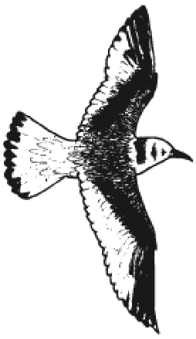
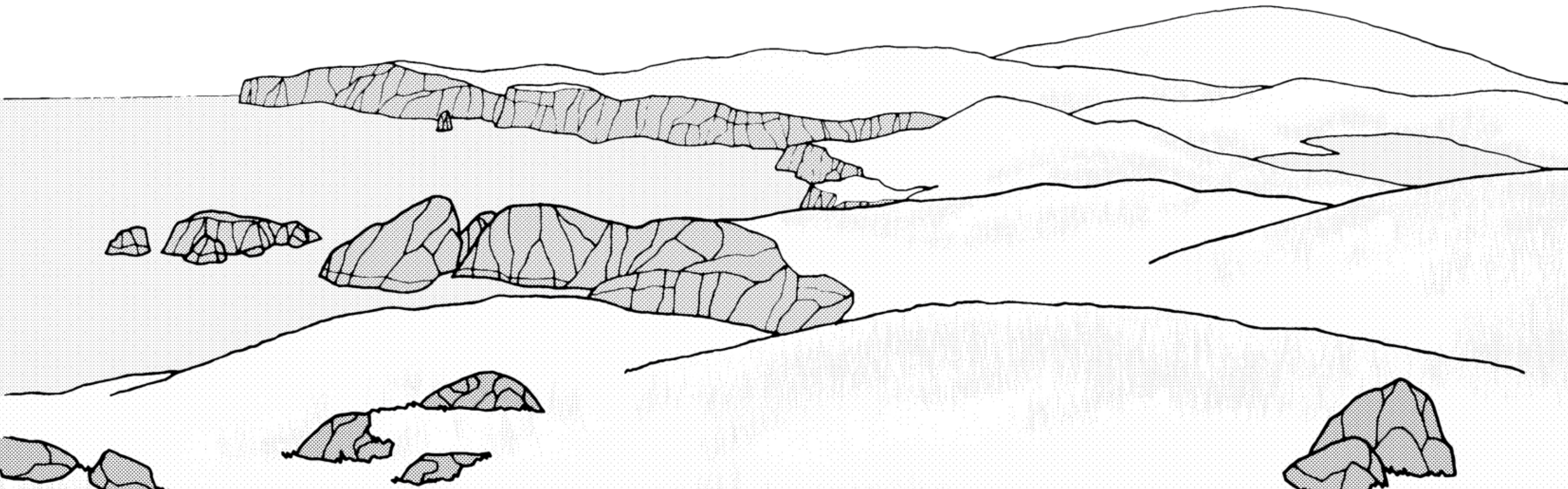
SOTEAG

Survey of the rocky shores in Sullom Voe



2017

A report to the Shetland Oil Terminal
Environmental Advisory Group
by
Aquatic Survey and Monitoring Ltd



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Survey of the rocky shores in the region of Sullom Voe, Shetland, July 2017

A report for SOTEAG

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Status:	**Final**
Date of Release:	7 December 2017

Recommended citation:

Moore, J.J. and Bunker, F. (2017). *Survey of the rocky shores in the region of Sullom Voe, Shetland, July 2017.* A report to SOTEAG from Aquatic Survey & Monitoring Ltd., Cosheston, Pembrokeshire. 43 pp + iv.

Acknowledgements

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Data access

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Summary

Biological monitoring of rocky shore communities in Sullom Voe has been carried out annually since 1976. Annual reports to SOTEAG have described the changes from year to year and assessed the effects of the terminal operation. This report summarises the work carried out in July 2017 – the 40th survey since the programme's inception.

The 2017 survey was carried out with a methodology and strategy used since 1993. Earlier data is still directly comparable for analyses. The fifteen original transects in Sullom Voe and the five reference transects outside the Voe were re-surveyed, and the abundance of conspicuous species was recorded at five stations along each transect. Five additional reference sites were established and surveyed, to increase the amount and quality of reference data. This should improve future statistical comparisons with the fifteen Sullom sites. A photographic record of each site was made.

Comparisons of recorded abundances, field notes and photographs from the 2017 survey with those from the 2016 survey and previous surveys have been carried out.

Rocky shore communities at the twenty sites in 2017 were generally very like 2016. The most notable features are listed below:

- Average densities of barnacles *Semibalanus balanoides* in Sullom Voe fell to a level not recorded since 1998, probably due to poor recruitment of young barnacles and poor survival of overwintering adults. Fluctuations and trends in records of barnacle spat are discussed.
- The recent lack of records of tortoiseshell limpets is highlighted.
- Densities of juvenile limpets, *Patella vulgata*, were low, but populations of adult limpets were slightly higher.
- Densities of edible winkles *Littorina littorea* increased slightly.
- No dogwhelks were found on either of the SV terminal jetty transects, but large numbers of adult, juveniles and eggs were found in a pile of large boulders between Jetty 3 and Jetty 4.
- Small numbers of dogwhelks were recorded on the Vidlin Ness transect; the first record since 1980.
- A large decrease in mean abundance and numbers of records of False Irish Moss *Mastocarpus stellatus* occurred between 2016 and 2017. An increase in abundance and records of Carrageen *Chondrus crispus* suggests an inconsistency in recording, as there had also been a change in the algal surveyor.
- Average abundance of serrated wrack *Fucus serratus* continued to decline at Sullom Voe sites.
- Fluctuations and trends in abundance of bladder wrack *Fucus vesiculosus* are discussed. Guidance to improve identification consistency between *F. vesiculosus* and *F. spiralis* is being developed for future surveys.
- Records and abundance of channelled wrack Pelvetia canaliculata has reduced over the last three years.
- Effects of the physical removal of boulders from one of the jetty transects, which occurred before the 2016 survey, are still very visible. It is unlikely that fucoid algae will return to the previous levels on the remaining substrata.

All of the changes summarised above are considered to be due to natural fluctuations, with the exception of the movement of boulders between Jetty 1 and Jetty 2.

No oil spills were reported in the period between July 2016 and July 2017, and there were no observed impacts on rocky shore communities from terminal activities.

Contents

1 Introduction

The potential environmental impacts of operations at the Sullom Voe oil terminal were recognised when construction of the complex began in 1975. A monitoring programme was devised by the Shetland Oil Terminal Environmental Advisory Group (SOTEAG). The rocky shore element of this monitoring programme began in 1976 and, apart from a break of two years (1982-83), the rocky shores in Sullom Voe have been surveyed annually. It is thought to be the longest running continuous programme of rocky shores surveys anywhere in the world. The programme was designed to assess gross changes in the plant and animal populations and the survey sites are centred on the oil terminal.

The survey methodology has been modified over this 41-year period, with various changes to the suite of sites and stations, but the species abundance data are comparable throughout.

This report describes the results of the survey in July 2017, highlighting changes that occurred since the survey in July 2016 and discussing any notable longer term fluctuations or trends.

Note: An associated programme of surveys of dogwhelk populations at rocky shore sites around Sullom Voe and Yell Sound is carried out approximately every two years, and was carried out during the July 2015 survey (Moore and Gubbins, 2015). Appendix 3 lists the dogwhelk survey years.

2 Methods

2.1 Methodological changes during the monitoring programme

Between 1976 and 1981 'full' surveys were carried out in all stations at between 23 and 43 sites, with surveyors recording onto blank recording forms – i.e. with no reference to previous results. Between 1984 and 1992, following a review of the programme (Hiscock 1983), the methodology was changed and the survey took the form of a rapid visual assessment of the shores to identify gross changes. This involved: comparing, in the field, abundances of species along the fixed transects with records from the most recent full survey (1981, 1987 or 1988), viewing longer sections of the shores from the sea or by walking; and comparing photographs taken from defined viewpoints with those taken in previous years.

In 1993, following suggestions from the SOTEAG monitoring committee, the methodology was modified to allow more detailed and objective analysis of the data. The number of survey sites in Sullom Voe was reduced and five reference sites were established outside the Voe. Full surveys, rather than rapid visual assessment surveys, were carried out at five stations along each transect, representing the main zones. The latter methodology has been used annually since 1993.

The various changes in sites and transect stations surveyed, survey month and survey personnel that have occurred over the 41 years of the SOTEAG rocky shore monitoring programme are summarised in Appendix 3.

Moore (2013) provides a more detailed summary of the whole rocky shore transect monitoring programme (1976 to 2012), including a description of the methodology, the methodological changes that have occurred over the course of the programme, the database and the limitations of the data.

2.2 Field survey, July 2017

Fieldwork was carried out by Jon Moore and Francis Bunker between the 7th and 16th July 2017. Kirsten Laurenson assisted on four days. Table 1 details the sites and the transect stations surveyed, and Figure 1 shows the location of the sites. Surveys were carried out within three hours of low water.

2.2.1 Site and station location

Fifteen sites are located within, or at the entrance to, Sullom Voe to enable monitoring of the effects of oil terminal activities. A further five sites, established in 1993, are in Vidlin Voe and Burra Voe to act as Reference sites for the natural changes that occur in rocky shore populations. A recent review of the programme highlighted that the five Reference sites did not fully represent the range of environmental variability present across the Sullom Voe sites. Thus, there were often notable differences in some species trends between the two groups of sites. Five additional Reference sites, representing more of the environmental variability present across the Sullom Voe sites, were therefore established during the July 2017 survey. Details are given in Section 2.2.2.

Access to sites was either by car and foot, or by boat as appropriate. A workboat was supplied by the BP Pollution Response Base. A hand-held GPS receiver and site location sheets, containing maps, colour photographs and written notes in laminated plastic, were used to aid relocation.

The site numbering system is based on the wave exposure of the shore. The first number (ranging from 1 to 6) is based on the Ballantine scale (Ballantine, 1961), which uses the biological communities on the shore to estimate the wave exposure (where 1 = extremely exposed, 5 = extremely sheltered, 6 = boulder / cobble shores). The second number is a consecutive number at that exposure.

Table 1 Rocky shore transect sites surveyed in Sullom Voe in July 2017, with the stations surveyed on each transect.

No.	Site name	Stations surveyed	Survey date
Monitoring sites			
1-1	W. of Mioness	15, 18, 21, 24, 27	08/07/2017
2-3	Roe Clett	8, 11, 14, 17, 20	1307/2017
3-3	Noust of Burraland	1, 3, 5, 7, 10	10/07/2017
3-4	Gluss Island East	6, 9, 11, 13, 15	08/07/2017
3-5	S. of Swarta Taing	4, 7, 10, 12, 15	08/07/2017
4-1	Grunn Taing	3, 5, 7, 9, 11	09/07/2017
4-3	The Kames	5, 7, 9, 12, 15	11/07/2017
4-6	Voxter Ness	5, 8, 10, 12, 14	13/07/2017
5-1	S. of Skaw Taing	9, 12, 15, 18, 20	13/07/2017
5-2	Jetty 3	5, 7, 9, 11, 13	16/07/2017
5-5	Mavis Grind	3, 5, 7, 9, 12, 14	07/07/2017
6-1	Fugla Ayre	3, 5, 7, 9, 11	09/07/2017
6-2	S. of Jetty 2	3, 6, 9, 11, 13	16/07/2017
6-12	Scatsta Ness (cleared)	2, 4, 6, 7, 8	14/07/2017
6-13	Scatsta Ness (uncleared)	4, 5, 8, 10, 12	14/07/2017
	Orka Voe bund		14/07/2017
Reference sites			
2-9	Riven Noust	13, 17, 19, 22, 24	10/07/2017
3-8	Vidlin Ness	5, 7, 9, 10, 12	11/07/2017
3-10	Ola's Ness	4, 7, 9, 11, 13	09/07/2017
3-12	Burgo Taing	3, 6, 9, 11, 13	12/07/2017
4-7	West Sandwick	1, 2, 3, 4, 5	10/07/2017
5-8	West Lunna Pund South	1, 2, 3, 4, 5	12/07/2017
6-3	Croo Taing	7, 9, 11, 12, 14	11/07/2017
6-11	Kirkabister	4, 6, 8, 10, 12	11/07/2017
6-14	N. Burra Voe	4, 6, 8, 10, 12	12/07/2017
6-15	West Lunna Pund North	1, 2, 3, 4, 5	12/07/2017

A fixed datum marker, usually a pat of concrete and/or a paint mark, marks the top of each transect. The line of the transect is defined by a bearing and by reference to conspicuous marks (permanent rock features and distant landmarks) shown in the photographs on the site location sheet. A tape may be laid down the shore from the fixed datum marker at the top of the transect, to provide a visible reference.

Fixed recording stations have been established along the transects at all sites. The stations are located at equal intervals of 20cm vertical height from the fixed datum, with Station 1 at the top. The number of stations on a transect varies between sites (maximum 29), but only five are monitored annually in the current programme. Precise relocation of the monitored stations is mainly with annotated close-up photographs; except on gradually sloping boulder / shingle shores where tape distances are used.

The five stations currently monitored on each transect were selected to represent the five major shore zones of upper shore (Station A), upper middle shore (Station B), middle shore (Station C), lower middle shore (Station D) and lower shore (Station E) as defined by their relative height above chart datum and their assemblages of plants and animals. At two sites (Mavis Grind and Voxter Ness), it has become routine to attempt an additional station in the sublittoral fringe (Station F). However, tides and time did not allow for this in 2017. The stations surveyed are listed in Table 1.

2.2.2 Selecting and establishing additional Reference sites

Five additional Reference sites were established during the July 2017 survey.

Apart from the need to increase the number of Reference sites a key objective was that the suite of Reference sites should better represent the environmental character and variability of the Sullom Voe sites. Selection of the new sites was therefore based on that objective but also on various logistical criteria. These included reasonable ease and safe access and reasonable proximity to other sites, to allow survey of more than one site in each low tide period. The initial search for suitable sites was to study available data and images from the various old sites outside Sullom Voe that had been established and surveyed in the early years of the programme but then dropped when the programme focussed just on Sullom Voe. Two of those (Ola’s Ness and Croo Taing) were selected. Searches for additional sites were then made using available maps and satellite imagery (i.e. Google Earth and Bing maps) and by several reconnaissance trips to potential areas. The selected sites are listed in Table 2 and shown in Figure 1.

Each site was established and surveyed during a single low tide period. GPS fixes, with an accuracy of approximately 3 metres, were taken at the top of each transect (and also at the bottom of the relatively long Croo Taing transect). Numerous photographs were taken of each transect and station, to illustrate their character and for relocation. The stations were also levelled relative to tidal height, as described in the next Section.

Table 2 Locations of the five additional Reference sites. Ola’s Ness and Croo Taing are re-established sites from the late 1970s.

Site	SiteName	Longitude	Latitude	OS Grid Ref
3-10	Ola's Ness	-1.35831	60.52986	HU 35320 83089
4-7	West Sandwick	-1.18870	60.56360	HU 44583 86955
5-8	West Lunna Pund South	-1.13378	60.40248	HU 47829 69044
6-15	West Lunna Pund North	-1.13200	60.40292	HU 47926 69094
6-3	Croo Taing	-1.21436	60.48884	HU 43275 78607

2.2.3 Levelling shore height of stations

During the July 2016 survey the transect stations were levelled with a simple low-tech Water Level (see method described in Moore and Mercer 2016). Levelling was repeated, using the same methodology, at many sites during the July 2017 survey, to verify and augment the 2016 measurements. The results are given in Appendix 3.

2.2.4 *In situ* species recording

Comprehensive surveys by the two surveyors, one surveying animals the other surveying algae and lichens, were made of all conspicuous species at each selected station. The categorical (semi-quantitative) abundance score for each species was noted and recorded from a 3 metre horizontal strip (1.5 m each side from the relocated station mark). The width of the strip varies depending on the slope of the substrata, aiming to represent the 10 cm height band lying below the relocated station mark. On vertical rock surfaces the band is therefore 10 cm high; but a broader band, to a maximum of 30 cm, is surveyed on gradually sloping areas. Precise relocation can be difficult over the full 3 m length, but can be improved with the aid of a 3 m length of leaded line laid horizontally by eye along the top of the station. Records were written into a standard pro-forma on waterproof paper, with checklists of species for animals and plants. Categorical abundance scores are assigned from a series of abundance scales, described in Baker and Wolff (1987) (Appendix 1), which have been used since the inception of the programme in 1976. The surveyors carry a copy of these abundance scales to refer to during the survey. Thus, in each station, species of algae, lichen and some colonial animals are each assigned a categorical abundance score based on percentage cover, while species of mobile and other non-colonial animals are each assigned a categorical abundance score based on numbers of individuals per unit area.

Protocol and rationale for estimating categorical abundance scores: Estimation of abundance for each species found is by eye and is necessarily rapid. Most species have a very patchy distribution across the long narrow (3m x 10cm) strip, many are cryptic and require some searching and many are not easy to identify rapidly and *in-situ*. Abundance estimation, averaged across the whole strip, therefore requires some mental collation of species occurrences as the surveyor works back and forth through it. Methodical use of the species checklists and occasional use of small quadrats (e.g. 10cm x 10cm) aid the process, but accurate quantitative measurement of abundance is not achievable for most species in the available time and is not recorded. Assignment to the less precise categorical abundance scores is quicker and achievable, though errors and inconsistencies in estimates may still occur. Survey time at each station depends on species richness and habitat complexity, so the time required to survey a dense algal turf habitat on the low shore takes a lot more time than upper shore bedrock covered in a few encrusting lichens. To relocate and survey a site (five stations) takes approximately 1 hour (not including travel time between sites).

Any points of interest on the shores or relating to the populations observed were also noted on the recording form.

2.2.5 Photography

Photographs were taken of each transect from different viewpoints and angles, usually the same as on the site location sheet, and close-ups of selected stations. The equipment used was a Ricoh WG-4 digital compact camera for most sites and a Sonim Ex-Handy 07 intrinsically safe mobile phone for the two Jetty sites. Digital images (high resolution jpgs) were recorded and copies are filed with SOTEAG and ASML.

2.3 Data analysis

The data from the survey were entered into a computer spreadsheet (*Microsoft Excel*). They were then transferred to a more versatile database package (*Microsoft Access*) that holds the data from previous surveys, for further analysis. Each record comprises the species name and taxonomic code (based on Howson & Picton, 1997), station number, site number, year and recorded abundance scores. The abundance scores are recorded as the numerical equivalent of the categories, e.g. 4 = Common (see Appendix 1).

All taxonomic nomenclature used in the database and this report has been revised and updated according to the World Register of Marine Species (www.marinespecies.org).

Tabulated printouts from the database and simple graphical presentations (graphs in Section 3.1) were used to compare the 2016 species abundances with previous years. In addition, the field notes and the photographs were compared with those from previous years and any notable changes described.

Because each abundance value is based on a semi-quantitative category, the numbers should not be summed or averaged. However, a method has been devised to calculate mean abundances from these values by replacing the abundance scores with the midpoint value on the appropriate scale (Table 3). Thus, a score of ‘Common’ for barnacles, corresponding to 10 to 99 per 0.01 m^2, was converted to a value of 50 per 0.01 m^2. These values were then converted to natural logs. Absence at a station was valued as a population density an order of magnitude less than the minimum density defined in the scale. For each species, average log-transformed abundance was calculated, then anti-logged (exponential) to provide a single time series. As most species show a strong zonation pattern that restricts their vertical range, the abundances were then multiplied by a factor calculated from the maximum number of stations at which the species was ever recorded, to give typical average abundance values from within their range.

