North Western IFCA Inshore Fisheries and Conservation Authority

The Wildlife Trusts Lancashire, Manchester & N Merseyside

The Wildlife Trusts Cumbria Wildlife Trust

Update 2014:

Distribution mapping and health assessment of honeycomb worm, *Sabellaria alveolata,* reefs on Heysham Flat, Lancashire

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Report to the North Western Inshore Fisheries and Conservation Authority

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1 Acknowledgements

This report was conducted as part of Cumbria Wildlife Trust and the Wildlife Trust for Lancashire, Manchester and North Merseyside's Marine Training Programme in collaboration with the North Western Inshore Fisheries and Conservation Authority. This work report was supervised and edited by Mandy Knott[1].

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2 Introduction

This report is intended to act as an update to Distribution mapping and health assessment of honeycomb worm, *Sabellaria alveolata*, reefs on Heysham Flat, Lancashire 2014 by Sian Egerton. Egerton (2014) includes a comprehensive introduction to the background of this report, along with details of survey locations and methodology.

Where possible, titles in this report reflect those in the original Egerton (2014) report for easy cross-referencing and updating. Additional sections have been added in the results and conclusion sections due to more in-depth analysis being run on the data. Some sections of the methodology required amendment as new procedures have been implemented as a result of recommendations from last year's report. Sections which did not require altering or updating have been omitted from this report to prevent repetition.

2.1 NWIFCA Byelaw 6

In 2012 Defra proposed a revised approach towards fisheries management within European Marine Sites (EMS) following a challenge by ClientEarth. A risk based approach was taken by organisations including Natural England, the MMO, Defra and the 10 IFCAs. This resulted in a matrix of fishing activities against conservation features within EMS, with a 'traffic light' system of perceived risk. Bottom towed gear on reef features was identified as a high (i.e. red) risk, and IFCA and MMO byelaws were introduced around English waters to prohibit their use.

On 15th May 2014 a North Western IFCA byelaw was passed (Byelaw 6) prohibiting the use of bottom towed gear over reef features within the NWIFCA District and including on a section of Heysham Flat (North Western Inshore Fishery and Conservation, 2014). This area was selected as it encompasses the largest historical area of *S. alveolata* reef and allowed for an 80 meter buffer around it (Figure 1).

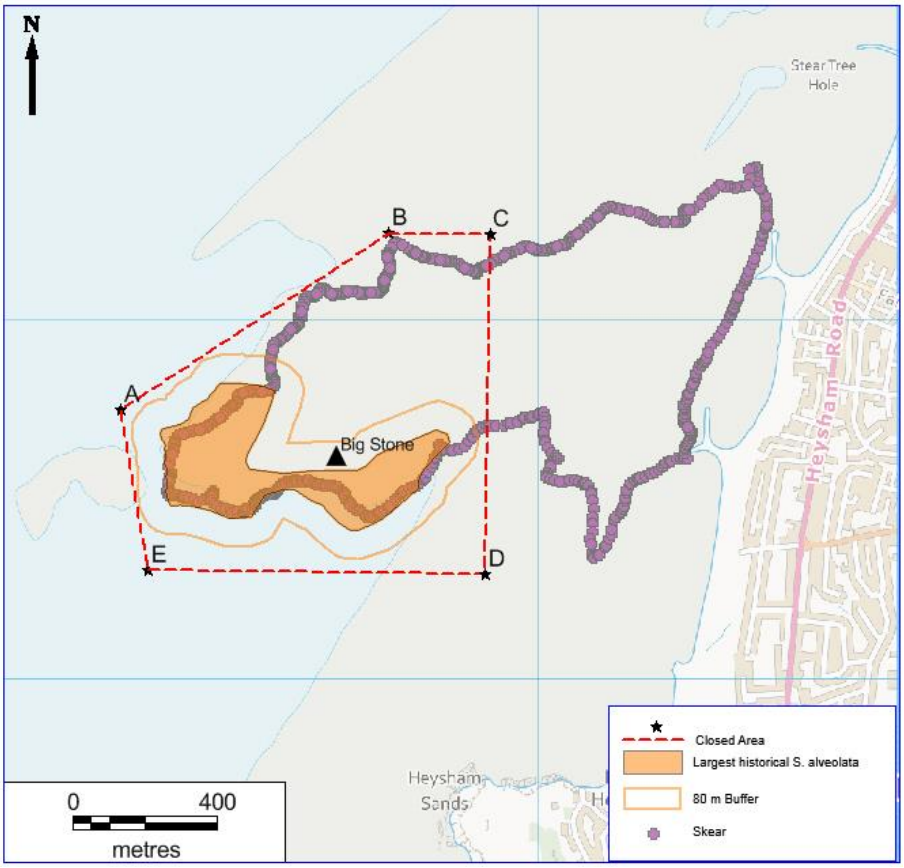


Figure 1. Byelaw 6; area closed to bottom towed gear

Largest historical area of *S. alveolata* with an 80 m buffer shown.

Field surveys

4.1.4 Dates, tides & surveying hours

Originally two surveys were conducted in 2011 in order to cover the entirety of the *S. alveolata* extent, both in early autumn. The project was expanded in 2012 and surveys were completed in the summer and autumn seasons. In 2013 surveys were conducted in spring, summer and autumn. In 2014 two surveys were completed to fulfil the new sampling requirements (see 4.2 Methodology amendment), one in spring and one in summer. Surveys were organised, whenever possible, on spring tides around extreme low water so that the furthest extent of the reef could be surveyed (Table 1). The surveys were conducted two hours before and up to one hour after the time of low tide.

Table 1. Survey dates and corresponding daylight hours and tide times (2014 surveys highlighted in light blue)

Date	Time of sunrise (BST)	Time of sunset (BST)	Time of low tide (BST)	Height of low tide (m)	Time of high tide (BST)	Height of high tide (m)
30/08/11	06:17	20:08	07:05/19:15	0.6/0.8	12:50	10.1
27/09/11	07:07	18:58	06:00/18:10	0.8/0.9	11:40	10.0
03/08/12	05:30	21:05	07:15/19:30	0.8/1.1	12:50	9.5
20/08/12	06:00	20:29	08:05	0.9	13:50	9.7
15/10/12	07:41	18.13	05:55/18:05	1.1/1.2	11:40	9.9
02/04/13	06:40	19:15	10:40	1.8	16:30	8.6
27/06/13	04:41	21:48	09:25	0.7	15:00	9.4
24/07/13	05:13	21:23	19:50	0.8	00:40	10.2
10/10/13	07:31	18:25	09:40/22:05	2//2.1	03:05/15:30	9.3/9.1
28/04/14	05:40	20:38	05:45/18:10	1.1/0.9	11:20/23:45	9.7/9.6
15/07/14	04:59	21:36	08:30/20:50	0.5/0.9	14:10	9.9

4.1.5 Surveyors

The 2014 spring survey was conducted by Mandy Knott and Sarah Temple of NWIFCA with the assistance of Sian Egerton and Emily Baxter from Cumbria Wildlife Trust.

The 2014 summer survey was conducted with assistance from Cumbria Wildlife Trust's (CWT) and the Wildlife Trust for Lancashire, Manchester and North Merseyside's (WTLMNM) Marine Training Programme. Trainee Marine and Coastal Conservation Officers Victoria Foster, Helen Hiley, Nick Walters and Amy Bradshaw assisted NWIFCA surveyors Mandy Knott and Abigail Leadbeater.

4.2 Methodology (amendment)

In order to ensure optimal survey routine, suggestions from Egerton (2014) have been implemented. This includes conducting two surveys per year in order to monitor the health and extent of the *S. alveolata* reef both in spring (March/April) before the seed mussel settlement and in Summer (July/August) after the settlement.

Due to the changing shape and extent of the *S. alveolata* reef, as well as the evolving nature of this monitoring program, the stations surveyed differ between years, making comparing data sets difficult. As recommended in Egerton (2014), 84 fixed stations have now been selected which will be sampled every year to allow for direct comparison of the data (Figure 2). These stations have been selected as they cover the main area of the reef which has been historically present, and this is the area protected under Byelaw 6 (North Western Inshore Fishery and Conservation, 2014). Additional stations have been added as the *S. alveolata* has extended its distribution; however, these areas appear to be much more ephemeral in their nature.

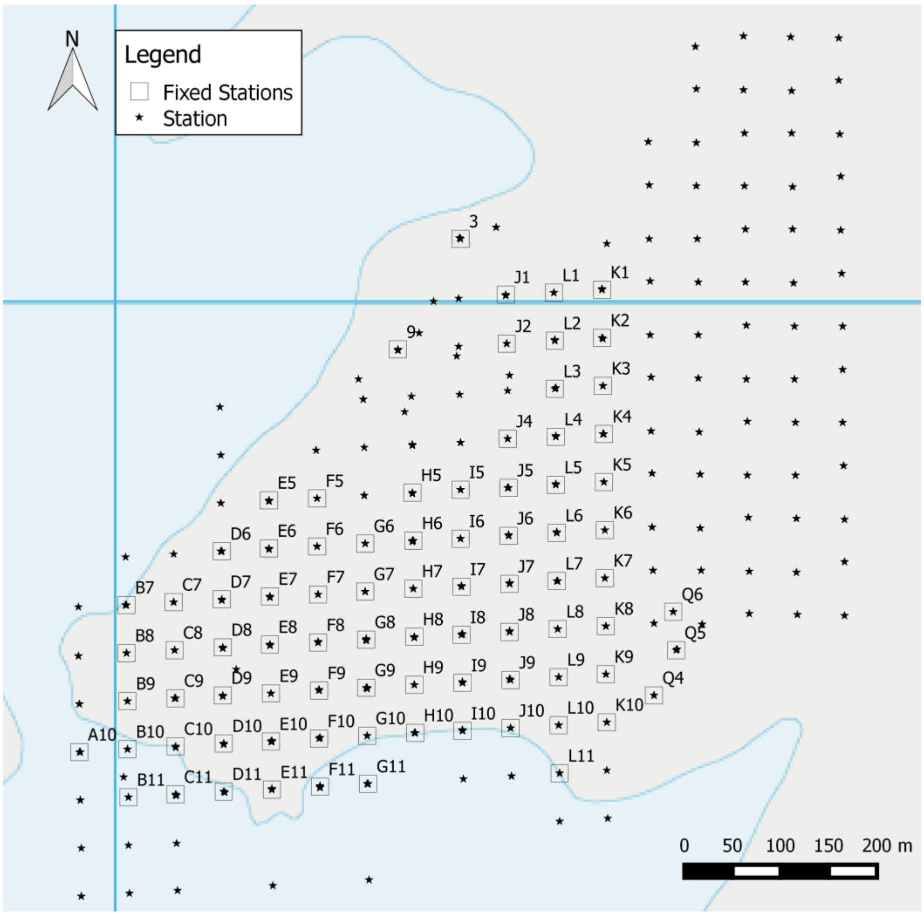


Figure 2. *S. alveolata* sampling stations on Heysham flat

Fixed stations are boxed and labelled with the sample stations number.

Assessment of biodiversity associated with *S. alveolata* has previously included records of dead specimens, which has led to concerns regarding the presence of non-native species on the site. Organisms should only be included in the list of associated biodiversity if there are live species present at the station. If dead species are recorded it should be made very clear on the recording form that the specimen was dead.

4.3 Data analysis

Data from all surveys were digitised, integrated and measuring units standardised. Records with discrepancies that could not be resolved were removed from the dataset[2].

Analysis focussed on investigating changes in:

• Distribution (i.e. percentage area cover) of *S. alveolata*	Stations: Fixed and All
• Health status and formation type of *S. alveolata*	Stations: Fixed
• Distribution of *M. edulis*	Stations: Fixed
• Distribution of *S. alveolata* in relation to seed *M. edulis*	Stations: All
• Biodiversity	Stations: All

Previously, variations in *S. alveolata* health and distribution have only been investigated for annual variations (Egerton, 2014). Seasonal variation created by seed mussel settlements on the reef has not been considered. Therefore this report will consider the seasonal variation of *S. alveolata* distribution, focussing on the fixed stations for easy future comparison. For clarity, the above list shows where only data at the fixed stations was used for the seasons where this was available (Fixed), and where data from all stations surveyed across all seasons was used (All).

The previous report (Egerton, 2014) did not directly investigate the relationship between seed mussels and the percentage cover of *S. alveolata*. It is hypothesised that the seed mussel settlement directly affects the coverage of *S. alveolata*, and this will be looked at here.

Biodiversity data was only available for 2012-2014 surveys. In accordance with the adjusted methodology, any records of Pacific oysters (all records were checked and did not include live specimens) and dead specimens were removed from the records.

4.3.1 Statistical analysis

Seasonal distribution of *S. alveolata*

The *S. alveolata* cover across the fixed stations was compared seasonally. The assumptions of normally distributed and homogenous residuals were analysed using a qqplot and a Shapiro-Wilk normality test, both of which showed violations of the assumptions. Due to the non-parametric nature of the data, a Kruskal–Wallis analysis of variance (ANOVA) test was used to investigate the difference in percentage cover of *S. alveolata* across seasons in the fixed stations. Subsequent analysis involved pairwise comparisons of the mean ranks between seasons.

Distribution of *S. alveolata* in relation to seed *M. edulis*

The relationship between seed mussel coverage and the percentage cover of *S. alveolata* was investigated using data for all the stations sampled in all years. Due to the non-parametric nature of this data, the correlation between *M. edulis* cover and *S. alveolata* cover was tested using Kendall's tau.

Biodiversity

[2] Not all data discrepancies were removed; see discussion.

Sabellaria alveolata reefs are considered to be habitat enhancing, biogenic reefs (Dubois, et al., 2002). This was investigated by investigating the relationship between the number of species present and the percentage cover of *S. alveolata* at all the stations sampled.

Mytilus edulis settlements can either enhance or degrade the associated benthic communities (Beadman, et al., 2004). Seed *M. edulis* can be a supreme competitor for space, and its presence can exclude other species. High rates of competition, smothering and anoxia can significantly decrease the diversity of the benthic communities (Beadman, et al., 2004). Conversely, benthic communities can be enhanced through the creation of more complex habitat on the surface of the shell matrix as well as the production of organically enriched sediment microhabitat (Saurel, et al., 2004). Whether the seed mussel beds are having a positive or negative effect on the associated biodiversity will be investigated by looking at the relationship between the number of species present and the percentage cover of seed *M. edulis* at all stations.

Species data was only available for the 2012-2014 period. Due to the non-parametric nature of this data, the correlations between species richness and both *S. alveolata* and *M. edulis* cover were tested using Kendall's tau.

Software

All data was analysed using the software R version 3.0.1 (R Development Core Team, 2014) in the integrated development environment RStudio, version 0.97.551 (RStudio, 2012).

4.3.2 Mapping data

QGIS 2.6.1 (QGIS Development Team, 2014) was used to create maps, with data overlaid on Ordnance Survey maps. Seasonal thematic maps were created to illustrate the annual variation in *S. alveolata* distribution; the health status of *S. alveolata* and the *formation type of S. alveolata* and the distribution of under-size *M. edulis*, in relation to *S. alveolata* distribution. Maps were overlaid with density estimate polygons of ≥30% and ≥70% *S. alveolata* area cover in order to show areas of high importance.

5 Results

Seasonal comparison of *S. alveolata* distribution, health and formation was conducted only using the data from the fixed stations. Fixed stations for surveying *S. alveolata* were only established for the 2014 summer survey season. Therefore, during previous seasons none or only some of these stations were sampled. Between 31% and 100% of the fixed stations were surveyed in the following seasons; autumn 2011, summer 2012, summer 2013, autumn 2013, spring 2014 and summer 2014 (Table 2).

Changes in distribution of *S. alveolata* were recorded across the survey period of 2011 to 2014. A seasonal comparison was made using all the stations surveyed to give an overview of the *S. alveolata* cover. This is important as the survey area changes annually depending on the extent and location of the *S. alveolata* reef, and by looking beyond the fixed stations it may be possible to see areas where the *S. alveolata* is becoming established in new areas of the skear. However, due to the variability in survey effort and location it is difficult to draw direct comparisons between all the surveys.

Table 2. Number of waypoints surveyed between 2011 and 2014 at Heysham Flat, Lancashire

Survey Year	2011	2012		2013			2014	
Survey Season	Autumn	Summer	Autumn	Spring	Summer	Autumn	Spring	Summer
No. stations surveyed	49	86	62	63	104	51	38	98
No. unique annual stations (replicates removed)	49	148		173			103	
No. fixed stations surveyed	49	79	0	0	78	44	26	84

5.1 Seasonal *Sabellaria alveolata* distribution at fixed stations

Of the 84 fixed stations 58.3% (49) were surveyed in autumn 2011 (Table 3). The average *S. alveolata* percentage cover across these stations was 18.4 ± 3.8% (±1 s.e., *n* = 49) with a standard deviation of 26.8%. Twelve (24.5%) of the stations surveyed contained no *S. alveolata*, while 13 (26.5%) had a *S. alveolata* percentage cover of ≥30%.

Summer 2012 saw many more of the fixed stations surveyed, with 94% (79) of the 84 stations included in the survey. The average *S. alveolata* percentage cover was 26.8 ± 2.9% (±1 s.e., *n* = 79), with a standard deviation of 26.1%. Only 19 (24.1%) of the stations contained no *S. alveolata*, the lowest percentage of stations without any *S. alveolata* present across all the seasons. Thirty-two (40.5%) of the stations contained had a *S. alveolata* percentage cover of ≥30%, the greatest percentage of stations with ≥30% *S. alveolata* cover across all the seasons.

2013 had two seasonal surveys which covered stations in the fixed survey area. In summer 2013 a high number of the fixed stations were surveyed, with 78 (92.9%) surveyed. The average *S. alveolata* percentage cover was 7.7 ± 1.9% (±1 s.e., *n* =78), with a standard deviation of 17%. Fifty-two (66.7%) of the stations contained no *S. alveolata*, while 7 (9%) contained 30% or more *S. alveolata* cover. Autumn of 2013 only saw 44 (52.4%) of the fixed stations surveyed. The average *S. alveolata* percentage cover was 18.4 ± 3.6% (±1 s.e., *n* =44), with a standard deviation of 27.3%. Twelve (27.3%) of the stations contained no *S. alveolata*, while 11 (25%) contained ≥30% *S. alveolata* cover.

