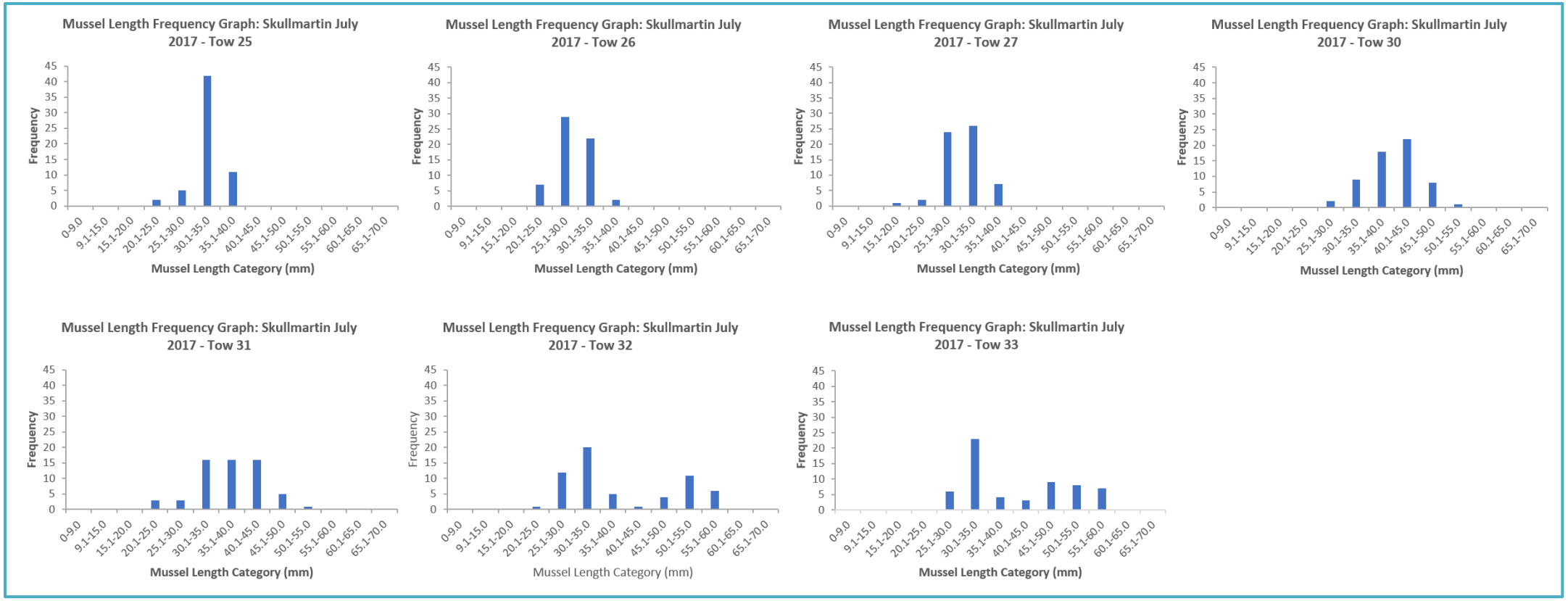


Figure 7: Length class distribution histograms for mussels found within dredge Tows undertaken within the area of Skullmartin during the July 2017 seed mussel survey.

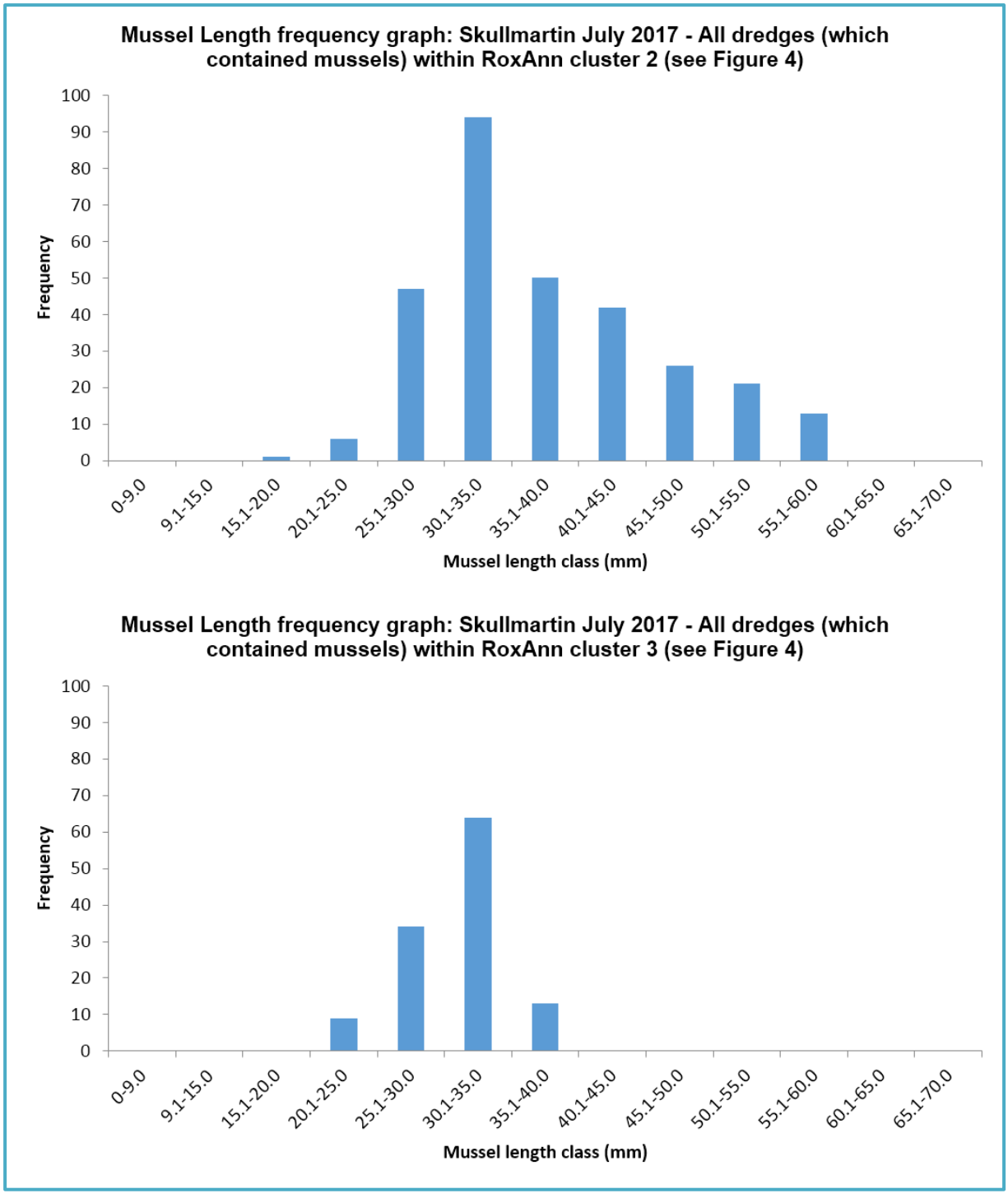


Figure 8: Length class distribution histograms for mussels found within the area of Skullmartin during the July 2017 seed mussel survey, grouped by the RoxAnn cluster within which they were located (refer to Figure 4).

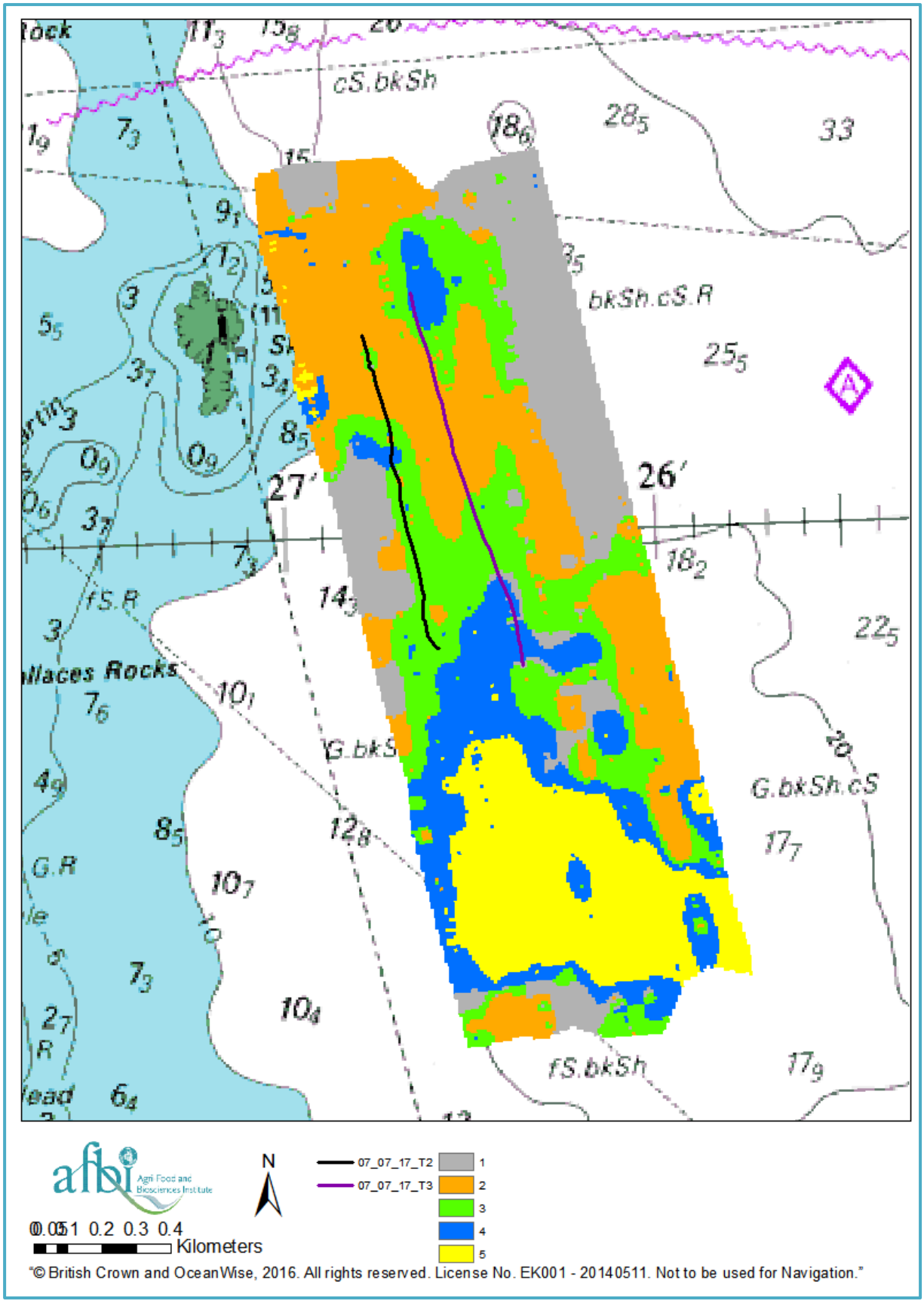


Figure 9: Location of video tows undertaken within the area of Skullmartin during the July 2017 seed mussel survey.