Table 3 Median values used in calculations for each abundance category

		Abundance category						
Scale	**Units**	**R**	**O**	**F**	**C**	**A**	**S**	**Ex**
1	No./0.01m2	0.005	0.5	5	50	200	400	600
2	No./0.01m2	0.005	0.05	0.5	5	55	200	350
3	No./0.1m2	0.05	0.25	0.75	2.5	7.5	15	30
4	No./0.1m2	0.05	0.5	2.5	7.5	15	35	60
5	No./1m2	0.25	0.5	2.5	7.5	25	75	130
6	% cover	0.1	1	2.5	12	35	65	90
7	No./0.01m2	0.005	0.05	0.5	25	60	-	-
8	No./0.01m2	0.005	0.05	0.5	50	150	-	-
9	% cover	0.1	1	2.5	12	25	-	-
10	% cover	0.1	0.5	2.5	10	35	65	90
11	% cover	0.2	1	2.5	17	45	75	95

Whilst it should be appreciated that this methodology will introduce some errors into the data, the transformation of the densities will reduce the scale of this inaccuracy by taking better account of shifts at both ends of the abundance scale. The mean abundance graphs are a useful means of presenting trends that have been identified by a detailed scrutiny of the data. For some groups of taxa, including epiphytic bryozoa on fucoid algae and red algal turf species, the abundance data can also be summed and graphed to look for any trends across those whole groups. The methodologies for calculating and presenting mean abundances have been improved since the 2015 survey report.

In addition to the average abundance histograms plotted from the above analysis, the graphs also include line plots of the number of stations from which the species was recorded. The values are given on a second y-axis (on the right of the graph). The maximum number of monitoring stations is 75 (15 sites x 5 stations). The maximum number of reference stations is 25 (5 sites x 5 stations).

2.4 Data archive

The master data are held in two *Microsoft Access* database files, one for species abundance data (currently 106,693 records) and one for the photograph catalogue (currently 7,692 photos), that are updated after each survey. ASML send copies to SOTEAG after completion of the annual report. In 2015 both databases were restructured to make them fully compliant with metadata standards developed by the Marine Environmental Data and Information Network (MEDIN). SOTEAG have sent a full copy of the database, up to 2016, to the Archive for Marine Species and Habitats Data (DASSH) (www.dassh.ac.uk).

The photographs are all in high resolution digital format (jpg and tiff). The original hard copies of 35mm transparencies and prints from the earlier surveys were scanned in 2015. Complete sets are held by ASML and SOTEAG.

Figure 1 Location of rocky shore transect sites. Surveys of rocky shores in the region of Sullom Voe, Shetland, July 2017. ● *Sullom Voe sites,* ● *Reference sites,* ● *new Reference sites.*

3 Results

3.1 Fluctuations in abundance of species

Table 4 provides a summary of the abundance changes that occurred between July 2016 and July 2017 for the most frequently recorded taxa. The majority of these changes continued to reflect a low level of natural variability from year to year, but there were notable changes in some species and at some sites. Species emboldened are discussed later in this Section.

Table 4 Summary of the main changes in selected species presence/absence and abundance between 2016 and 2017 over all sites and stations (not including the 5 new reference sites). Values are the No. of stations out of 100 (20 sites x 5 stations). See category definitions at bottom of table. Species names in bold indicate those which are discussed in the sections below. Distribution is the known biogeographic distribution relative to Britain.

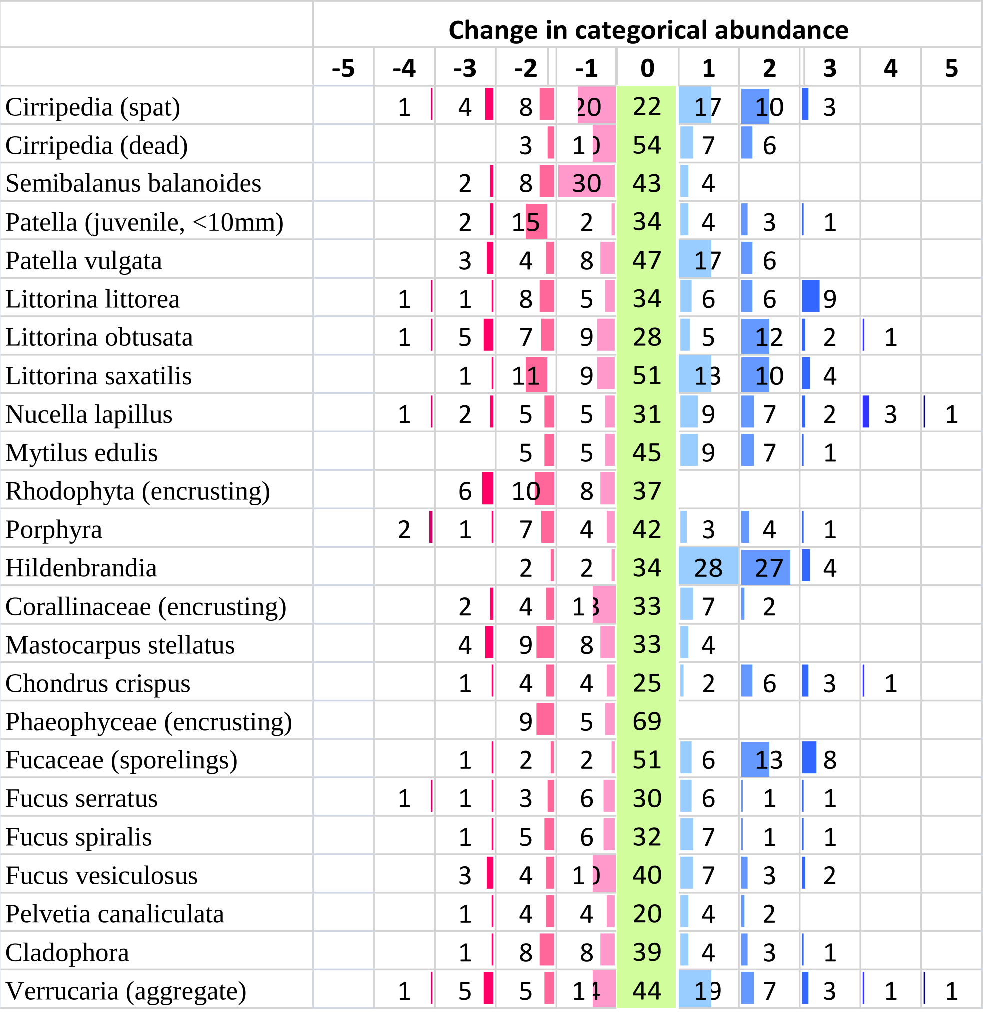
Taxa	Distribution	None	Gone	Down	Same	Up	New
Halichondria panicea	Ubiquitous	83	2	0	15	0	0
Halichondria panicea	Ubiquitous	82	1	0	14	0	3
Dynamena pumila	Ubiquitous	87	3	0	8	0	2
Spirorbinae	Ubiquitous	73	5	2	19	0	1
Cirripedia (spat)	Ubiquitous	21	5	8	53	4	9
Cirripedia (dead)	Ubiquitous	26	2	1	65	0	6
Chthamalus stellatus	Southern	95	1	0	2	0	2
Semibalanus balanoides	Northern	19	4	8	69	0	0
Austrominius modestus	Invasive	95	1	0	2	0	2
Carcinus maenas	Ubiquitous	78	5	0	5	0	12
Patella (juvenile, <10mm)	Ubiquitous	60	16	1	19	1	3
Patella vulgata	Northern	29	7	0	58	5	1
Gibbula cineraria	Ubiquitous	91	0	1	3	0	5
Littorina littorea	Northern	54	8	2	21	3	12
Littorina obtusata	Ubiquitous	50	11	3	21	2	13
Littorina saxatilis (ecotype neglecta)	Southern	57	6	0	31	0	6
Littorina saxatilis	Northern	31	9	4	42	4	10
Nucella lapillus	Northern	59	4	4	20	1	12
Mytilus edulis	Ubiquitous	57	5	0	28	1	9
Flustrellidra hispida	Ubiquitous	83	2	0	10	0	5
Rhodophyta (encrusting)	Ubiquitous	75	23	0	2	0	0
Hildenbrandia	Ubiquitous	29	4	0	16	2	49
Corallinaceae (encrusting)	Ubiquitous	57	6	3	31	0	3
Corallina	Ubiquitous	80	4	1	9	0	6
Mastocarpus stellatus	Northern	70	17	1	11	0	1
Chondrus crispus	Northern	77	9	0	3	4	7
Lomentaria articulata	Ubiquitous	89	0	0	8	0	3
Osmundea hybrida	Southern	90	5	0	2	0	3
Osmundea pinnatifida	Southern	85	3	0	9	1	2
Vertebrata lanosa	Ubiquitous	84	3	1	11	0	1
Ascophyllum nodosum	Northern	85	0	2	12	0	1
Fucus serratus	Northern	72	3	2	20	1	2
Fucus spiralis	Northern	73	8	0	17	0	2
Fucus vesiculosus	Northern	59	4	3	29	2	3
Pelvetia canaliculata	Northern	75	3	4	14	1	3
Ulva (tubular)	Ubiquitous	54	10	2	23	2	9

Taxa	**Distribution**	**None**	**Gone**	**Down**	**Same**	**Up**	**New**
Ulva (flat)	Ubiquitous	85	6	2	4	0	3
Verrucaria (aggregate)	Ubiquitous	6	11	2	69	8	4

None = not recorded at the station in 2016 or 2017
Gone = recorded at the station in 2016, but not in 2017
Down = decreased abundance in 2017
Same = same or almost same (up or down by only one class) in 2016 and 2017
Up = increased abundance in 2017
New = recorded at station in 2017 but not in 2016

Table 5 provides an alternative presentation, using colour bars to highlight notable increases and decreases in recorded abundance. The larger changes are discussed later in this Section.

Table 5 Changes in categorical abundance of selected species between 2016 and 2017 at all monitoring stations (not including the 5 new reference sites). Values are the number of stations at which there was a change in abundance shown in the top row of the table. Example: Cirripedia spat reduced in abundance by two categories at 8 stations.



	Change in categorical abundance										
	-5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Cirripedia (spat)		1	4	8	20	22	17	10	3		
Cirripedia (dead)				3	10	54	7	6			
Semibalanus balanoides			2	8	30	43	4				
Patella (juvenile, <10mm)			2	15	2	34	4	3	1		
Patella vulgata			3	4	8	47	17	6			
Littorina littorea		1	1	8	5	34	6	6	9		
Littorina obtusata		1	5	7	9	28	5	12	2	1	
Littorina saxatilis			1	11	9	51	13	10	4		
Nucella lapillus		1	2	5	5	31	9	7	2	3	1
Mytilus edulis				5	5	45	9	7	1		
Rhodophyta (encrusting)			6	10	8	37					
Porphyra		2	1	7	4	42	3	4	1		
Hildenbrandia				2	2	34	28	27	4		
Corallinaceae (encrusting)			2	4	13	33	7	2			
Mastocarpus stellatus			4	9	8	33	4				
Chondrus crispus			1	4	4	25	2	6	3	1	
Phaeophyceae (encrusting)				9	5	69					
Fucaceae (sporelings)			1	2	2	51	6	13	8		
Fucus serratus		1	1	3	6	30	6	1	1		
Fucus spiralis			1	5	6	32	7	1	1		
Fucus vesiculosus			3	4	10	40	7	3	2		
Pelvetia canaliculata			1	4	4	20	4	2			
Cladophora			1	8	8	39	4	3	1		
Verrucaria (aggregate)		1	5	5	14	44	19	7	3	1	1

The following sections describe the results for selected characterising species and others that have shown notable changes. The mean abundance graphs have been prepared using the methodology described in Section 2.3, for Sullom Voe sites and Reference sites.

Other tables of data have been prepared from the species abundance data, with colour coding (conditional formatting features in Excel) to highlight patterns in those abundances between years, sites and species.

Appendix 1 provides the abundance scales used for each species. The fixed monitored stations, representing the five shore zones, are referred to in the text and some tables as follows: upper shore (A), upper middle shore (B), middle shore (C), lower middle shore (D), lower shore (E) and sublittoral fringe (F).

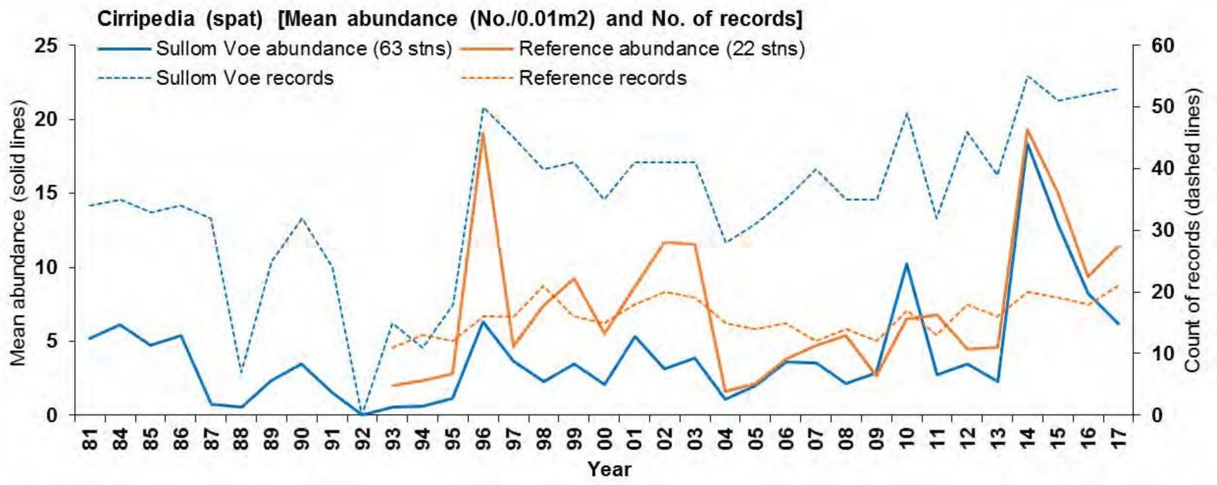
Note: for readers with the electronic version of this report, the species names in the section headings below contain hyperlinks to relevant pages on their biology on the MarLIN website.

3.1.1 Chthamalus stellatus

This southern species of barnacle has been recorded from a few of the more wave exposed sites since 2011. Small numbers were found at three sites in 2017 – West of Mioness (1.1) and the reference sites Riven Noust (2.9) and Burgo Taing (3.12).

3.1.2 Semibalanus balanoides

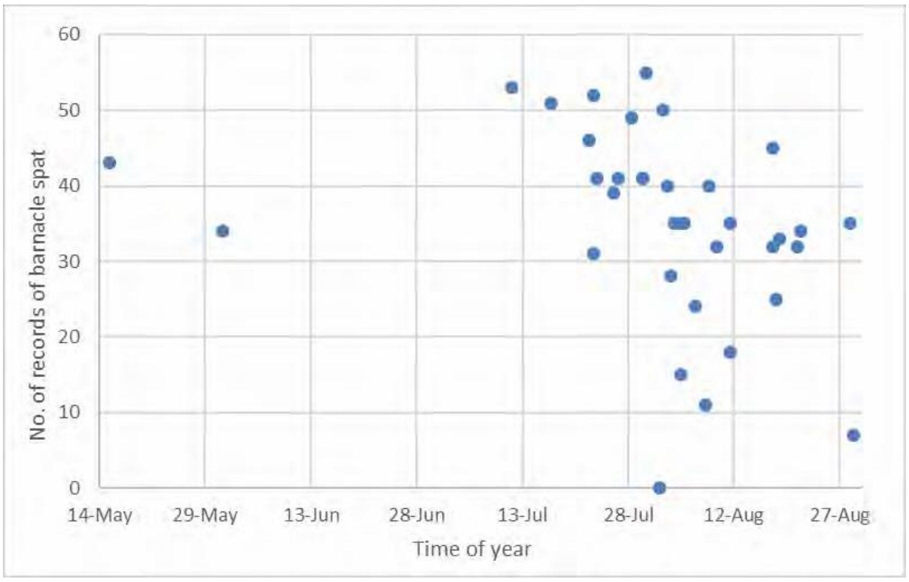
Large fluctuations in abundance of barnacle spat occurred at individual stations, but there was little change in average densities.

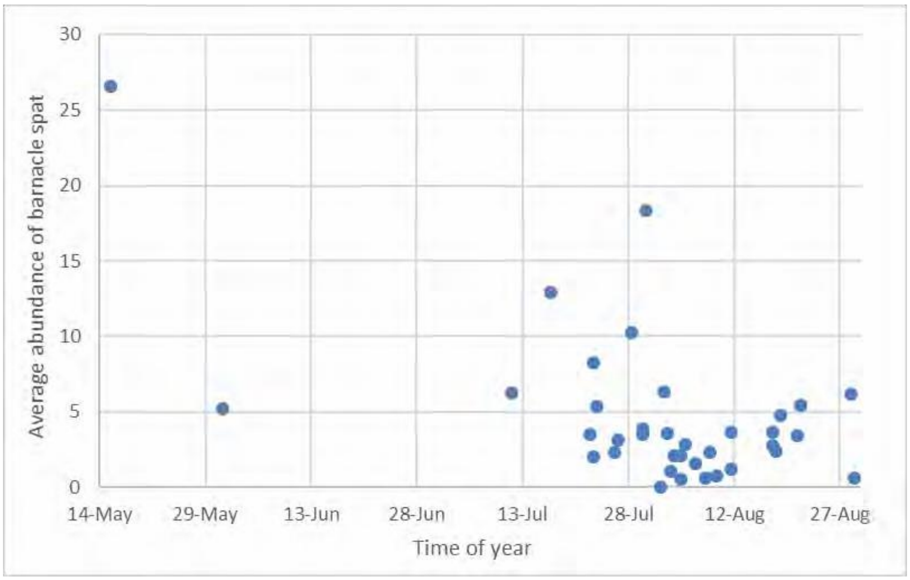


The number of stations at which barnacle spat are recorded has increased considerably since the early years of the programme. There may be some inconsistency in the recording of barnacle spat, as there is no easily applied definition of when to differentiate spat from juveniles, as illustrated by the range of individuals in this photograph:

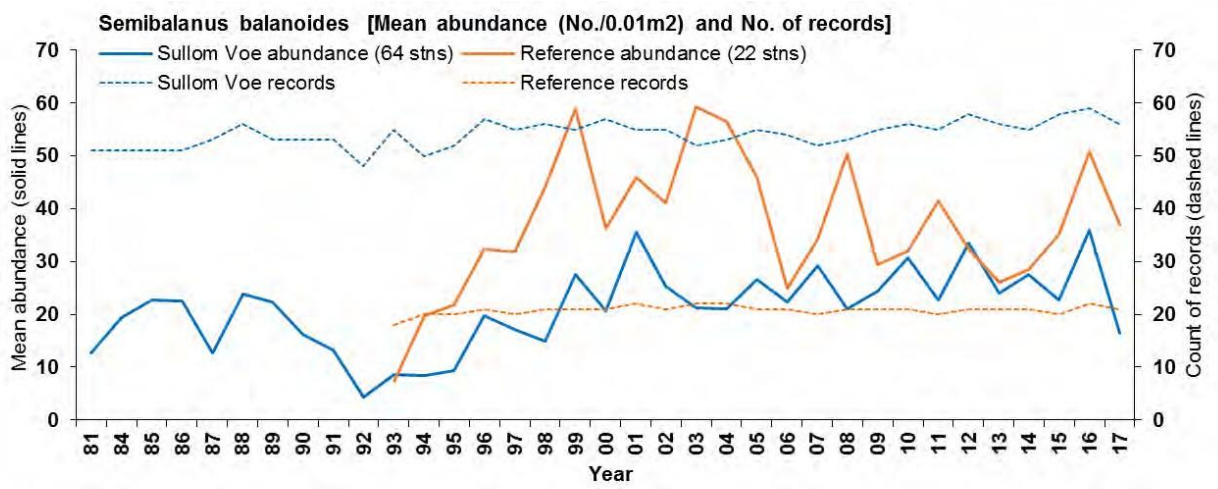
Another important influence is the time of year of the survey, as settlement of *Semibalanus balanoides* in Shetland probably peaks in June. The graph below shows some relationship between numbers of records and time of year, with fewer records in the August surveys. The survey timing has shifted slightly earlier in July recent years. The relationship between average abundance and time of year is shown in the lower graph. The two outliers, in May & early June were from the 1980 and 1981 surveys. Barnacle spat were not listed on the recording forms until 1980, so were not routinely recorded in the 1976 to 1979 surveys.