In 2014 both of the seasonal surveys included stations from the fixed survey area. The spring 2014 survey only 26 (31%) of the fixed stations were surveyed, the fewest in any season. This was the season with the lowest overall survey effort, with only 38 stations sampled in total. The average *S. alveolata* percentage cover was 9.5 ± 3.6 (±1 s.e., *n* =26), with a standard deviation of 18.1%. Fourteen (53.8%) of the stations contained no *S. alveolata*, while only 3 (11.5%) contained 30% or more *S. alveolata* cover. The summer 2014 survey was the first one were the new methodology was implemented, meaning that all 84 fixed stations were surveyed. Although, all the stations were included, the lowest percentage cover of *S. alveolata* was recorded in his season, with 75 (89.3%) of the quadrats containing no *S. alveolata*. Only 2 (2.4%) stations contained *S. alveolata* percentage cover of ≥30%.

Table 3. Seasonal percentage cover of *Sabellaria alveolata* on Heysham Flat between 2011 and 2014

	2011 autumn	2012 summer	2013 summer	2013 autumn	2014 spring	2014 summer
n (% of fixed stations)	49 (59.8)	79 (94)	78 (92.9)	44 (52.4)	26 (31)	84 (100)
Mean *Sabellaria* cover (%) (± 1 SE)	18.4 ± 3.8	26.4 ± 2.9	7.7 ± 1.9	18.4 ± 3.6	9.5 ± 3.6	2 ± 1
Standard deviation in *Sabellaria* cover (%)	26.8	26.1	17	23.7	18.1	9.2
Median *Sabellaria* cover (%)	3	25	0	4.5	0	0
Stations with 0% *Sabellaria* (% of stations surveyed)	12 (24.5)	19 (24.1)	52 (66.7)	12 (27.3)	14 (53.8)	75 (89.3)
Stations with ≥30% *Sabellaria* (% of stations surveyed)	13 (26.5)	32 (40.5)	7 (9)	11 (25)	3 (11.5)	2 (2.4)

Kruskal–Wallis analysis of variance (ANOVA) confirmed that there was significant variation in the average percentage *S. alveolata* cover between the seasons $H(5) = 102.31$, $p < .001$ (Figure 3). Subsequent pairwise comparisons of the mean ranks between seasons indicated that autumn 2011 had a greater percentage cover of *S. alveolata* than summer 2013 (*difference* = 70.06) and summer 2014 (*difference* = 109.96). Summer 2012 had the highest mean percentage *S. alveolata* cover, and this was significantly greater than the mean cover in summer 2013 (*difference* = 94.21), spring 2014 (*difference* = 74.68) and summer 2014 (*difference* = 134.11). Autumn 2013 had a greater average S. alveolata percentage cover than both summer 2013 (*difference* = 70.41) and summer 2014 (*difference* = 110.30).

As the summer seasons in 2012, 2013 and 2014 all surveyed in excess of 90% of the fixed stations it is worthwhile looking at these seasons in more detail, as they may be more representative of annual changes in *S. alveolata* cover. Pairwise comparisons of the mean ranks between years indicate that there was significantly more *S. alveolata* cover in the summer of 2012 than in summer 2014. However, 2013 percentage cover of *S. alveolata* was not significantly different from the cover in either 2012 or 2014.

Figure 4 (a - f) outlines where areas of denser *S. alveolata* existed in each of the survey seasons and highlight the densest zones of ≥70% *S. alveolata* area cover.

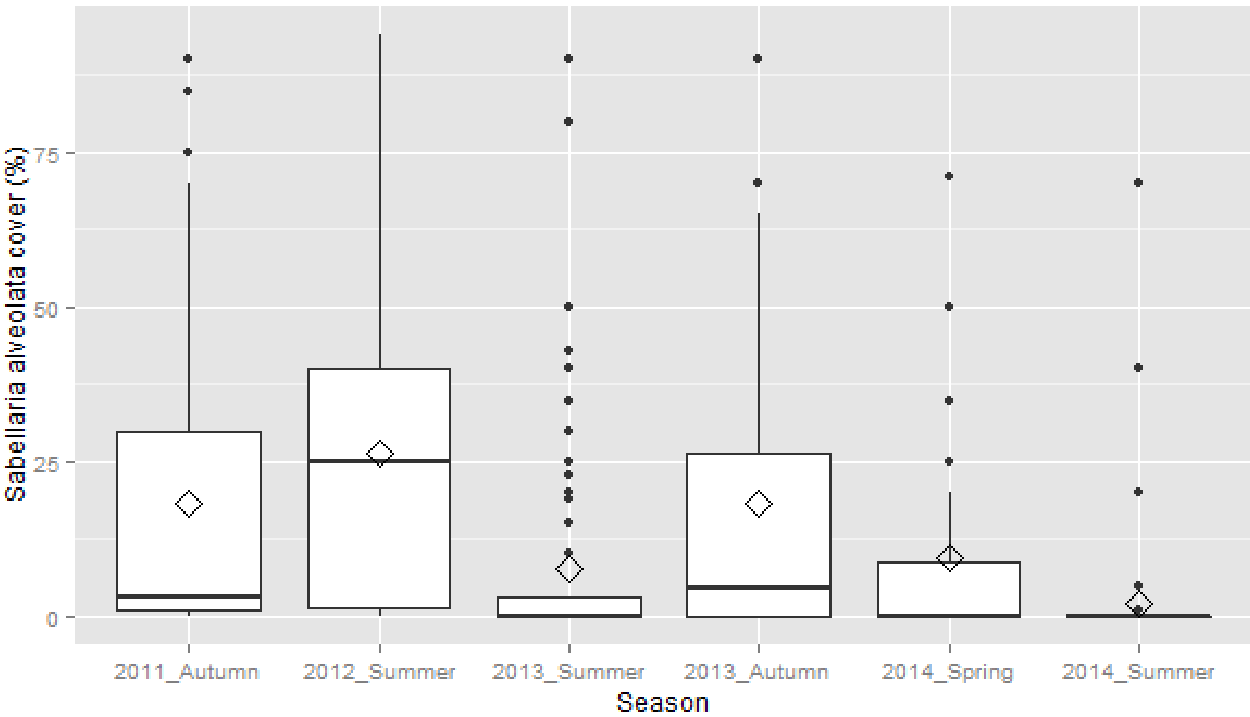


Figure 3. Average percentage cover of *Sabellaria alveolata* at fixed stations on Heysham Flat

Diamond = mean

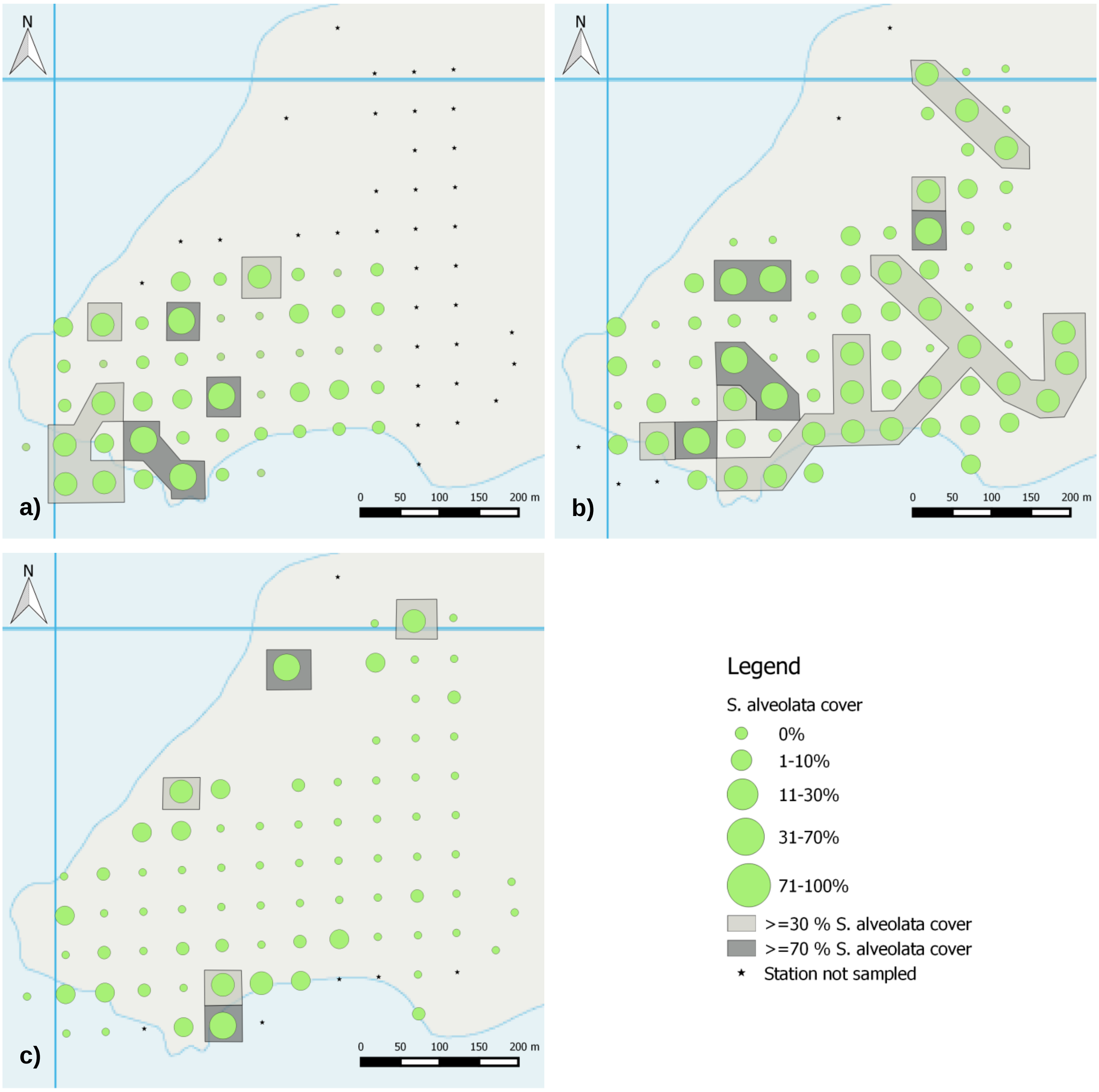


Figure 4. Percentage cover of *Sabellaria alveolata* at fixed stations on Heysham Flat

a) 2011 autumn; b) 2012 summer; c) 2013 summer

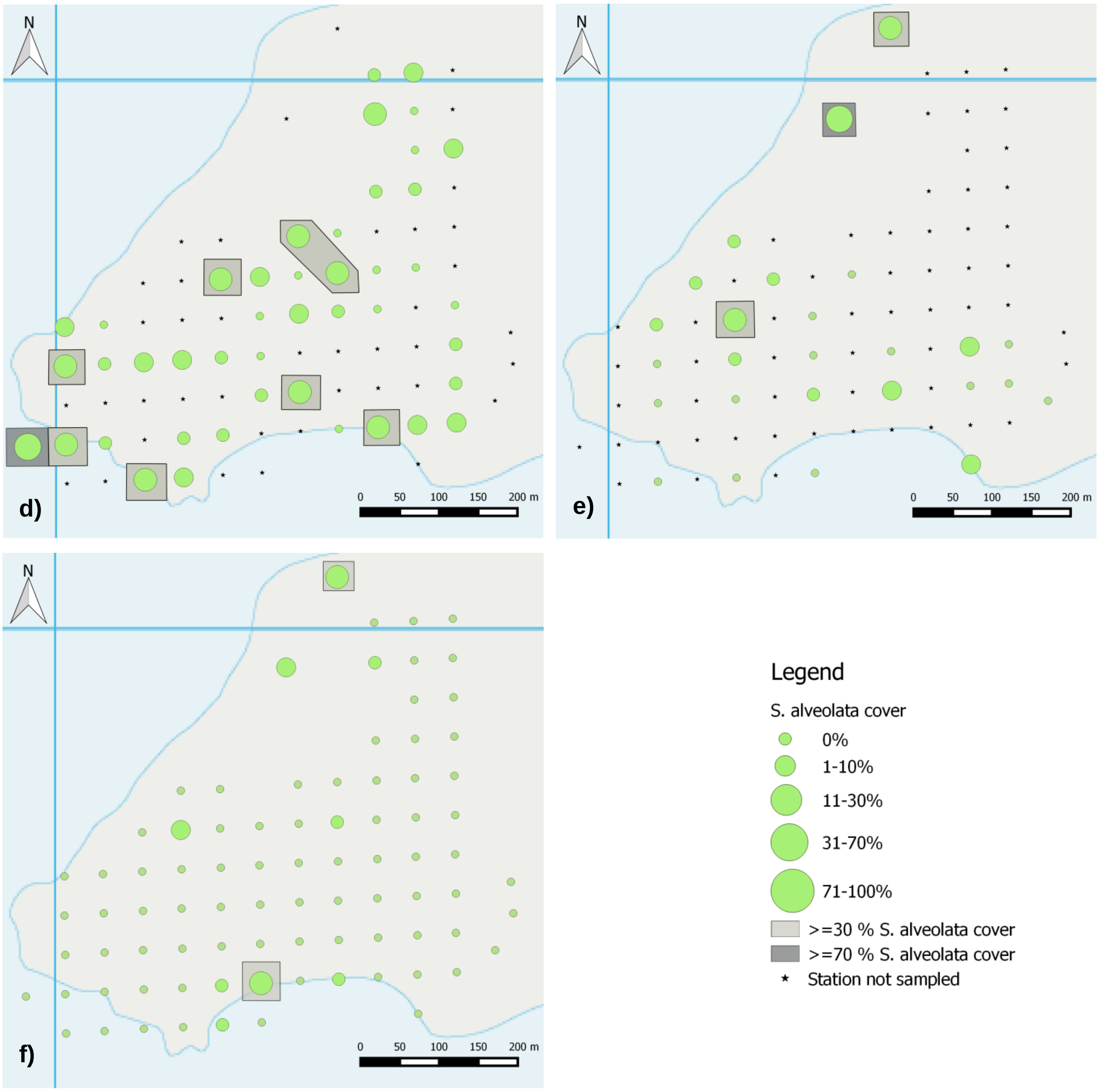


Figure 4 (cont.). Percentage cover of *Sabellaria alveolata* at fixed stations on Heysham Flat

d) 2013 autumn; e) 2014 Spring; f) 2014 summer

5.1.1 Seasonal *Sabellaria alveolata* distribution at all stations

This descriptive overview of *S. alveolata* coverage from all eight seasons over the four years gives an insight into how *S. alveolata* distribution has changed. It also highlights areas where *S. alveolata* has previously been recorded in high densities but that have not been re-surveyed to check if these extensions are permanent or ephemeral.

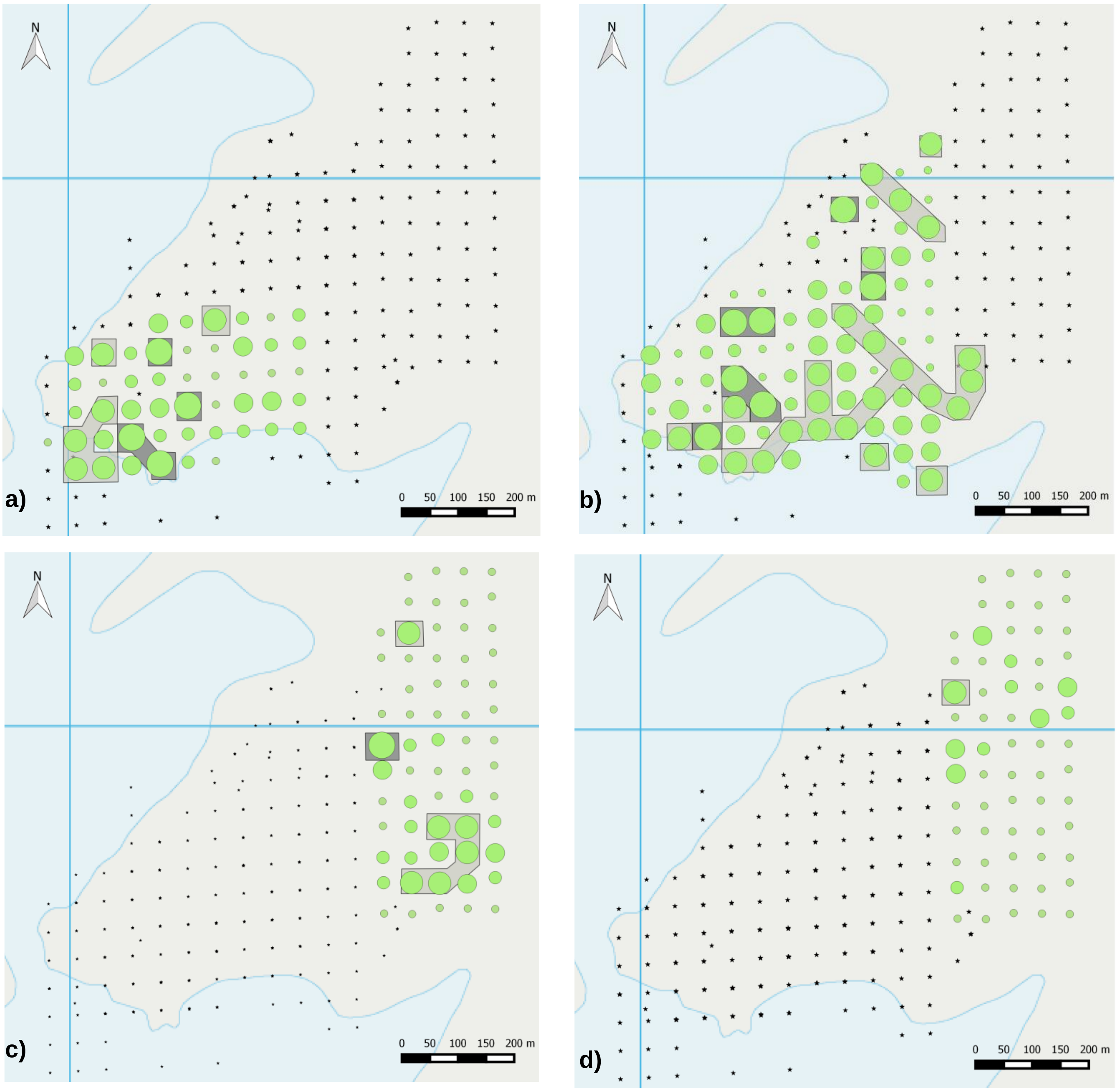
The autumn 2011 surveys only covered the fixed station, so this expanded overview shows no more than the fixed station maps (Figure 5 a).