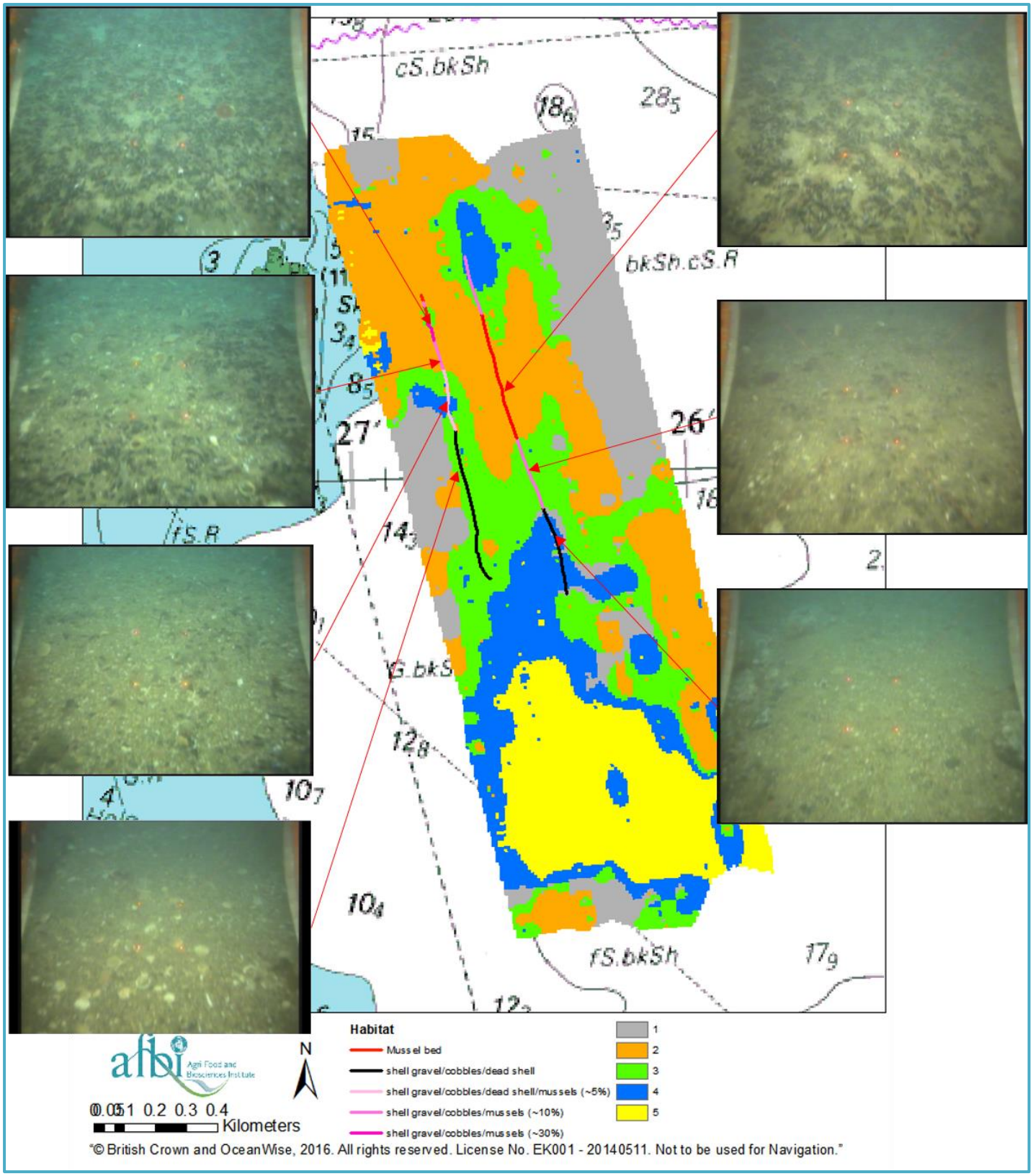


Figure 10: Location of video tows undertaken within the area of Skullmartin during the July 2017 seed mussel survey showing observed habitat type.

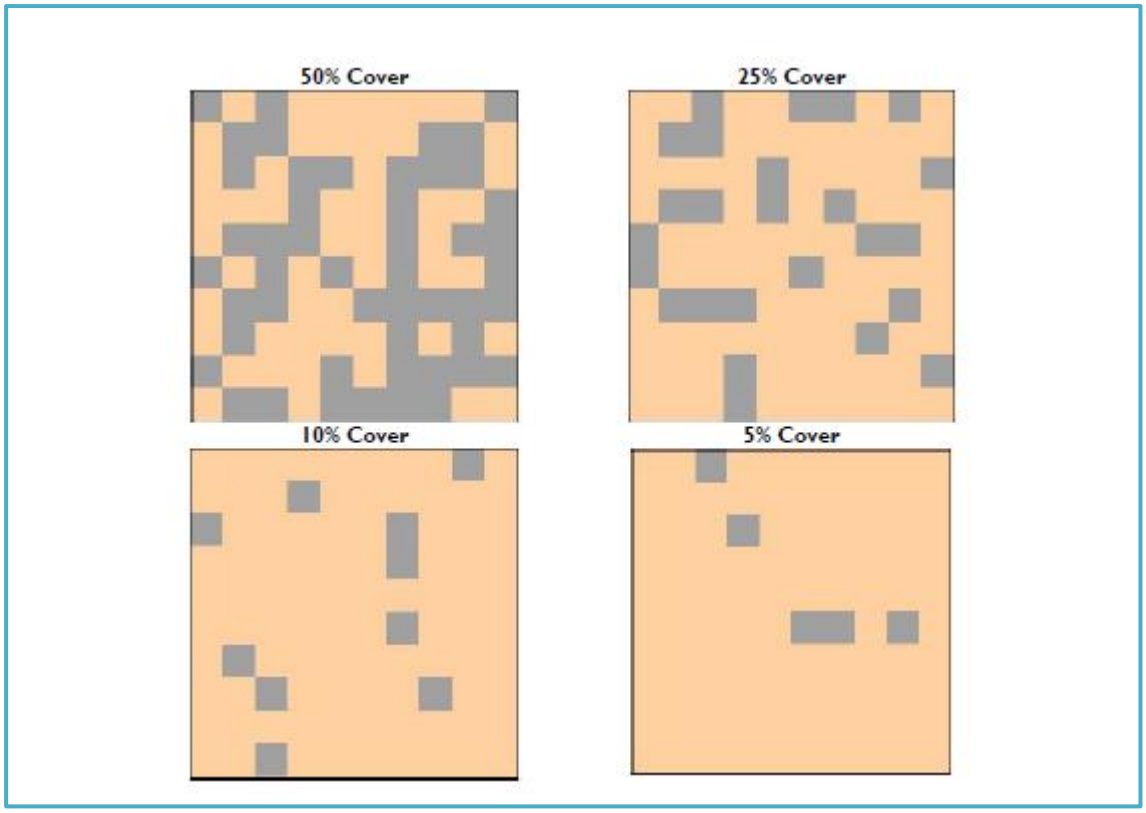
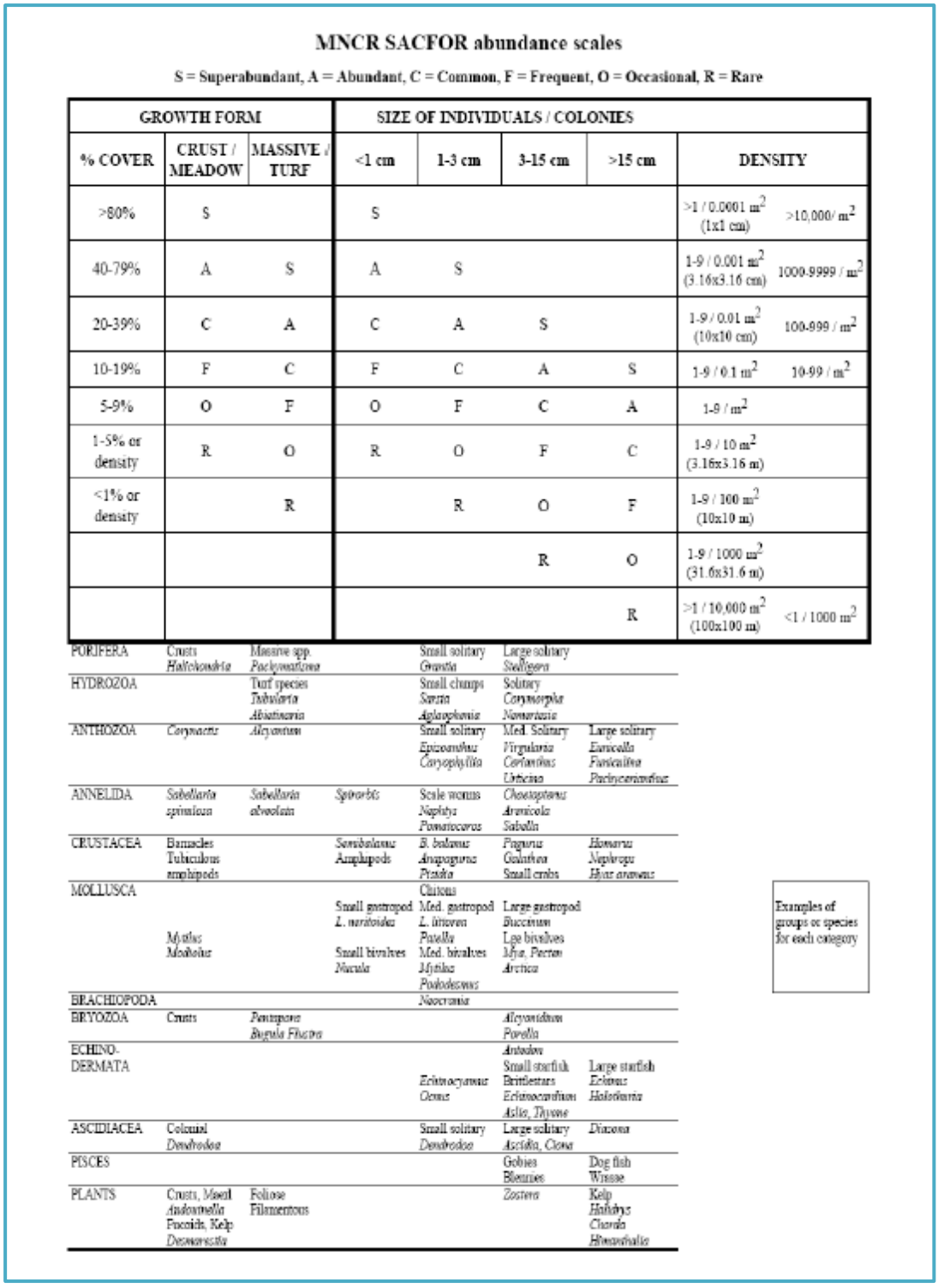


Figure 11: Graphical illustrations to assist with estimation of percentage cover, as taken from Turner *et al* (2016) Figure 2.



MNCR SACFOR abundance scales

S = Superabundant, A = Abundant, C = Common, F = Frequent, O = Occasional, R = Rare

GROWTH FORM			SIZE OF INDIVIDUALS / COLONIES				
% COVER	CRUST / MEADOW	MASSIVE / TURF	<1 cm	1-3 cm	3-15 cm	>15 cm	DENSITY
>80%	S		S				>1 / 0.0001 m^2 (1x1 cm) >10,000/ m^2
40-79%	A	S	A	S			1-9 / 0.001 m^2 (3.16x3.16 cm) 1000-9999 / m^2
20-39%	C	A	C	A	S		1-9 / 0.01 m^2 (10x10 cm) 100-999 / m^2
10-19%	F	C	F	C	A	S	1-9 / 0.1 m^2 10-99 / m^2
5-9%	O	F	O	F	C	A	1-9 / m^2
1-5% or density	R	O	R	O	F	C	1-9 / 10 m^2 (3.16x3.16 m)
<1% or density		R		R	O	F	1-9 / 100 m^2 (10x10 m)
					R	O	1-9 / 1000 m^2 (31.6x31.6 m)
						R	>1 / 10,000 m^2 (100x100 m) <1 / 1000 m^2

PORIFERA	Crusts *Halichondria*	Massive spp. *Packymatisma*		Small solitary *Grantia*	Large solitary *Stelligera*	
HYDROZOA		Turf species *Tubularia* *Abietinaria*		Small clumps *Sarsia* *Aglaophenia*	Solitary *Corymorpha* *Nemertesia*	
ANTHOZOA	*Corynactis*	*Alcyonium*		Small solitary *Epizoanthus* *Caryophyllia*	Med. Solitary *Virgularia* *Cerianthus* *Urticina*	Large solitary *Eunicella* *Funiculina* *Pachycerianthus*
ANNELIDA	*Sabellaria spinulosa*	*Sabellaria alveolata*	*Spirorbis*	Scale worms *Nephtys* *Pomatoceros*	*Chaetopterus* *Arenicola* *Sabella*	
CRUSTACEA	Barnacles Tuberculous amphipods		*Semibalanus* Amphipods	*B. balanus* *Anapagurus* *Pisidia*	*Pagurus* *Galathea* Small crabs	*Homarus* *Nephrops* *Hyas araneus*
MOLLUSCA	*Mytilus* *Modiolus*		Small gastropod *L. neritoides* Small bivalves *Nucula*	Chitons Med. gastropod *L. littorea* *Patella* Med. bivalves *Mytilus* *Pododesmus*	Large gastropod *Buccinum* Lge bivalves *Mya, Pecten* *Arctica*	
BRACHIOPODA				*Neocrania*		
BRYOZOA	Crusts	*Pentapora* *Bugula Flustra*			*Alcyonidium* *Porella*	
ECHINO-DERMATA				*Echinocyamus* *Ocnus*	*Antedon* Small starfish Brittlestars *Echinocardium* *Asilia, Thyone*	Large starfish *Echinus* *Holothuria*
ASCIDIACEA	Colonial *Dendrodoa*			Small solitary *Dendrodoa*	Large solitary *Ascidia, Ciona*	*Diazona*
PISCES					Gobies Blennies	Dog fish Wrasse
PLANTS	Crusts, Maerl *Audouinella* Fucoids, Kelp *Desmarestia*	Foliose Filamentous			*Zostera*	Kelp *Halidrys* *Chorda* *Himanthalia*

Examples of groups or species for each category

Figure 12: MNCR SACFOR abundance scales, as taken from Turner *et al* (2016) Annex 4.