It is clear, however, that natural fluctuations from year to year can also be much greater than the seasonal trends and inconsistencies of recording, as evidenced by the apparently complete absence of barnacle spat at any site in 1992. The reliability of those absence records is supported by hand-written field notes and some close-up photographs.

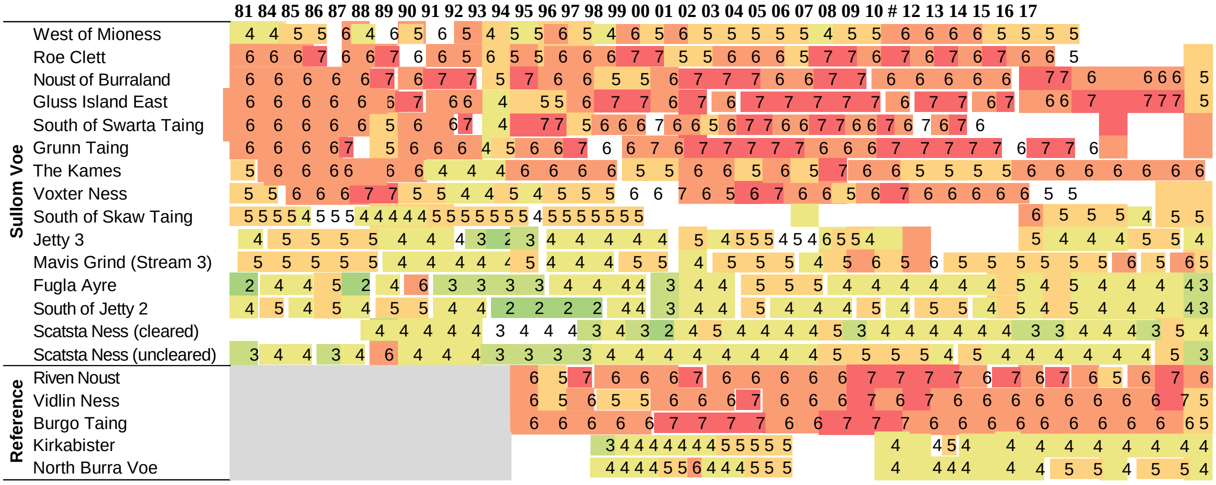




Following the peak densities in 2016, the average density of adult barnacles across Sullom Voe sites in 2017 fell to a level not recorded since 1998. There were still a number of mid shore stations with abundances >3 per cm^2 (Super abundant), but many more with relatively large areas of bare rock. Field notes and photographs suggests that this was due to poor recruitment of young barnacles and also poor survival of overwintering adults. A large reduction was also shown across the Reference sites, but average abundances remained higher than many previous years. The reduction in Sullom Voe is not considered to be related to terminal activities.



Semibalanus balanoides (max of abundance scores from five stations, by site and year)

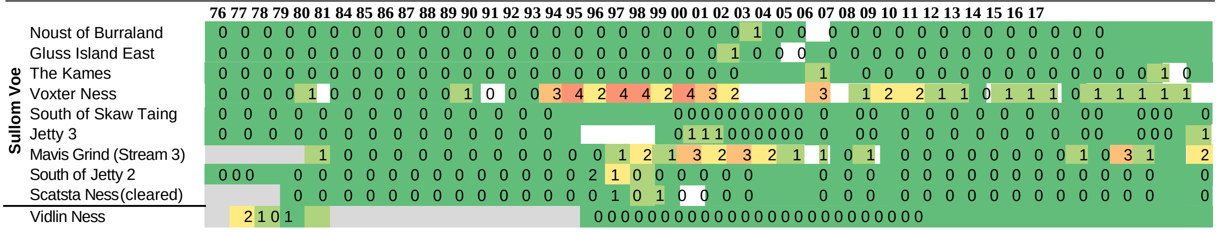


		81	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	#	12	13	14	15	16	17
Sullom Voe	West of Mioness	4	4	5	5	6	4	6	5	6	5	4	5	5	6	5	4	6	5	6	5	5	5	5	5	4	5	5	6	6	6	6	5	5	5	5
	Roe Clett	6	6	6	7	6	6	7	6	6	5	6	5	5	6	6	6	7	7	5	5	6	6	6	5	7	7	6	7	6	7	6	7	6	6	5
	Noust of Burraland	6	6	6	6	6	7	6	7	7	5	7	6	6	5	5	6	7	7	7	6	6	7	7	6	6	6	6	6	7	7	6	6	6	6	5
	Gluss Island East	6	6	6	6	6	6	7	6	6	4	5	5	6	7	7	6	7	6	7	7	7	7	7	6	7	7	6	7	6	6	7	7	7	7	5
	South of Swarta Taing	6	6	6	6	6	5	6	6	7	4	7	7	5	6	6	6	7	6	6	5	6	7	7	6	6	7	7	6	6	7	6	7	6	7	6
	Grunn Taing	6	6	6	6	7	5	6	6	6	4	5	6	6	7	6	6	7	6	7	7	7	7	7	6	6	6	7	7	7	7	7	6	7	7	6
	The Kames	5	6	6	6	6	6	6	4	4	4	6	6	6	6	5	5	6	6	5	6	5	7	6	6	5	5	5	5	6	6	6	6	6	6	6
	Voxter Ness	5	5	6	6	6	7	7	5	5	4	4	5	4	5	5	5	6	6	7	6	5	6	7	6	6	5	6	7	6	6	6	6	6	5	5
	South of Skaw Taing	5	5	5	5	4	5	5	5	4	4	4	4	4	5	5	5	5	5	5	5	4	5	5	5	5	5	5	5	6	5	5	5	4	5	5
	Jetty 3	4	5	5	5	5	4	4	4	3	2	3	4	4	4	4	4	5	4	5	5	5	4	5	4	6	5	5	4	5	4	4	4	5	5	4
	Mavis Grind (Stream 3)	5	5	5	5	5	4	4	4	4	4	5	4	4	4	5	5	4	5	5	5	4	5	6	5	6	5	5	5	5	5	5	6	5	6	5
	Fugla Ayre	2	4	4	5	2	4	6	3	3	3	3	4	4	4	4	3	4	4	5	5	5	4	4	4	4	4	4	5	4	5	4	4	4	4	3
	South of Jetty 2	4	5	4	5	4	5	5	4	4	2	2	2	2	4	4	3	4	4	5	4	4	4	5	4	5	5	4	5	4	5	4	4	4	4	3
	Scatsta Ness (cleared)	4	4	4	4	4	3	4	4	4	3	4	3	2	4	5	4	4	4	4	5	3	4	4	4	4	4	4	3	3	4	4	4	3	5	4
	Scatsta Ness (uncleared)	3	4	4	3	4	6	4	4	4	3	3	3	3	4	4	4	4	4	4	4	4	5	5	5	5	4	5	4	4	4	4	4	4	5	3
Reference	Riven Noust											6	5	7	6	6	6	7	6	6	6	6	6	7	7	7	7	6	7	6	7	6	5	6	7	6
	Vidlin Ness											6	5	6	5	5	6	6	6	7	6	6	6	7	6	7	6	6	6	6	6	6	6	6	7	5
	Burgo Taing											6	6	6	6	6	7	7	7	7	6	6	7	7	7	6	6	6	6	6	6	6	6	6	6	5
	Kirkabister											3	4	4	4	4	4	4	4	5	5	5	5	5	4	4	5	4	4	4	4	4	4	4	4	4
	North Burra Voe											4	4	4	4	5	5	6	4	4	4	5	5	5	4	4	4	4	4	4	5	5	4	5	5	4

3.1.3 Austrominius modestus

Small populations of this immigrant barnacle persist in low densities (typically <10 per m^2 in upper shore zones) at some sites within the Voe.

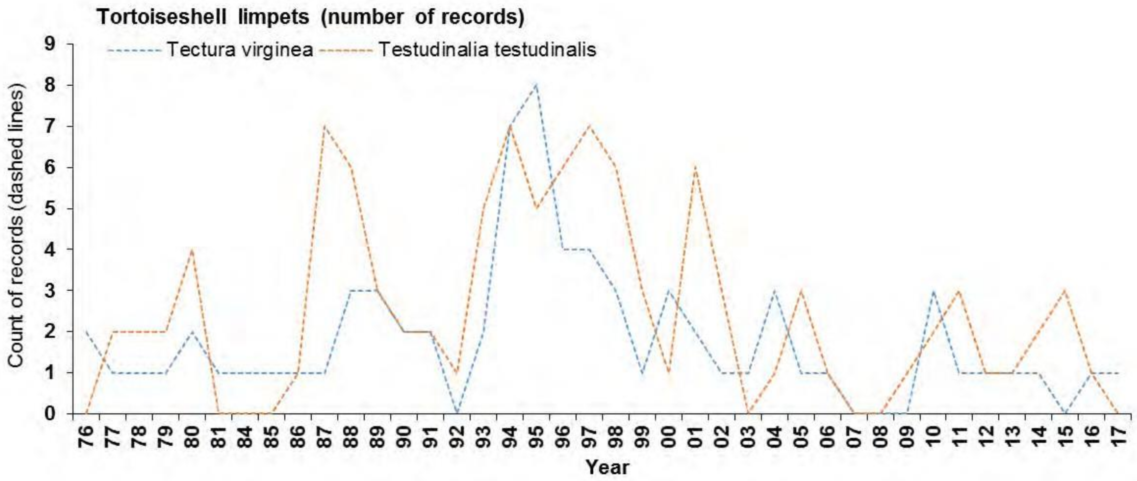
Austrominius modestus (number of records from five stations, by site and year)



		76 77 78 79 80 81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
Sullom Voe	Noust of Burraland	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Gluss Island East	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	The Kames	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0
	Voxter Ness	0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 3 4 2 4 4 2 4 3 2 3 1 2 2 1 1 0 1 1 1 0 1 1 1 1 1
	South of Skaw Taing	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Jetty 3	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
	Mavis Grind (Stream 3)	1 0 0 0 0 0 0 0 0 0 0 0 1 2 1 3 2 3 2 1 1 0 1 0 0 0 0 0 0 0 0 1 0 3 1 2
	South of Jetty 2	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Scatsta Ness (cleared)	0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Vidlin Ness	2 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

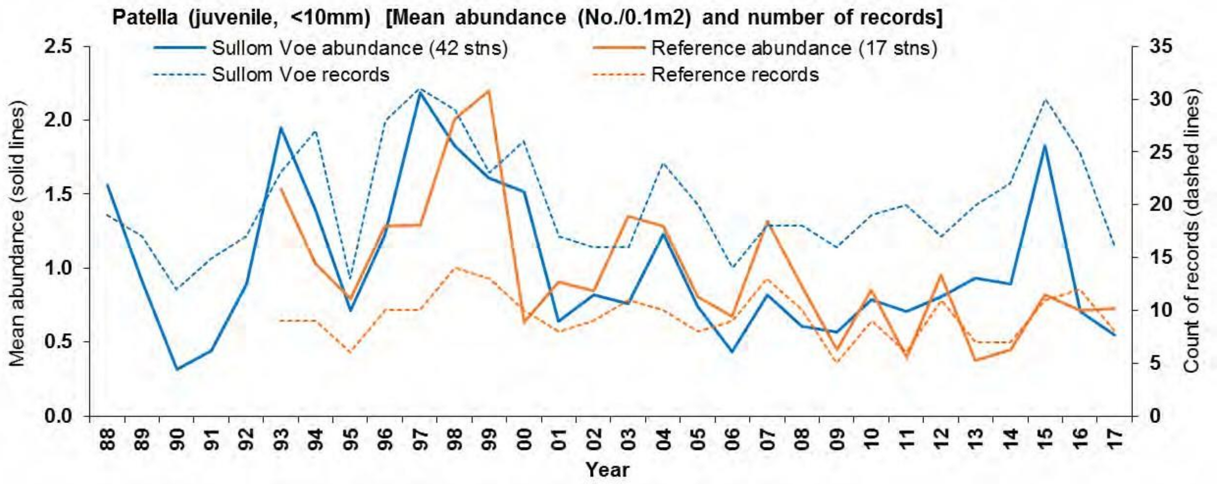
3.1.4 Testudinalia testudinalis and Tectura virginea

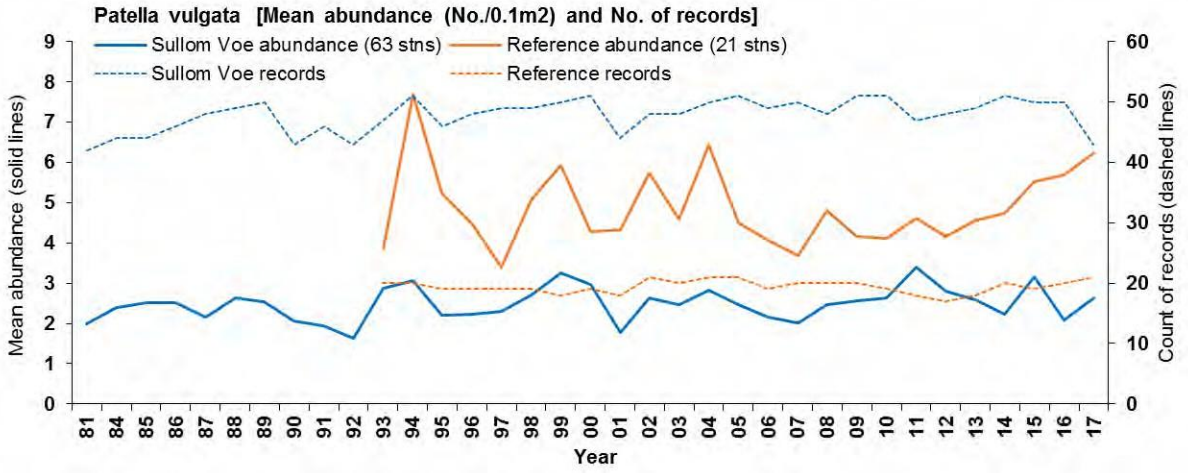
There have been very few records of either tortoiseshell limpet or white tortoiseshell limpet in recent years.



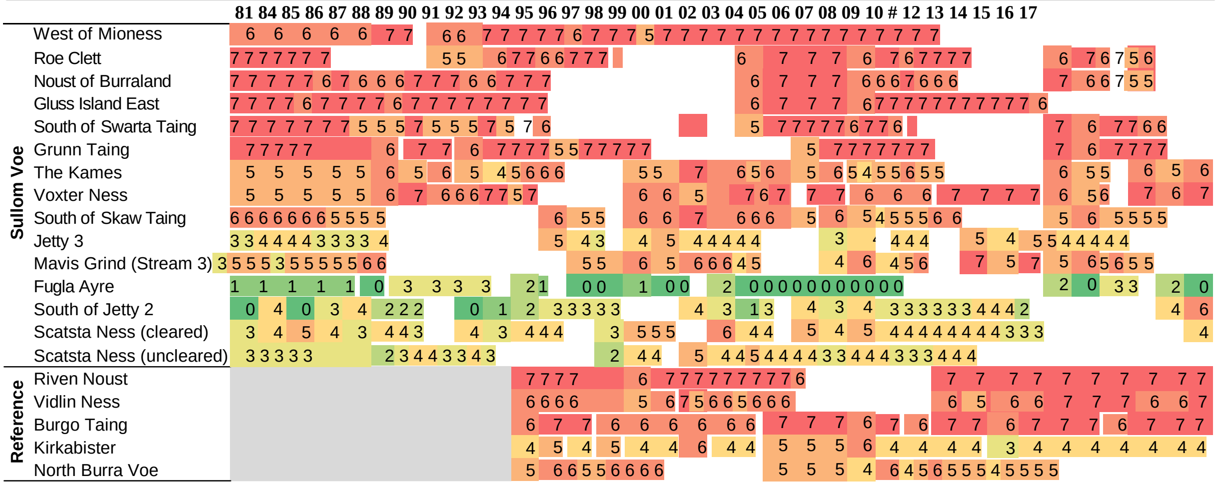
3.1.5 Patella vulgata

Juvenile limpet densities were low in 2017, but adult densities rose slightly, particularly at the Reference sites. There were no notable changes to discuss.





Patella vulgata (max of abundance scores from five stations, by site and year)



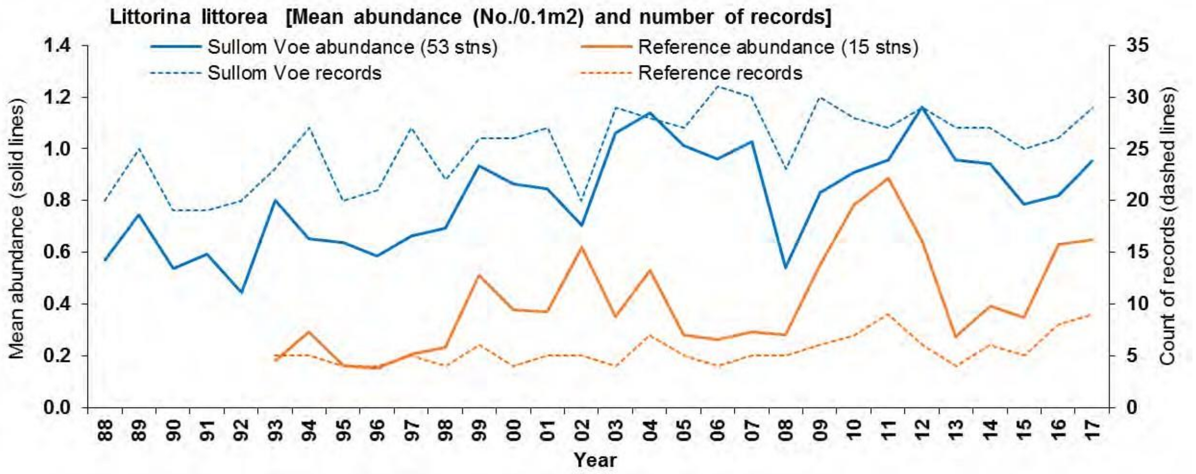
		81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 # 12 13 14 15 16 17
Sullom Voe	West of Mioness	6 6 6 6 6 7 7 6 6 7 7 7 7 7 6 7 7 7 5 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7
	Roe Clett	7 7 7 7 7 7 7 5 5 6 7 7 6 6 7 7 7 6 7 7 7 6 7 6 7 7 7 7 6 7 6 7 5 6
	Noust of Burraland	7 7 7 7 7 6 7 6 6 6 7 7 7 6 6 7 7 7 6 7 7 7 6 6 6 7 6 6 6 7 6 6 7 5 5
	Gluss Island East	7 7 7 7 6 7 7 7 7 6 7 7 7 7 7 7 7 7 6 7 7 7 6 7 7 7 7 7 7 7 7 7 7 7 6
	South of Swarta Taing	7 7 7 7 7 7 7 5 5 5 7 5 5 5 7 5 7 6 5 7 7 7 7 7 6 7 7 6 7 6 7 7 6 6
	Grunn Taing	7 7 7 7 7 6 7 7 6 7 7 7 7 5 5 7 7 7 7 7 5 7 7 7 7 7 7 7 7 6 7 7 7 7
	The Kames	5 5 5 5 5 6 5 6 5 4 5 6 6 6 5 5 7 6 5 6 5 6 5 4 5 5 6 5 5 6 5 5 6 5 6
	Voxter Ness	5 5 5 5 5 6 7 6 6 6 7 7 5 7 6 6 5 7 6 7 7 7 6 6 6 7 7 7 7 6 5 6 7 6 7
	South of Skaw Taing	6 6 6 6 6 6 6 5 5 5 5 6 5 5 6 6 7 6 6 6 5 6 5 4 5 5 5 6 6 5 6 5 5 5 5
	Jetty 3	3 3 4 4 4 4 3 3 3 3 4 5 4 3 4 5 4 4 4 4 4 3 4 4 4 4 5 4 5 5 4 4 4 4 4
	Mavis Grind (Stream 3)	3 5 5 5 3 5 5 5 5 5 6 6 5 5 6 5 6 6 6 4 5 4 6 4 5 6 7 5 7 5 6 5 6 5 5
	Fugla Ayre	1 1 1 1 1 0 3 3 3 3 2 1 0 0 1 0 0 2 0 0 0 0 0 0 0 0 0 0 0 2 0 3 3 2 0
	South of Jetty 2	0 4 0 3 4 2 2 2 0 1 2 3 3 3 3 3 4 3 1 3 4 3 4 3 3 3 3 3 3 4 4 4 2 4 6
	Scatsta Ness (cleared)	3 4 5 4 3 4 4 3 4 3 4 4 4 3 5 5 5 6 4 4 5 4 5 4 4 4 4 4 4 4 4 3 3 3 4
	Scatsta Ness (uncleared)	3 3 3 3 3 2 3 4 4 3 3 4 3 2 4 4 5 4 4 5 4 4 4 4 3 3 4 4 4 3 3 3 4 4 4
Reference	Riven Noust	7 7 7 7 6 7 7 7 7 7 7 7 7 7 6 7 7 7 7 7 7 7 7 7 7
	Vidlin Ness	6 6 6 6 5 6 7 5 6 6 5 6 6 6 6 5 6 6 7 7 7 6 6 7
	Burgo Taing	6 7 7 6 6 6 6 6 6 7 7 7 6 7 6 7 7 6 7 7 7 6 7 7 7
	Kirkabister	4 5 4 5 4 4 6 4 4 5 5 5 6 4 4 4 4 3 4 4 4 4 4 4 4
	North Burra Voe	5 6 6 5 5 6 6 6 6 5 5 5 4 6 4 5 6 5 5 5 4 5 5 5 5