The summer survey of 2012 shows a good *S. alveolata* coverage over the entirety of the survey area (Figure 5 b). There is an additional section of reef to the south of the skear, which is beyond the fixed stations. Part of this section was surveyed again in summer 2014 but there was no *S. alveolata* present, suggesting this was an ephemeral section of reef, and not a permanent feature.

Surveys from Autumn 2012 and spring 2013 reveal that the *S. alveolata* distribution extends further east from the fixed stations (Figure 5 c & d). However, this section of the reef appears quite ephemeral, with high *S. alveolata* coverage in the south in 2012 which disappears in 2013 to be replaced with sparser coverage in the more northern end of this section.

Surveys from summer and autumn 2013 show an extensive expansion of the central section of the reef northwards (Figure 5 e & f). In both these seasonal surveys coverage in this northern area is good with *S. alveolata* coverage often exceeding 70%.

In 2014 this northern extension of the reef was not re-surveyed in its entirety, although the few stations which were surveyed in this area showed higher percentage coverage of *S. alveolata* than the surrounding areas (Figure 5 g & h). Both surveys from 2014 show very low percentage coverage of *S. alveolata*. In both spring and summer surveys, an area of higher *S. alveolata* coverage can be seen on the western end of the skear, which is not covered by the fixed station survey



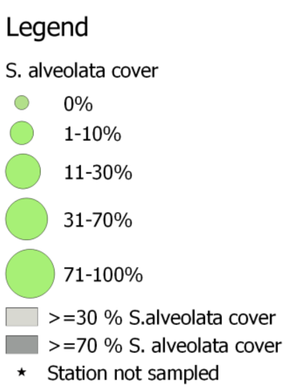
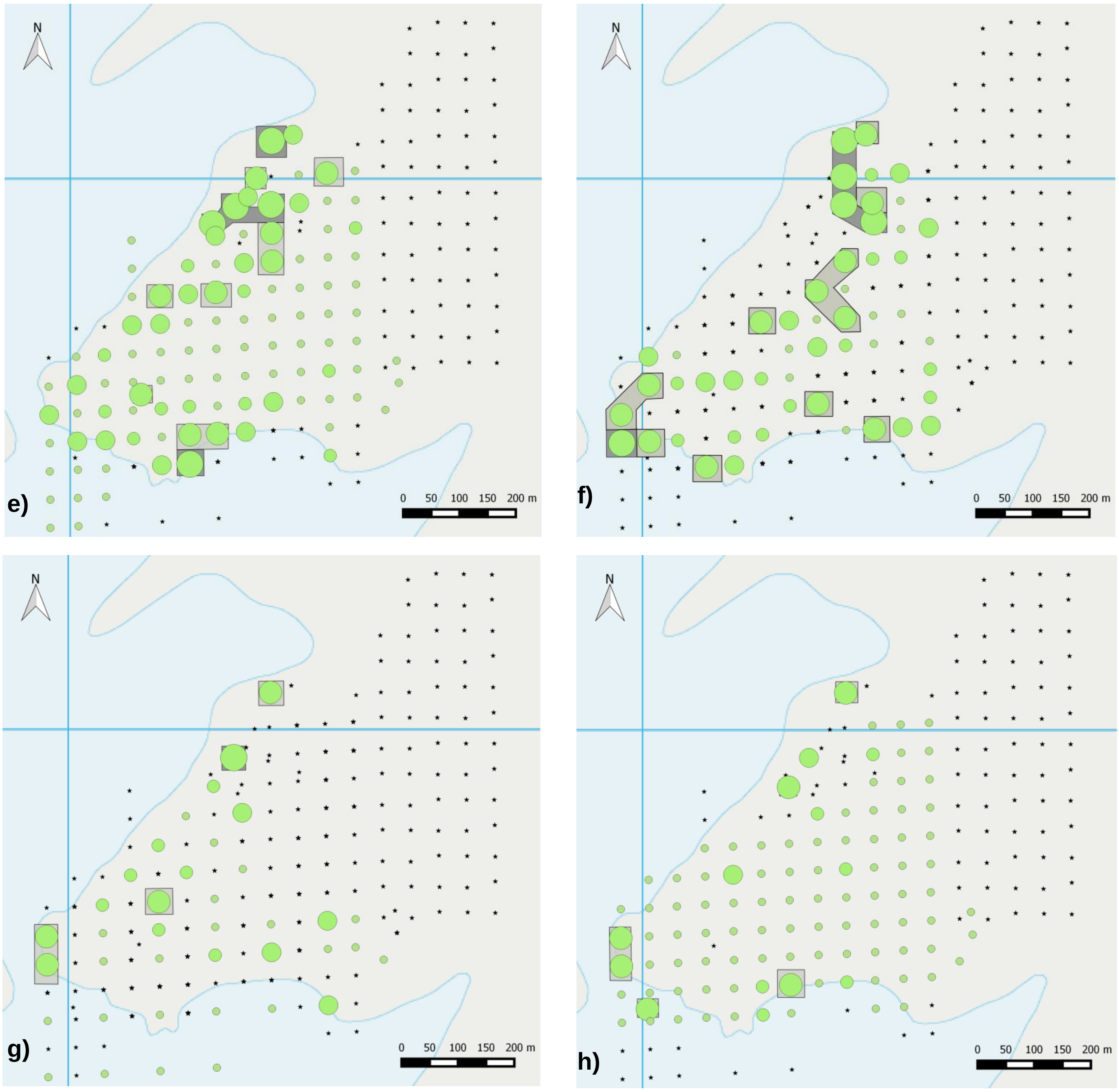


Figure 5. Percentage cover of *Sabellaria alveolata* on Heysham Flat

a) 2011 autumn; b) 2012 summer; c) 2012 autumn; d) 2013 spring



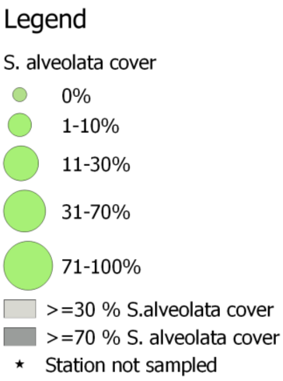


Figure 5 (cont.). Percentage cover of *Sabellaria alveolata* on Heysham Flat

e) 2013 summer; f) 2013 autumn; g) 2014 spring; h) 2014 summer

5.2 Seasonal health and formation of *Sabellaria alveolata*

The health and formation type of *S. alveolata* was investigated at the fixed stations for the seasons where this data was available. Four of the records which have been used previously to map the extent of both *S. alveolata* and *M. edulis* were removed for this section of the analysis as they were missing health and/or formation information. These records were;

- 2012 summer, station K4
- 2013 summer, station D10
- 2013 autumn, station K8
- 2014 summer, station I1

5.2.1 Formation of *Sabellaria alveolata*

Focussing on the 183 stations where *S. alveolata* was recorded, the most prevalent formation type throughout the seasons was patchy (Figure 6). The average percentage of *S. alveolata* recorded in patchy formation remained between 41-76% across all seasons, peaking in spring 2014 and dropping to its lowest prevalence in summer 2014.

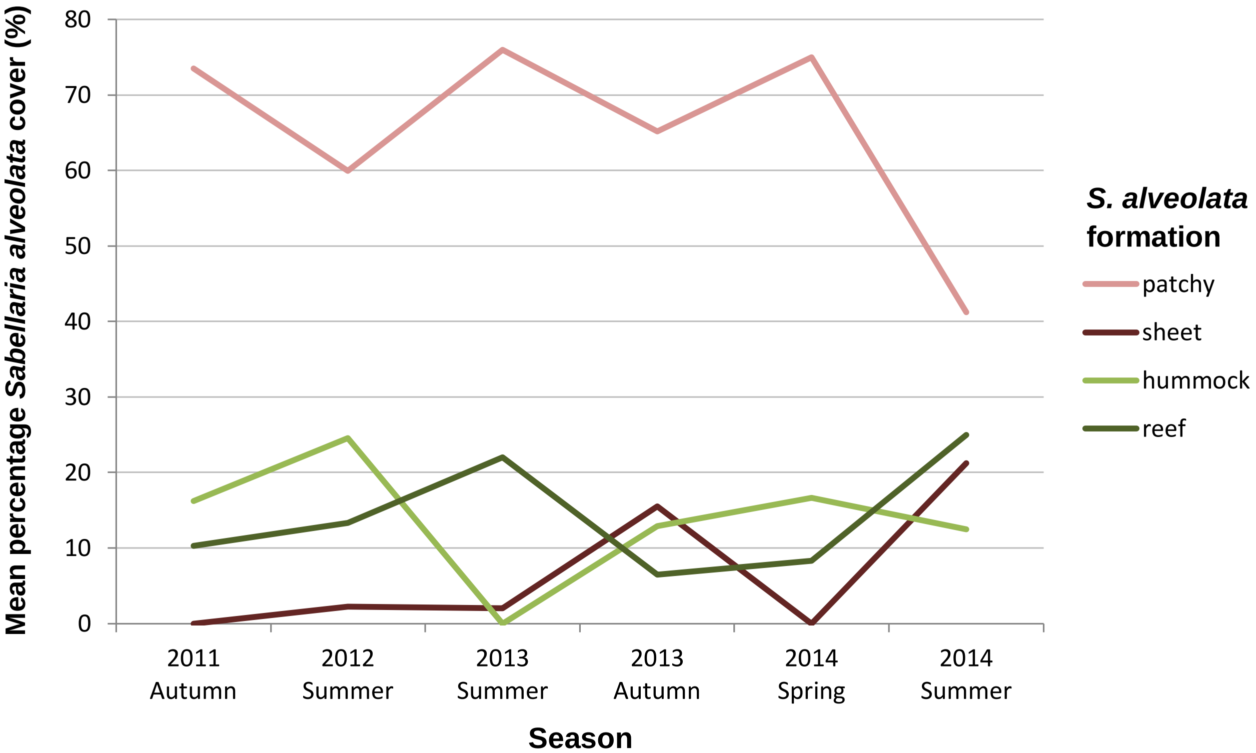


Figure 6. The average percentage cover of *Sabellaria alveolata* associated with different reef formations

The percentage of *S. alveolata* found in either sheet, hummock or reef formations were consistently low across all seasons. Only 6.5% to 25% of *Sabellaria alveolata* was found in reef formation between autumn 2011 to summer 2013.

From no records of *S. alveolata* in sheet formation in autumn 2011, the average proportion of *S. alveolata* recorded in sheet formation steadily rose from 2.2% in summer 2012 to 21.3% in summer 2014. This trend was only broken in spring 2014 when again there were no records of *S. alveolata* in sheet formation.

The average cover of *S. alveolata* in hummock formation was generally stable between 12.5% and 24.6%. Only in summer 2013 was *S. alveolata* not found in hummock formation at any station.

5.2.2 Health of *Sabellaria alveolata*

The health of the *S. alveolata* formations is highly variable across the seasons (Figure 7). Autumn 2011 showed the highest percentage of *S. alveolata* recorded with crisp apertures (51.76%). However, a significant proportion of the *S. alveolata* was also recorded as dead (30.08%). Comparatively little *S. alveolata* occurred with worn apertures (4.73%) or newly settled (13.43).

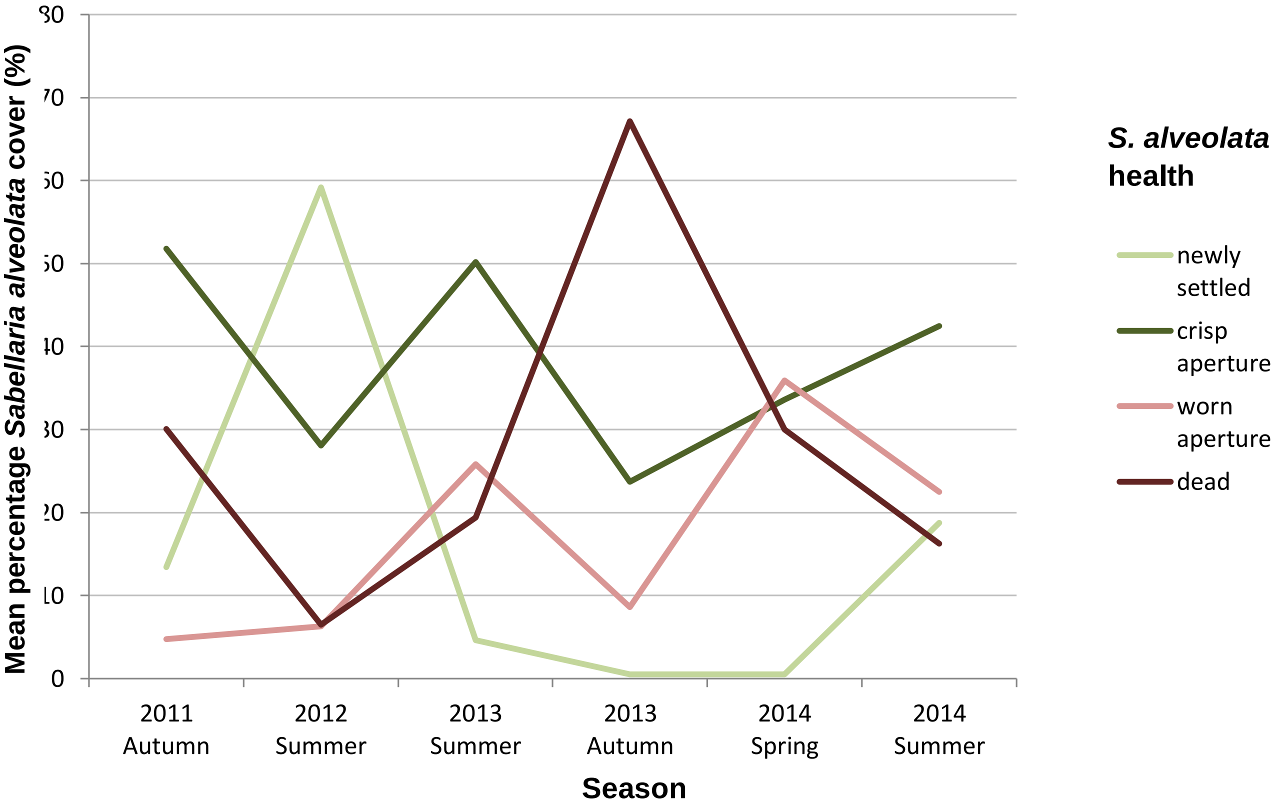


Figure 7. The average percentage cover of *Sabellaria alveolata* associated with different health types

In summer 2012 there was a peak in the percentage of *S. alveolata* recorded as newly settled, with 59.2% of the *S. alveolata* recorded in this condition. There was a decrease in the amount of *S. alveolata* recorded with both crisp apertures (28.05%) and dead (6.47%). The amount of *S. alveolata* recorded with worn apertures remained low at 6.27%.

Summer 2013 saw a large decline in the amount *of S. alveolata* recorded as newly settled, dropping to only 4.6%. However, there was significantly more *S. alveolata* recorded as having crisp apertures (50.2%). The amount of *S. alveolata* recorded as both dead and with worn apertures rose again, to 19.4% and 25.8% respectively.

Autumn 2013 saw the highest recorded percentage of *S. alveolata* recorded as dead (67.16%). Very little of the *S. alveolata* recorded in this season were newly settled (0.52%) or had worn apertures (8.61%).

The very low levels of newly settled S. alveolata continued into spring 2014 (0.5%). The percentage of *S. alveolata* recorded with crisp apertures, worn apertures or dead was between 30-36% for each category.

Summer 2014 saw an increase in the amount of *S. alveolata* recorded as newly settled (18.75%) and with crisp apertures (42.5%). The percentage of *S. alveolata* recorded as dead or with worn apertures was very similar, 16.25% and 22.5% respectively.

5.2.3 Correlation between percentage cover, health and formation

At each station, *S. alveolata* could be present in several different formations or fit into several different health categories. In order to ease analysis, the most dominant formations and health categories for each station have been considered. Where ≥50% of the *S. alveolata* in a station was recorded in a health or formation category, that was considered to be the prevalent type.

Although patchy formations were the most common with a total of 122 stations having patchy formations dominating them, where they occur the average percentage coverage of *S.alveolata* is generally low (16.4%). They are also highly variable in their condition with the percentage *S. alveolata* cover varying very little dependant on the health of the patchy formations (Figure 8).

Sheet formation was the least abundant, with only 9 stations having ≥50% *S. alveolata* cover in sheet formations. Where *S. alveolata* was recorded primarily in sheet formation the average percentage coverage varied between 22.5% and 62.5%. The health of *S. alveolata* in sheet formation was also highly variable. It does appear that the highest percentage coverage of sheet formation is found when the *S. alveolata* tubes appear newly settled.

A total of 30 stations were found to have ≥50% of *S. alveolata* coverage in a hummock formation. Where the *S. alveolata* cover predominantly in a hummock formation, the coverage is on average 37.9%. This formation type has only been recorded in association with crisp and newly settled tubes.