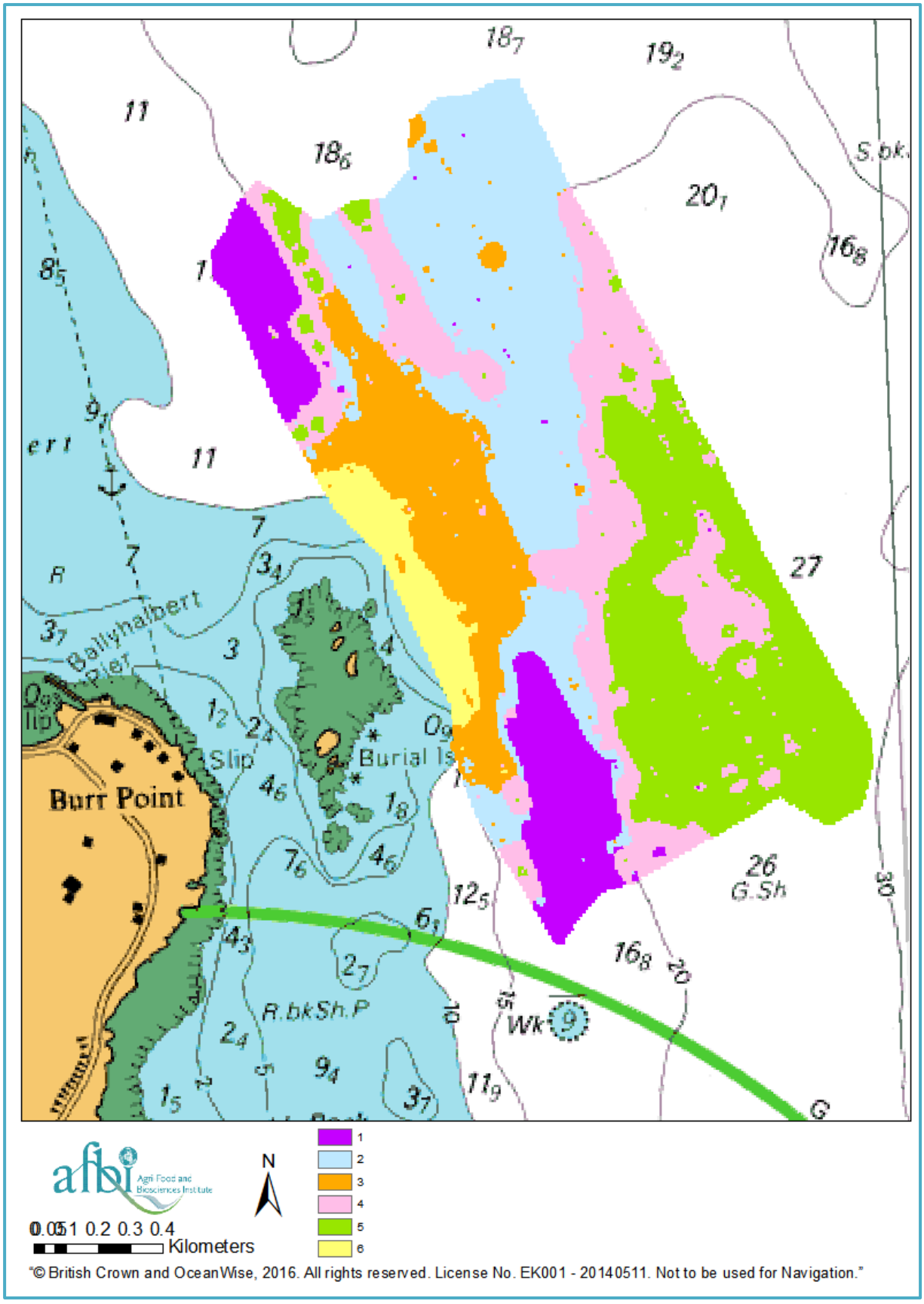


Figure 13: RoxAnn cluster map (from roughness and hardness values) from the June 2017 survey of Burial Island.

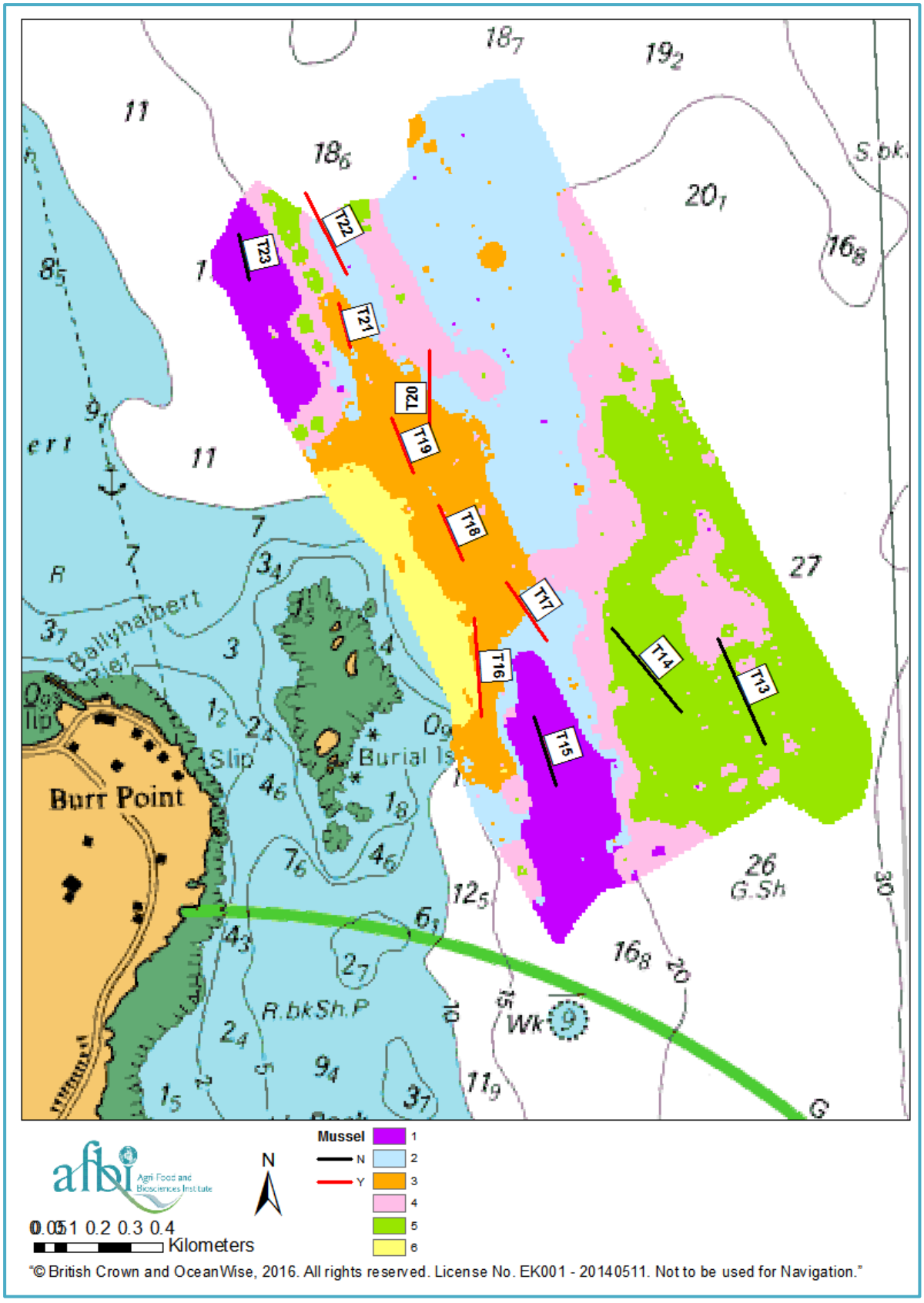


Figure 14: RoxAnn cluster map (from roughness and hardness values) from the June 2017 survey of Burial Island overlaid with the dredge tows undertaken on the 3rd of July 2017. Dredges within which mussels were found are coloured red.

Figure 15: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Burial Island during the July 2017 seed mussel survey.

Figure 15 continued: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of Burial Island during the July 2017 seed mussel survey.

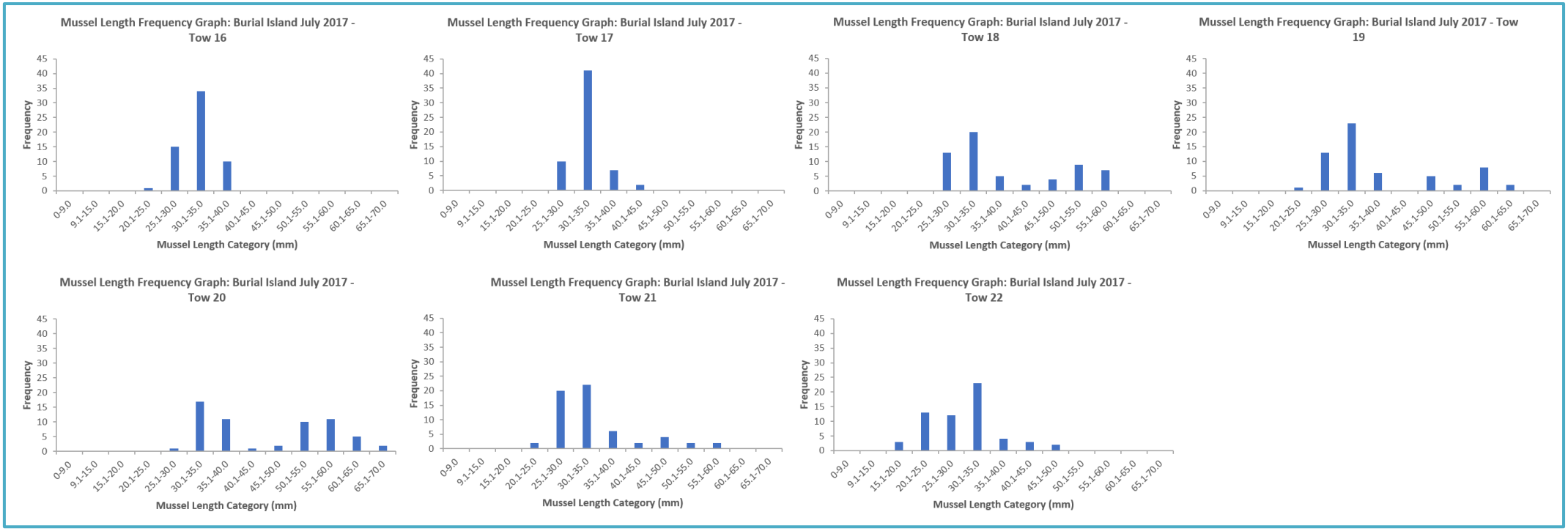


Figure 16: Length class distribution histograms for mussels found within dredge Tows undertaken within the area of Burial Island during the July 2017 seed mussel survey.