3.1.6 Patella ulyssiponensis

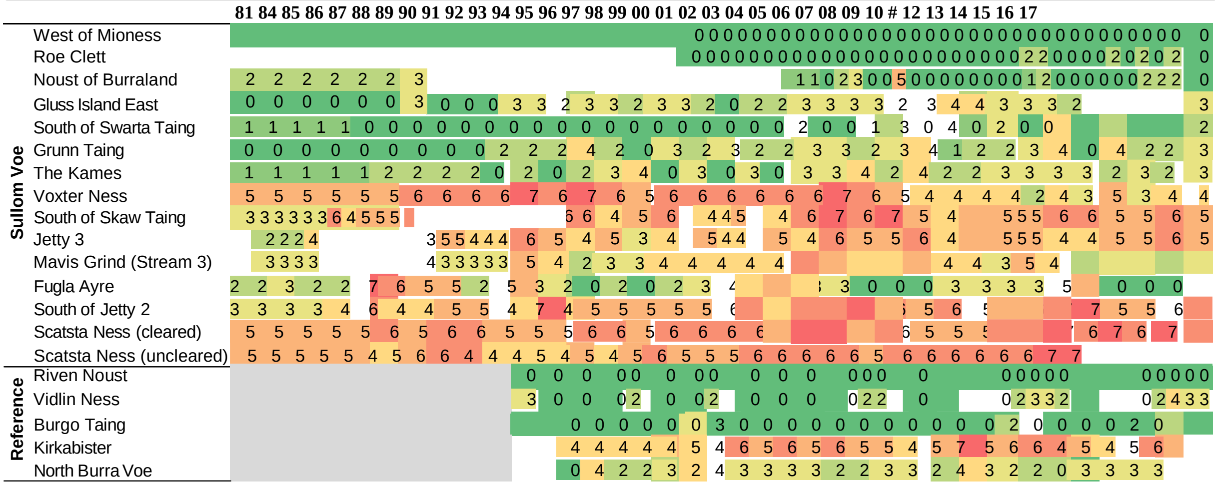
Confirmed records of this southern species of limpet in 2017 were from only two sites: Riven Noust and South of Skaw Taing.

3.1.7 Littorina littorea

Edible winkles are most abundant at the relatively sheltered sites, particularly on the boulder shores. Annual fluctuations of two or three abundance categories are not uncommon in the midshore stations, but fluctuations in the average abundance across all of the Sullom Voe sites is less marked. The overall trend in 2017 was of increasing abundance and numbers of records, at Sullom Voe sites and Reference sites.



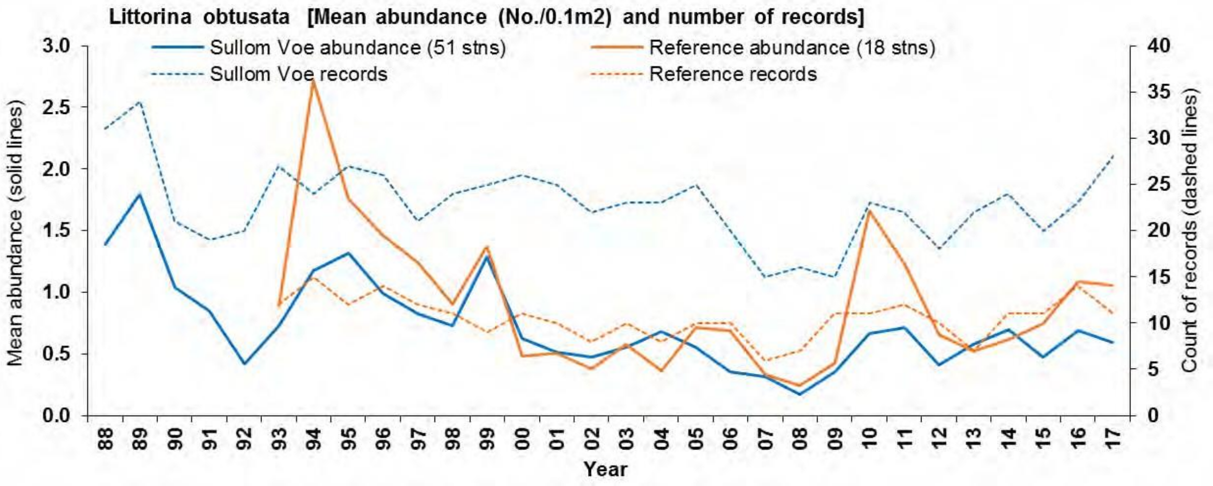
Littorina littorea (max of abundance scores from five stations, by site and year)



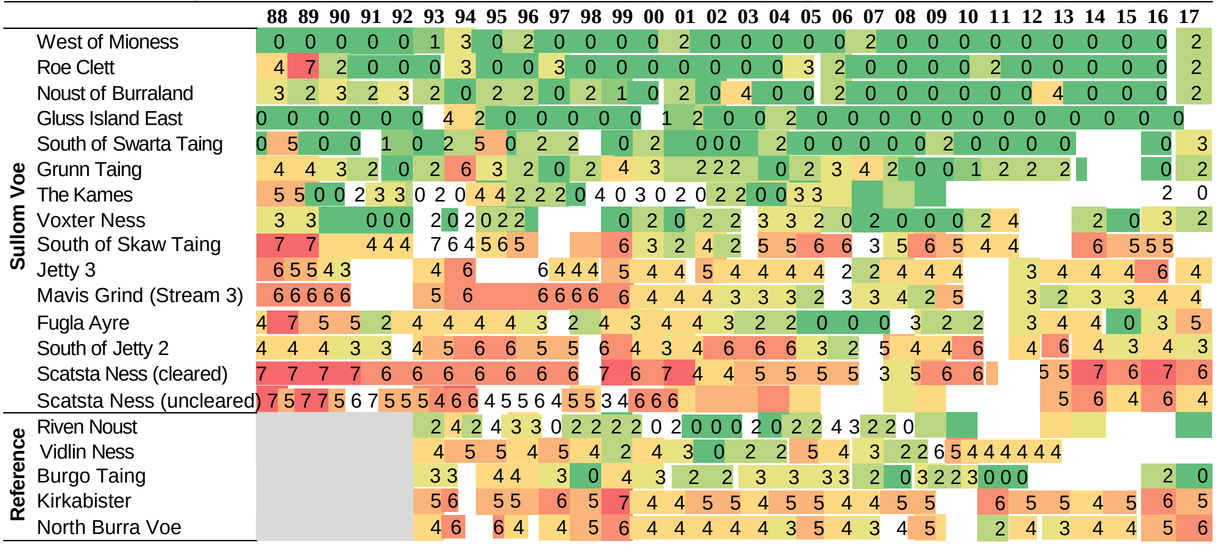
		81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 # 12 13 14 15 16 17
Sullom Voe	West of Mioness	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Roe Clett	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 2 0 0 0 0 2 0 2 0 2 0
	Noust of Burraland	2 2 2 2 2 2 3 1 1 0 2 3 0 0 5 0 0 0 0 0 0 0 0 1 2 0 0 0 0 0 0 2 2 2 0
	Gluss Island East	0 0 0 0 0 0 3 0 0 0 3 3 2 3 3 2 3 3 2 0 2 2 3 3 3 3 2 3 4 4 3 3 3 2 3
	South of Swarta Taing	1 1 1 1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 1 3 0 4 0 2 0 0 2
	Grunn Taing	0 0 0 0 0 0 0 0 0 2 2 2 4 2 0 3 2 3 2 2 3 3 2 3 4 1 2 2 3 4 0 4 2 2 3
	The Kames	1 1 1 1 1 2 2 2 2 0 2 0 2 3 4 0 3 0 3 0 3 3 4 2 4 2 2 3 3 3 3 2 3 2 3
	Voxter Ness	5 5 5 5 5 5 6 6 6 6 7 6 7 6 5 6 6 6 6 6 6 7 6 5 4 4 4 4 2 4 3 5 3 4 4
	South of Skaw Taing	3 3 3 3 3 3 6 4 5 5 5 6 6 4 5 6 4 4 5 4 6 7 6 7 5 4 5 5 5 6 6 5 5 6 5
	Jetty 3	2 2 2 4 3 5 5 4 4 4 6 5 4 5 3 4 5 4 4 5 4 6 5 5 6 4 5 5 5 4 4 5 5 6 5
	Mavis Grind (Stream 3)	3 3 3 3 4 3 3 3 3 3 5 4 2 3 3 4 4 4 4 4 4 4 3 5 4
	Fugla Ayre	2 2 3 2 2 7 6 5 5 2 5 3 2 0 2 0 2 3 4 3 3 0 0 0 3 3 3 3 5 0 0 0
	South of Jetty 2	3 3 3 3 4 6 4 4 5 5 4 7 4 5 5 5 5 5 6 5 5 6 5 7 5 5 6
	Scatsta Ness (cleared)	5 5 5 5 5 6 5 6 6 5 5 5 6 6 5 6 6 6 6 6 5 5 5 6 7 6 7
	Scatsta Ness (uncleared)	5 5 5 5 5 4 5 6 6 4 4 4 5 4 5 4 5 6 5 5 5 6 6 6 6 6 5 6 6 6 6 6 6 7 7
Reference	Riven Noust	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Vidlin Ness	3 0 0 0 2 0 0 2 0 0 0 0 2 2 0 0 2 3 3 2 0 2 4 3 3
	Burgo Taing	0 0 0 0 0 0 3 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 2 0
	Kirkabister	4 4 4 4 4 5 4 6 5 6 5 6 5 5 4 5 7 5 6 6 4 5 4 5 6
	North Burra Voe	0 4 2 2 3 2 4 3 3 3 3 2 2 3 3 2 4 3 2 2 0 3 3 3 3

3.1.8 Littorina obtusata & L. mariae

The average densities of flat winkles have not changed dramatically in recent years, but remain at relatively low levels compared to the average densities recorded in the early years of the programme.



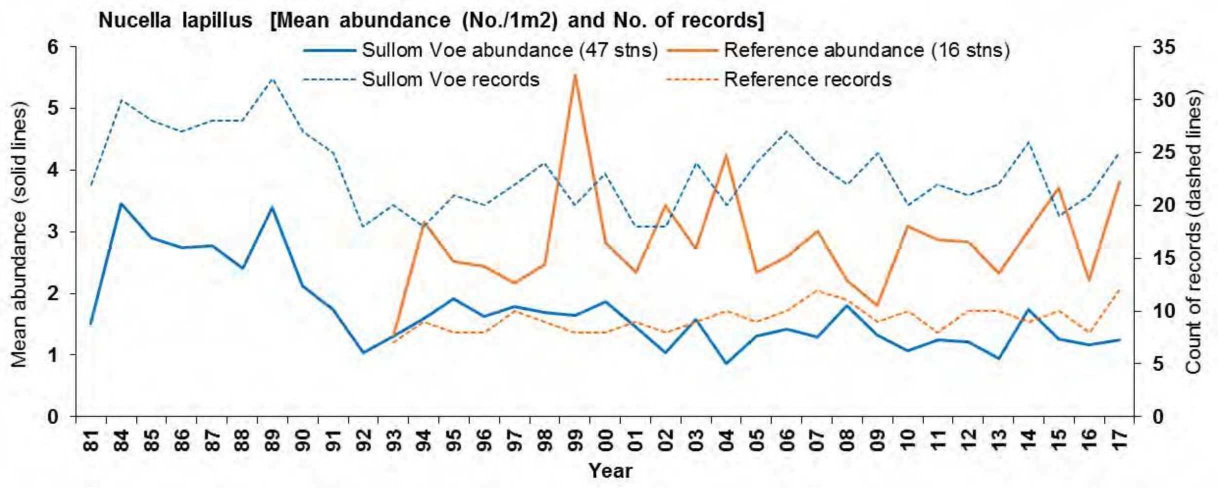
Littorina obtusata (max of abundance scores from five stations, by site and year)



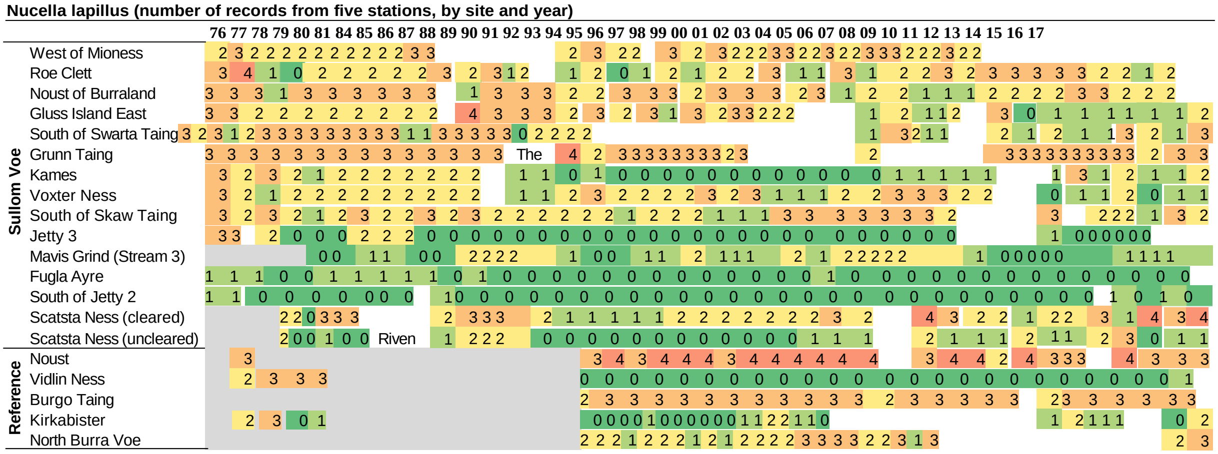
		88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
Sullom Voe	West of Mioness	0 0 0 0 0 1 3 0 2 0 0 0 0 2 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 2
	Roe Clett	4 7 2 0 0 0 3 0 0 3 0 0 0 0 0 0 0 3 2 0 0 0 0 2 0 0 0 0 0 2
	Noust of Burraland	3 2 3 2 3 2 0 2 2 0 2 1 0 2 0 4 0 0 2 0 0 0 0 0 0 4 0 0 0 2
	Gluss Island East	0 0 0 0 0 0 4 2 0 0 0 0 0 1 2 0 0 2 0 0 0 0 0 0 0 0 0 0 0 0
	South of Swarta Taing	0 5 0 0 1 0 2 5 0 2 2 0 2 0 0 0 2 0 0 0 0 0 2 0 0 0 0 0 3
	Grunn Taing	4 4 3 2 0 2 6 3 2 0 2 4 3 2 2 2 0 2 3 4 2 0 0 1 2 2 2 0 2
	The Kames	5 5 0 0 2 3 3 0 2 0 4 4 2 2 2 0 4 0 3 0 2 0 2 2 0 0 3 3 2 0
	Voxter Ness	3 3 0 0 0 2 0 2 0 2 2 0 2 0 2 2 3 3 2 0 2 0 0 0 2 4 2 0 3 2
	South of Skaw Taing	7 7 4 4 4 7 6 4 5 6 5 6 3 2 4 2 5 5 6 6 3 5 6 5 4 4 6 5 5 5
	Jetty 3	6 5 5 4 3 4 6 6 4 4 4 5 4 4 5 4 4 4 4 2 2 4 4 4 3 4 4 4 6 4
	Mavis Grind (Stream 3)	6 6 6 6 6 5 6 6 6 6 6 6 4 4 4 3 3 3 2 3 3 4 2 5 3 2 3 3 4 4
	Fugla Ayre	4 7 5 5 2 4 4 4 4 3 2 4 3 4 4 3 2 2 0 0 0 3 2 2 3 4 4 0 3 5
	South of Jetty 2	4 4 4 3 3 4 5 6 6 5 5 6 4 3 4 6 6 6 3 2 5 4 4 6 4 6 4 3 4 3
	Scatsta Ness (cleared)	7 7 7 7 6 6 6 6 6 6 6 7 6 7 4 4 5 5 5 5 3 5 6 6 5 5 7 6 7 6
	Scatsta Ness (uncleared)	7 5 7 7 5 6 7 5 5 5 4 6 6 4 5 5 6 4 5 5 3 4 6 6 6 5 6 4 6 4
Reference	Riven Noust	2 4 2 4 3 3 0 2 2 2 2 0 2 0 0 0 2 0 2 2 4 3 2 2 0
	Vidlin Ness	4 5 5 4 5 4 2 4 3 0 2 2 5 4 3 2 2 6 5 4 4 4 4 4 4
	Burgo Taing	3 3 4 4 3 0 4 3 2 2 3 3 3 3 2 0 3 2 2 3 0 0 0 2 0
	Kirkabister	5 6 5 5 6 5 7 4 4 5 5 4 5 5 4 4 5 5 6 5 5 4 5 6 5
	North Burra Voe	4 6 6 4 4 5 6 4 4 4 4 4 3 5 4 3 4 5 2 4 3 4 4 5 6

3.1.9 Nucella lapillus

A gradual recovery of dogwhelk populations, following their decline at sites impacted by TBT antifouling paints, has been described in recent years from sites close to the oil terminal. However, their average abundance across the Sullom Voe sites still appears to be lower than it was in the 1980s.



Average abundance is slightly higher across the Reference sites, but not at Vidlin Ness (3.8). That transect was originally established in 1977, dropped from the programme in 1981 and then re-established in 1993. As a moderately exposed bedrock shore with large densities of their barnacle prey, dogwhelks were typically common in 1977 to 1980, but were absent in 1993 and were not found in any subsequent survey until a small number were found at one station this year. The reason for their long absence is not known, but hopefully the population will now return to the pre-1981 condition. A similar situation occurred at Kirkabister (6.11), on the opposite side of Vidlin Voe; but dogwhelks returned there in 2004 and have been recorded in low densities in most years since then. As a boulder / cobble shore, with relatively few prey, the habitat at Kirkabister is not ideal for dogwhelks, so their long absence from Vidlin Ness was even more striking.