Where reef formations are dominant, there is generally a higher percentage cover of *S. alveolata* (average 59.5%). High *S. alveolata* coverage occurs when the predominate health catagories are newly settled, crisp or worn appatures. Of the 22 stations where reef formations were recorded, 13 (59.1%) were reported as having predominantly crisp apertures. Only 9.1% (2) of the stations where the *S. alveolata* was in reef formations were reported as predonimantly dead. Where the reef formations were reported as predominantly dead, the average percentage coverage of *S. alveolata* was low (8.5%).

Figure 9 (a - f) and Figure 10 (a - f) show the condition and formation of *S. alveolata* at the fixed sations.

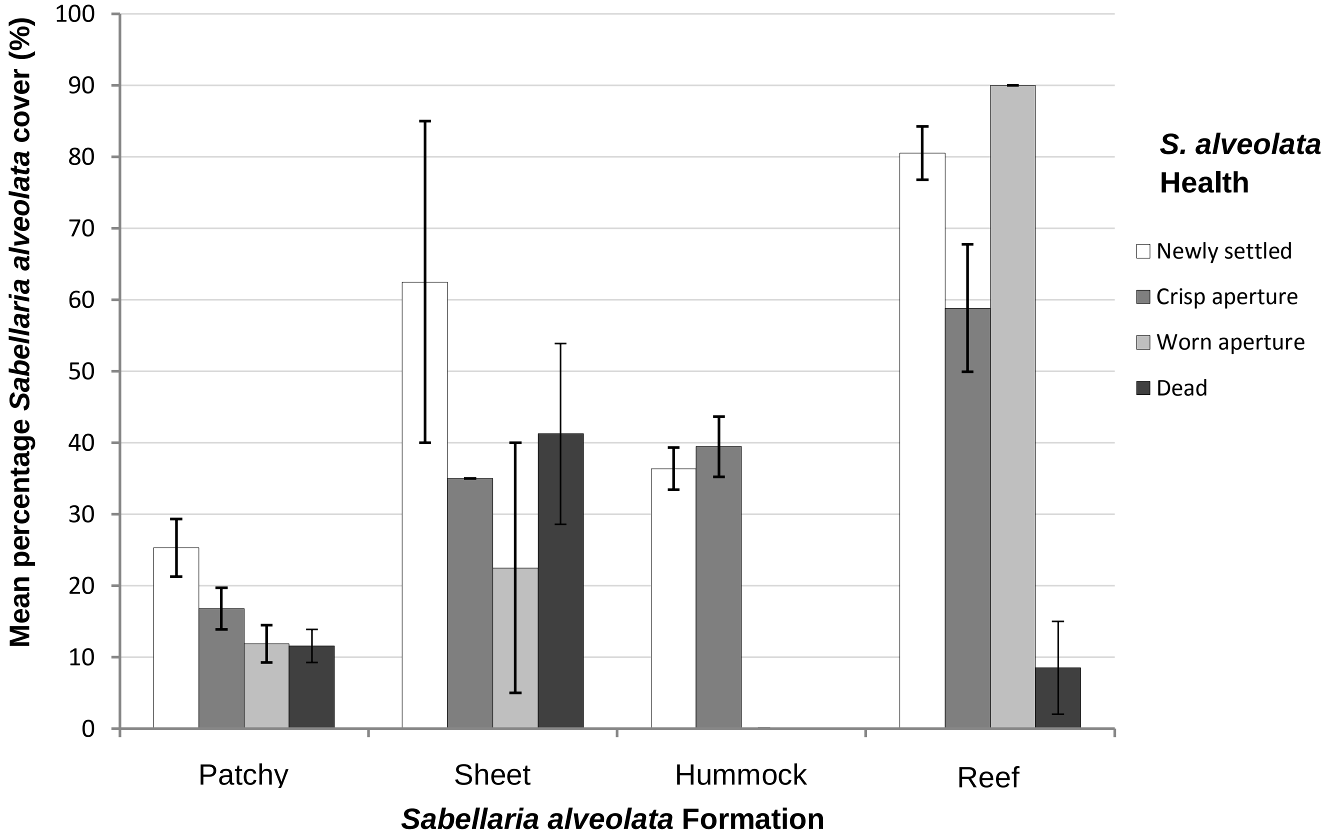


Figure 8. The health of *Sabellaria alveolata* worms associated with different reef formations

Mean proportion of each health category across all fixed station samples (± 1 s.e.)

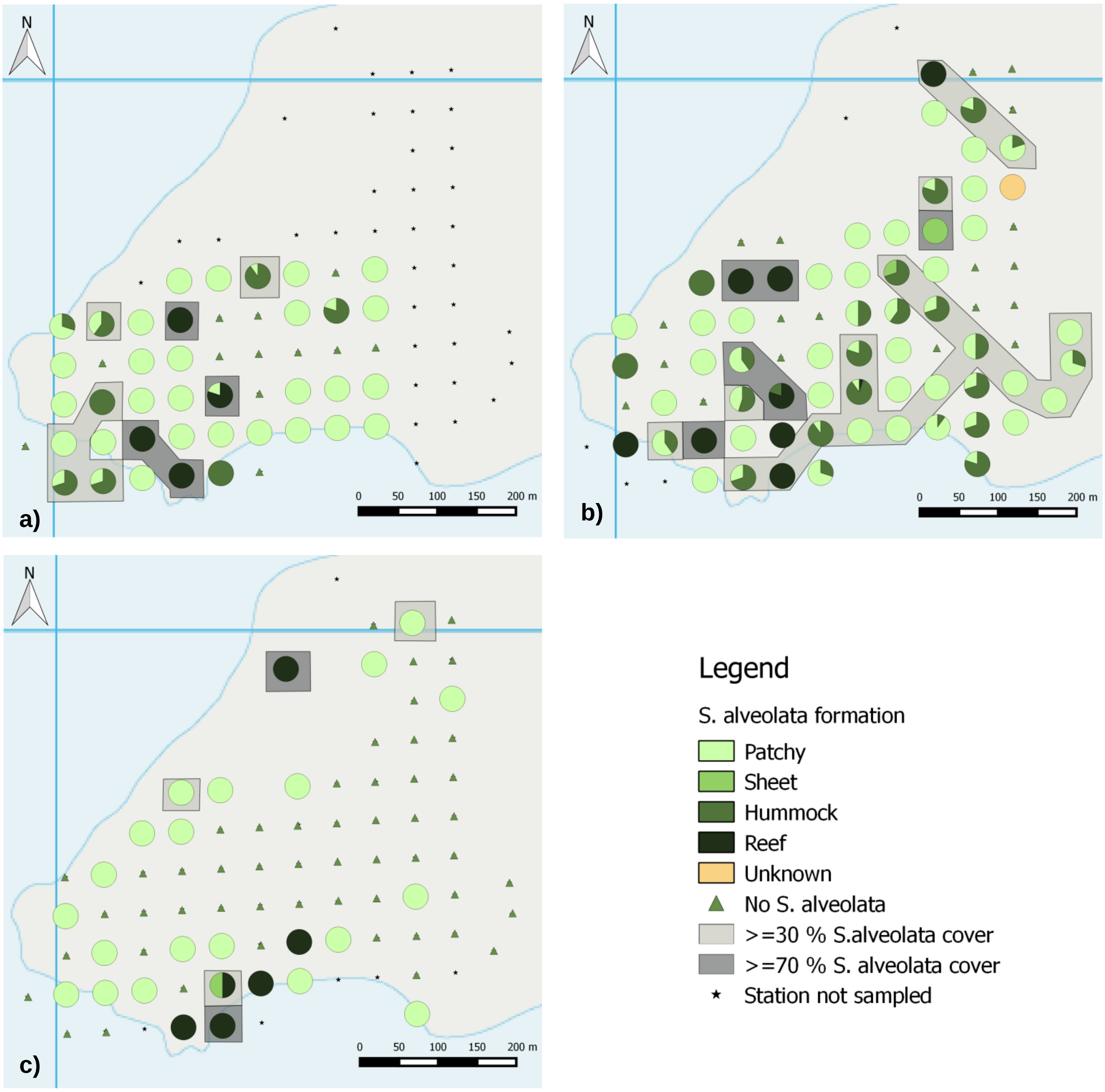


Figure 9. Distribution of formation types of *Sabellaria alveolata* at fixed stations on Heysham Flat

a) 2011 autumn; b) 2012 summer; c) 2013 summer

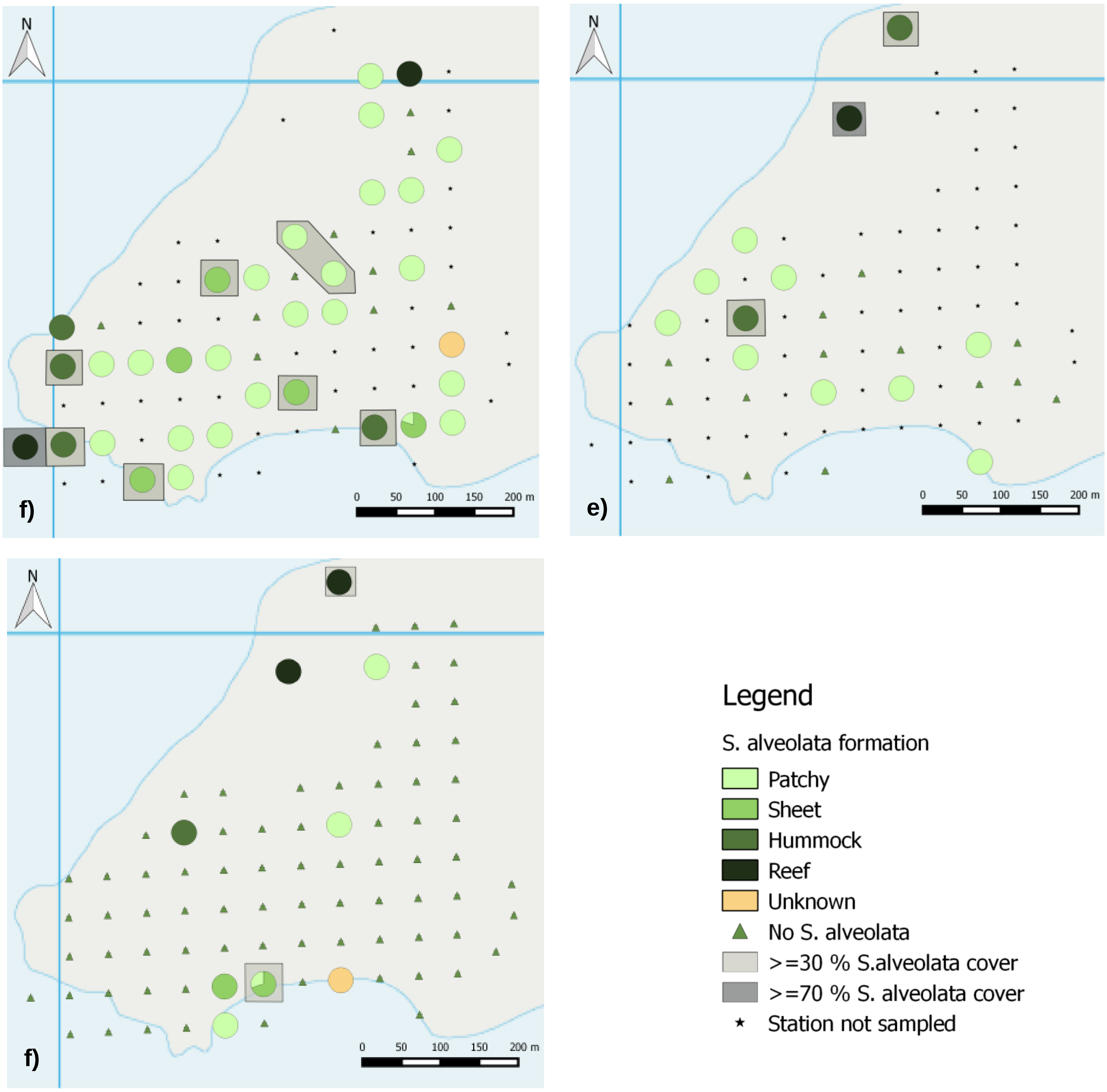


Figure 9 (cont.). Distribution of formation types of *Sabellaria alveolata* at fixed stations on Heysham Flat

d) 2013 autumn; e) 2014 Spring; f) 2014 summer

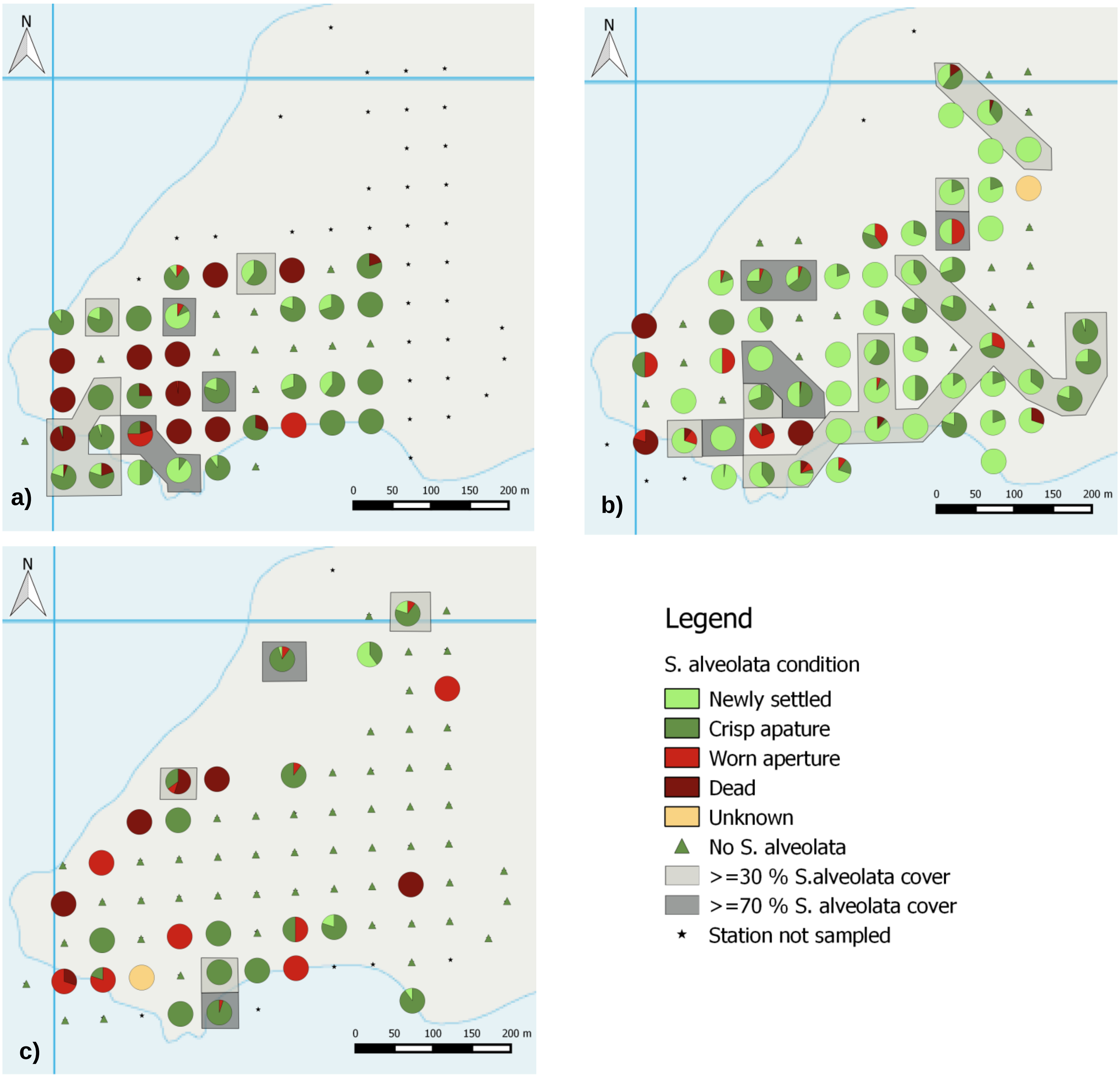


Figure 10. Distribution of health types of *Sabellaria alveolata* at fixed stations on Heysham Flat

a) 2011 autumn; b) 2012 summer; c) 2013 summer

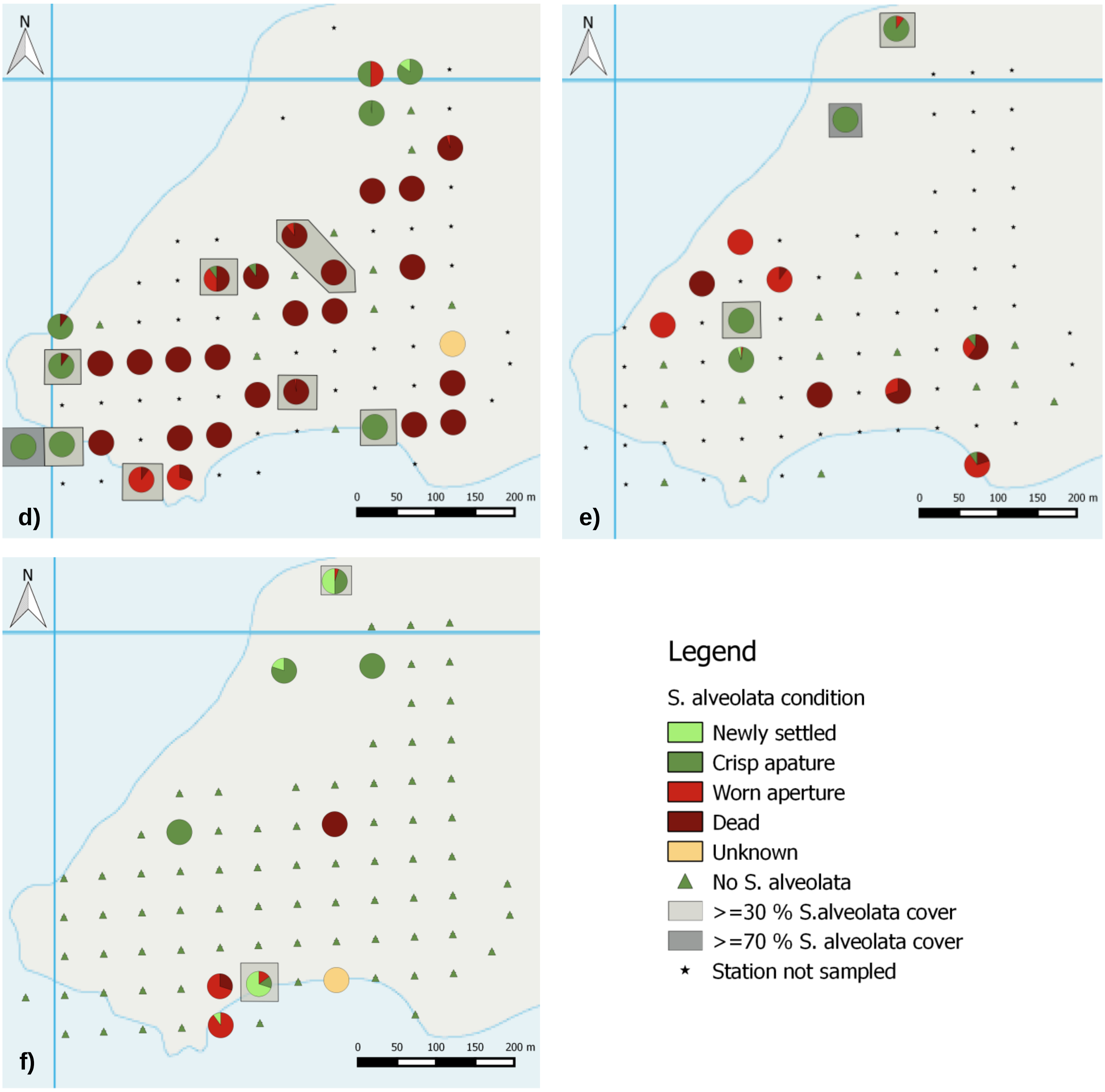


Figure 10 (cont.). Distribution of health types of *Sabellaria alveolata* at fixed stations on Heysham Flat