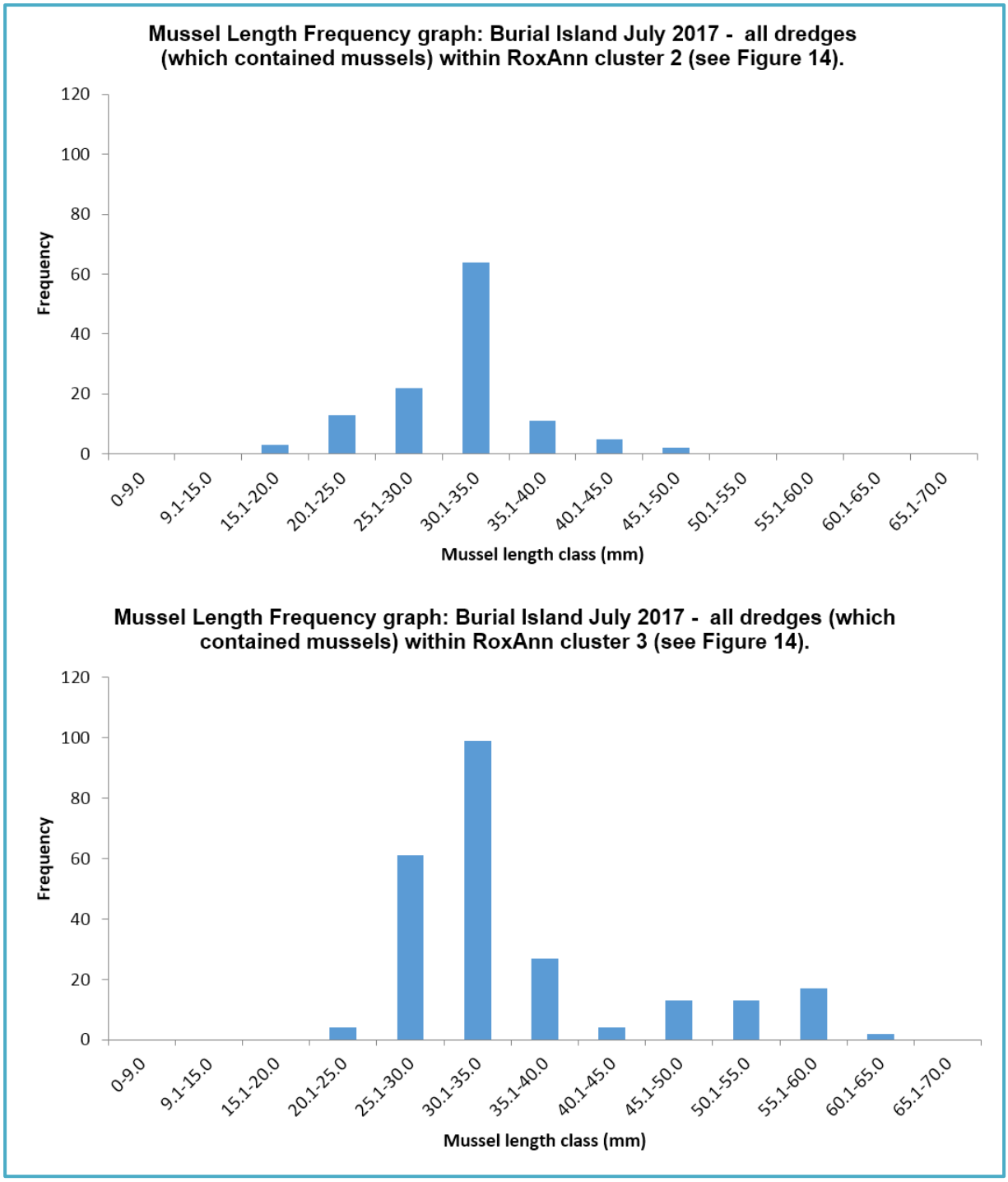


Figure 17: Length class distribution histograms for mussels found within the area of Burial Island during the July 2017 seed mussel survey, grouped by the RoxAnn cluster within which they were located (refer to Figure 14).

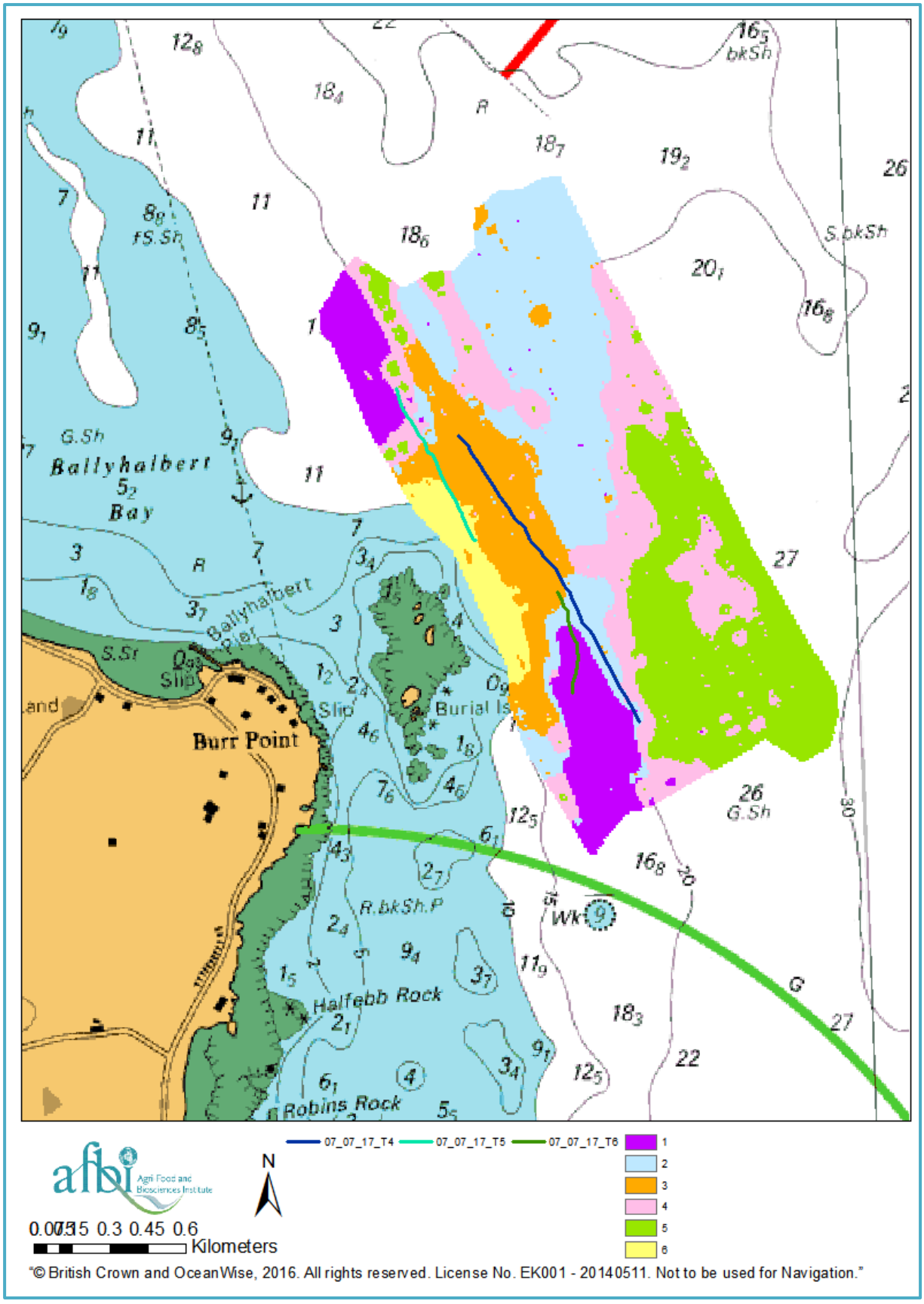


Figure 18: Location of video tows undertaken within the area of Burial Island during the July 2017 seed mussel survey.

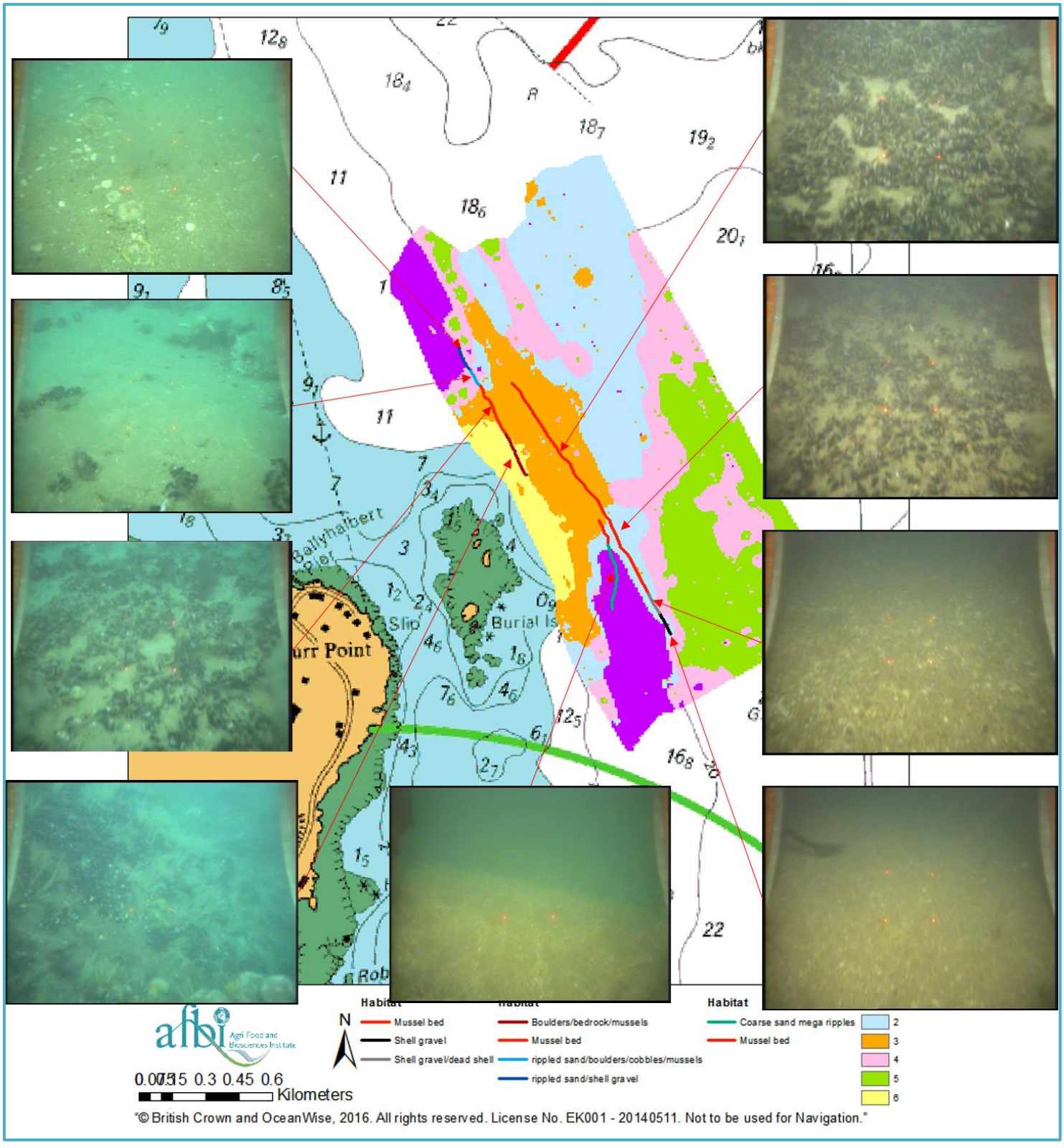


Figure 19: Location of video tows undertaken within the area of Burial Island during the July 2017 seed mussel survey showing observed habitat type.

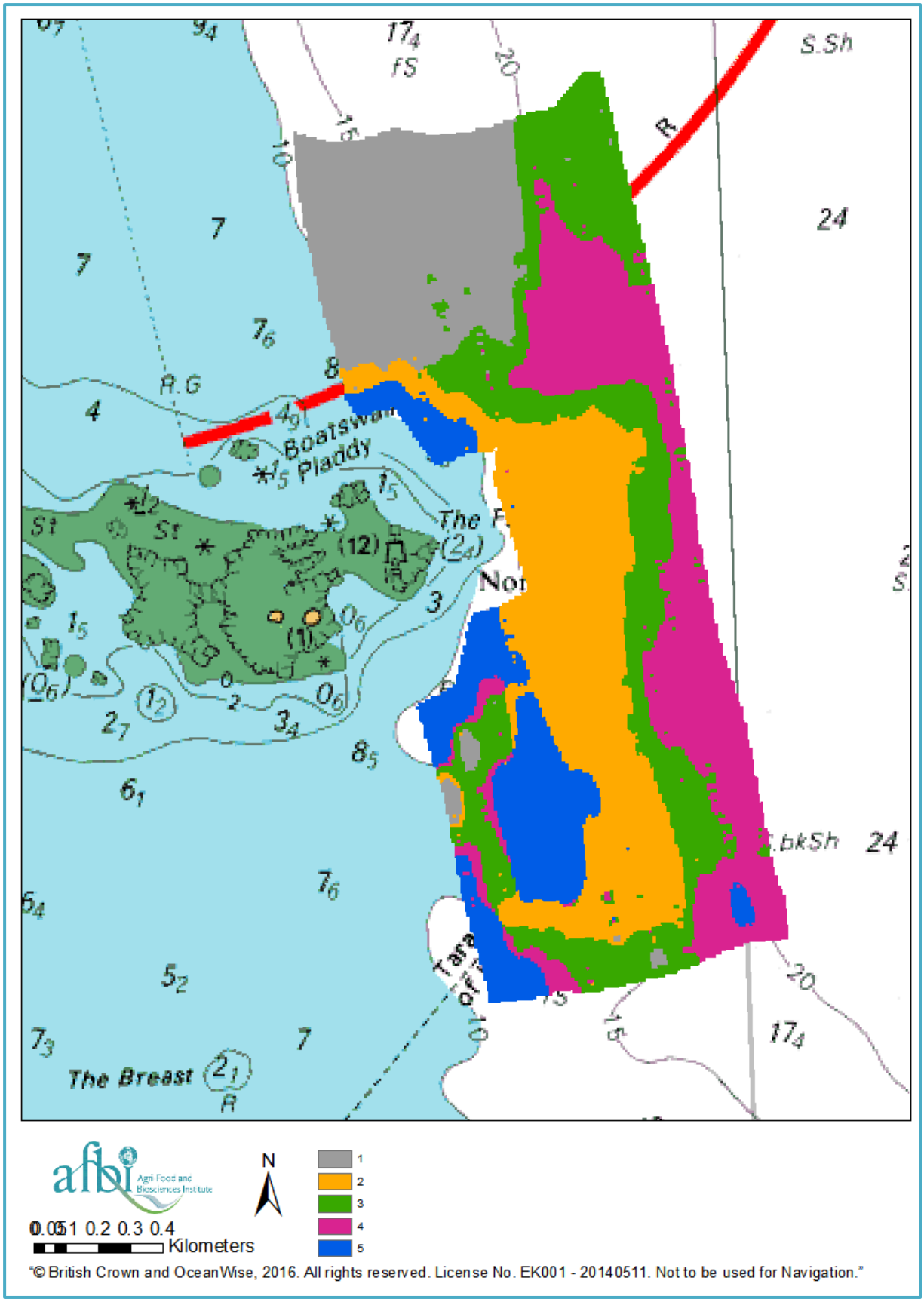


Figure 20: RoxAnn cluster map (from roughness and hardness values) from the June 2017 survey of The Feathers.