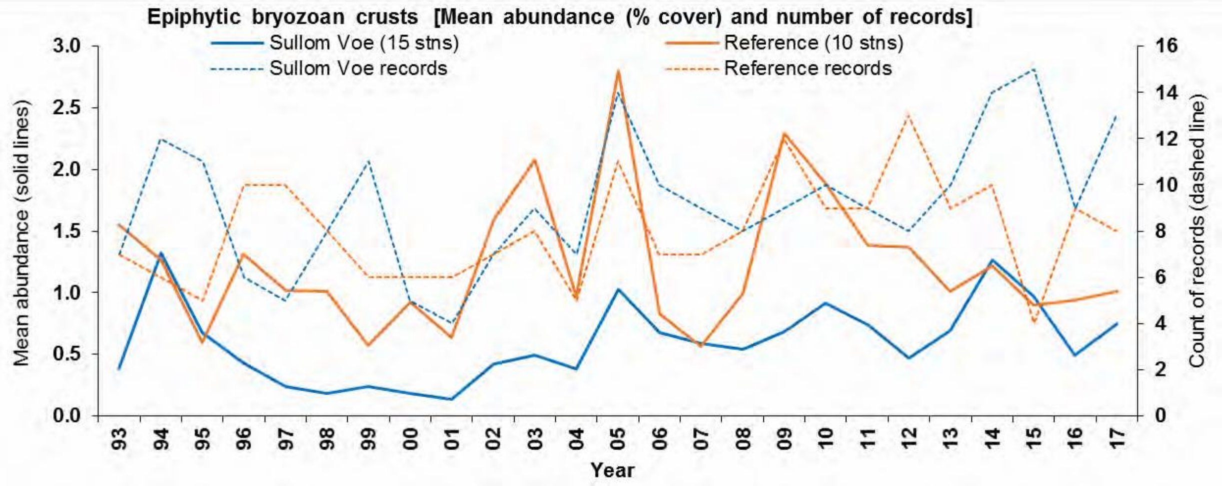
Nucella lapillus (number of records from five stations, by site and year)

		76 77 78 79 80 81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
Sullom Voe	West of Mioness	2 3 2 2 2 2 2 2 2 2 2 2 3 3 2 3 2 2 3 2 3 2 2 2 3 3 2 2 3 2 2 3 3 3 2 2 2 3 2 2
	Roe Clett	3 4 1 0 2 2 2 2 2 3 2 3 1 2 1 2 0 1 2 1 2 2 3 1 1 3 1 2 2 3 2 3 3 3 3 3 2 2 1 2
	Noust of Burraland	3 3 3 1 3 3 3 3 3 3 1 3 3 3 2 2 3 3 3 2 3 3 3 2 3 1 2 2 1 1 1 2 2 2 2 3 3 2 2 2
	Gluss Island East	3 3 2 2 2 2 2 2 2 2 4 3 3 3 2 3 2 3 1 3 2 3 3 2 2 2 1 2 1 1 2 3 0 1 1 1 1 1 1 2
	South of Swarta Taing	3 2 3 1 2 3 3 3 3 3 3 3 3 3 1 1 3 3 3 3 3 0 2 2 2 2 1 3 2 1 1 2 1 2 1 1 3 2 1 3
	Grunn Taing	3 3 3 3 3 3 3 3 3 3 3 3 3 3 The 4 2 3 3 3 3 3 3 3 3 2 3 2 3 3 3 3 3 3 3 3 3 3 2 3 3
	Kames	3 2 3 2 1 2 2 2 2 2 2 2 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 1 1 1 3 1 2 1 1 2
	Voxter Ness	3 2 1 2 2 2 2 2 2 2 2 2 1 1 2 3 2 2 2 2 3 2 3 1 1 1 2 2 3 3 3 2 2 0 1 1 2 0 1 1
	South of Skaw Taing	3 2 3 2 1 2 3 2 2 3 2 3 2 2 2 2 2 2 1 2 2 2 1 1 1 3 3 3 3 3 3 3 2 3 2 2 2 1 3 2
	Jetty 3	3 3 2 0 0 0 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0
	Mavis Grind (Stream 3)	0 0 1 1 0 0 2 2 2 2 1 0 0 1 1 2 1 1 1 2 1 2 2 2 2 2 1 0 0 0 0 0 1 1 1 1
	Fugla Ayre	1 1 1 0 0 1 1 1 1 1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	South of Jetty 2	1 1 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 1 0
	Scatsta Ness (cleared)	2 2 0 3 3 3 2 3 3 3 2 1 1 1 1 1 2 2 2 2 2 2 2 3 2 4 3 2 2 1 2 2 3 1 4 3 4
	Scatsta Ness (uncleared)	2 0 0 1 0 0 Riven 1 2 2 2 0 0 0 0 0 0 0 0 0 0 0 0 1 1 1 2 1 1 1 2 1 1 2 3 0 1 1
Reference	Noust	3 3 4 3 4 4 4 3 4 4 4 4 4 4 3 4 4 2 4 3 3 3 4 3 3 3
	Vidlin Ness	2 3 3 3 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 1
	Burgo Taing	2 3 3 3 3 3 3 3 3 3 3 3 2 3 3 3 3 3 2 3 3 3 3 3 3
	Kirkabister	2 3 0 1 0 0 0 0 1 0 0 0 0 0 0 1 1 2 2 1 1 0 1 2 1 1 1 0 2
	North Burra Voe	2 2 2 1 2 2 2 1 2 1 2 2 2 2 3 3 3 3 2 2 3 1 3 2 3

No dogwhelks were found on either of the SV terminal jetty transects (5.2 or 6.2), but large numbers of adult, juveniles and eggs were found in a pile of large boulders (the boulder tumble) between Jetty 3 and Jetty 4 – which has been searched annually since 2004. Like Vidlin Ness, dogwhelks had been common on the Jetty 3 transect in the 1970s and early 1980s, but tributyltin (TBT) contamination from antifouling paints caused a collapse of all dogwhelk populations in the vicinity of the terminal. Recovery to levels similar to those recorded in pre-TBT surveys has been shown at transect sites close to the terminal (e.g. The Kames (4.3)) and it is hoped that this will also occur at the Jetty transect sites. The population in the boulder tumble has increased dramatically since the first individuals were found there in 2012. However, substrata on the Jetty transects are likely less stable and more scoured than they were before the terminal construction, so the habitat may be less favourable for dogwhelks.

3.1.10 Flustrellidra hispida & Alcyonidium spp.

There were no notable fluctuations in epiphytic bryozoa, growing on serrated wrack and other lower shore algae, at either the Sullom Voe or Reference sites.



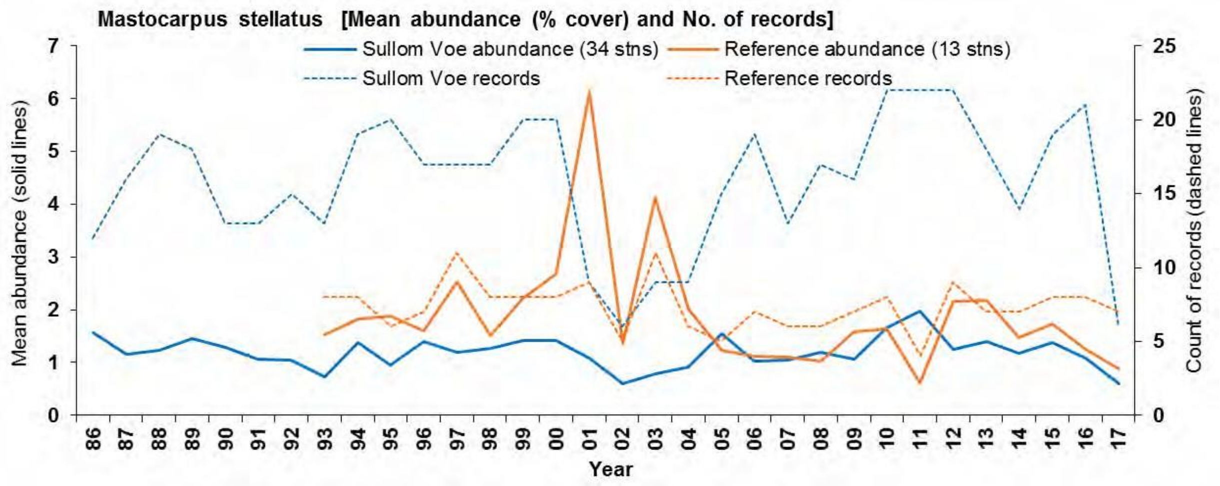
Flustrellidra hispida is the most abundant and frequently recorded species at the transect sites, but *Alcyonidium hirsutum* and *A. gelatinosum* are often present. Selected data for *Alcyonidium hirsutum* are tabulated below.

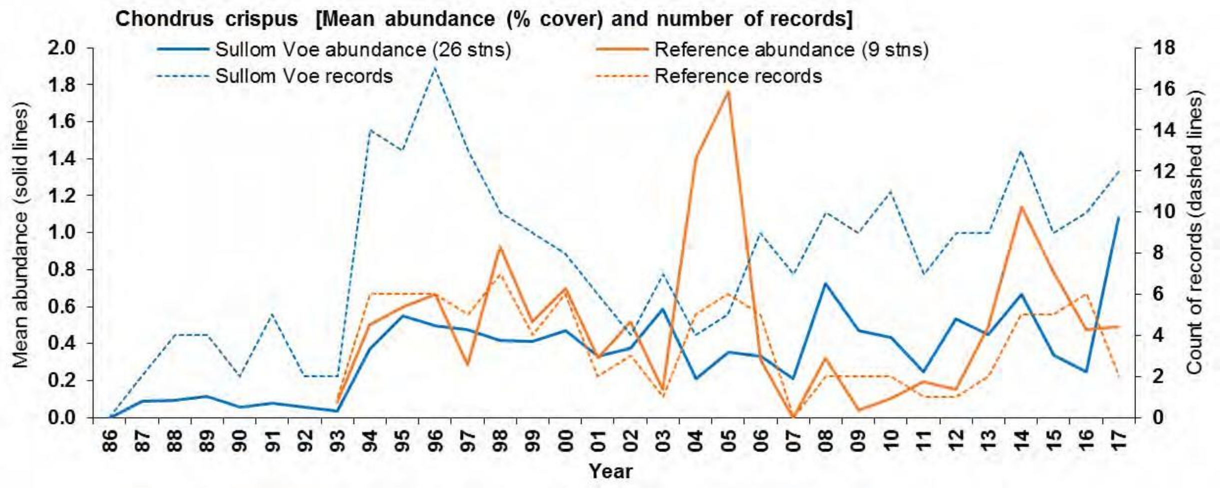
Alcyonidium hirsutum (abundance in lower shore stations, by year at selected sites)

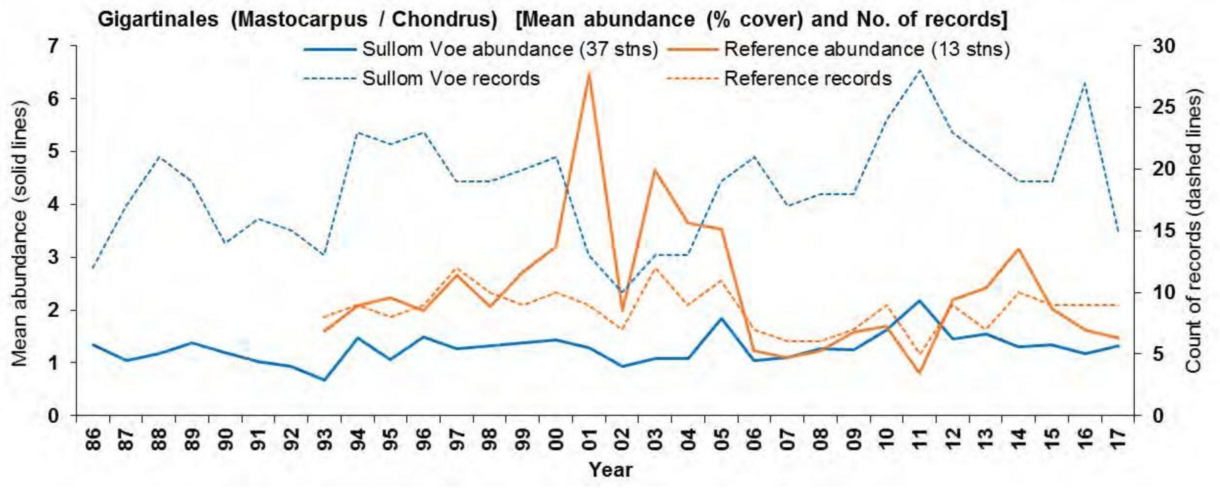
		93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
Sullom Voe	Noust of Burraland	0 0 0 0 0 0 0 0 0 0 0 South 2 2 0 0 3 2 0 0 0 0 0 2 0 0
	of Swarta Taing	0 3 0 0 0 1 1 2 0 0 0 2 2 3 0 0 2 0 2 2 2 2 2 2 0
	The Kames	0 0 0 0 0 0 0 0 0 0 2 0 2 0 2 0 0 0 0 0 2 2 2 2 2
	South of Skaw Taing	0 2 0 0 0 1 1 0 0 0 1 1 2 2 2 0 0 2 0 0 1 2 2 1 0
	Jetty 3	0 0 2 0 0 0 0 0 0 2 0 0 0 0 0 0 0 2 0 0 2 0 0 2
	Fugla Ayre	1 3 2 3 2 0 1 0 0 3 2 0 2 2 0 2 3 3 2 2 3 2 3 0 0
Reference	Riven Noust	0 0 0 0 2 0 0 0 0 0 0 0 0 2 2 2 2 0 0 0 2 0 0 1 0
	Vidlin Ness	0 0 2 2 2 0 2 4 2 4 4 3 3 2 2 2 3 3 3 3 2 0 0 0 2
	Burgo Taing	0 0 0 2 0 1 1 0 0 0 0 0 2 0 0 0 0 0 0 0 0 0 0 2 0
	Kirkabister	3 2 0 4 2 3 1 3 3 5 3 4 4 3 0 2 5 3 2 2 0 2 0 3 3
	North Burra Voe	0 0 0 0 0 2 0 0 0 0 0 0 2 0 0 0 1 0 0 2 0 2 0 0 0

3.1.11 Mastocarpus stellatus and Chondrus crispus

The red algae False Irish Moss (*Mastocarpus stellatus*) and Carrageen (*Chondrus crispus*) are both common on rocky shores in Shetland. *M. stellatus* is usually recorded in higher abundance and in more stations at the transect sites, but distinguishing it from *C. crispus* is not always easy, particularly with young plants. Large fluctuations in recorded abundance are not uncommon and have sometimes coincided with changes in the algal surveyor. Some fluctuations may have been partly caused by misidentifications between the two species, but detailed inspection of records have rarely highlighted possible errors. The graph below shows that a particularly large decrease in mean abundance and numbers of records of *M. stellatus* occurred between 2016 and 2017, while the second graph shows increases of *C. crispus*, but only at Sullom Voe sites. It is possible that some of that change may have been due to the change in algal surveyor and inspection of the data and photographs does indicate stations where there has been a notable loss of *M. stellatus* and equivalent rise of *C. crispus*. Aggregating the data from the two species (see third graph) suggests that there was little change in the average abundance in Sullom Voe, though there was a large decline in the number of Sullom Voe records.

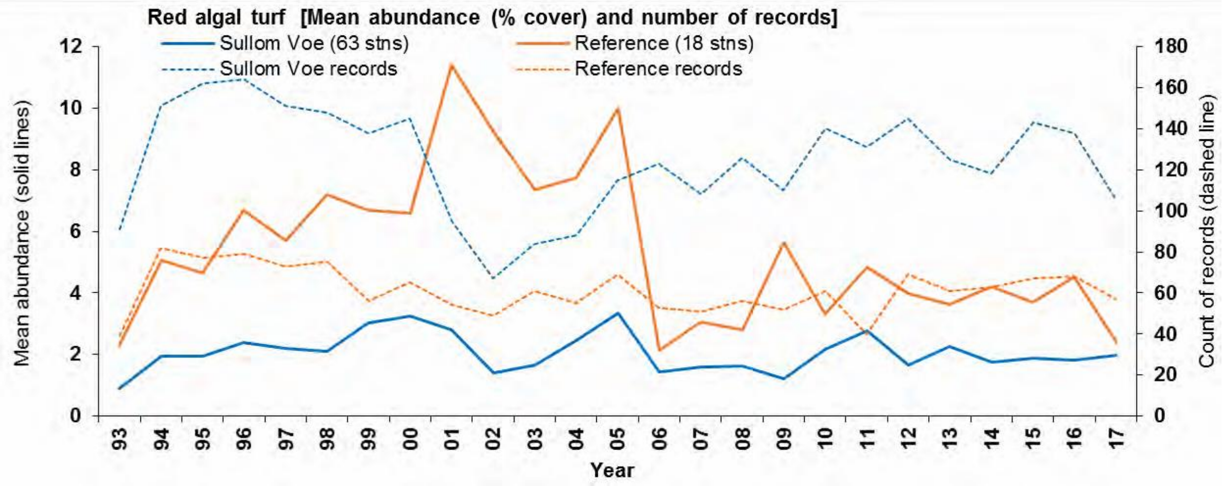


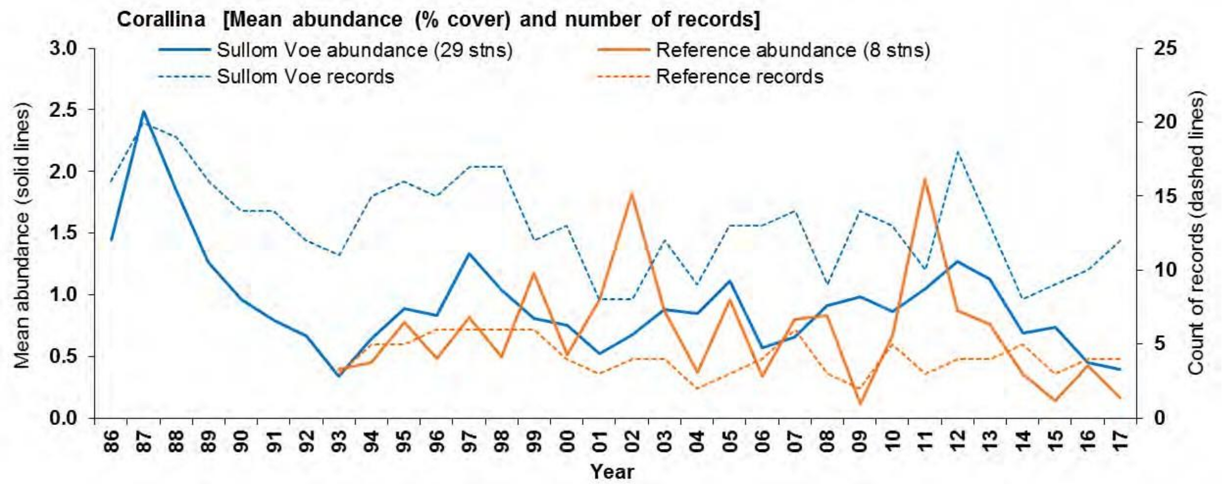




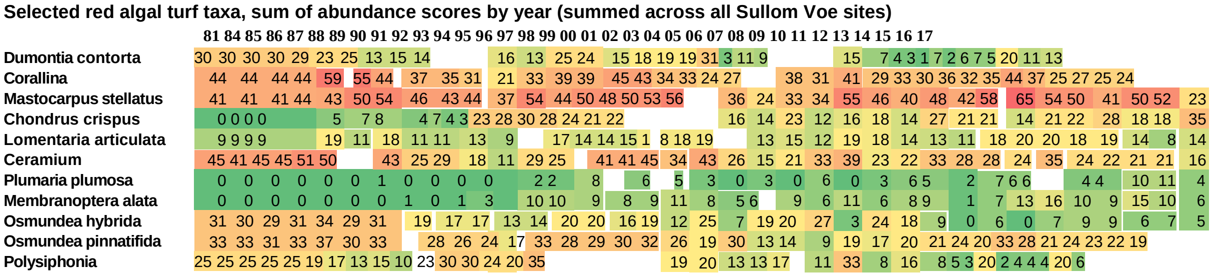
3.1.12 Other red algae

Approximately 20 individual species of red algae are regularly recorded from the transect sites each year; including *M. stellatus* and *C. crispus*. Aggregated data across all species is shown in the graph below, which suggests a decline in average abundance at the Reference sites but very little change at the Sullom Voe sites. However, this masks some notable fluctuations in individual species, including a reduction in abundance of Corallina over the last five years.