d) 2013 autumn; e) 2014 Spring; f) 2014 summer

5.3 Seasonal *Mytilus edulis* distribution

Under NWIFCA's Byelaw 3 there is a minimum landing size (MLS) for mussels of 45mm. Heysham Flat skear is subject to mass recruitment of edible mussel, which is known to build up large deposits of pseudo faeces (mussel mud), become unstable and get washed out by autumn and winter storms before it can reach MLS. Due to the ephemeral nature of this mussel stock the NWIFCA has a policy of authorising the removal of seed / undersize mussel by hand to Byelaw 3 permit holders, subject to Habitats Regulations Assessment. There is also an on-going competition for settlement space between *S. alveolata* formations and seed *M. edulis* beds, as described by Egerton (2014). The distribution and abundance of *M. edulis* is recorded in conjunction with *S. alveolata* both for fisheries management and conservation interests.

The prevalence of adult mussels on the skear is very limited (Figure 11). Whilst slightly higher abundances of adult *M. edulis* were recorded in both autumn 2011 and summer 2012, the maximum percentage coverage was only 35%, with an average coverage of adult mussels in those seasons of 3.29% and 4.84% respectively. In 2013 both the summer and autumn surveys showed very few adult *M. edulis*, with nearly 80% (62 and 35 respectively) of fixed stations surveyed in both seasons containing no adult *M. edulis*. Across the 2013 surveys, the maximum coverage of adult *M. edulis* was only 6%, with the average for the year being only 0.33%. There was a slight increase in the prevalence of adult mussels in spring 2014, with 57.7% (15) of quadrats surveyed containing adult *M. edulis*. However, the percentage cover was still low, never exceeding 10% with an average of only 1.54%. Spring 2014 continued the trend of low prevalence of *M. edulis* adults, with 95.24% (80) of stations surveyed not containing any, and an average coverage of just 0.15%.

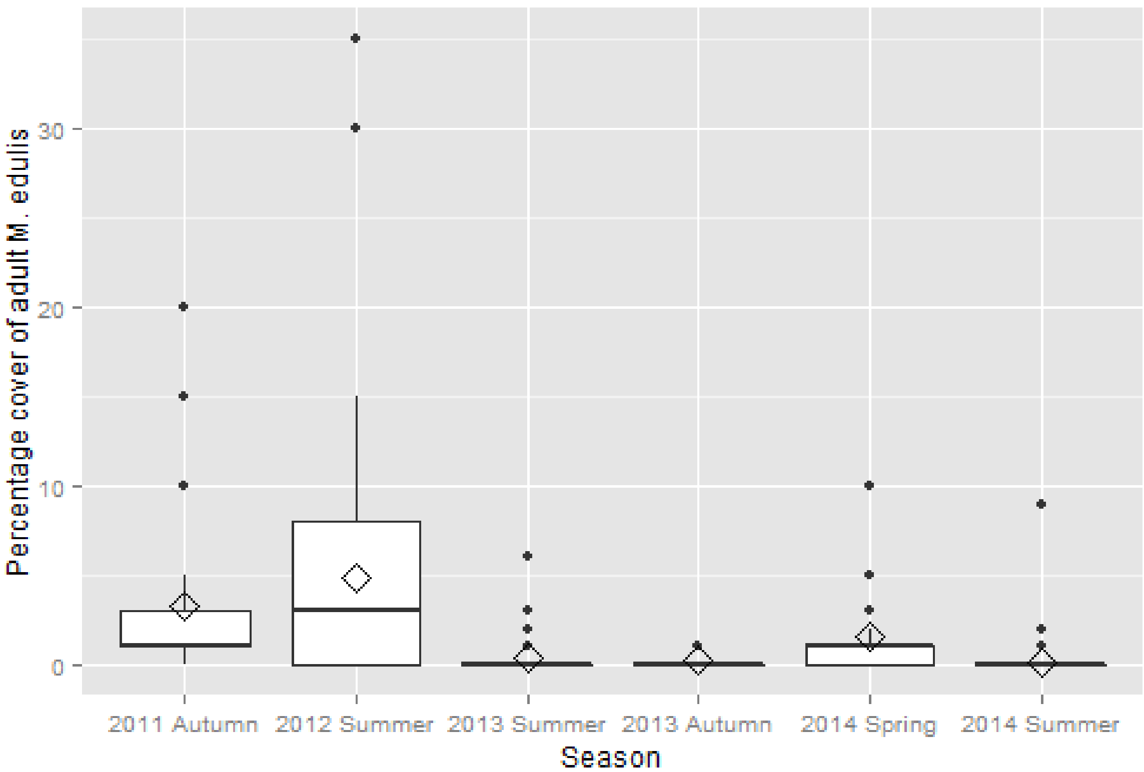


Figure 11. Percentage cover of *adult M. edulis* at fixed stations on Heysham Flat

Diamond = mean

Conversely, undersized *M. edulis* are prevalent on the skear at all times, though abundance does fluctuate (Figure 12). Autumn 2011 and summer 2012 show the lowest abundances of undersized *M. edulis*, with 55.1% (27) of stations surveyed in 2011 and 72.15% (57) of stations surveyed in 2012 not containing undersized mussels. Although the maximum coverage of undersized mussels in both the 2011 and 2012 surveys was 90-95%, in neither year did the average coverage exceed 12%. Summer 2013 saw a large increase in the abundance of undersized *M. edulis*, with an average coverage of 50.76% and a maximum of 100%. In only 12.82% (10) of the stations surveyed in summer 2013 were undersized *M. edulis* absent. The abundance of undersized *M. edulis* decreased somewhat in autumn 2013, with over 20% (9) of the stations surveyed not containing any undersized mussels and an average coverage of 24.73%. The abundance remained low in spring 2014, with an average coverage of undersized mussels only slightly higher at 30.58%, with the lowest recorded maximum coverage from all seasons of 77%. Summer 2014 saw another increase in undersized *M. edulis* cover, with the highest average coverage for all seasons recorded at 50.95%. Only 14.29% (12) of all stations surveyed did not contain undersized mussels.

Kruskal–Wallis analysis of variance (ANOVA) confirmed that there was significant variation in the average percentage undersized *M. edulis* cover between the seasons $H(5) = 118.73$, $p < .001$. Subsequent pairwise comparisons of the mean ranks between seasons indicated that autumn 2011 and summer 2012 had significantly lower mean percentage coverage of undersized *M. edulis* than summer 2013, autumn 2013 and summer 2014. Summer 2013 had a significantly higher mean percentage coverage than autumn of that year (*difference* = 65.20).

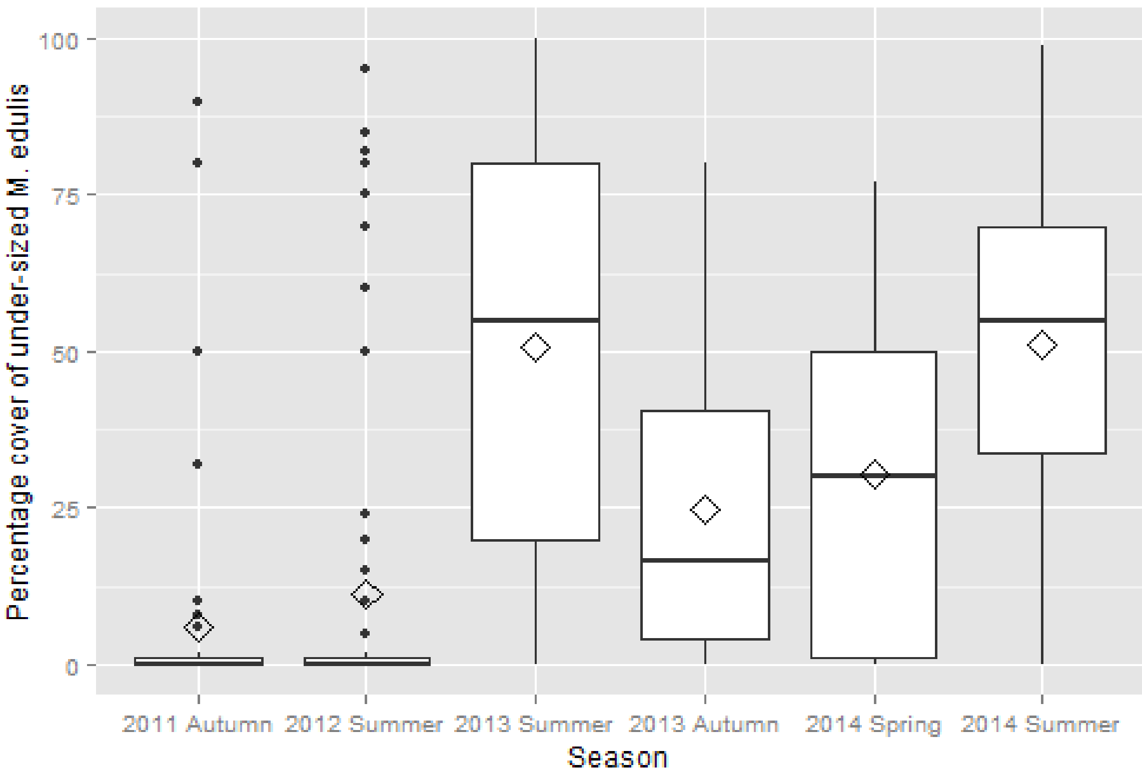


Figure 12. Percentage cover of *undersized M. edulis* at fixed stations on Heysham Flat

Diamond = mean

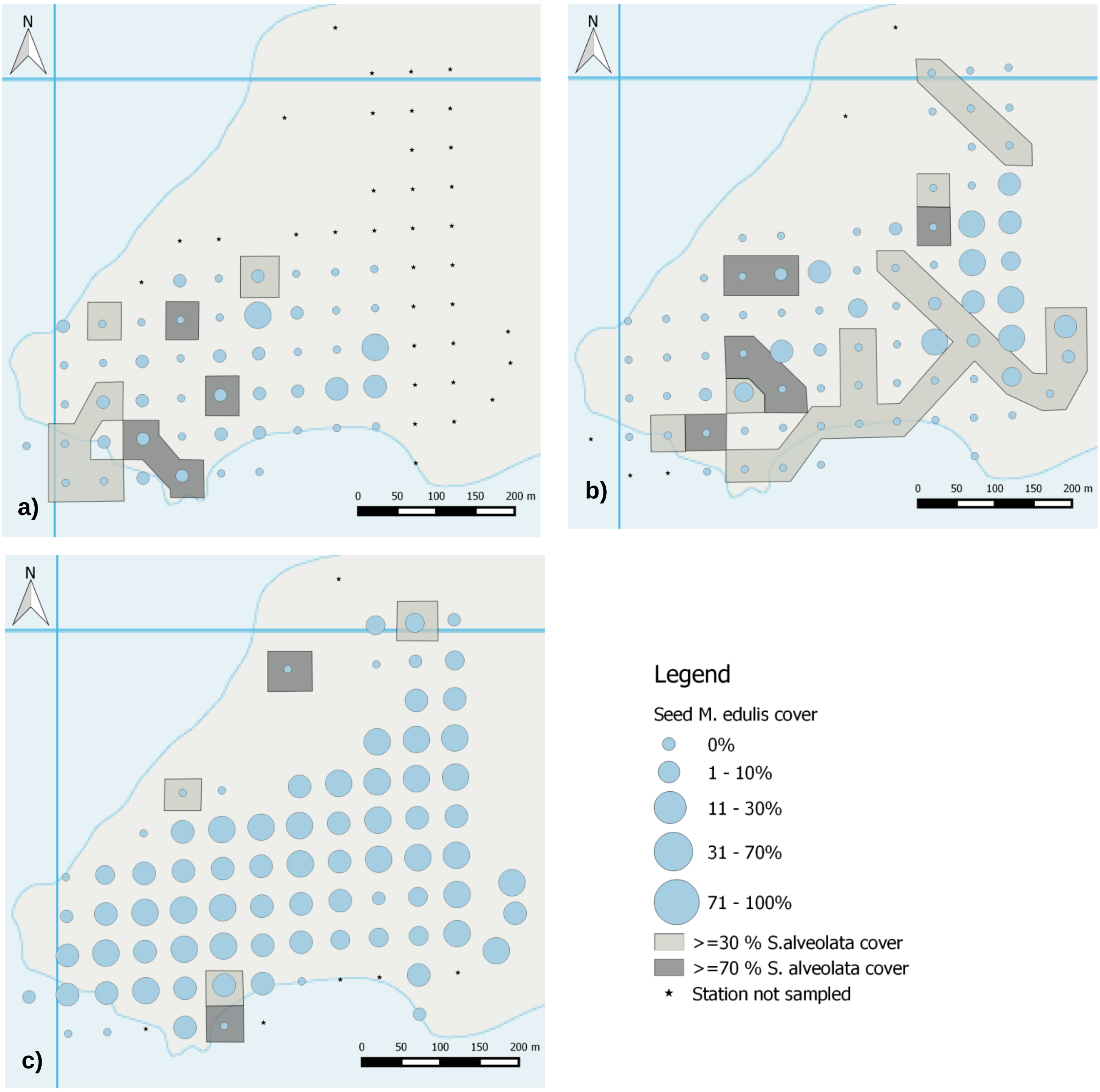


Figure 13. Percentage cover of undersized *M. edulis* at fixed stations on Heysham Flat

a) 2011 autumn; b) 2012 summer; c) 2013 summer

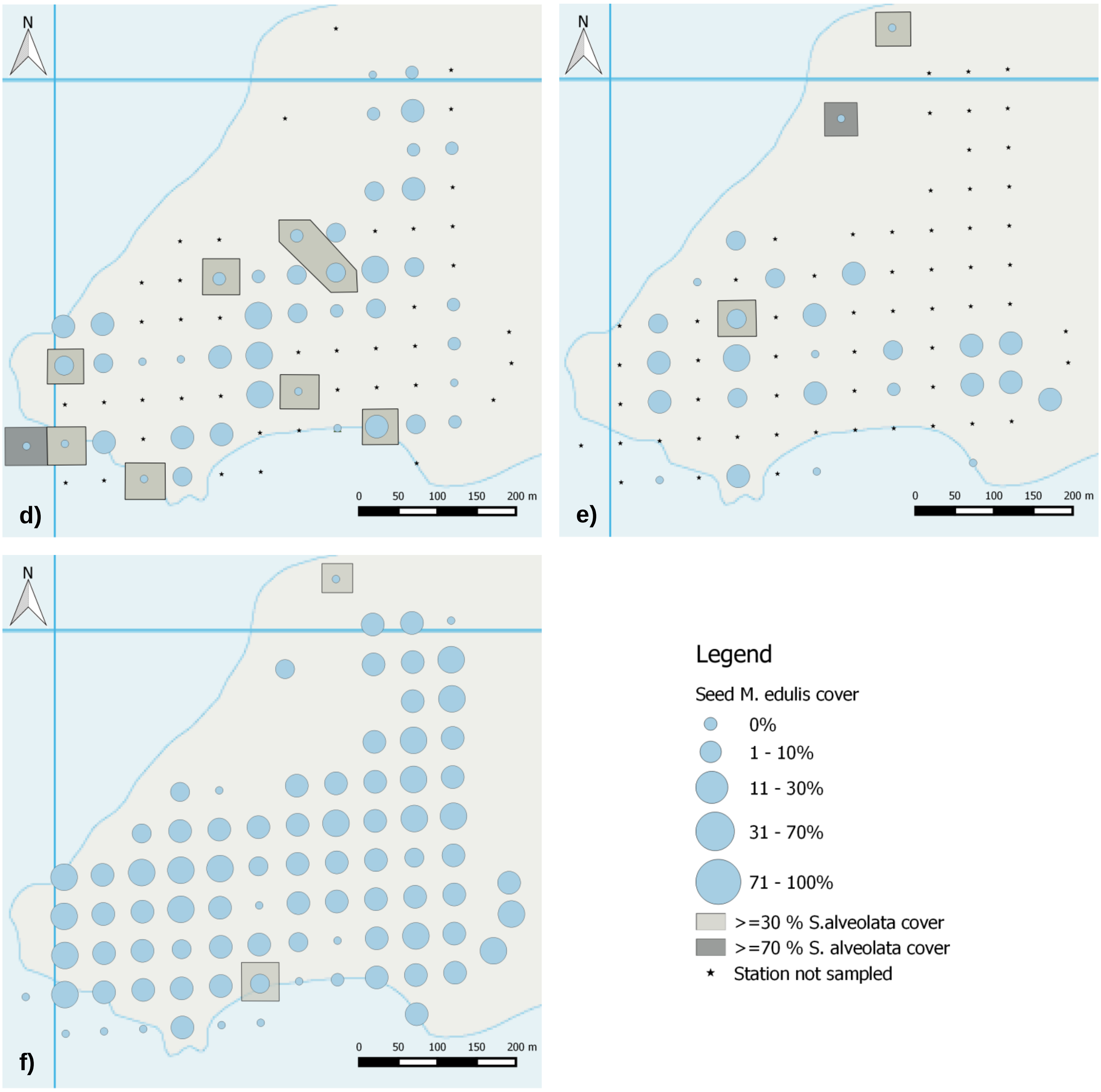


Figure 13 (cont.). Percentage cover of undersized *M. edulis* at fixed stations on Heysham Flat

d) 2013 autumn; e) 2014 Spring; f) 2014 summer

5.3.1 Relationship between *Sabellaria alveolata* and seed *Mytilus edulis*

Sabellaria alveolata coverage and seed *M. edulis* coverage at all 551 stations surveyed over the 4 year survey season were compared. In the 245 stations where *S. alveolata* was recorded, seed *M. edulis* was absent in 52.2% of the stations.