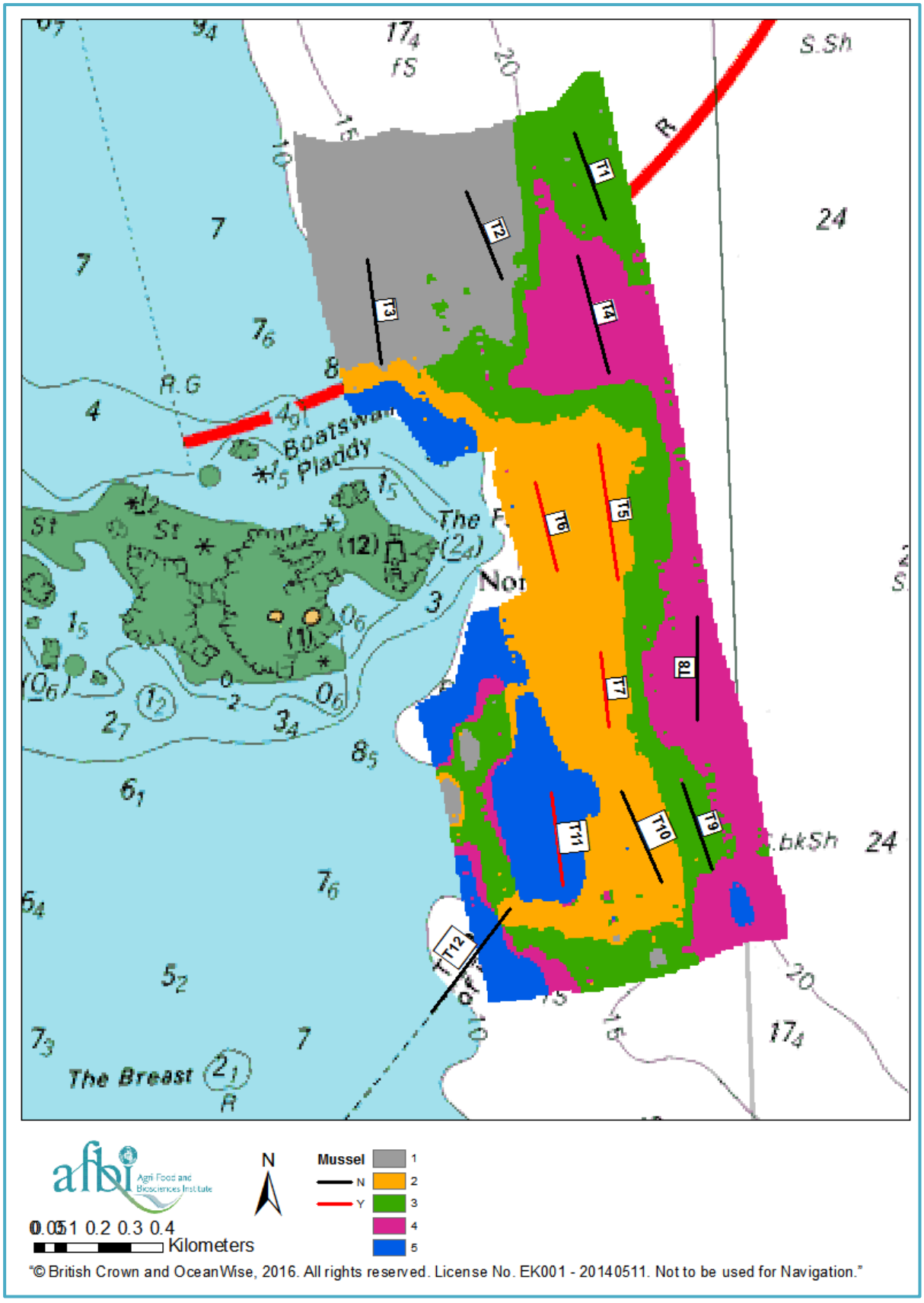


Figure 21: RoxAnn cluster map (from roughness and hardness values) from the June 2017 survey of The Feathers overlaid with the dredge tows undertaken on the 3rd of July 2017. Dredges within which mussels were found are coloured red.

Figure 22: Photographs showing the contents of the dredge tows which yielded mussels undertaken within the area of The Feathers during the July 2017 seed mussel survey.

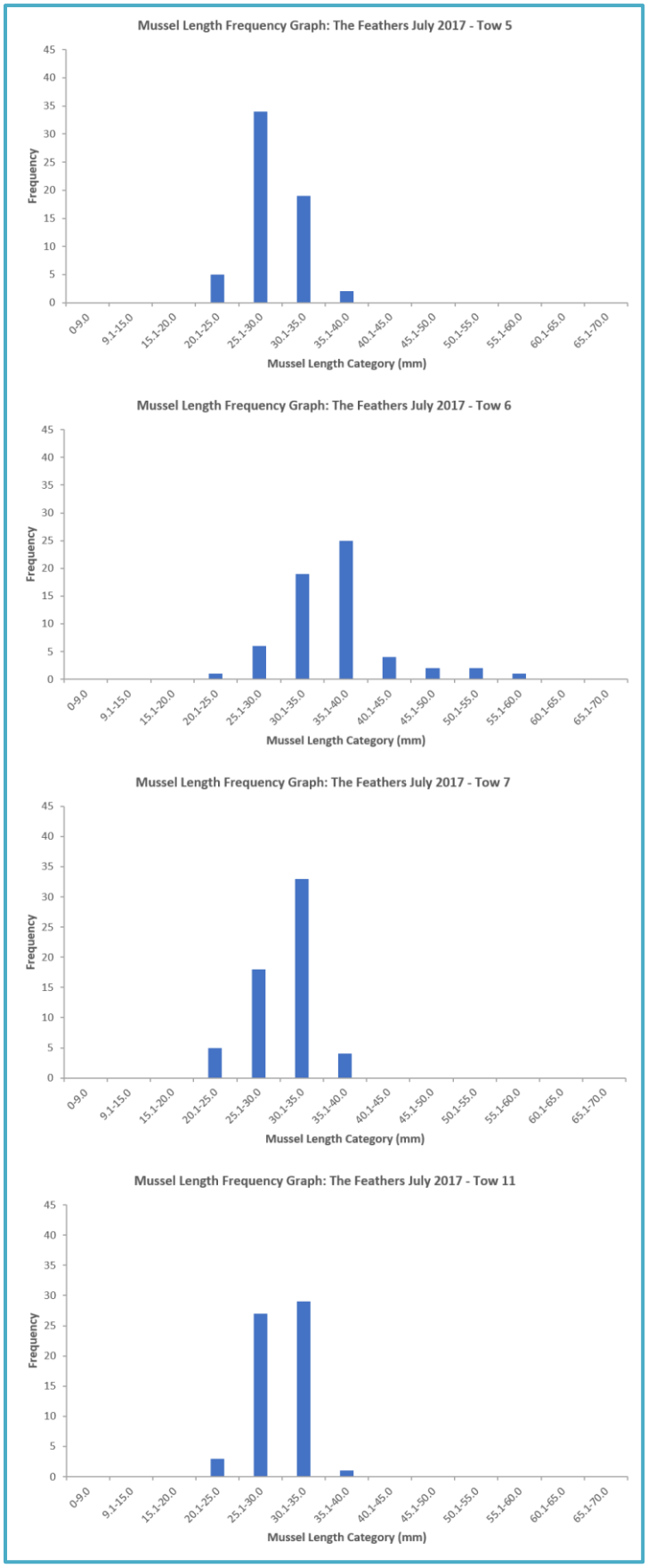


Figure 23: Length class distribution histograms for mussels found within dredge Tows undertaken within the area of The Feathers during the July 2017 seed mussel survey.

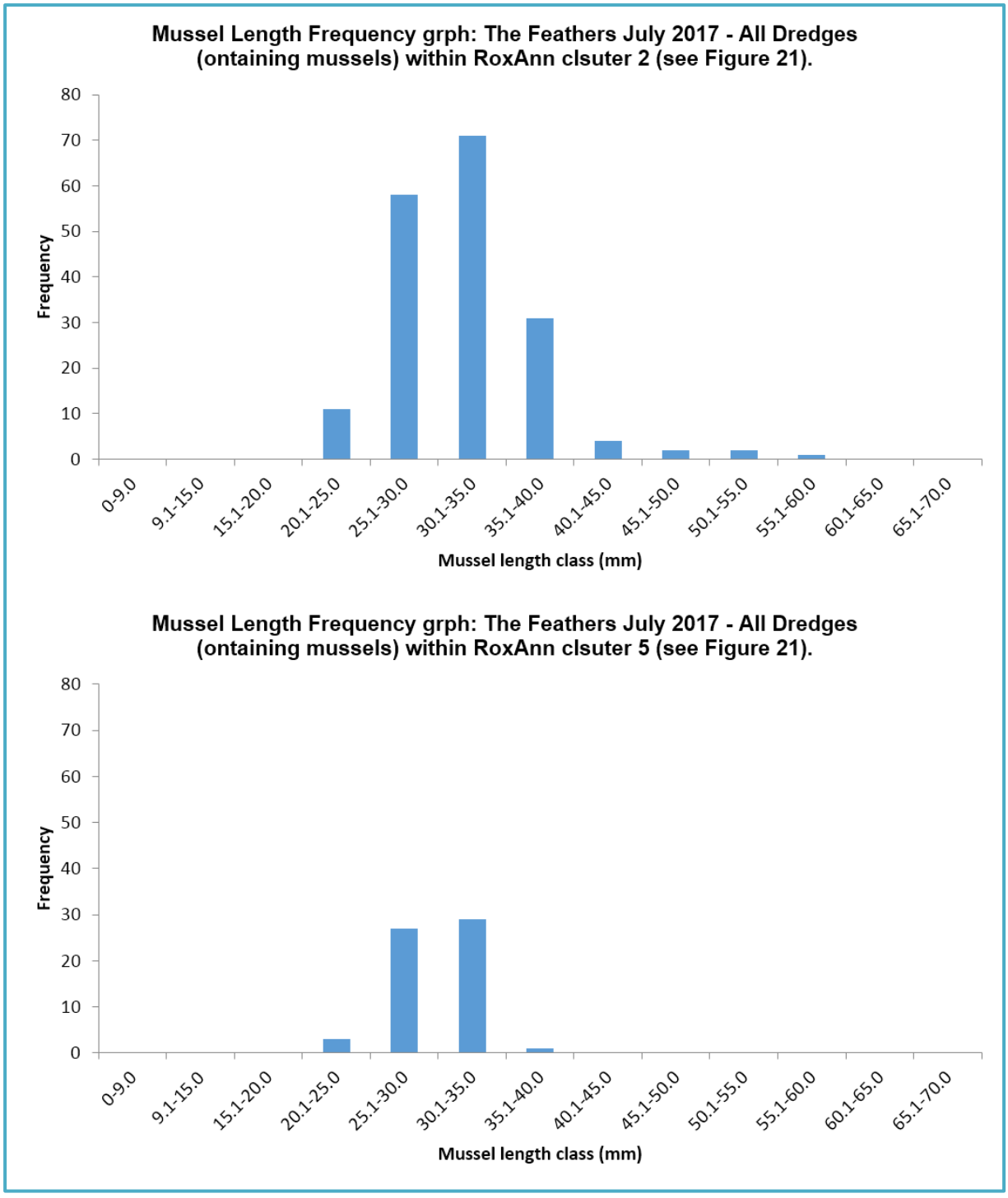


Figure 24: Length class distribution histograms for mussels found within the area of The Feathers during the July 2017 seed mussel survey, grouped by the RoxAnn cluster within which they were located (refer to Figure 21).