The following table highlights fluctuations in the most frequently recorded red algal species. The values are sums of the categorical abundance scores and are only presented as a means to illustrate the major trends. Some species, like the Osmundeas have been showing low abundances in recent years, while others, like Dumontia, have seen an increase.

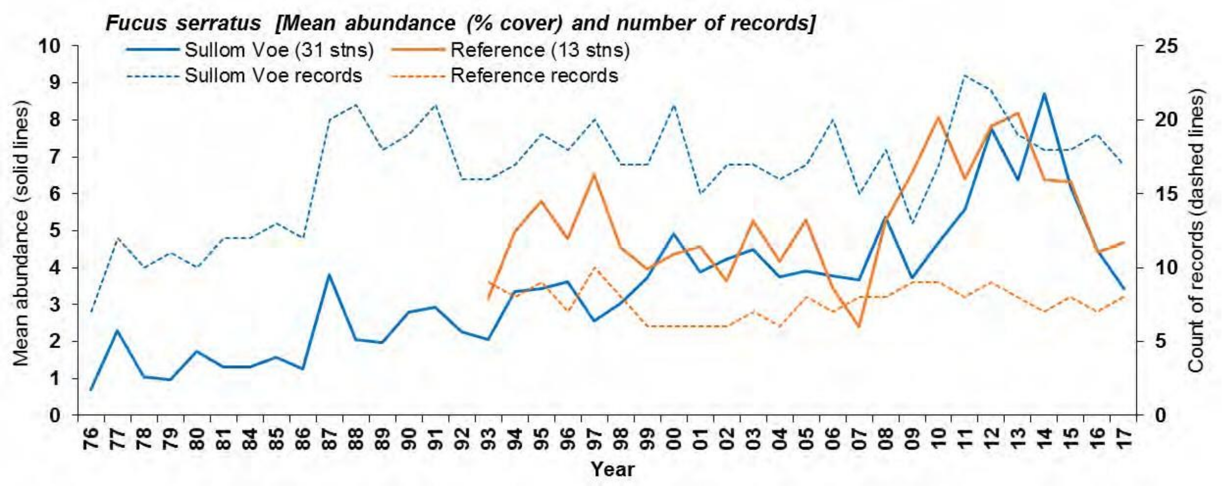


Selected red algal turf taxa, sum of abundance scores by year (summed across all Sullom Voe sites)

	81	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
Dumontia contorta	30	30	30	30	29	23	25	13	15	14	16	13	25	24	15	18	19	19	31	3	11	9	15	7	4	3	1	7	2	6	7	5	20	11	13
Corallina	44	44	44	44	59	55	44	37	35	31	21	33	39	39	45	43	34	33	24	27	38	31	41	29	33	30	36	32	35	44	37	25	27	25	24
Mastocarpus stellatus	41	41	41	44	43	50	54	46	43	44	37	54	44	50	48	50	53	56	36	24	33	34	55	46	40	48	42	58	65	54	50	41	50	52	23
Chondrus crispus	0	0	0	0	5	7	8	4	7	4	3	23	28	30	28	24	21	22	16	14	23	12	16	18	14	27	21	21	14	21	22	28	18	18	35
Lomentaria articulata	9	9	9	9	19	11	18	11	11	13	9	17	14	14	15	1	8	18	19	13	15	12	19	18	14	13	11	18	20	20	18	19	14	8	14
Ceramium	45	41	45	45	51	50	43	25	29	18	11	29	25	41	41	45	34	43	26	15	21	33	39	23	22	33	28	28	24	35	24	22	21	21	16
Plumaria plumosa	0	0	0	0	0	0	1	0	0	0	0	2	2	8	6	5	3	0	3	0	6	0	3	6	5	2	7	6	6		4	4	10	11	4
Membranoptera alata	0	0	0	0	0	0	0	1	0	1	3	10	10	9	8	9	11	8	5	6	9	6	11	6	8	9	1	7	13	16	10	9	15	10	6
Osmundea hybrida	31	30	29	31	34	29	31	19	17	17	13	14	20	20	16	19	12	25	7	19	20	27	3	24	18	9	0	6	0	7	9	9	6	7	5
Osmundea pinnatifida	33	33	31	33	37	30	33	28	26	24	17	33	28	29	30	32	26	19	30	13	14	9	19	17	20	21	24	20	33	28	21	24	23	22	19
Polysiphonia	25	25	25	25	25	19	17	13	15	10	23	30	30	24	20	35	19	20	13	13	17	11	33	8	16	8	5	3	20	2	4	4	4	20	6

3.1.13 Fucus serratus

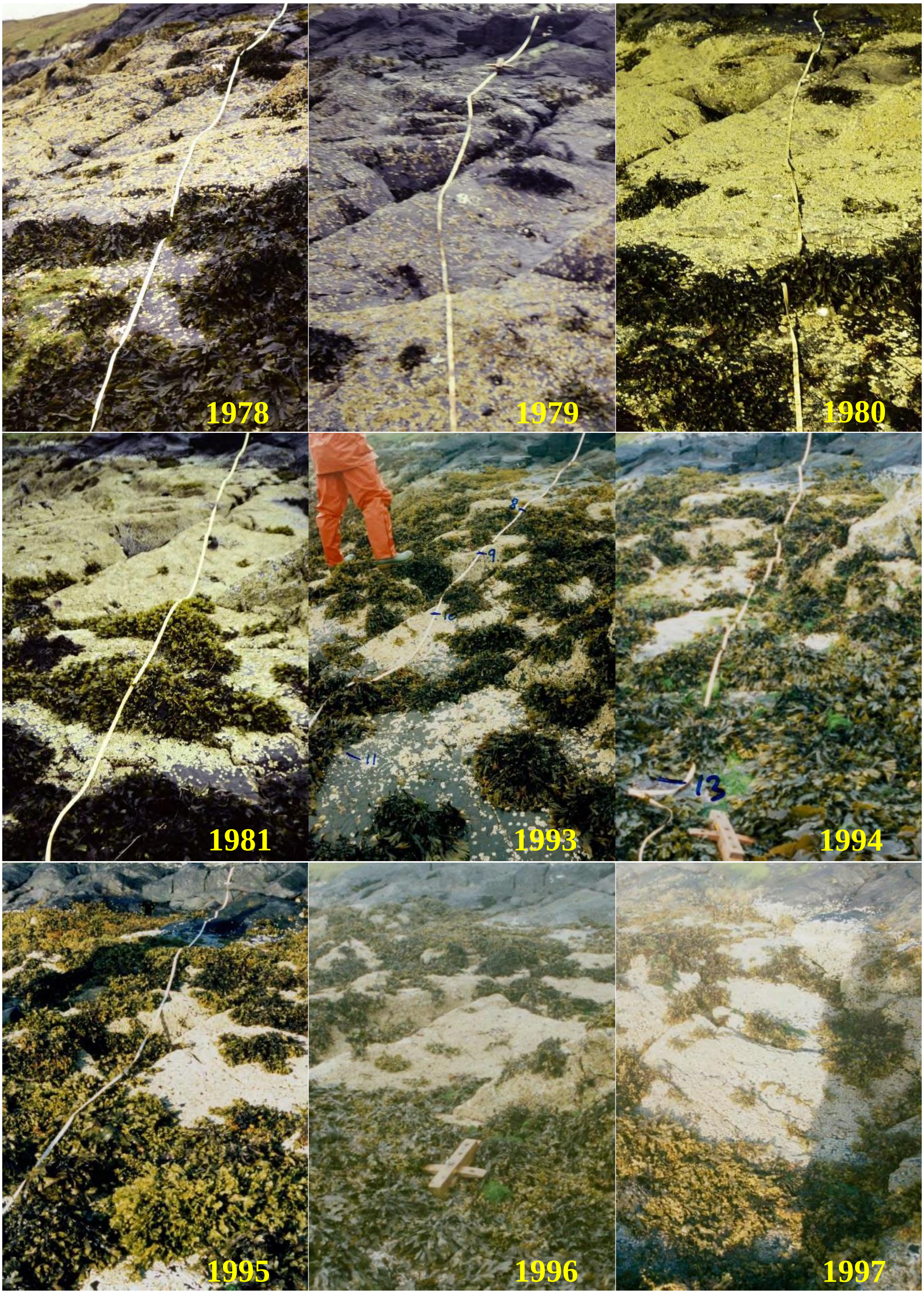
Average abundance of serrated wrack on lower shores continued to decline at Sullom Voe sites but levelled off at Reference sites. The distribution of increases and decreases shows no obvious geographic trends. However, percentage covers remain higher than recorded in the early years of the programme.



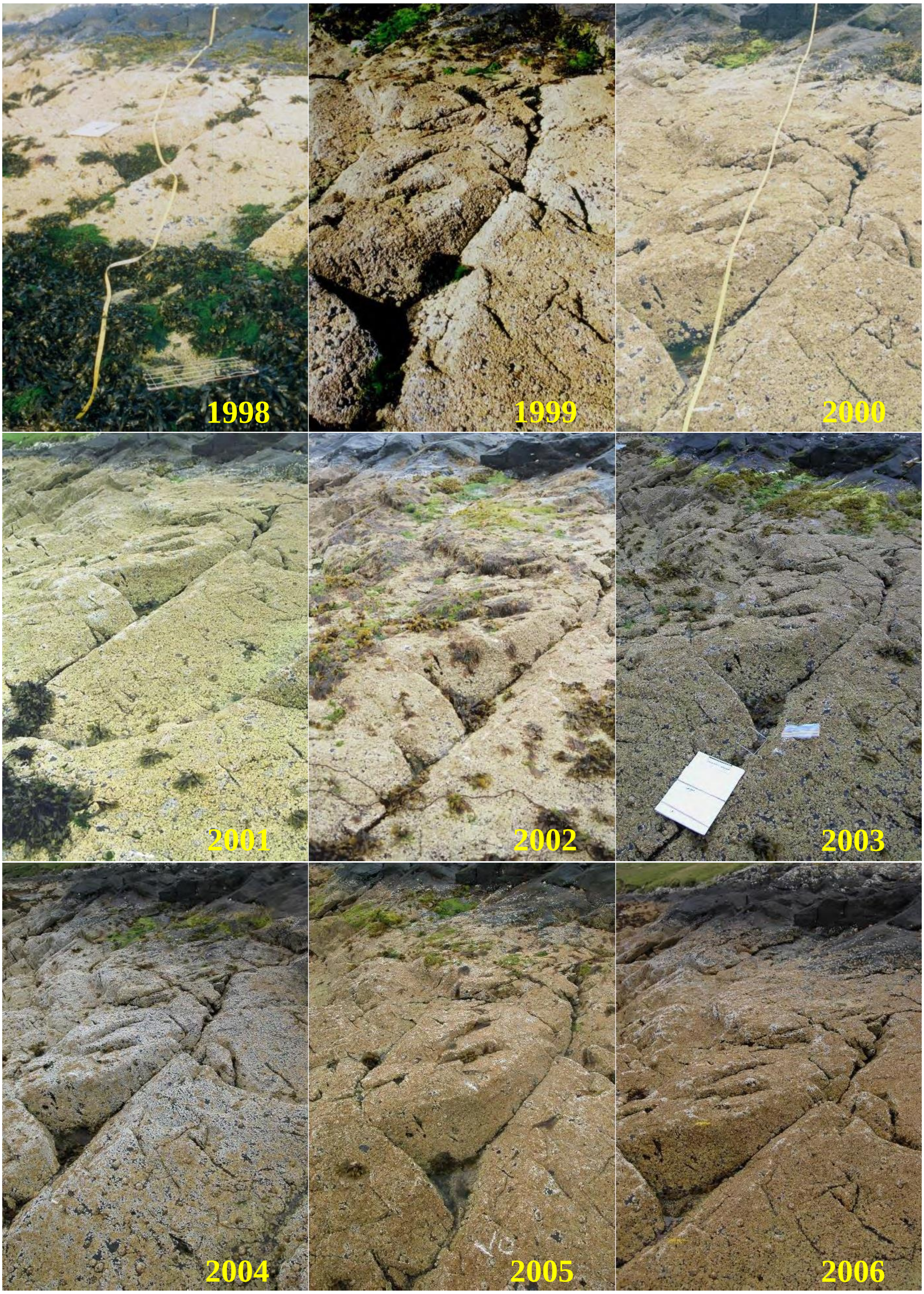
3.1.14 Fucus vesiculosus and Fucus spiralis

There was little change in the average abundance of bladder wrack at the Sullom Voe sites and it remained at fairly high levels compared to earlier years; but there was a further notable decrease in average abundance at the Reference sites. Inspection of the data shows that the latter is due to reduced abundances and apparently reduced vertical range at four of the Reference sites over a period of five to seven years.

These changes are clearly visible in the site photographs. An example series of photographs, on the next three pages, were taken at Vidlin Ness (3.8) from 1978 to 2017. The more recent photographs show a dramatic dense recruitment of *Fucus vesiculosus* in 2009 and 2010, followed by a gradual reduction. The earlier photographs show that there had been similar recruitment in 1993 and 1994, followed by a gradual return to the barnacle / limpet domination that persisted through the first decade of the 2000s.



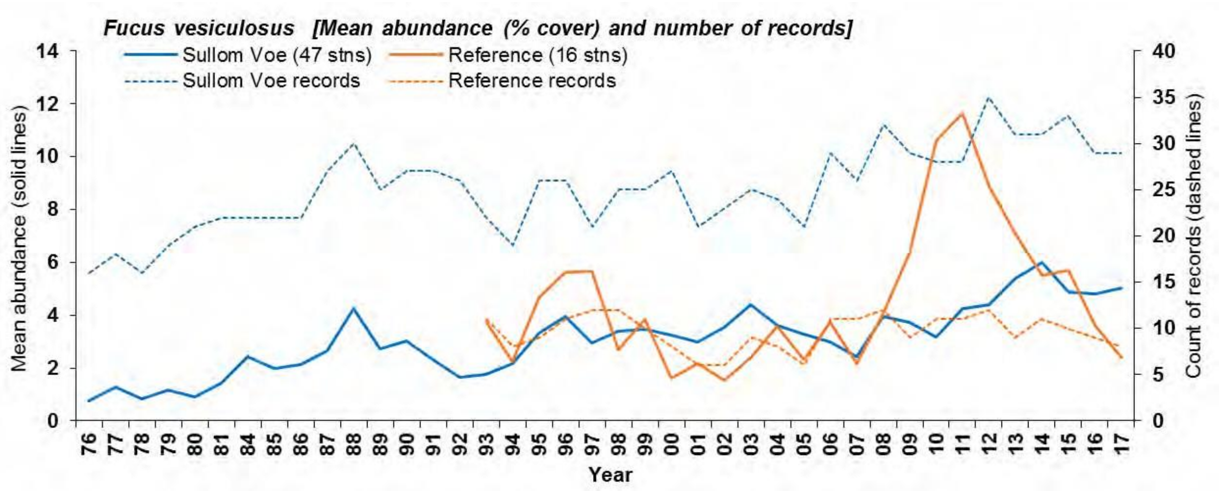
Vidlin Ness – view up transect, 1978 to 2017



Vidlin Ness – view up transect, 1978 to 2017 cont.

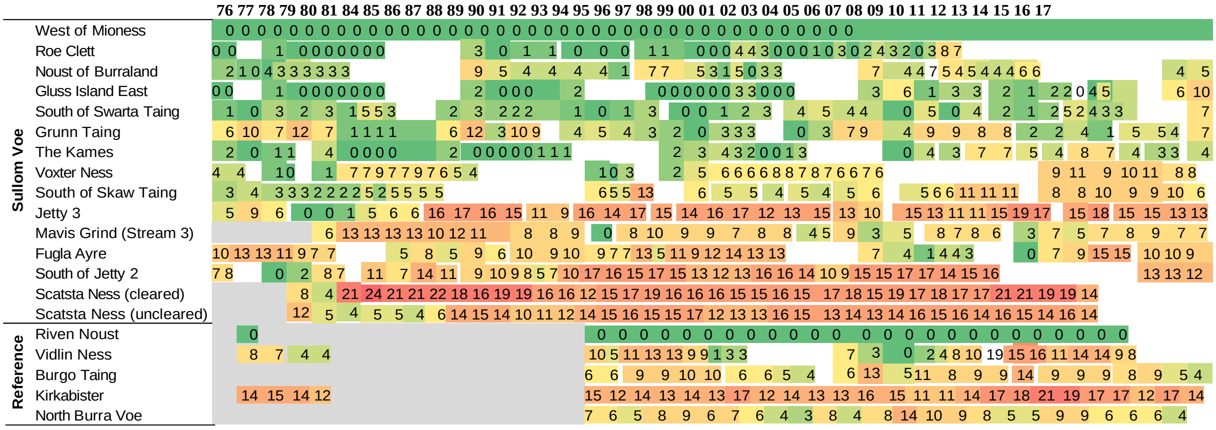
Vidlin Ness – view up transect, 1978 to 2017 cont.

Vidlin Ness – view up transect, 1978 to 2017 cont.



The graph above shows, for the Sullom Voe sites, a gradual trend of increasing average abundance and increasing numbers of records. This is also shown in the table below, where the trend of increasing abundances is most apparent in the colour shifts (from green to yellow and orange) in rows representing the more exposed sites – Jetty 3 and above.