When *S. alveolata* cover was 70% or greater, the maximum seed mussel cover was only 10%, with an average *M. edulis* cover of 1.3%. However, when *S. alveolata* coverage was 1-30% the maximum seed *M. edulis* coverage was 94%, with an average of 15.8%. This can be seen in Figure 13 a-f, where the 'hotspots' of *S. alveolata* coverage are highlighted.

There was a weak but significant negative correlation between *S. alveolata* coverage and seed *M. edulis* coverage, $\tau = -.19$, $p < .001$ (Figure 14).

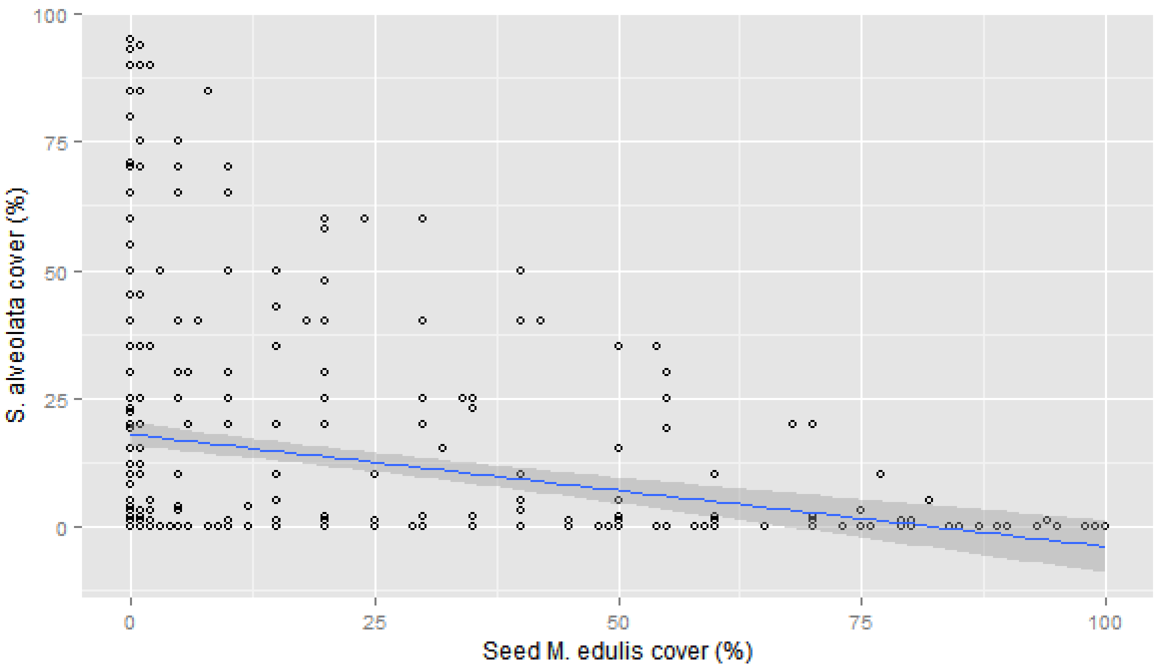


Figure 14. Correlation between percentage cover of *Sabellaria alveolata* and percentage cover of undersized *Mytilus edulis*

Linear regression line with shaded area showing 95% confidence region

5.4 Biodiversity

At each station, the species associated with *S. alveolata reefs* was recorded. For this analysis, *M. edulis* has been excluded due to its prevalence. A total of 9 records were removed prior to analysis, including 7 records of Pacific oysters (dead shells) and one of a dead hermit crab. A record of paddle worm eggs was also removed, as the living paddle worm was also recorded therefore it was not adding to the number of distinct species present.

Between 2012 and 2014 five hundred and two stations were sampled, of which 294 did not contain *S. alveolata*. Of the quadrats containing *S. alveolata*, 65.1% (136) also contained other species, with nearly 20% of these containing between 3 and 5 other species.

In total 23 different species have been recorded in association with *S. alveolata* reefs at Heysham (Appendix I). The detail of the data recorded varies from as broad as ‘algae species’ down to species name. By far the most common species recorded in association with *S. alveolata* reefs are sand masons (*Lanice conchilega*; 90 records) and barnacle species (77 records).

Of the 294 stations where *S. alveolata* was absent, only 22.8% (67) contained between 1 and 4 species. Again, the most common species were sand masons (38 records) and barnacle species (32 records).

Species richness was found to be weakly positively correlated with *S. alveolata* coverage, $\tau = .35$, $p < .001$ (Figure 12). When *M. edulis* is included in the analysis as an associated species, the weak positive correlation between *S. alveolata* cover and species richness is not greatly changed, $\tau = .31$, $p < .001$.

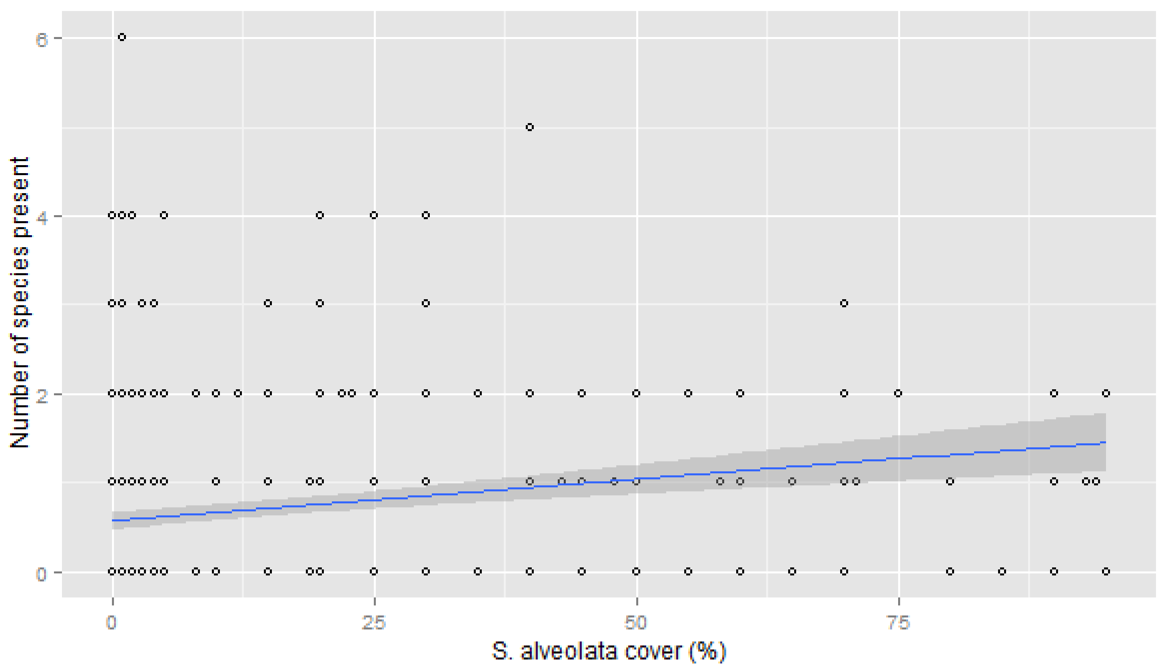


Figure 15. Correlation between percentage cover of *Sabellaria alveolata* and species richness.

Excludes *Mytilus edulis*. For 2012-2014 only. Linear regression line with shaded area showing 95% confidence region.

When looking at the biodiversity associated with seed *M. edulis* cover, the correlation is reversed. Of the 502 stations sampled in the 2012-104 period, 262 contained records of seed *M. edulis*. Of these 138 (52.67%) also contained associated species. The negative correlation is apparent, as in quadrats where seed *M. edulis* cover was less than 30% an average of 1.4 species were present with the maximum number of species recorded being seven. However, when seed *M. edulis* cover was 70% or more, the average number of species present declined to 0.35, with the maximum number of recorded species dropping to 3.

The negative correlation between seed *M. edulis* cover and species richness is weak but significant, $\tau = -.19$, $p < .001$ (Figure 16). If M. edulis cover was expanded to include both seed and adults, the negative correlation with species richness is reduced, although still significant, $\tau = -.07$, $p < .05$.

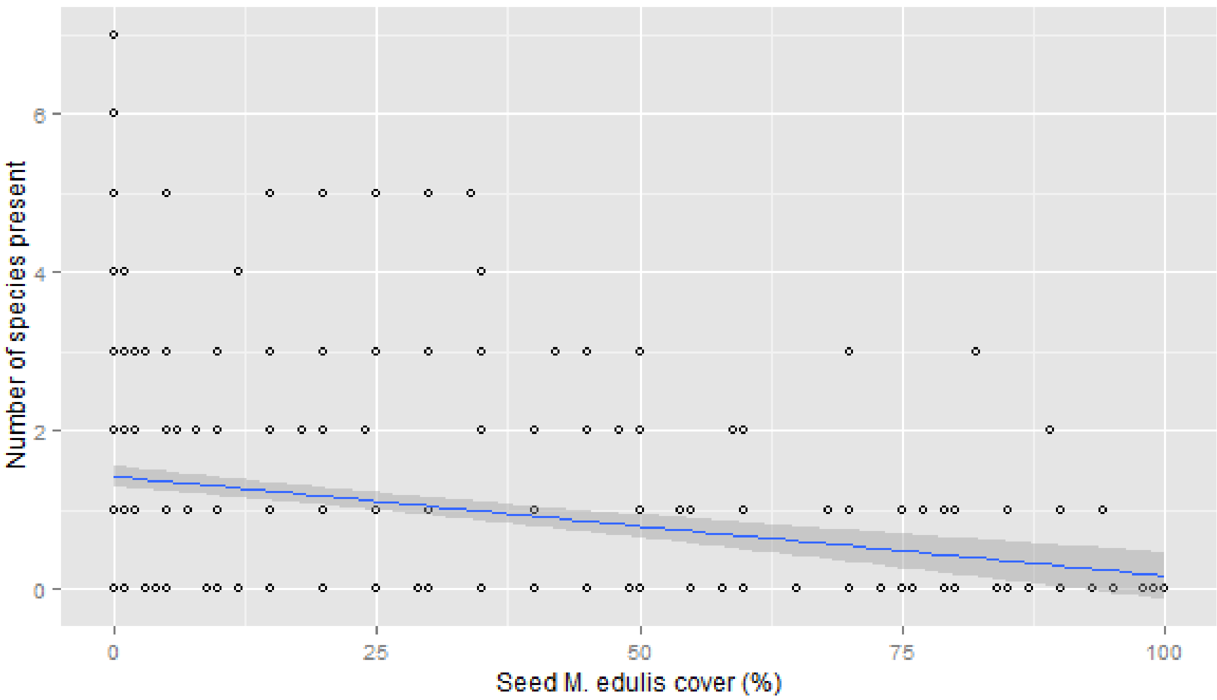


Figure 16. Correlation between percentage cover of seed *M. edulis* and species richness.

For 2012-2014 only. Linear regression line with shaded area showing 95% confidence region.

6 Discussion

The pattern of *S. alveolata* growth expected was outlined by Egerton (2014), suggesting that *S. alveolata* coverage will be greatest in spring, prior to the settlement of *M. edulis* spat. As mussel spat require a hard substrate to attach to and Morecambe Bay predominantly consists of soft sediment substrate, it is expected that they will settle on the *S. alveolata* formations and exposed cobble and boulder skear. Dense settlements of tens of thousands of mussels per square metre occur during April / May, with the mussel spat appearing as tiny 'pin-prick' size organisms. Growth is rapid reaching around 10mm by July and August, resulting in low recordings of *S. alveolata* and high *M. edulis* coverage in the summer surveys. However, the *M. edulis* scours out during autumn and winter storms uncovering areas of dead *S. alveolata* due it being smothered and crushed by the seed *M. edulis* and its associated mussel mud. In late winter and early spring recruitment of *S. alveolata* is observed when it is likely that the percentage coverage of *S. alveolata* will increase, and the cycle continues.

6.1 *Sabellaria alveolata* distribution

General patterns and trends in *S. alveolata* distribution are difficult to draw from this data set, as there are very few directly comparable seasons, and survey effort varied highly across the years.

Summer and autumn of 2013 appear to support the expected pattern of *S. alveolata* coverage. The coverage of *S. alveolata* is significantly lower in summer, when it is expected that *S. alveolata* formations will have been covered by *M. edulis* settlements. The higher coverage of *S. alveolata* recorded in the autumn is potentially linked to the uncovering of previously smothered reef formations as the seed *M. edulis* is scoured out by storms.

Spring and summer 2014 add further support to this cyclic relationship between *M. edulis* coverage and *S. alveolata* coverage. Although the difference in *S. alveolata* coverage between these two seasons is not statistically different; there is lower percentage coverage of *S. alveolata* in summer and a higher percentage of stations without *S. alveolata*. This again follows the expected trend of high *S. alveolata* coverage in the spring prior to the *M. edulis* spat fall in the summer.

Despite the statistical analysis concluding that *S. alveolata* coverage was very low in spring 2014, observations suggested it was the best ever, and *S. alveolata* was considered to be doing exceptionally well (M. Knott 2015, pers. comms). This brings into question the suitability of methodology for recording this extensive yet patchy and ephemeral formation. Sampler bias may be occurring, as in order to prevent positive bias towards *S. alveolata* the quadrat may be thrown away from areas of *S. alveolata* growth at stations, thus creating negative bias. It may also be that the sites of the stations sampled are not where the denser reef formations are located, therefore not giving the complete picture. Section 8 contains some suggestions for future surveys which may help overcome this.

6.2 Health & formation of honeycomb worm reef

The health of the *S. alveolata* formations is highly variable. However, some patterns can be drawn across the seasons. In summer 2012 there is a peak in the percentage of *S. alveolata* recorded as newly settled. This is followed by a peak in *S. alveolata* formations recorded with crisp apertures in summer 2013. This may be the newly recruited settlement from 2012 growing, and from Figure 10 it can be seen that areas of *S. alveolata* which have crisp apertures in 2013 often occur at the same stations where the newly settled *S. alveolata* was recorded in 2012. However, S. alveolata has been observed to grow extremely quickly, so these areas of crisp apertures may be new worms which have been recruited in the spring of 2013.

The percentage of *S. alveolata* recorded as dead peaks in autumn 2013. There is also a slightly higher percentage of *S. alveolata* recorded as dead in autumn 2011 (Figure 10). This may be indicative of the effect of *M. edulis* settling on top of the *S. alveolata* reefs during the summer months, however there is no evidence of a causal relationship.Figure 10. Distribution of health types of *Sabellaria alveolata* at fixed stations on Heysham Flat

6.3 *Mytilus edulis* distribution

Both filter feeders settling in the intertidal region on hard substratum, it is clear that *M. edulis* and *S. alveolata* thrive under the same environmental conditions (Northern Ireland Environment Agency, 2005).

In terms of adult mussels, the percentage coverage on Heysham Flat is consistently low across the years. If conditions remain the same with this low survival rate for juveniles, it is highly unlikely that adult mussels will outcompete or overgrow the *S. alveolata* reefs.

Conversely, the high densities of seed mussels may have a detrimental effect on the *S. alveolata* reefs. These seed *M. edulis* beds are highly ephemeral, but due to a lack of data in terms of seasonal repeats, it is difficult to show a definite seasonal pattern to their presence from this data. However, the *M. edulis* beds have been surveyed for many years as part of the fisheries management of this site, and these provided documented evidence of regular and fairly consistent mussel recruitment on the skear (Saurel, et al., 2004). From the seasonal surveys of *M. edulis* conducted in conjunction with the *S. alveolata* survey it is apparent that in the summers of both 2013 and 2014 the seed mussel coverage is high. Summer 2013 coverage is significantly higher than autumn of the same year. To the eastern region of the fixed station area the seed mussel coverage was decreased, and this was likely due to the fact that this area was opened up to the hand gathered seed mussel fishery in August 2013 (North Western Inshore Fisheries and Conservation Authority, 2013). Other areas of low seed *M. edulis* coverage may be due to storms scouring out the loosely attached seed mussels. Summer 2014 appears to have greater seed mussel coverage than the spring of the same year, but due to the low number of fixed stations sampled in spring this difference is not significant. It does, however, follow the expected trend of spring having lower *M. edulis* cover as it is prior to the main spat fall which occurs around April.