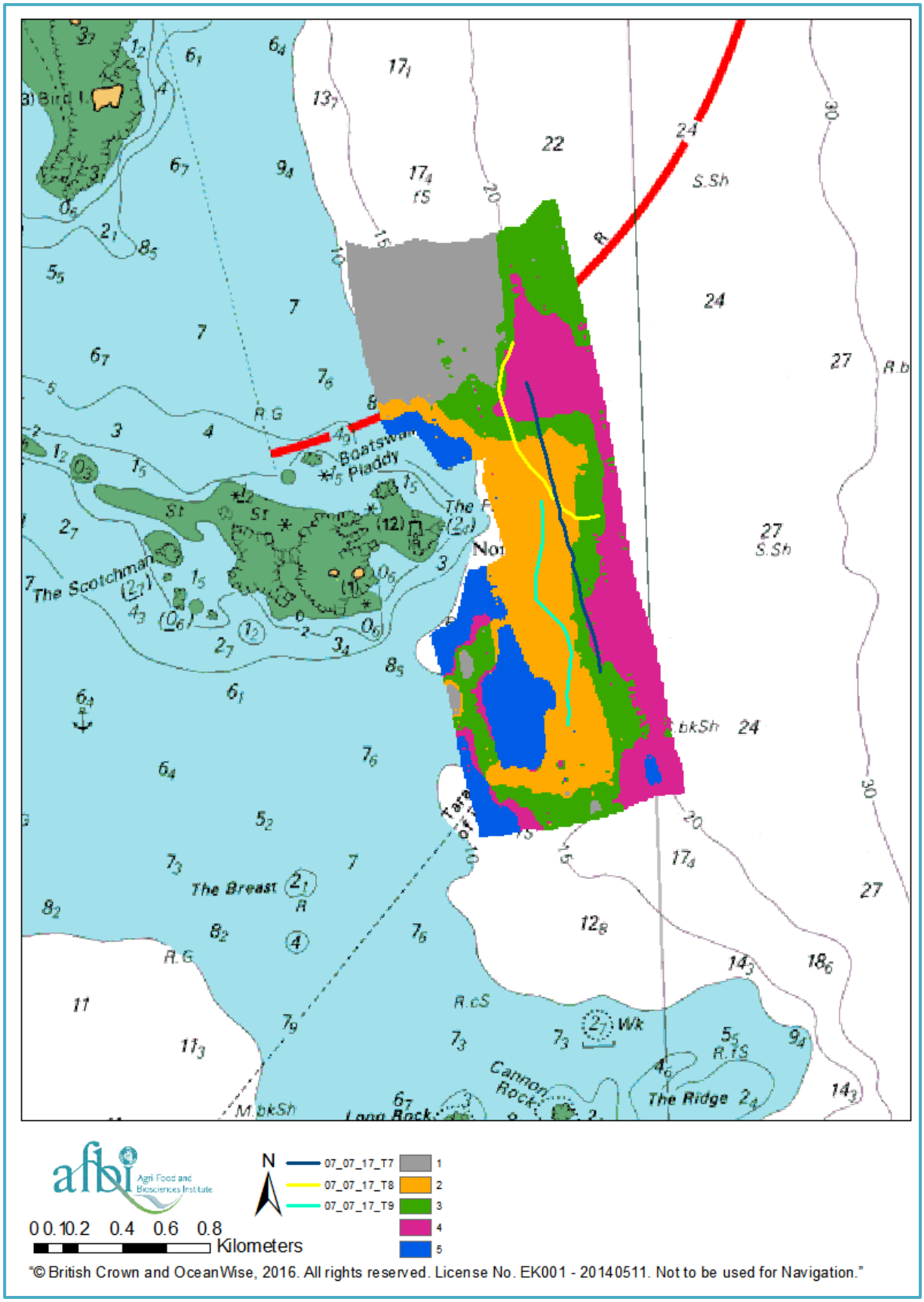


Figure 25: Location of video tows undertaken within the area of The Feathers during the July 2017 seed mussel survey.

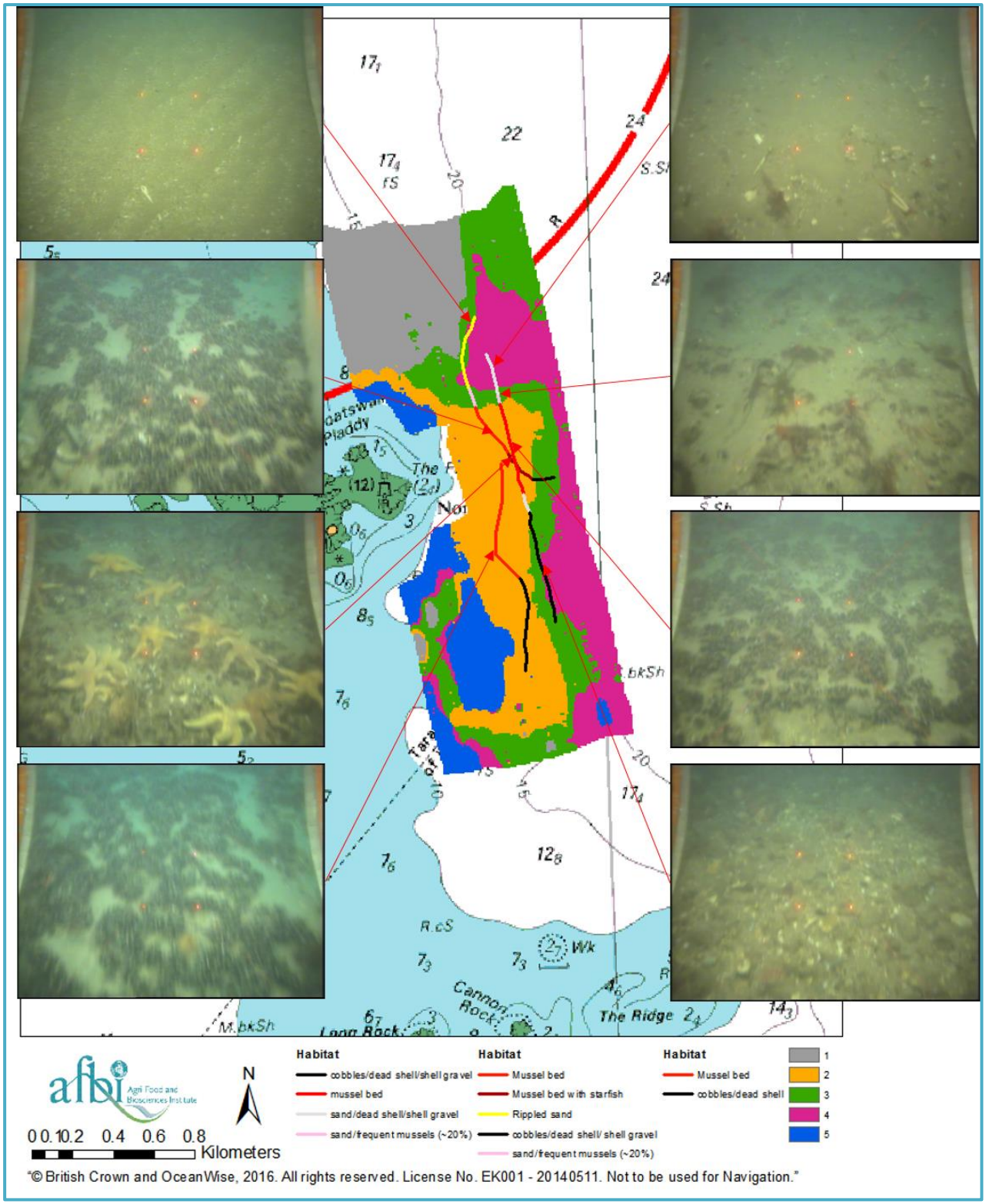


Figure 26: Location of video tows undertaken within the area of The Feathers during the July 2017 seed mussel survey showing observed habitat type.

Discussion

Skullmartin

Following acoustic and ground truthing surveys (dredge and towed video) undertaken in June and July 2017 an area of seed mussels was identified within the area of Skullmartin (Figure 27). There has not been a seed mussel bed identified within this area since 2007, at which time it was heavily fished. As this is the first sign of recruitment to 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 early 2018 to monitor the development of the seed mussel bed within this area. At this time if a significant seed bed is discovered then an assessment of the tonnages within this area will be undertaken and the bed boundaries defined.

Burial Island

Following acoustic and ground truthing surveys (dredge and towed video) undertaken in June and July 2017 an area of seed mussels was identified within Burial Island (Figure 28). The area identified as Cluster 3 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 29). 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 2 does not contain blue mussels but the horse mussel *Modiolus modiolus*. Mussel tonnages were calculated for the area of Clusters 2 and 3 determined to contain mussels and a mussel Fishery box was assigned to this region (Figure 30).

It should be noted that the seaward edge of the Fishery area has been constrained by an 80 m buffer (pink line in Figure 30) 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 (Cluster 1, Figure 19). Therefore the seed mussel fishery area has been drawn so as to avoid this habitat.

From all the information collected during the June and July 2017 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 30, contains approximately 1,000 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 June and July 2017 an area of seed mussels was identified within The Feathers (Figure 31). A proportion of the area identified as Cluster 2 and a proportion of the area identified as Cluster 5 were found to correspond to seed mussel (Figure 32). It is believed that Cluster 2 contains the more dense areas of seed mussel. 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 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).

Mussel tonnages were calculated for the area of Clusters 2 and 5 determined to contain mussels and a mussel Fishery box was assigned to this region (Figure 33).

From all the information collected during the June and July 2017 surveys (utilising the calculations, as per Strong and Service, 2011) we can therefore approximate that the Feathers Seed Fishery Area, as shown within Figure 33, contains approximately 900 tonnes of seed mussel and would therefore recommend that this area be opened to fishing on the next suitable tide.

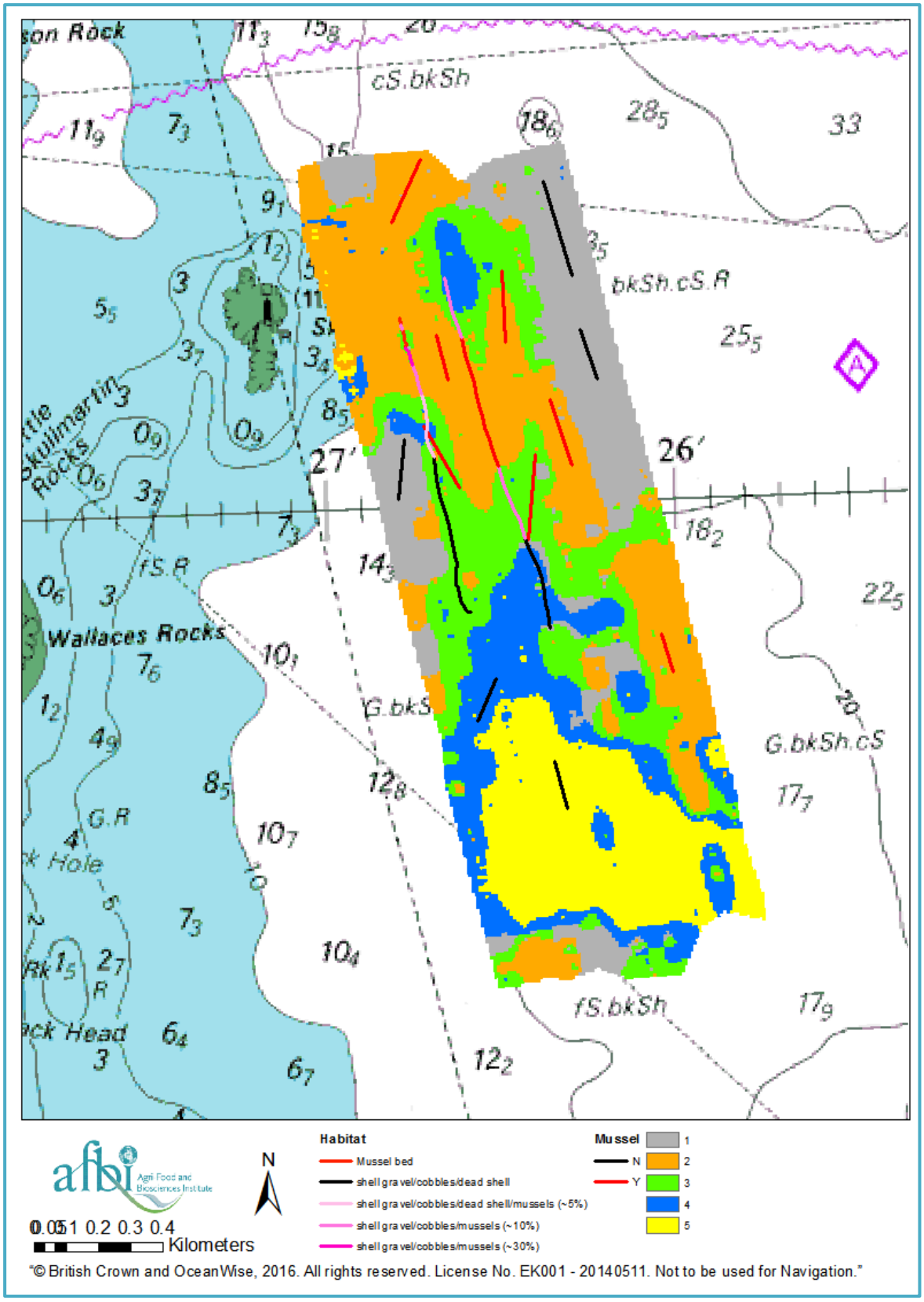


Figure 27: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of Skullmartin, overlaid with the dredges undertaken on the 3rd of July and the video tows undertaken on the 7th of July 2017. All red lines on the above map indicate the presence of seed mussels.