Fucus vesiculosus (sum of abundance scores from five stations, by site and year)

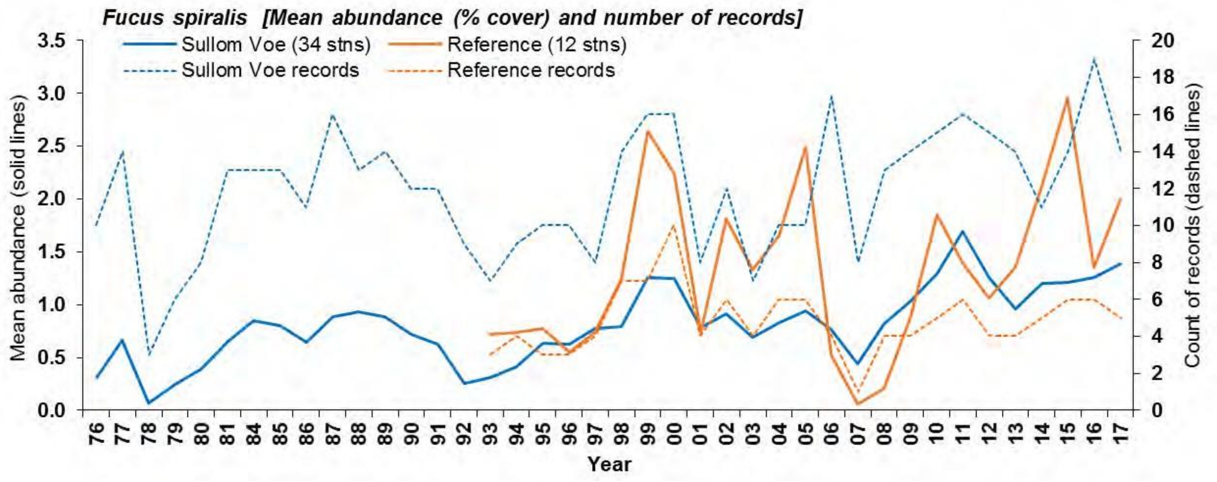


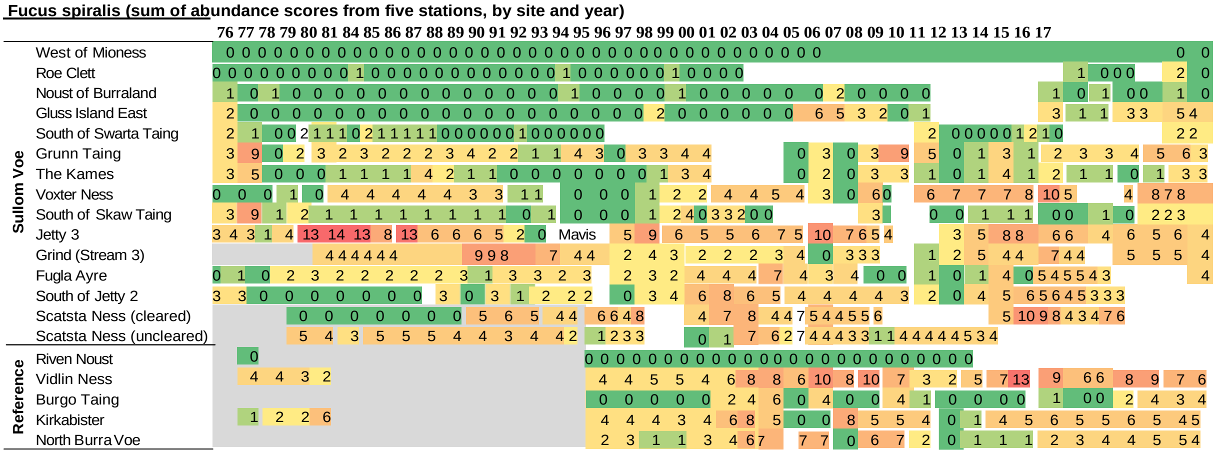
		76 77 78 79 80 81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17
Sullom Voe	West of Mioness	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Roe Clett	0 0 1 0 0 0 0 0 0 0 3 0 1 1 0 0 0 1 1 0 0 0 4 4 3 0 0 0 1 0 3 0 2 4 3 2 0 3 8 7
	Noust of Burraland	2 1 0 4 3 3 3 3 3 3 9 5 4 4 4 4 1 7 7 5 3 1 5 0 3 3 7 4 4 7 5 4 5 4 4 4 6 6 4 5
	Gluss Island East	0 0 1 0 0 0 0 0 0 0 2 0 0 0 2 0 0 0 0 0 0 3 3 0 0 0 3 6 1 3 3 2 1 2 2 0 4 5 6 10
	South of Swarta Taing	1 0 3 2 3 1 5 5 3 2 3 2 2 2 1 0 1 3 0 0 1 2 3 4 5 4 4 0 5 0 4 2 1 2 5 2 4 3 3 7
	Grunn Taing	6 10 7 12 7 1 1 1 1 6 12 3 10 9 4 5 4 3 2 0 3 3 3 0 3 7 9 4 9 9 8 8 2 2 4 1 5 5 4 7
	The Kames	2 0 1 1 4 0 0 0 0 2 0 0 0 0 0 1 1 1 2 3 4 3 2 0 0 1 3 0 4 3 7 7 5 4 8 7 4 3 3 4
	Voxter Ness	4 4 1 0 1 7 7 9 7 7 9 7 6 5 4 1 0 3 2 5 6 6 6 6 8 8 7 8 7 6 6 7 6 9 11 9 10 11 8 8
	South of Skaw Taing	3 4 3 3 3 2 2 2 2 5 2 5 5 5 5 6 5 5 13 6 5 5 4 5 4 5 6 5 6 6 11 11 11 8 8 10 9 9 10 6
	Jetty 3	5 9 6 0 0 1 5 6 6 16 17 16 15 11 9 16 14 17 15 14 16 17 12 13 15 13 10 15 13 11 11 15 19 17 15 18 15 15 13 13
	Mavis Grind (Stream 3)	6 13 13 13 13 10 12 11 8 8 9 0 8 10 9 9 7 8 8 4 5 9 3 5 8 7 8 6 3 7 5 7 8 9 7 7
	Fugla Ayre	10 13 13 11 9 7 7 5 8 5 9 6 10 9 10 9 7 7 13 5 11 9 12 14 13 13 7 4 1 4 4 3 0 7 9 15 15 10 10 9
	South of Jetty 2	7 8 0 2 8 7 11 7 14 11 9 10 9 8 5 7 10 17 16 15 17 15 13 12 13 16 16 14 10 9 15 15 17 17 14 15 16 13 13 12
	Scatsta Ness (cleared)	8 4 21 24 21 21 22 18 16 19 19 16 16 12 15 17 19 16 16 16 15 15 16 15 17 18 15 19 17 18 17 17 21 21 19 19 14
	Scatsta Ness (uncleared)	12 5 4 5 5 4 6 14 15 14 10 11 12 14 15 16 15 15 17 12 13 13 16 15 13 14 13 14 16 15 16 14 16 15 14 16 14
Reference	Riven Noust	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Vidlin Ness	8 7 4 4 10 5 11 13 13 9 9 1 3 3 7 3 0 2 4 8 10 19 15 16 11 14 14 9 8
	Burgo Taing	6 6 9 9 10 10 6 6 5 4 6 13 5 11 8 9 9 14 9 9 9 8 9 5 4
	Kirkabister	14 15 14 12 15 12 14 13 14 13 17 12 14 13 13 16 15 11 11 14 17 18 21 19 17 17 12 17 14
	North Burra Voe	7 6 5 8 9 6 7 6 4 3 8 4 8 14 10 9 8 5 5 9 9 6 6 6 4

Some large fluctuations in the abundances of spiral wrack *Fucus spiralis* have also been recorded over the course of the programme, but do not appear to correlate with those of *F. vesiculosus*. However, like

F. vesiculosus, average abundances have been relatively high in recent years, but there was a slight decrease across Sullom Voe and Reference sites in 2017, following the notable increase in 2016. As described in the last report (Moore and Mercer 2016), it is possible that some of the *F. spiralis* fluctuations are due to confused identifications with *F. vesiculosus*, particularly in young plants. The two species often overlap on the upper mid shore and are also known to hybridise. Likely instances of identity confusion are present between a few of the 2016 and 2017 records, but do not make much difference to the apparent trends in *F. spiralis* average abundance. It is unlikely that these confusions would make any notable effect on the *F. vesiculosus* trends because the overlap between the two fucoids constitutes a relatively small proportion of the *F. vesiculosus* records.

To improve future consistency of recording, a short guide and protocol for identifying the upper mid shore fucoids will be prepared in advance of the 2018 survey. This guide will also include notes on *Fucus guiryi*, a recently described species that has been recorded elsewhere in UK. Shetland may be too far north for the current geographic range of the new species, but specimens showing some characteristics of *F. guiryi* were collected from two sites (Orka Voe bund and Mavis Grind) and have been sent to a specialist for identification.





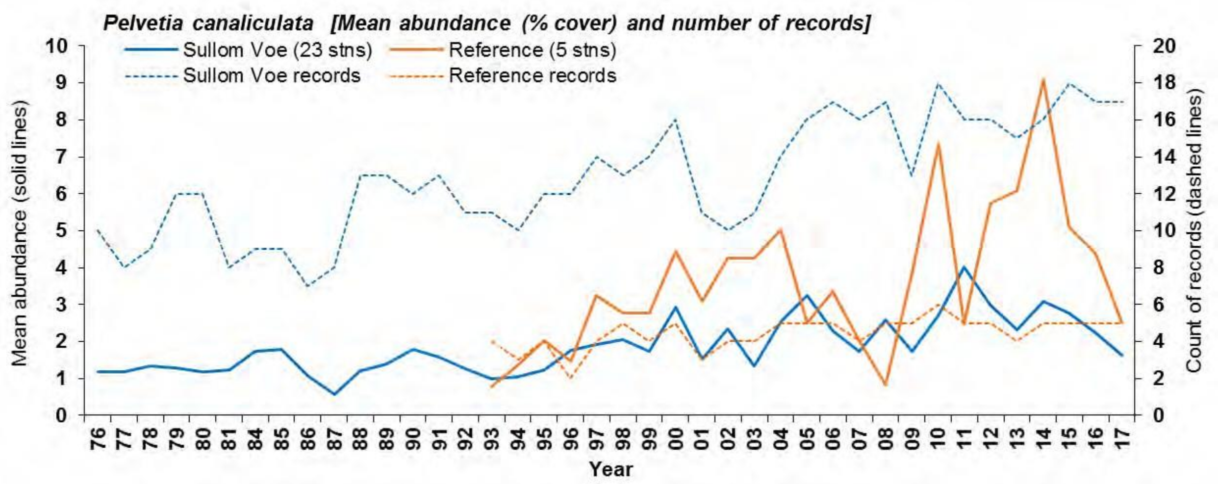
Fucus spiralis (sum of abundance scores from five stations, by site and year)

76 77 78 79 80 81 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 00 01 02 03 04 05 06 07 08 09 10 11 12 13 14 15 16 17

Sullom Voe	West of Mioness	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Roe Clett	0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 2 0
	Noust of Burraland	1 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 1 0 0 0 0 0 0 2 0 0 0 0 1 0 1 0 0 1 0
	Gluss Island East	2 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 2 0 0 0 0 0 0 6 5 3 2 0 1 3 1 1 3 3 5 4
	South of Swarta Taing	2 1 0 0 2 1 1 1 0 2 1 1 1 1 1 0 0 0 0 0 0 1 0 0 0 0 0 0 2 0 0 0 0 0 1 2 1 0 2 2
	Grunn Taing	3 9 0 2 3 2 3 2 2 2 3 4 2 2 1 1 4 3 0 3 3 4 4 0 3 0 3 9 5 0 1 3 1 2 3 3 4 5 6 3
	The Kames	3 5 0 0 0 1 1 1 1 4 2 1 1 0 0 0 0 0 0 0 1 3 4 0 2 0 3 3 1 0 1 4 1 2 1 1 0 1 3 3
	Voxter Ness	0 0 0 1 0 4 4 4 4 4 3 3 1 1 0 0 0 1 2 2 4 4 5 4 3 0 6 0 6 7 7 7 8 10 5 4 8 7 8
	South of Skaw Taing	3 9 1 2 1 1 1 1 1 1 1 1 0 1 0 0 0 1 2 4 0 3 3 2 0 0 3 0 0 1 1 1 0 0 1 0 2 2 3
	Jetty 3	3 4 3 1 4 13 14 13 8 13 6 6 6 5 2 0 Mavis 5 9 6 5 5 6 7 5 10 7 6 5 4 3 5 8 8 6 6 4 6 5 6 4
	Grind (Stream 3)	4 4 4 4 4 4 9 9 8 7 4 4 2 4 3 2 2 2 3 4 0 3 3 3 1 2 5 4 4 7 4 4 5 5 5 4
	Fugla Ayre	0 1 0 2 3 2 2 2 2 2 3 1 3 3 2 3 2 3 2 4 4 4 7 4 3 4 0 0 1 0 1 4 0 5 4 5 5 4 3 4
	South of Jetty 2	3 3 0 0 0 0 0 0 0 3 0 3 1 2 2 2 0 3 4 6 8 6 5 4 4 4 4 3 2 0 4 5 6 5 6 4 5 3 3 3
	Scatsta Ness (cleared)	0 0 0 0 0 0 0 5 6 5 4 4 6 6 4 8 4 7 8 4 4 7 5 4 4 5 5 6 5 10 9 8 4 3 4 7 6
	Scatsta Ness (uncleared)	5 4 3 5 5 5 4 4 3 4 4 2 1 2 3 3 0 1 7 6 2 7 4 4 4 3 3 1 1 4 4 4 4 4 5 3 4
Reference	Riven Noust	0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
	Vidlin Ness	4 4 3 2 4 4 5 5 4 6 8 8 6 10 8 10 7 3 2 5 7 13 9 6 6 8 9 7 6
	Burgo Taing	0 0 0 0 0 2 4 6 0 4 0 0 4 1 0 0 0 0 1 0 0 2 4 3 4
	Kirkabister	1 2 2 6 4 4 4 3 4 6 8 5 0 0 8 5 5 4 0 1 4 5 6 5 5 6 5 4 5
	North Burra Voe	2 3 1 1 3 4 6 7 7 7 0 6 7 2 0 1 1 1 2 3 4 4 5 5 4

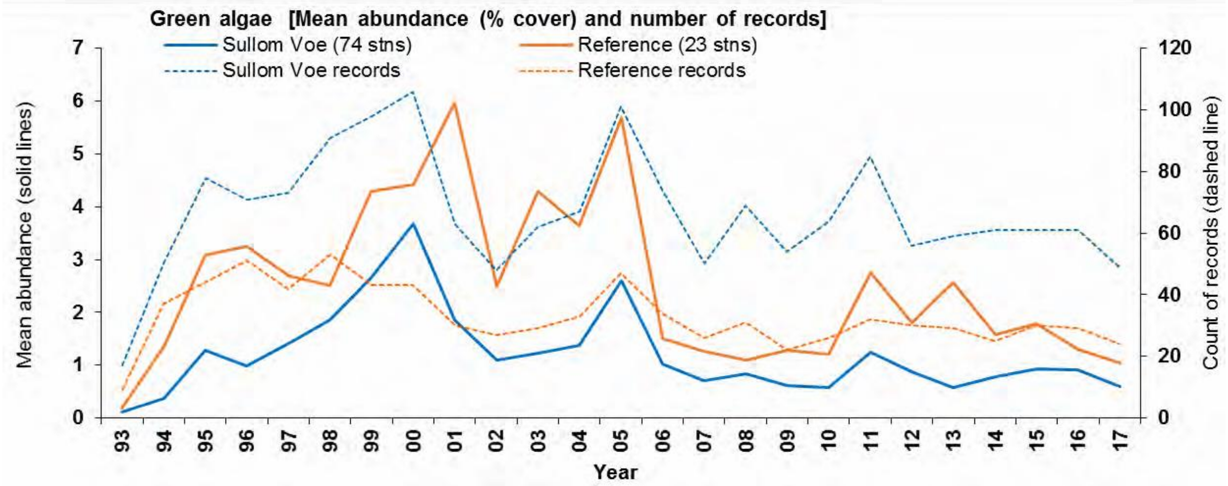
3.1.15 Pelvetia canaliculata

Numbers of records and mean abundance of channelled wrack, which lives in the upper intertidal, have increased over the course of the monitoring programme. However, the graph below shows a notable reduction in average abundance over the last three years. Inspection of the photographs clearly shows the reduced abundances at some sites, like Mavis Grind. The high abundance in 2014 is emphasised in the photographs by the lush plants after a period of damp weather, compared to the dried up plants present in 2017.



3.1.16 Green algae

Green algae, comprising *Ulva* (tubular and flat forms), *Cladophora*, *Codium* and various other taxa, were again present in relatively low abundances compared to some previous years.



3.2 Site-specific descriptions

3.2.1 South of Jetty 2

As described in the previous report (Moore & Mercer 2016), remediation of the backshore between Jetty 1 and Jetty 2 included movement of boulders from the rocky shore transect monitoring site (*South of Jetty 2, site 6.2*). This altered the topography and substrata of upper and midshore sections of the transect which resulted in some reduced abundances of fucoid algae.

The 2017 data and photographs show that there has been some movement of boulders and smaller substrata since the 2016 survey, but probably only due to wave action and resettlement of the shore substrata. The loss of upper mid shore fucoid cover, particularly *A. nodosum*, is still very apparent and it is unlikely to return without some larger stabilizing boulders.

		93	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17
Pelvetia canaliculata	**A**													2	1	1	2	1	3	2	1	4	2	1		2
	B	1		3	4	2	3	2	3	4	4	3	3	3	3	2		2	4	4	4	3	3		1	1
Fucus spiralis	**B**			3	4	6	6	6	5	4	4	4	4	3	2		4	5	5	5	6	4	5	3	3	3
Fucus vesiculosus	**C**			4	6	5	5	5	4	4	4	5	6	5	4	1	4	5	5	6	5	6	5	4	4	3
	D	4	5	7	6	6	7	6	4	4	5	6	5	5	4	3	6	5	7	6	4	5	6	4	5	5
	E	3	5	6	4	4	5	4	5	4	4	5	5	4	2	5	5	5	5	5	4	4	5	4	4	4
Ascophyllum nodosum	**C**	2							2	4	4	4	4	4	2	2	4	1	4	4	4	5	5	4		
	D	2											4	3	1					2		4	4	3	3	2
Fucus serratus	**D**	1	1		1	2		2	4	4	3	3			2	2	4	4	4	4	2		4	3		
	E	2	3	4	5	5	4	5	5	5	5	5	4	5	4	5	6	6	6	6	6	5	5	5	5	5

3.2.2 Orka Voe bund

The bund, created when Orka Voe was filled in during the construction of the terminal in the late 1970s, is visited during the annual survey for a brief assessment of the condition of the rocky shore communities present. Attention is paid to the area of disturbance caused by the installation of the Magnus EOR pipeline in 2004/2005.

There were no notable changes in habitat or communities along the bund compared to recent years.

3.2.3 Additional reference sites

The five additional reference sites were established and surveyed successfully. Selected photos and tabulated data are given in Appendix 3. Three of the sites are new and their data are not discussed further in this report. Ola's Ness and Croo Taing were originally established in 1977 and 1976 respectively. The transect stations were not relocated precisely, but have been assigned as best possible to the originals. Some comparisons between the 2017 data and those from the earlier surveys are given below:

Ola's Ness (site 3-10)

Comparisons between 1977 and 2017 show very high similarity. The few differences include:

- *Prasiola* was Frequent in the upper shore station in 2017, but not recorded in 1977.
- Filamentous green algae were Common across the midshore in 1977, but no more than Occasional in 2017.
- Littorina saxatilis were more abundant in 1977 (Common to Extremely abundant, compared to Occasional to Common in 2017).
- Littorina littorea were Frequent across the midshore in 1977, but not recorded in 2017
- Fucus vesiculosus was Common in the bottom two stations in 2017, but no more than Occasional in 1977.

Croo Taing (site 6-3)

Comparisons between 1976 / 1977 and 2017 show very high similarity, and there were as many differences between the two earlier years as there were with 2017. The few differences include:

- *Semibalanus balanoides* was Common across the midshore in 2017, but no more than Rare in 1976 & 1977.
- *Fucus vesiculosus* was more abundant on the upper mid shore in 2017.

4 Discussion

4.1 Changes in rocky shore communities

There were few notable changes in rocky shore communities around Sullom Voe between 2016 and 2017. The fluctuations described in the results sections are all considered to be natural and mostly within typical levels for those shores and the survey methodology. None of the recorded fluctuations are considered to be related to the terminal.

There was another change in algal surveyor in 2017 which resulted in some differences in recording. Very few notable differences have been identified, but a large reduction in numbers of records of Mastocarpus stellatus and an increase in Chondrus crispus has highlighted a potential inconsistency that warrants some attention. The known issue with recording of *Fucus spiralis* (spiral wrack) and *F. vesiculosus* (bladder wrack) is also being addressed with guidance notes and protocols for future surveys.

4.2 Effects of terminal operations and oil spills

During the period 1st July 2016 to 1st July 2017 there were no pollution incidents reported within Sullom Voe (Simon Skinner, pers. comm.).

As described in Section 3.2.1 and discussed in the 2016 report, the effects of the movement of boulders from rocky shore transect 6.2 (*South of Jetty 2*) is still very evident. However, the community has not deteriorated further and no ongoing impacts are expected.

Terminal activities during the past 12 months appear to have had no obvious impacts upon the rocky shore communities of Sullom Voe.

4.3 Additional Reference sites

The recommended (Jenkins 2015) increase to the suite of Reference sites was implemented in 2017. There are now ten Reference sites, which will provide improved statistical comparisons with changes at the Sullom Voe sites. The new sites should also provide better representation of the range of habitats present amongst the Sullom Voe sites. It will take a few years of surveys before the new sites provide sufficient data to become well integrated into the data analyses, but some comparisons will be achievable in 2018.

Comparison of 2017 data from the two re-established sites (Ola's Ness and Croo Taing) has shown a high level of similarity with the previous survey data, from 40 years ago.

4.4 Transect station levelling

Repeated levelling of monitoring stations was carried out successfully at many of the transects (see Appendix 2). The additional data improves the accuracy of the station height measurements, although in most cases the 2017 measurements were very similar to the 2016 measurements.