Summer 2011 shows little seed *M. edulis*, and that correlates with the historical records which states that due to low recruitment the seed mussel fishery was not open that year (Egerton, 2014). However, 2012 also appear to have relatively low seed mussel coverage, although records indicate that the seed mussel spat fall was high this year and the seed mussel fishery was re-opened (Egerton, 2014). The high seed *M. edulis* coverage in 2013 and 2014 correlated with the records stating that the seed mussel fishery was again open both these years.

Where seed *M. edulis* occurs with *S. alveolata* it is likely to overgrow the honeycomb worm reef and smother it with bio deposits (Desroy, et al., 2011). Therefore the negative relationship between *S. alveolata* and seed *M. edulis* is as expected. However, this correlation should be interpreted with caution, as there is no indication of the direction of the causality or if there is another, unconsidered, variable which is driving this pattern.

6.4 Biodiversity

Sabellaria alveolata is considered a potential community enhancer by creating varied habitats in what would otherwise be scoured, homogenous environments (Dubois, et al., 2002). This study has shown a weak positive correlation between the percentage coverage of *S. alveolata* and the associated species.

The opposite is true for the percentage cover of seed *M. edulis* and the diversity of associated benthic communities, with a weak but significant negative correlation between the two. This would support the theory that while low densities of adult *M. edulis* can create complex habitat and therefore enrich the benthic communities, high densities of *M. edulis* spat outcompete benthic species, resulting in a reduction in biodiversity (Beadman, et al., 2004).

However, as with the relationship between *S. alveolata* and *M. edulis*, the relationships between biodiversity and both *S. alveolata* and *M. edulis* coverage should be interpreted with caution, as there is no indication of the direction of the causality or if there is another, unconsidered, variable which is driving this pattern.

6.5 Data Issues

These surveys have been recorded over the past four years, with data being entered by various different researchers. This has resulted in some records with discrepancies that could not be resolved. As detailed in the results section, some were removed from the dataset. However, some data issues affected large sections of the data, and the removal of these records would have made analysis and interpretation of the data very difficult.

Although the 2012 data has been used in this report, there are serious issues with this data set. The percentage cover for *S. alveolata*, mussels and different sediment types should total 100%. However, of the 147 quadrat surveys taken in 2012, the percentage cover in 12 of the stations totals less than 100%, and 47 stations have coverage totalling in excess of 100%.

2013 data set also has anomalies. In the three seasons the survey was conducted, 219 stations were sampled. Thirty six of these stations have 0% cover reported, while one has cover of 102%.

These data sets were left in and included in the analysis. It was reasoned that as the survey was primarily for *S. alveolata* and the associated *M. edulis*, it is likely that these sections were filled in correctly. The assumption is that the errors occurred in estimating the percentage cover of other sediment types, or that these estimations were overlooked.

However, this assumption may not hold true. Ideally, all the original data from these surveys would be revisited and errors in the dataset rectified where possible.

7 Conclusion

Although there is still insufficient data to have statistically robust evidence, it would appear from the data gathered so far during this project that the cyclic relationship predicted between *S. alveolata* and seed *M. edulis* is occurring on the reefs at Heysham Flat. This natural relationship has obviously been occurring for some time, without permanent harm or long term detriment to the *S. alveolata* reefs.

The continuation of this project on a more regimented regime, sampling twice annually in the spring and summer seasons and at all 84 fixed stations will provide more robust data for analysis.

8 Future research & recommendations

Section 6.1 expresses the concern that there may be an issue with sampling bias and accuracy. Despite observational evidence suggesting that the *S. alveolata* reefs in spring 2014 were more abundant and healthy than they have been in previous years, the survey data suggests that the coverage of *S. alveolata* was at a three year low.

Obviously the main constraints to sampling technique are the tide times and manpower. However, the following is an alternative sampling technique which may be used in conjunction with or instead of existing methodologies. Trials should be undertaken to see if this method produces results more reflective of the coverage being observed.

Use of a MarinX ("Dutch-wand") style survey may be beneficial in this situation to map the distribution of the reef (Fariñas-Franco, et al., 2014). This method records where a species is present ('hit') or absent ('miss') along a straight line transect between two stations using a sampling ring on the end of a stick ('wand'). A full quadrat survey could then be taken at the 'hit' closest to a fixed station. This would give a fuller picture of how abundant the *S. alveolata* is, and where the coverage is more consistent (reef or sheet formations, as opposed to hummock or patchy). Although this would be time consuming, a similar survey technique has already been successfully trialled by NWIFCA for assessing biomass of *M. edulis* on the skear, with a full survey being carried out in a day.

It would be beneficial if an experienced science officer also made a qualitative assessment of the *S. alveolata*, attaching a short written statement summarising their personal assessment on the extent and health of the reef to the survey data. Although not statistically comparable or robust, this would provide more evidence and allow for better assessment of the survey technique.

Further studies into the effects of over growing by *M. edulis* could be conducted alongside experiments to investigate the effects of removing the *M. edulis* from the *S. alveolata* reefs by hand fishermen. This was previously suggested by Egerton (2014) and would be a study which Cumbria Wildlife Trusts trainees may be able to assist with.

More time should be taken to investigate the relationship between *S. alveolata* and biodiversity. Currently there are time constraints on gathering biodiversity data during *S. alveolata* studies as the access is tide limited. Biodiversity is not the primary concern of these studies; *S. alveolata* cover, health and formation data take priority. It may be that time is not being spent actively searching in the nooks and crannies created by the reef formations for associated biodiversity. Future studies could be done focussing on biodiversity, potentially focussing on areas of *high S. alveolata* coverage and taking multiple quadrats at each station.

9 References

Beadman, H. A. et al., 2004. Changes in species richness with stocking density of marine bivalves. *Journal of Applied Ecology,* Volume 41.

Desroy, N. et al., 2011. The conservation status of *Sabellaria alveolata* (L.) (Polychaeta:Sabellariidae) reefs in the Bay of Mont-Saint-Michel. *Aquatic Conservation: Marine and Freshwater Ecosystems,* 21(5), pp. 462-471.

Dubois, S., Retière, C. & Olivier, F., 2002. Biodiversity associated with *Sabellaria alveolata* (Polychaeta: Sabellariidae) reefs: effects of human disturbances. *Journal of Marine Biological Association of United Kingdom,* Volume 82, pp. 817-826.

Egerton, S., 2014. D*istibrution mapping and health assessment of honeycomb worm,* Sabellaria alveolata*, reefs on Heysham Flat, Lancashire.* Carnforth: NWIFCA.

Fariñas-Franco, J. M. et al., 2014. *Marine Strategy Framework Directive Indicators for Biogenic Reefs formed by* Modiolus modiolus, Mytilus edulis and Sabellaria spinulosa. *Part 1: Defining and validating the indicators,* Peterborough: JNCC report No: 523.

North Western Inshore Fisheries and Conservation Authority, 2013. *Authorisation to remove undersized mussels from Heysham Flat skear.* [Online]
Available at: http://www.nw-ifca.gov.uk/contents/images/Mussels/2013/Heysham%20Flat%20Seed%20Mussel%20authorisation%202013.pdf

North Western Inshore Fishery and Conservation, 2014. *NWIFCA Byelaw 6; Protection for European Marine Site Features.* Carnforth: NWIFCA.

Northern Ireland Environment Agency, 2005. *Northern Ireland Habitat Action Plan;* Sabellaria alveolata *reefs.* [Online]
Available at: http://www.doeni.gov.uk/niea/sabellariaalveolatareefs-2.pdf

QGIS Development Team, 2014. *QGIS Geographic Information System. Open Source Geospatial Foundation Project.* [Online]
Available at: http://qgis.osgeo.org

R Development Core Team, 2014. *R: A language and environment for statistical computing.* [Online]
Available at: http://www.R-project.org

RStudio, 2012. *RStudio: Integrated development environment for R (Version 0.97.551).* [Online]
Available at: http://www.rstudio.org/
[Accessed 6 January 2015].

Saurel, C., Gascoigne, J. & Kaiser, M. J., 2004. *The Ecology of Seed Mussel Beds; Literature Review,* Bangor: School of Ocean Sciences.

10 Appendices

10.1 Appendix I

Species	Common name	Number of Records
Algae species		1
Amphipod species		1
Barnacle species		109
Bryzoa species		7
Cerastoderma edule	Cockle	6
Fucus vesiculosus	Bladder wrack	2
Fucus spiralis	Spiral wrack	6
Ulva intestinalis	Gutweed	7
Hartlaubella gelatinosa		12
-	Hermit crab	1
Flustra foliacea	Hornwrack	7
Hydriod species		7
Idotea emarginata		1
Arenicola marina	Lug worm	18
Phyllodoce maculata		5
Lanice conchilega	Sand mason	128
Sea anemone species		7
Ulva lactuca	Sea lettuce	6
Carcinus maenas	Shore crab	5
Shrimp species		6
Tellin species		1
Chlamys varia	Variegated scallop	1
Littorina spp	Winkles	1
Wrack spp		1

2.2 Appendix II – A guide to the classification of *Sabellaria alveolata*

Formation Type			
Patchy	**Sheet**	**Hummock**	**Reef**
			
Small crusts or mounds which are less than 30 cm^2	Flat crust which are greater than 30 cm^2	Raised mound which are greater than 30 cm^2	Large mounds which are greater than 1 m^2

Health Categories			
Dead	**Worn Apertures**	**Crisp Apertures**	**Newly Settled**
			
Tubes have merged into a block of sediment. If a piece of reef is detached from the substratum.	There has been no clear new growth/ tube building. The apertures can still be seen. The tubes are still attached to the substratum.	New growth of tubes can be seen, the apertures are crisp and will have a fine wall. Tend to be a lighter sandy colour compared with worn reef.	Very small apertures between 1 mm and 4 mm. Usually found around the larger, older apertures as shown above.

2.3 Appendix III – *Sabellaria alveolata* raw data 2014

Quadrat	Easting	Northing	Latitude	Longitude	Year	Season	Date	*Sabellaria*	Patchy	Sheet	Hummock	Reef	Crisp	Worn	New	Dead
3	340360	463066	54.06007	-2.91264	2014	Spring	28/04/2014	50	0	0	100	0	90	10	0	0
9	340295	462950	54.05903	-2.91361	2014	Spring	28/04/2014	71	0	0	0	100	100	0	0	0
A11	339965	462482	54.05478	-2.91855	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
A13	339966	462382	54.05388	-2.91852	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
A8	339963	462632	54.05613	-2.91861	2014	Spring	28/04/2014	60	0	0	100	0	95	5	0	0
A9	339964	462582	54.05568	-2.91859	2014	Spring	28/04/2014	50	0	0	0	100	40	20	0	40
C11	340064	462488	54.05484	-2.91703	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
C13	340066	462388	54.05394	-2.917	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
C7	340062	462688	54.05664	-2.91711	2014	Spring	28/04/2014	1	100	0	0	0	0	100	0	0
C8	340063	462638	54.05619	-2.91709	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
C9	340064	462588	54.05574	-2.91707	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
D6	340112	462741	54.05712	-2.91637	2014	Spring	28/04/2014	1	100	0	0	0	0	0	0	100
E11	340164	462493	54.0549	-2.91551	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
E13	340165	462393	54.05401	-2.91548	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
E5	340161	462794	54.0576	-2.91562	2014	Spring	28/04/2014	5	100	0	0	0	0	100	0	0
E7	340162	462694	54.0567	-2.91559	2014	Spring	28/04/2014	35	0	0	100	0	100	0	0	0
E8	340162	462644	54.05625	-2.91557	2014	Spring	28/04/2014	10	100	0	0	0	93	2	5	0
E9	340163	462593	54.0558	-2.91555	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
F4	340210	462846	54.05808	-2.91488	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
F6	340211	462746	54.05718	-2.91485	2014	Spring	28/04/2014	4	100	0	0	0	0	90	0	10
G11	340264	462499	54.05497	-2.914	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
G13	340265	462399	54.05407	-2.91396	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
G3	340259	462899	54.05856	-2.91414	2014	Spring	28/04/2014	3	100	0	0	0	50	0	0	50
G5	340260	462799	54.05766	-2.91411	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
G7	340261	462699	54.05676	-2.91407	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
G8	340262	462649	54.05631	-2.91405	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0

G9	340262	462599	54.05586	-2.91403	2014	Spring	28/04/2014	1	100	0	0	0	0	0	0	100
H4	340310	462852	54.05814	-2.91336	2014	Spring	28/04/2014	20	100	0	0	0	100	0	0	0
H6	340311	462752	54.05724	-2.91333	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
I11	340363	462504	54.05503	-2.91248	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
I8	340361	462654	54.05638	-2.91253	2014	Spring	28/04/2014	0		0	0	0	0	0	0	0
I9	340362	462604	54.05593	-2.91251	2014	Spring	28/04/2014	25	100	0	0	0	0	30	0	70
K8	340511	462663	54.05647	-2.91025	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
K9	340511	462613	54.05602	-2.91024	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
L11	340463	462510	54.05509	-2.91096	2014	Spring	28/04/2014	20	100	0	0	0	10	70	0	20
L8	340461	462660	54.05644	-2.91101	2014	Spring	28/04/2014	25	100	0	0	0	10	29	1	60
L9	340462	462610	54.05599	-2.91099	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
Q4	340561	462591	54.05583	-2.90947	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	0
3	340360	463066	54.06007	-2.91264	2014	Summer	15/07/2014	70	0	0	0	100	45	5	50	0
9	340295	462951	54.05903	-2.91361	2014	Summer	15/07/2014	20	0	0	0	100	80	0	20	0
A10	339964	462532	54.05523	-2.91857	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
A11	339965	462482	54.05478	-2.91855	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
A7	339963	462683	54.05658	-2.91862	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
A8	339963	462632	54.05613	-2.91861	2014	Summer	15/07/2014	40	0	0	0	100	0	50	0	50
A9	339964	462582	54.05568	-2.91859	2014	Summer	15/07/2014	40	100	0	0	0	20	15	5	60
B10	340014	462535	54.05526	-2.91781	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
B11	340015	462485	54.05481	-2.91779	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
B14	340010	462506	54.055	-2.91787	2014	Summer	15/07/2014	60	0	0	0	100	90	10	0	0
B6	340012	462735	54.05706	-2.91788	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
B7	340013	462685	54.05661	-2.91787	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
B8	340013	462635	54.05616	-2.91785	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
B9	340014	462585	54.05571	-2.91783	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
C10	340064	462538	54.05529	-2.91705	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
C11	340064	462488	54.05484	-2.91704	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
C6	340062	462738	54.05709	-2.91712	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0

C7	340062	462688	54.05664	-2.91711	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
C8	340063	462638	54.05619	-2.91709	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
C9	340064	462588	54.05574	-2.91707	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D10	340114	462541	54.05533	-2.91629	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D11	340114	462491	54.05488	-2.91628	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D5	340111	462791	54.05757	-2.91638	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D6	340112	462741	54.05712	-2.91637	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D7	340112	462691	54.05667	-2.91635	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D8	340113	462641	54.05622	-2.91633	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
D9	340113	462591	54.05577	-2.91631	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E10	340163	462543	54.05536	-2.91553	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E11	340164	462493	54.05491	-2.91552	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E5	340161	462794	54.0576	-2.91562	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E6	340161	462744	54.05715	-2.91561	2014	Summer	15/07/2014	20	0	0	100	0	100	0	0	0
E7	340162	462694	54.0567	-2.91559	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E8	340162	462644	54.05626	-2.91557	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
E9	340163	462593	54.0558	-2.91555	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
F10	340213	462546	54.05539	-2.91477	2014	Summer	15/07/2014	5	0	100	0	0	0	70	0	30
F11	340214	462496	54.05494	-2.91476	2014	Summer	15/07/2014	5	100	0	0	0	0	90	10	0
F5	340211	462796	54.05763	-2.91486	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
F6	340211	462746	54.05718	-2.91485	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
F7	340212	462696	54.05673	-2.91483	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
F8	340212	462646	54.05629	-2.91481	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
F9	340213	462596	54.05584	-2.91479	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
G10	340263	462549	54.05542	-2.91402	2014	Summer	15/07/2014	40	30	70	0	0	15	15	70	0
G11	340264	462499	54.05497	-2.914	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
G3	340259	462899	54.05856	-2.91414	2014	Summer	15/07/2014	45	0	0	0	100	70	25	5	0
G5	340260	462799	54.05766	-2.91411	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
G6	340261	462749	54.05721	-2.91409	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0

G7	340261	462699	54.05676	-2.91407	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
G8	340262	462649	54.05632	-2.91405	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
G9	340262	462599	54.05587	-2.91403	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H10	340313	462552	54.05545	-2.91326	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H4	340310	462852	54.05814	-2.91336	2014	Summer	15/07/2014	10	0	0	0	100	55	0	45	0
H5	340310	462802	54.05769	-2.91335	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H6	340311	462752	54.05725	-2.91333	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H7	340311	462702	54.0568	-2.91331	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H8	340312	462652	54.05635	-2.91329	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
H9	340312	462602	54.0559	-2.91327	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
I10	340362	462554	54.05548	-2.9125	2014	Summer	15/07/2014	1	0	0	0	0	0	0	0	0
I4	340360	462854	54.05817	-2.9126	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
I5	340360	462805	54.05773	-2.91259	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
I6	340360	462754	54.05727	-2.91257	2014	Summer	15/07/2014	1	100	0	0	0	0	0	0	100
I7	340361	462704	54.05683	-2.91255	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
I8	340361	462654	54.05638	-2.91253	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
I9	340362	462604	54.05593	-2.91251	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J1	340407	463008	54.05955	-2.9119	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J10	340412	462557	54.05551	-2.91174	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J11	340413	462507	54.05506	-2.91172	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J2	340408	462957	54.0591	-2.91188	2014	Summer	15/07/2014	5	100	0	0	0	100	0	0	0
J3	340409	462908	54.05866	-2.91186	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J4	340409	462858	54.05821	-2.91185	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J5	340410	462807	54.05775	-2.91183	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J6	340410	462757	54.05731	-2.91181	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J7	340411	462707	54.05686	-2.91179	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J8	340411	462657	54.05641	-2.91177	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
J9	340412	462607	54.05596	-2.91176	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K1	340507	463013	54.05962	-2.91038	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0