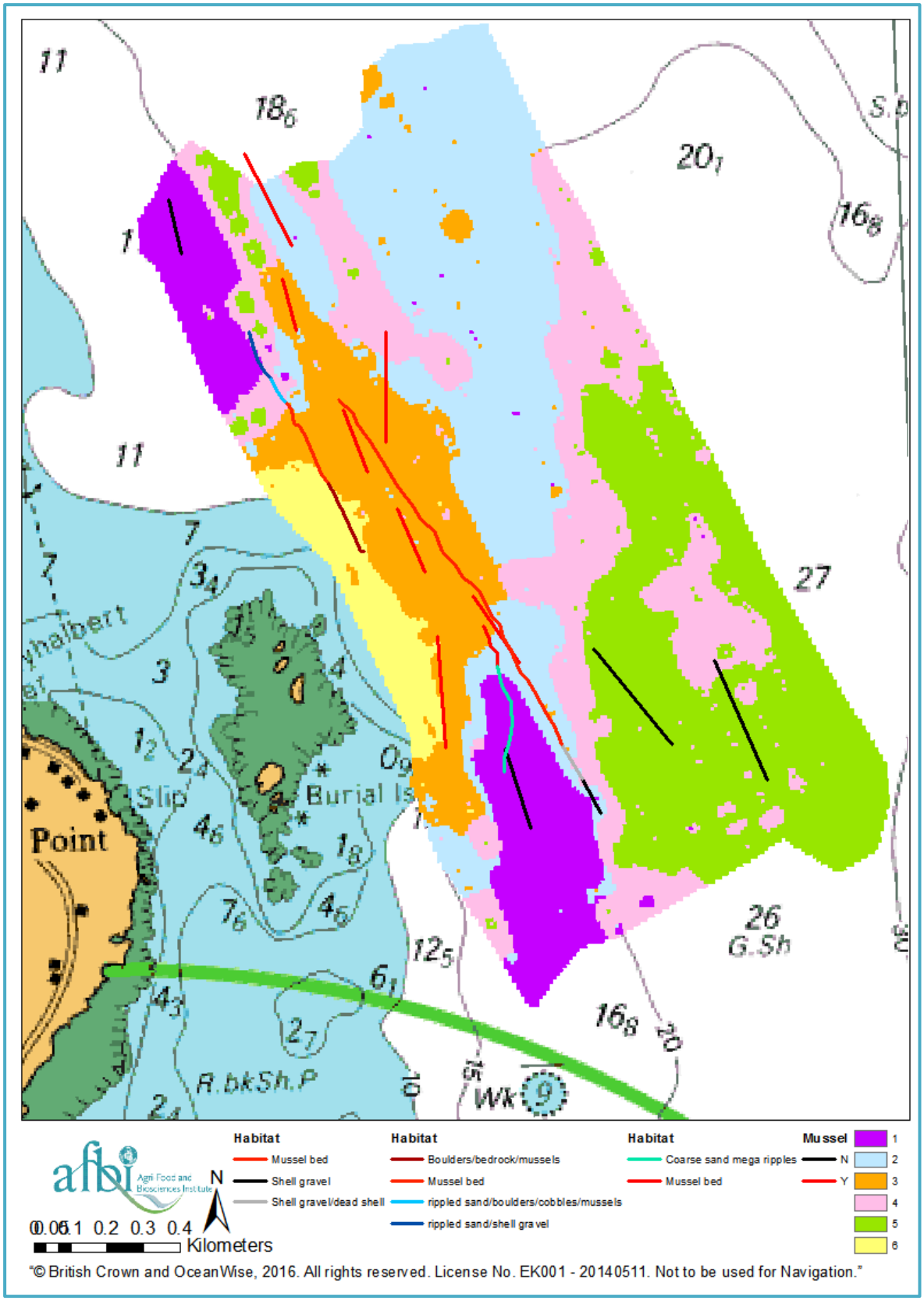


Figure 28: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of Burial Island, overlaid with the dredges undertaken on the 3rd of July and the video tows undertaken on the 7th of July 2017. All red lines on the above map indicate the presence of seed mussels.

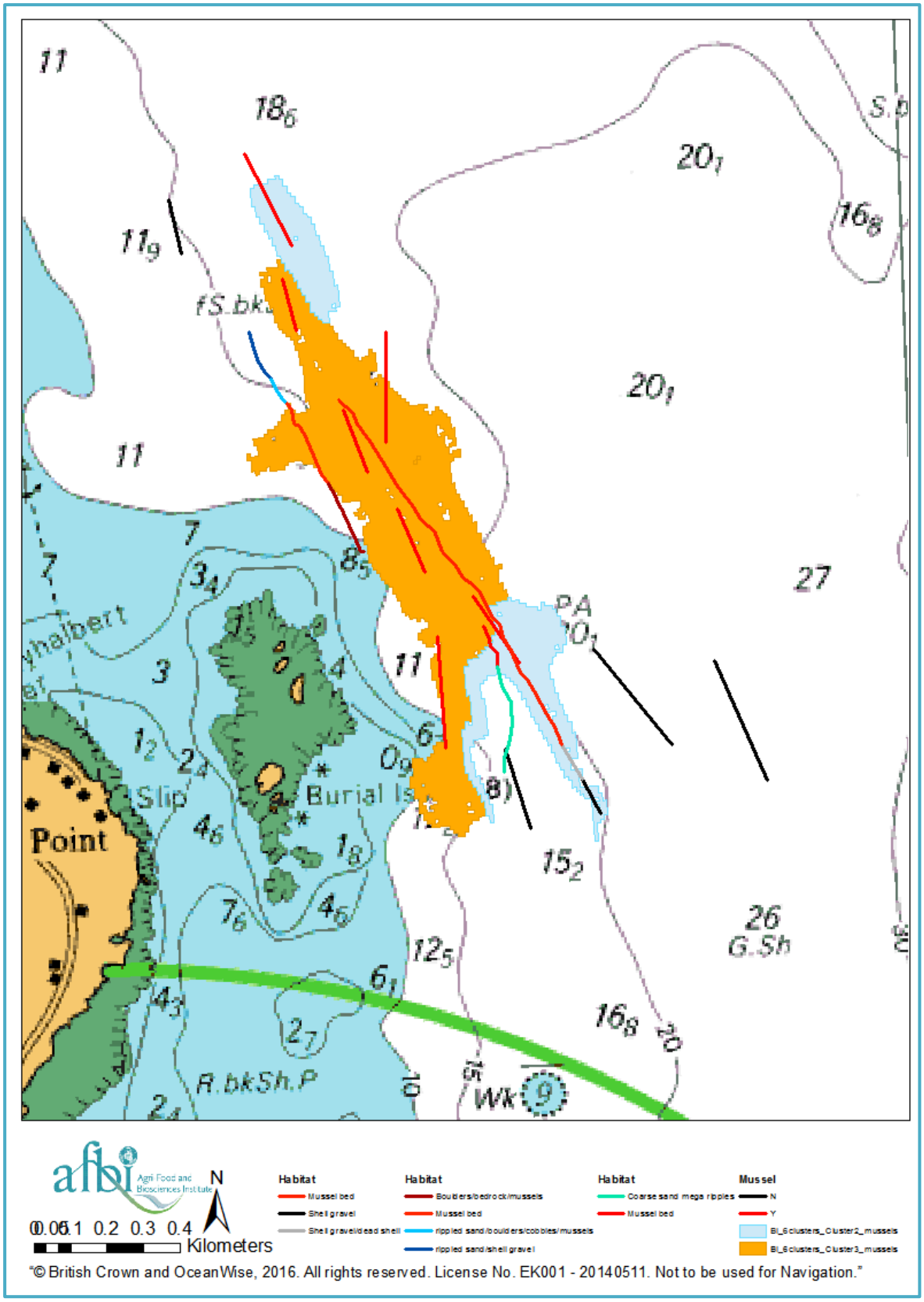


Figure 29: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of Burial Island showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 3rd of July and the video tows undertaken on the 7th of July 2017. All red lines on the above map indicate the presence of seed mussels.

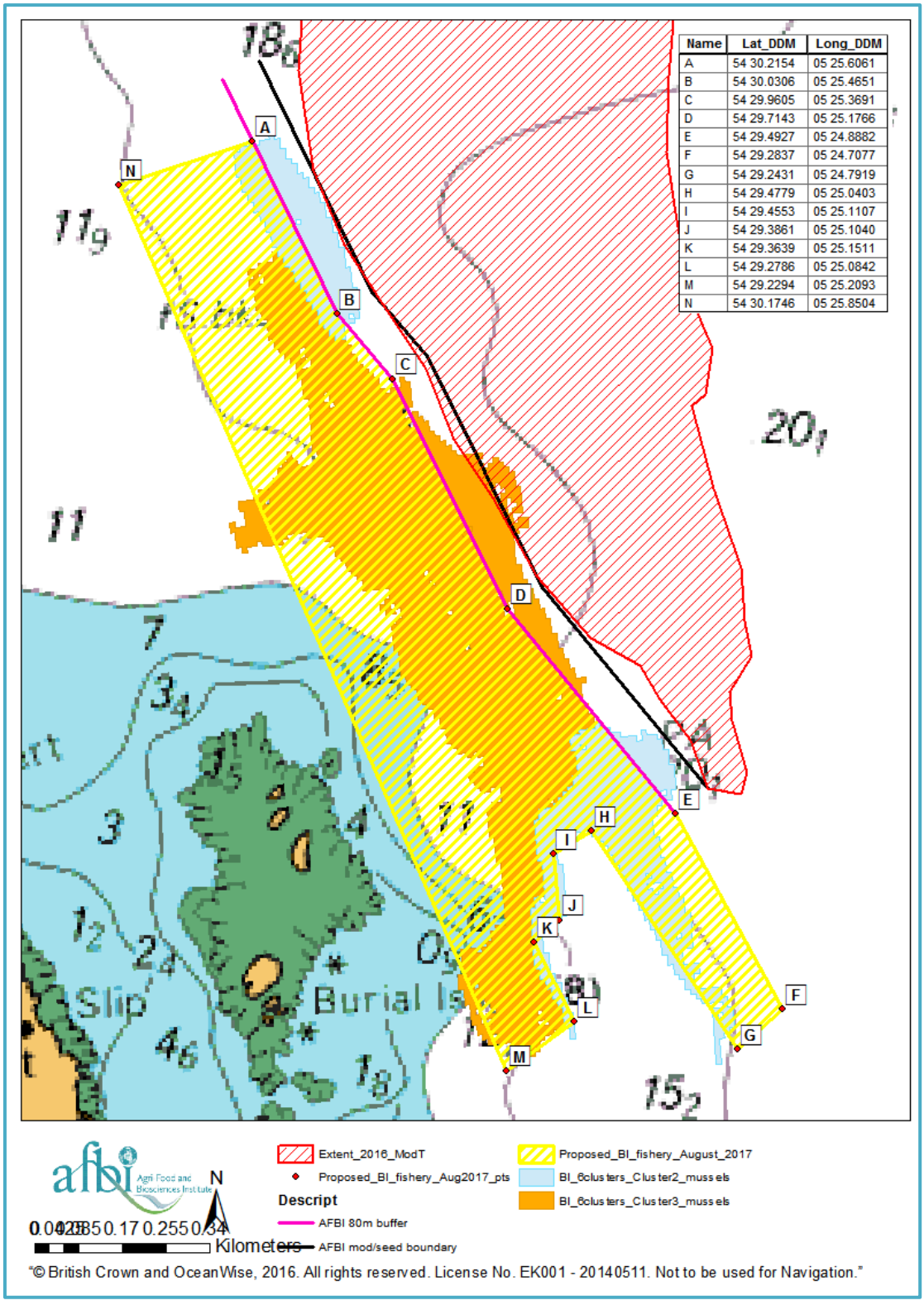


Figure 30: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of Burial Island, highlighting the area of Cluster 2 (light blue area on map) and Cluster 3 (orange area on map) that represents seed mussel. The proposed fishery area is shown by the yellow hashed area on the map. The red hashed area represent the extent of the *Modiolus modiolus* bed. The pink line indicates the 80 m buffer which has previously been applied to safeguard the *M. modiolus* bed.