K10	340512	462563	54.05557	-2.91022	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K2	340507	462963	54.05916	-2.91036	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K3	340508	462913	54.05872	-2.91034	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K4	340509	462863	54.05827	-2.91033	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K5	340509	462813	54.05782	-2.91031	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K6	340510	462763	54.05737	-2.91029	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K7	340510	462713	54.05692	-2.91027	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K8	340511	462663	54.05647	-2.91025	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
K9	340511	462613	54.05602	-2.91024	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L1	340457	463010	54.05958	-2.91114	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L10	340462	462560	54.05554	-2.91098	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L11	340463	462510	54.05509	-2.91096	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L2	340458	462960	54.05914	-2.91112	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L3	340458	462910	54.05869	-2.9111	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L4	340459	462860	54.05824	-2.91109	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L5	340459	462810	54.05779	-2.91107	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L6	340460	462760	54.05734	-2.91105	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L7	340460	462710	54.05689	-2.91103	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L8	340461	462660	54.05644	-2.91101	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
L9	340462	462610	54.05599	-2.91099	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
Q4	340561	462591	54.05583	-2.90947	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
Q5	340584	462638	54.05626	-2.90912	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0
Q6	340581	462678	54.05661	-2.90919	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	0

2.4 Appendix IV –*Mytilus edulis* and substrate raw data 2014

Quadrat	Easting	Northing	Latitude	Longitude	Year	Season	Date	Adult	Seed	Mud	Shell	Sand	Rock	Cobble	Algae	Pool	Other
3	340360	463066	54.06007	-2.91264	2014	Spring	28/04/2014	0	0	0	9	40	0	0	0	0	1
9	340295	462950	54.05903	-2.91361	2014	Spring	28/04/2014	1	0	0	2	25	0	0	0	0	1
A11	339965	462482	54.05478	-2.91855	2014	Spring	28/04/2014	0	0	0	0	0	0	0	0	100	0
A13	339966	462382	54.05388	-2.91852	2014	Spring	28/04/2014	0	0	0	0	99	0	0	0	0	1
A8	339963	462632	54.05613	-2.91861	2014	Spring	28/04/2014	0	0	0	5	35	0	0	0	0	0
A9	339964	462582	54.05568	-2.91859	2014	Spring	28/04/2014	0	0	0	5	43	0	0	0	0	2
C11	340064	462488	54.05484	-2.91703	2014	Spring	28/04/2014	0	0	0	23	5	0	70	0	0	2
C13	340066	462388	54.05394	-2.917	2014	Spring	28/04/2014	0	0	0	0	100	0	0	0	0	0
C7	340062	462688	54.05664	-2.91711	2014	Spring	28/04/2014	1	25	0	7	60	0	0	1	0	5
C8	340063	462638	54.05619	-2.91709	2014	Spring	28/04/2014	5	50	0	0	44	0	0	0	0	1
C9	340064	462588	54.05574	-2.91707	2014	Spring	28/04/2014	10	54	0	10	25	0	0	0	0	1
D6	340112	462741	54.05712	-2.91637	2014	Spring	28/04/2014	0	0	0	2	60	0	0	0	0	37
E11	340164	462493	54.0549	-2.91551	2014	Spring	28/04/2014	10	45	0	30	15	0	0	0	0	0
E13	340165	462393	54.05401	-2.91548	2014	Spring	28/04/2014	0	0	0	0	100	0	0	0	0	0
E5	340161	462794	54.0576	-2.91562	2014	Spring	28/04/2014	1	15	0	10	66	0	0	0	0	3
E7	340162	462694	54.0567	-2.91559	2014	Spring	28/04/2014	1	15	0	3	46	0	0	0	0	0
E8	340162	462644	54.05625	-2.91557	2014	Spring	28/04/2014		77	0	3	10	0	0	0	0	0
E9	340163	462593	54.0558	-2.91555	2014	Spring	28/04/2014	1	30	0	10	59	0	0	0	0	0
F4	340210	462846	54.05808	-2.91488	2014	Spring	28/04/2014	0	0	0	15	75	0	0	0	0	10
F6	340211	462746	54.05718	-2.91485	2014	Spring	28/04/2014		12	0	12	71	0	0	0	0	1
G11	340264	462499	54.05497	-2.914	2014	Spring	28/04/2014	0	0	0	0	99	0	0	0	0	1
G13	340265	462399	54.05407	-2.91396	2014	Spring	28/04/2014	0	0	0	0	100	0	0	0	0	0
G3	340259	462899	54.05856	-2.91414	2014	Spring	28/04/2014	5	5	0	50	34	0	0	0	0	3
G5	340260	462799	54.05766	-2.91411	2014	Spring	28/04/2014	0	0	0	35	65	0	0	0	0	0
G7	340261	462699	54.05676	-2.91407	2014	Spring	28/04/2014	1	70	0	3	26	0	0	0	0	0

G8	340262	462649	54.05631	-2.91405	2014	Spring	28/04/2014	1	0	0	14	60	0	0	0	0	25
G9	340262	462599	54.05586	-2.91403	2014	Spring	28/04/2014	3	60	16	10	10	0	0	0	0	0
H4	340310	462852	54.05814	-2.91336	2014	Spring	28/04/2014	1	1	0	7	69	0	0	0	0	2
H6	340311	462752	54.05724	-2.91333	2014	Spring	28/04/2014	1	45	0	25	28	0	0	0	0	1
I11	340363	462504	54.05503	-2.91248	2014	Spring	28/04/2014	0	0	0	0	99	0	0	0	0	1
I8	340361	462654	54.05638	-2.91253	2014	Spring	28/04/2014	1	30	0	5	39	0	0	0	0	25
I9	340362	462604	54.05593	-2.91251	2014	Spring	28/04/2014	2	5	0	15	32	0	1	0	0	20
K8	340511	462663	54.05647	-2.91025	2014	Spring	28/04/2014	0	48	5	20	15	0	7	0	0	5
K9	340511	462613	54.05602	-2.91024	2014	Spring	28/04/2014	0	70	25	5	0	0	0	0	0	0
L11	340463	462510	54.05509	-2.91096	2014	Spring	28/04/2014	0	0	50	20	5	0	0	0	0	5
L8	340461	462660	54.05644	-2.91101	2014	Spring	28/04/2014	0	34	20	8	0	0	3	0	0	10
L9	340462	462610	54.05599	-2.91099	2014	Spring	28/04/2014	1	60	27	10	0	0	0	0	0	2
Q4	340561	462591	54.05583	-2.90947	2014	Spring	28/04/2014	0	50	0	10	39	0	0	0	0	1
3	340360	463066	54.06007	-2.91264	2014	Summer	15/07/2014	0	0	0	15	15	0	0	0	0	0
9	340295	462951	54.05903	-2.91361	2014	Summer	15/07/2014	1	20	0	9	46	0	0	0	0	4
A10	339964	462532	54.05523	-2.91857	2014	Summer	15/07/2014	0	0	0	15	55	0	20	10	0	0
A11	339965	462482	54.05478	-2.91855	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
A7	339963	462683	54.05658	-2.91862	2014	Summer	15/07/2014	0	99	1	0	0	0	0	0	0	0
A8	339963	462632	54.05613	-2.91861	2014	Summer	15/07/2014	0	40	6	0	13	0	1	0	0	0
A9	339964	462582	54.05568	-2.91859	2014	Summer	15/07/2014	1	20	4	5	19	1	5	5	0	0
B10	340014	462535	54.05526	-2.91781	2014	Summer	15/07/2014	0	80	20	0	0	0	0	0	0	0
B11	340015	462485	54.05481	-2.91779	2014	Summer	15/07/2014	0	0	0	1	99	0	0	0	0	0
B14	340010	462506	54.055	-2.91787	2014	Summer	15/07/2014	0	20	0	10	10	0	0	0	0	0
B6	340012	462735	54.05706	-2.91788	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
B7	340013	462685	54.05661	-2.91787	2014	Summer	15/07/2014	0	98	2	0	0	0	0	0	0	0
B8	340013	462635	54.05616	-2.91785	2014	Summer	15/07/2014	0	99	1	0	0	0	0	0	0	0
B9	340014	462585	54.05571	-2.91783	2014	Summer	15/07/2014	0	95	5	0	0	0	0	0	0	0
C10	340064	462538	54.05529	-2.91705	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0
C11	340064	462488	54.05484	-2.91704	2014	Summer	15/07/2014	0	0	0	5	95	0	0	0	0	0

C6	340062	462738	54.05709	-2.91712	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
C7	340062	462688	54.05664	-2.91711	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
C8	340063	462638	54.05619	-2.91709	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
C9	340064	462588	54.05574	-2.91707	2014	Summer	15/07/2014	0	70	30	0	0	0	0	0	0	0
D10	340114	462541	54.05533	-2.91629	2014	Summer	15/07/2014	0	50	20	10	20	0	0	0	0	0
D11	340114	462491	54.05488	-2.91628	2014	Summer	15/07/2014	0	0	0	5	95	0	0	0	0	0
D5	340111	462791	54.05757	-2.91638	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
D6	340112	462741	54.05712	-2.91637	2014	Summer	15/07/2014	0	30	70	0	0	0	0	0	0	0
D7	340112	462691	54.05667	-2.91635	2014	Summer	15/07/2014	0	90	10	0	0	0	0	0	0	0
D8	340113	462641	54.05622	-2.91633	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0
D9	340113	462591	54.05577	-2.91631	2014	Summer	15/07/2014	0	40	55	5	0	0	0	0	0	0
E10	340163	462543	54.05536	-2.91553	2014	Summer	15/07/2014	0	65	0	1	34	0	0	0	0	0
E11	340164	462493	54.05491	-2.91552	2014	Summer	15/07/2014	0	35	0	5	60	0	0	0	0	0
E5	340161	462794	54.0576	-2.91562	2014	Summer	15/07/2014	0	15	0	0	85	0	0	0	0	0
E6	340161	462744	54.05715	-2.91561	2014	Summer	15/07/2014	0	70	0	0	10	0	0	0	0	0
E7	340162	462694	54.0567	-2.91559	2014	Summer	15/07/2014	0	95	5	0	0	0	0	0	0	0
E8	340162	462644	54.05626	-2.91557	2014	Summer	15/07/2014	0	80	20	0	0	0	0	0	0	0
E9	340163	462593	54.0558	-2.91555	2014	Summer	15/07/2014	0	20	10	10	60	0	0	0	0	0
F10	340213	462546	54.05539	-2.91477	2014	Summer	15/07/2014	0	40	0	5	50	0	0	0	0	0
F11	340214	462496	54.05494	-2.91476	2014	Summer	15/07/2014	0	0	0	30	65	0	0	0	0	0
F5	340211	462796	54.05763	-2.91486	2014	Summer	15/07/2014	0	0	0	1	99	0	0	0	0	0
F6	340211	462746	54.05718	-2.91485	2014	Summer	15/07/2014	0	65	35	0	0	0	0	0	0	0
F7	340212	462696	54.05673	-2.91483	2014	Summer	15/07/2014	0	75	25	0	0	0	0	0	0	0
F8	340212	462646	54.05629	-2.91481	2014	Summer	15/07/2014	0	40	60	0	0	0	0	0	0	0
F9	340213	462596	54.05584	-2.91479	2014	Summer	15/07/2014	0	70	30	0	0	0	0	0	0	0
G10	340263	462549	54.05542	-2.91402	2014	Summer	15/07/2014	0	30	0	10	20	0	0	0	0	0
G11	340264	462499	54.05497	-2.914	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
G3	340259	462899	54.05856	-2.91414	2014	Summer	15/07/2014	0	0	0	10	45	0	0	0	0	0
G5	340260	462799	54.05766	-2.91411	2014	Summer	15/07/2014	0	10	0	20	70	0	0	0	0	0

G6	340261	462749	54.05721	-2.91409	2014	Summer	15/07/2014	0	50	50	0	0	0	0	0	0	0
G7	340261	462699	54.05676	-2.91407	2014	Summer	15/07/2014	0	30	70	0	0	0	0	0	0	0
G8	340262	462649	54.05632	-2.91405	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
G9	340262	462599	54.05587	-2.91403	2014	Summer	15/07/2014	0	50	0	0	50	0	0	0	0	0
H10	340313	462552	54.05545	-2.91326	2014	Summer	15/07/2014	0	0	0	10	90	0	0	0	0	0
H4	340310	462852	54.05814	-2.91336	2014	Summer	15/07/2014	0	15	0	5	45	0	0	0	0	25
H5	340310	462802	54.05769	-2.91335	2014	Summer	15/07/2014	0	65	35	0	0	0	0	0	0	0
H6	340311	462752	54.05725	-2.91333	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
H7	340311	462702	54.0568	-2.91331	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0
H8	340312	462652	54.05635	-2.91329	2014	Summer	15/07/2014	0	50	50	0	0	0	0	0	0	0
H9	340312	462602	54.0559	-2.91327	2014	Summer	15/07/2014	0	29	0	1	70	0	0	0	0	0
I10	340362	462554	54.05548	-2.9125	2014	Summer	15/07/2014	0	10	35	20	0	0	10	4	0	20
I4	340360	462854	54.05817	-2.9126	2014	Summer	15/07/2014	0	12	0	5	83	0	0	0	0	0
I5	340360	462805	54.05773	-2.91259	2014	Summer	15/07/2014	0	55	40	5	0	0	0	0	0	0
I6	340360	462754	54.05727	-2.91257	2014	Summer	15/07/2014	0	79	0	10	10	0	0	0	0	0
I7	340361	462704	54.05683	-2.91255	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0
I8	340361	462654	54.05638	-2.91253	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	
I9	340362	462604	54.05593	-2.91251	2014	Summer	15/07/2014	0	0	0	0	0	0	0	0	100	0
J1	340407	463008	54.05955	-2.9119	2014	Summer	15/07/2014	0	65	0	25	10	0	0	0	0	0
J10	340412	462557	54.05551	-2.91174	2014	Summer	15/07/2014	0	49	0	2	49	0	0	0	0	0
J11	340413	462507	54.05506	-2.91172	2014	Summer	15/07/2014	0	8	0	5	85	0	0	2	0	0
J2	340408	462957	54.0591	-2.91188	2014	Summer	15/07/2014	0	50	0	0	40	0	0	5	0	0
J3	340409	462908	54.05866	-2.91186	2014	Summer	15/07/2014	1	20	0	5	74	0	0	0	0	0
J4	340409	462858	54.05821	-2.91185	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
J5	340410	462807	54.05775	-2.91183	2014	Summer	15/07/2014	0	65	35	0	0	0	0	0	0	0
J6	340410	462757	54.05731	-2.91181	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
J7	340411	462707	54.05686	-2.91179	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
J8	340411	462657	54.05641	-2.91177	2014	Summer	15/07/2014	0	60	40	0	0	0	0	0	0	0
J9	340412	462607	54.05596	-2.91176	2014	Summer	15/07/2014	0	60	0	0	40	0	0	0	0	0

K1	340507	463013	54.05962	-2.91038	2014	Summer	15/07/2014	0	0	0	25	75	0	0	0	0	0
K10	340512	462563	54.05557	-2.91022	2014	Summer	15/07/2014	0	50	50	0	0	0	0	0	0	0
K2	340507	462963	54.05916	-2.91036	2014	Summer	15/07/2014	2	80	18	0	0	0	0	0	0	0
K3	340508	462913	54.05872	-2.91034	2014	Summer	15/07/2014	0	80	0	0	20	0	0	0	0	0
K4	340509	462863	54.05827	-2.91033	2014	Summer	15/07/2014	0	50	49	1	0	0	0	0	0	0
K5	340509	462813	54.05782	-2.91031	2014	Summer	15/07/2014	0	70	25	5	0	0	0	0	0	0
K6	340510	462763	54.05737	-2.91029	2014	Summer	15/07/2014	0	84	15	1	0	0	0	0	0	0
K7	340510	462713	54.05692	-2.91027	2014	Summer	15/07/2014	0	58	40	0	0	0	0	2	0	0
K8	340511	462663	54.05647	-2.91025	2014	Summer	15/07/2014	0	70	30	0	0	0	0	0	0	0
K9	340511	462613	54.05602	-2.91024	2014	Summer	15/07/2014	0	70	30	0	0	0	0	0	0	0
L1	340457	463010	54.05958	-2.91114	2014	Summer	15/07/2014	9	40	10	1	30	0	0	10	0	0
L10	340462	462560	54.05554	-2.91098	2014	Summer	15/07/2014	0	70	29	1	0	0	0	0	0	0
L11	340463	462510	54.05509	-2.91096	2014	Summer	15/07/2014	0	60	0	1	39	0	0	0	0	0
L2	340458	462960	54.05914	-2.91112	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0
L3	340458	462910	54.05869	-2.9111	2014	Summer	15/07/2014	1	40	59	0	0	0	0	0	0	0
L4	340459	462860	54.05824	-2.91109	2014	Summer	15/07/2014	0	75	25	0	0	0	0	0	0	0
L5	340459	462810	54.05779	-2.91107	2014	Summer	15/07/2014	0	79	20	1	0	0	0	0	0	0
L6	340460	462760	54.05734	-2.91105	2014	Summer	15/07/2014	0	85	15	0	0	0	0	0	0	0
L7	340460	462710	54.05689	-2.91103	2014	Summer	15/07/2014	0	25	25	0	0	0	0	0	50	0
L8	340461	462660	54.05644	-2.91101	2014	Summer	15/07/2014	0	70	30	0	0	0	0	0	0	0
L9	340462	462610	54.05599	-2.91099	2014	Summer	15/07/2014	0	85	0	1	14	0	0	0	0	0
Q4	340561	462591	54.05583	-2.90947	2014	Summer	15/07/2014	0	80	20	0	0	0	0	0	0	0
Q5	340584	462638	54.05626	-2.90912	2014	Summer	15/07/2014	0	75	25	0	0	0	0	0	0	0
Q6	340581	462678	54.05661	-2.90919	2014	Summer	15/07/2014	0	55	45	0	0	0	0	0	0	0