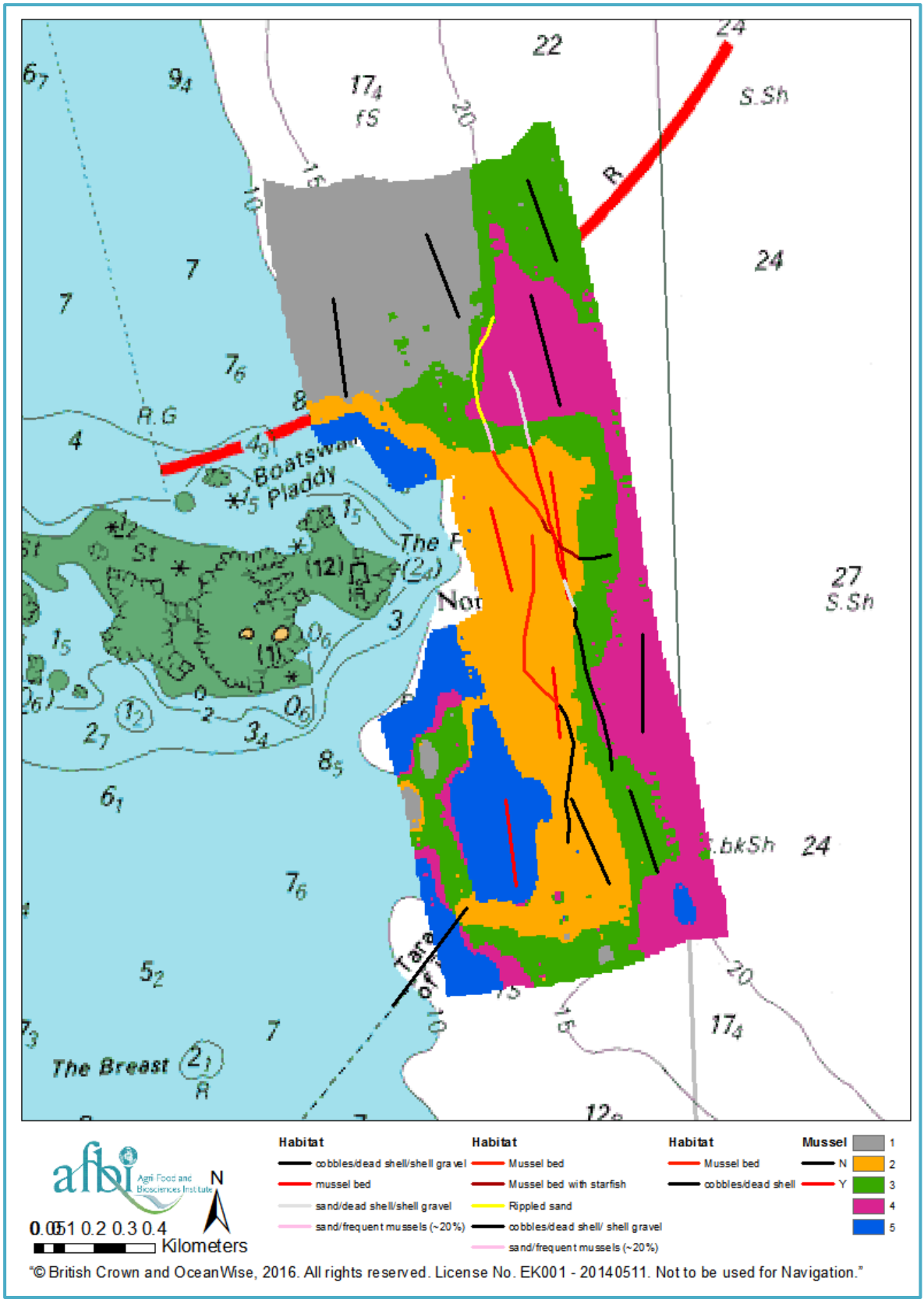


Figure 31: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of The Feathers, overlaid with the dredges undertaken on the 3rd of July and the video tows undertaken on the 7th of July 2017. All red lines on the above map indicate the presence of seed mussels.

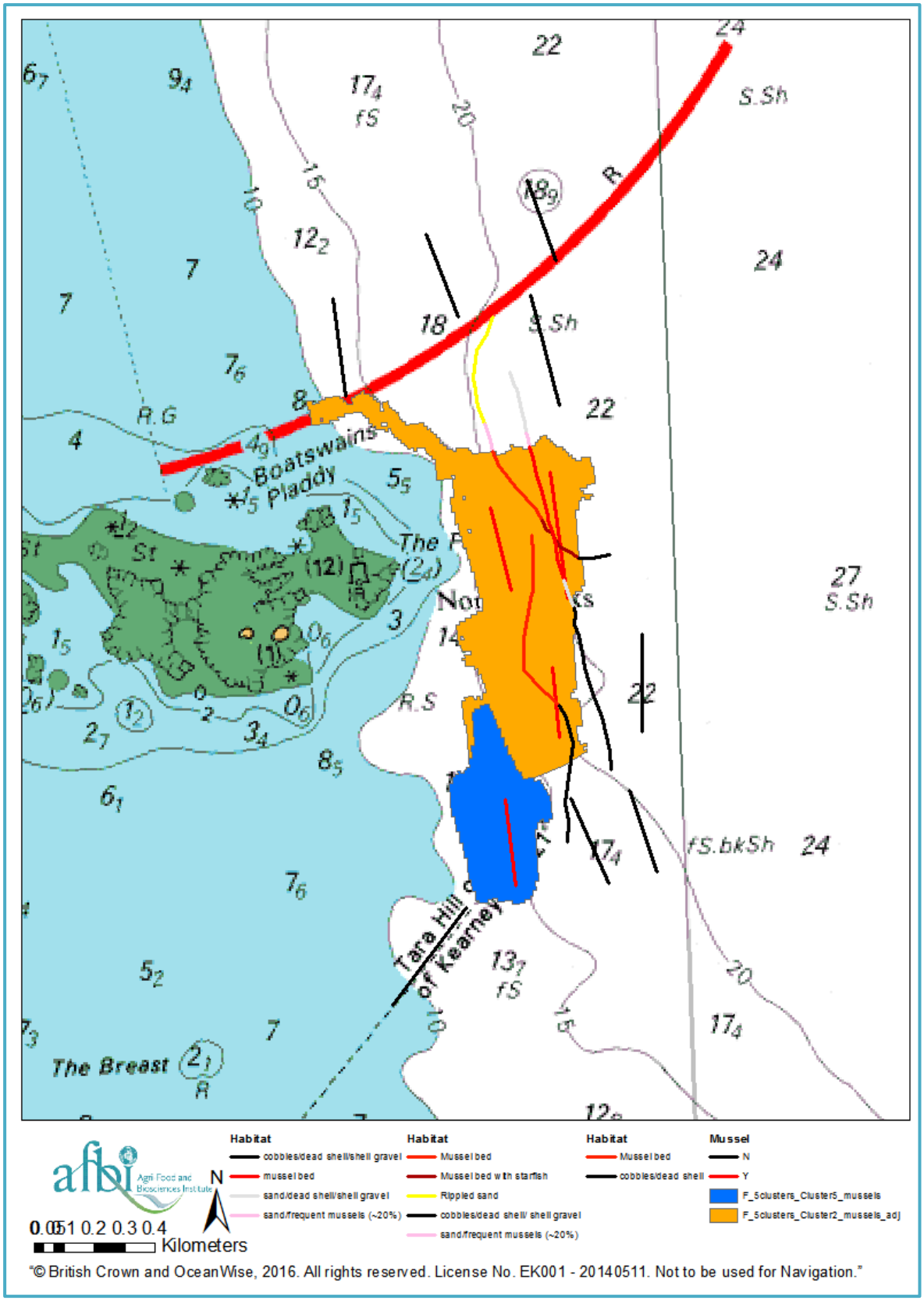


Figure 32: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of The Feathers showing only those clusters within which mussels were found, overlaid with the dredges undertaken on the 3rd of July and the video tows undertaken on the 7th of July 2017. All red lines on the above map indicate the presence of seed mussels.

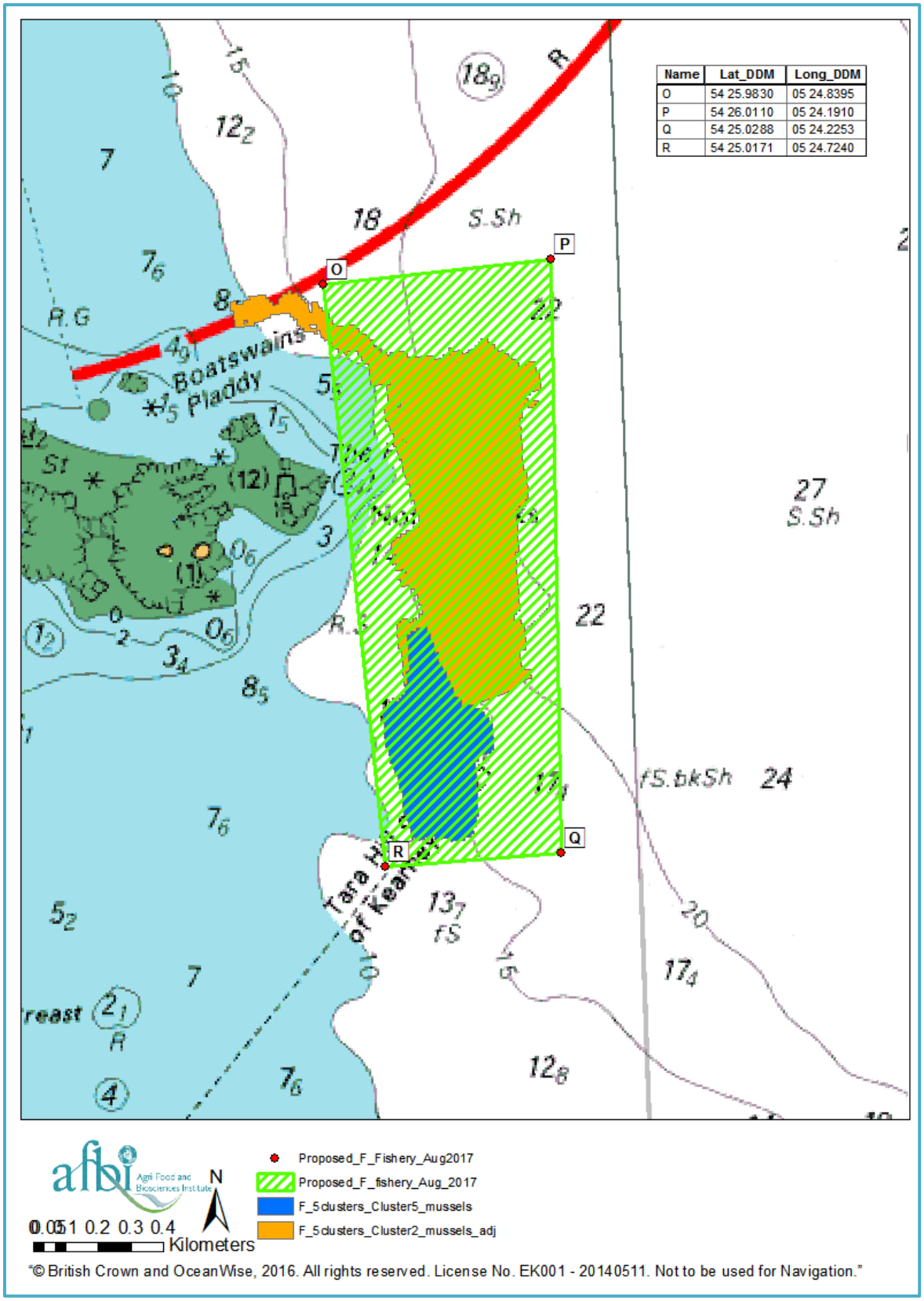


Figure 33: RoxAnn cluster map (from roughness and hardness values) from AFBI June 2017 survey of The Feathers, highlighting the area of Cluster 5 (dark blue area on map) and Cluster 2 (orange area on map) that represents seed mussel. The proposed fishery area is shown by the green hashed area on the 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.

McQuaid, N., Roberts, D., McMinn, C., Browne, L. and McDonough, N. 2017. A multi-disciplinary study of the blue mussel seed resource in the north Irish Sea and ongrowing strategies for the Northern Ireland Bottom mussel industry. Report to the Department of Agriculture and Rural Development for Northern Ireland. pp 155.

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.