5 References

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Appendix 1 Abundance scales used for intertidal organisms

1. Live barnacles (except *B. perforatus*) (record adults, spat, cyprids separately); *Littorina neritoides; Littorina neglecta*

7	Ex	500 or more per 0.01 m^2, 5+ per cm^2
6	S	300-499 per 0.01 m^2, 3-4 cm^2
5	A	100-299 per 0.01 m^2, 1-2 per cm^2
4	C	10-99 per 0.01 m^2
3	F	1-9 per 0.01 m^2
2	O	1-99 per m^2
1	R	Less than 1 per m^2

2. *Balanus perforatus*

7	Ex	300 or more per 0.01 m^2
6	S	100-299 per 0.01 m^2
5	A	10-99 per 0.01 m^2
4	C	1-9 per 0.01 m^2
3	F	1-9 per 0.1 m^2
2	O	1-9 per m^2
1	R	Less than 1 per m^2

3. *Patella* spp. 10 mm+, *Littorina littorea* (juv. & adults), *Littorina mariae/obtusata* (adults), *Nucella lapillus* (juv., <3 mm).

7	Ex	20 or more per 0.1 m^2
6	S	10-19 per 0.1 m^2
5	A	5-9 per 0.1 m^2
4	C	1-4 per 0.1 m^2
3	F	5-9 per m^2
2	O	1-4 per m^2
1	R	Less than 1 per m^2

4. *Littorina 'saxatilis'*, *Patella* <10 mm, *Anurida maritima, Hyale nilssoni* and other amphipods, *Littorina mariae/obtusata* juv.

7	Ex	50 or more per 0.1 m^2
6	S	20-49 per 0.1 m^2
5	A	10-19 per 0.1 m^2
4	C	5-9 per 0.1 m^2
3	F	1-4 per 0.1 m^2
2	O	1-9 per m^2
1	R	Less than 1 per m^2

5. *Nucella lapillus* (>3 mm), *Gibbula* sp. *Monodonta lineata, Actinia equina, Idotea granulosa, Carcinus* (juv. & recent settlement), *Ligia oceanica*

7	Ex	10 or more per 0.1 m^2
6	S	5-9 per 0.1 m^2
5	A	1-4 per 0.1 m^2
4	C	5-9 per m^2, sometimes more
3	F	1-4 per m^2, locally sometimes more
2	O	Less than 1per m^2, locally sometimes more
1	R	Always less than 1 per m^2

6. *Mytilus edulis, Dendrodoa grossularia*

7	Ex	80% or more cover
6	S	50-79% cover
5	A	20-49% cover
4	C	5-19% cover
3	F	Small patches, 5%, 10+ small individuals per 0.1 m^2, 1 or more large per 0.1 m^2
2	O	1-9 small per 0.1 m^2 1-9 large per m^2; no patches except small in crevices
1	R	Less than 1 per m^2

7. *Pomatoceros* sp.

5 A 50 or more tubes per 0.01 m^2
4 C 1-49 tubes per 0.01 m^2
3 F 1-9 tubes per 0.1 m^2
2 O 1-9 tubes per m^2
1 R Less than 1 tube per m^2

8. Spirorbinidae

5	A	5 or more per cm^2 on appropriate substrata; more than 100 per 0.01 m^2 generally
4	C	Patches of 5 or more per cm^2; 1-100 per 0.01 m^2 generally
3	F	Widely scattered small groups; 1-9 per 0.1 m^2 generally
2	O	Widely scattered small groups; less than 1 per 0.1 m^2 generally
1	R	Less than 1 per m^2

9. Sponges, hydroids, Bryozoa

5	A	Present on 20% or more of suitable surfaces.
4	C	Present on 5-19% of suitable surfaces
3	F	Scattered patches; <5% cover
2	O	Small patch or single sprig in 0.1 m^2
1	R	Less than 1 patch over strip; 1 small patch or sprig per 0.1 m^2

10. Flowering plants, lichens, lithothamnia

7	Ex	More than 80% cover
6	S	50-79% cover
5	A	20-49% cover
4	C	1-19% cover
3	F	Large scattered patches
2	O	Widely scattered patches all small
1	R	Only 1 or 2 patches

11. Algae

7	Ex	More than 90% cover
6	S	60-89% cover 7
5	A	30-59% cover
4	C	5-29% cover
3	F	Less than 5% cover, zone still apparent
2	O	Scattered plants, zone indistinct
1	R	Only 1 or 2 plants

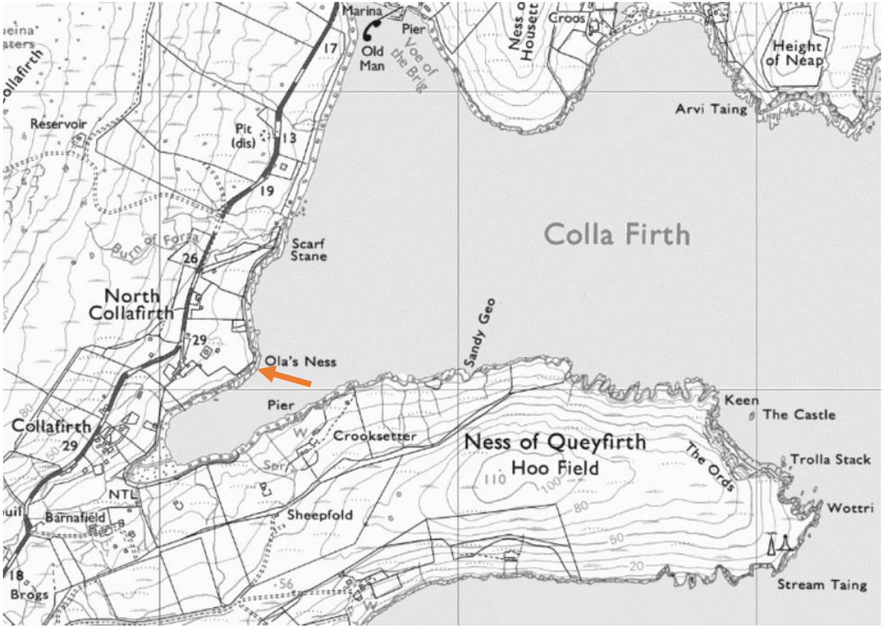
Other animal species:
record as percentage cover or approximate numbers within 0.01, 0.1 or 1 m^2

Appendix 2 Additional reference sites

Selected photographs and data from the five new reference sites established in July 2017.

ST3-10 Ola's Ness

Originally established and surveyed in May 1977, but not re-surveyed until 2017.



ST3-10 Ola's Ness	**Stations**				
	4	**7**	**9**	**11**	**13**
Coryne				O	R
Dynamena pumila				R	
Campanulariidae				O	R
Sagartia			C		
Spirorbinae					F
Acari (red)		O			
Cirripedia (spat)		F	A	A	C
Cirripedia (dead)		O	O	F	F
Semibalanus balanoides		C	A	A	A
Amphipoda		O	O	F	
Patella (juvenile, <10mm)				F	C
Patella vulgata		C	A	E	S
Littorina obtusata			O	C	F
Littorina saxatilis (neglecta)		O	F	F	O
Littorina saxatilis	O	C	O		
Nucella lapillus				F	
Mytilus edulis			O	O	F
Alcyonidium gelatinosum				O	
Rhodothamniella floridula					O
Palmaria palmata					R
Dumontia contorta					O
Hildenbrandia			O		
Corallinaceae (encrusting)				O	C
Corallina				R	O
Mastocarpus stellatus					R
Ceramium					R
Ceramium virgatum				R	
Osmundea hybrida				O	F
Osmundea pinnatifida					F
Polysiphonia					R
Rhodomela confervoides					R
Ectocarpaceae				R	R
Ralfsia					R
Elachista fucicola				C	O
Scytosiphon lomentaria					R
Laminaria (sporelings)					R
Fucus serratus					C
Fucus spiralis		A	F		
Fucus vesiculosus				A	C
Pelvetia canaliculata		O			
Ulva (tubular)			R		F
Ulva (flat)					R
Prasiola stipitata	F				
Cladophora				R	O
Fungi (Lichen: dark grey)	C				
Pyrenocollema halodytes		R	R	R	R
Caloplaca marina	O				
Tephromela atra var. atra	O				
Ramalina siliquosa	O				
Verrucaria maura	S	A			
Verrucaria mucosa		A	A	F	
Xanthoria parietina	R				

ST4-7 West Sandwick – new site, established July 2017

ST4-7 West Sandwick	**Stations**				
	1	**2**	**3**	**4**	**5**
Dynamena pumila					O
Actinia equina			O		O
Sagartia			F		
Spirorbinae					C
Acari (red)		F			
Cirripedia (spat)		F	C	C	O
Cirripedia (dead)		O	F	F	O
Semibalanus balanoides		C	A	A	F
Amphipoda	O				O
Idotea					O
Anurida maritima		O	O	O	
Patella vulgata	O	C	A	A	F
Littorina obtusata			A		O
Littorina saxatilis (ecotype neglecta)			O	F	
Littorina saxatilis	O	O		O	
Nucella lapillus				A	F
Mytilus edulis			O	O	
Anomiidae					O
Bryozoa (encrusting)					O
Rhodophyta (encrusting)					O
Rhodothamniella floridula					F
Hildenbrandia		O	O	O	
Corallinaceae (encrusting)			F		C
Membranoptera alata					R
Polysiphonia stricta					O
Ectocarpaceae					F
Spongonema tomentosum					O
Elachista fucicola			O	O	F
Fucaceae (sporelings)					O
Fucus serratus					S
Fucus vesiculosus			C	C	C
Pelvetia canaliculata	A				
Ulva (tubular)			F	F	F
Ulva (flat)					R
Acrosiphonia					R
Cladophora			R		
Cladophora rupestris			R		O
Pyrenocollema halodytes				O	
Verrucaria maura	S	F			
Verrucaria mucosa	C	A	C	F	

ST5-8 West Lunna Pund South – new site, established July 2017

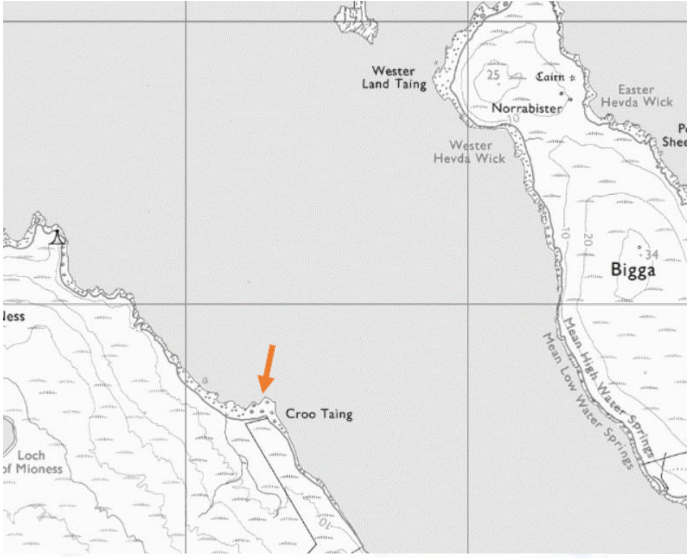
ST5-8 West Lunna Pund South	**Stations**				
	1	**2**	**3**	**4**	**5**
Leucosolenia					O
Coryne					R
Dynamena pumila				O	R
Campanulariidae					O
Actinia equina				O	
Spirorbinae					A
Cirripedia (spat)			C	C	F
Cirripedia (dead)			F	F	F
Semibalanus balanoides		O	C	C	C
Carcinus maenas				O	
Patella (juvenile, <10mm)			O	F	
Patella vulgata			S	S	C
Gibbula cineraria					O
Littorina littorea				F	F
Littorina obtusata			E	A	A
Littorina saxatilis (ecotype neglecta)			O	O	
Littorina saxatilis		F	O		
Nucella lapillus			A	A	A
Mytilus edulis			O	O	
Alcyonidium hirsutum					O
Asterias rubens					O
Rhodophyta (encrusting)					O
Hildenbrandia		C	F	O	F
Corallinaceae (encrusting)			F	F	C
Mastocarpus stellatus					F
Vertebrata lanosa			C	C	O
Phaeophyceae (encrusting)					O
Ralfsia					O
Fucaceae (sporelings)		O	O	O	O
Ascophyllum nodosum			A	A	F
Fucus serratus					C
Fucus spiralis		C			
Fucus vesiculosus					C
Pelvetia canaliculata		S			
Ulva (tubular)				R	
Ulva (flat)					R
Cladophora			R	R	
Cladophora rupestris			O	O	F
Pyrenocollema halodytes			O	O	
Caloplaca marina	O				
Caloplaca thallincola	O				
Verrucaria maura	E	S	S	A	C
Verrucaria mucosa				A	

ST6-15 West Lunna Pund North – new site, established July 2017

ST6-15 West Lunna Pund North	**Stations**				
	1	**2**	**3**	**4**	**5**
Halichondria panicea					O
Campanulariidae					O
Polynoidae					O
Spirobranchus				O	O
Spirorbinae				O	A
Acari (red)	O	O			
Cirripedia (spat)		O	O	F	C
Cirripedia (dead)			O	F	O
Semibalanus balanoides		F	F	F	C
Amphipoda	A	O		O	
Carcinus maenas		O			
Testudinalia testudinalis					O
Patella (juvenile, <10mm)				O	O
Patella vulgata			C	F	C
Littorina littorea			A	C	C
Littorina obtusata		O	C	E	C
Littorina saxatilis (ecotype neglecta)			O		
Littorina saxatilis	A	E	C	O	
Nucella lapillus				O	
Mytilus edulis					F
Bryozoa (encrusting)					O
Alcyonidium hirsutum					O
Electra pilosa					O
Asterias rubens					F
Gelidium pusillum			O	O	
Hildenbrandia	R	O	F	F	O
Corallinaceae (encrusting)			C	O	F
Mastocarpus stellatus			O	R	F
Catenella caespitosa		O	R		
Lomentaria articulata			R		O
Plumaria plumosa					R
Membranoptera alata					R
Bostrychia scorpioides	O		R		
Vertebrata lanosa			O	O	
Ectocarpaceae				O	
Elachista fucicola			O	O	O
Fucaceae (sporelings)				O	O
Ascophyllum nodosum			S	C	
Fucus serratus					A
Fucus spiralis			C		
Fucus vesiculosus			F	S	C
Pelvetia canaliculata	C	A			
Ulva (tubular)				R	
Cladophora rupestris	R	O	F		
Fungi (Lichen: dark grey)	C				
Pyrenocollema halodytes			R	R	R
Verrucaria maura	A	A	F	O	
Verrucaria mucosa		A	A	F	

ST6-3 Croo Taing

Originally established and surveyed in May 1976, re-surveyed in 1977 & briefly revisited in 1978.



ST6-3 Croo Taing	**Stations**				
	7	**9**	**11**	**12**	**14**
Leucosolenia					O
Coryne					O
Dynamena pumila			O	F	F
Campanulariidae				O	
Actinia equina			C	O	C
Spirorbinae				C	A
Acari (red)	O				
Cirripedia (spat)		O	O	F	O
Cirripedia (dead)		O	O	F	O
Semibalanus balanoides		C	C	C	F
Amphipoda		A			
Carcinus maenas	O	F			
Patella vulgata			F	C	F
Gibbula cineraria					C
Littorina littorea			F	C	
Littorina obtusata		O	C	F	F
Littorina saxatilis	A	S			
Nucella lapillus			O	C	O
Bryozoa (encrusting)				O	
Alcyonidium hirsutum					O
Flustrellidra hispida					F
Rhodophyta (encrusting)			O		
Rhodothamniella floridula					O
Hildenbrandia	R	F	F	F	F
Corallinaceae (encrusting)			F	C	A
Melobesia membranacea					O
Mastocarpus stellatus			O	O	F
Lomentaria articulata				R	F
Ceramium virgatum					O
Membranoptera alata				R	O
Vertebrata lanosa			C	C	F
Ectocarpaceae					O
Ralfsia			O	O	R
Elachista fucicola				O	
Laminaria (sporelings)					O
Fucaceae (sporelings)		O	R	R	R
Ascophyllum nodosum		O	S	C	C
Fucus serratus					A
Fucus vesiculosus		S	F	F	
Pelvetia canaliculata	O				
Ulva (tubular)		O	O	F	C
Cladophora					O
Cladophora rupestris			C	F	C
Fungi (Lichen: dark grey)	F				
Pyrenocollema halodytes			O	R	R
Verrucaria maura	A	A			
Verrucaria mucosa		C	C	C	O

Appendix 3 Tidal heights of monitoring stations

Results of station levelling carried out during the July 2016 and July 2017 surveys. See Section 2.2.3 for a description of the methodology and Section 4.4 for a discussion of the results.

		Sea level			Metres above chart datum				
Site	**No.**	**Date**	**Time (bst)**	**Height (m)**	**E**	**D**	**C**	**B**	**A**
W. of Mioness	1-1	20/7/16	15:00	0.70	0.95	1.5	2.1	2.7	3.3
Roe Clett	2-3	22/7/16	16:00	0.80	0.93	1.54	2.06	2.64	3.24
Roe Clett	2-3	13/7/17	17:50	0.70	0.93	1.59	2.11	2.70	3.29
Riven Noust	2-9	20/7/16	07:25	0.70	0.4	0.8	1.43	1.83	2.635
Ola's Ness	3-1	9/7/17	16:10	0.50	0.75	1.09	1.60	1.92	2.49
Noust of Burraland	3-3	21/7/16	18:00	0.40	0.7	1.34	1.81	2.26	2.53
Noust of Burraland	3-3	13/7/17	06:45	0.40	0.68	1.34	1.84	2.25	2.52
Gluss Island East	3-4	21/7/16	17:03	0.40	1.1	1.45	1.74	2.17	2.79
S. of Swarta Taing	3-5	24/7/16	07:35	0.30	0.75	1.34	1.7	2.4	2.98
Vidlin Ness	3-8	22/7/16	05:15	0.55	0.7	1.1	1.32	1.77	2.14
Burgo Taing	3-12	23/7/16	17:23	0.60	0.86	1.23	1.6	2.21	2.79
Burgo Taing	3-12	12/7/17	17:41	0.50	0.77	1.17	1.50	2.13	2.71
Grunn Tang	4-1	21/7/16	15:40	0.70	0.98	1.38	1.71	2.09	2.53
Grunn Taing	4-1	9/7/17	17:17	0.50	0.67	1.14	1.45	1.82	2.24
The Kames	4-3	20/7/16	16:34	0.40	0.92	1.52	2.12	2.49	2.89
The Kames	4-3	11/7/17	19:12	0.70	0.82	1.48	2.04	2.47	2.85
Voxter Ness	4-6	20/7/16	17:50	0.50	0.7	1.1	1.48	1.83	2.44
Voxter Ness	4-6	13/7/17	07:30	0.40	0.84	1.23	1.62	2.00	2.61
West Sandwick	4-7	10/7/17	15:35	0.80	0.80	1.22	1.59	1.92	2.21
South of Skaw Taing	5-1	22/7/16	17:30	0.40	0.75	1.12	1.84	2.39	3.07
South of Skaw Taing	5-1	13/7/17	19:30	0.60	0.62	1.20	1.86	2.40	3.09
Jetty 3	5-2	23/7/16	06:15	0.20	0.72	1.04	1.55	2	2.39
Jetty 3	5-2	16/7/17	08:45	0.60	0.67	0.91	1.37	1.88	2.27
Mavis Grind	5-5	21/7/16	05:30	0.20	0.76	1.16	1.56	1.93	2.37
West Lunna Pund South	5-8	12/7/17	06:30	0.20	0.54	1.09	1.42	1.75	2.23
Fugla Ayre	6-1	22/7/16	18:55	0.45	0.53	1.14	1.59	1.82	2.11
South of Jetty 2	6-2	23/7/16	07:40	0.30	0.58	0.97	1.22	1.79	2.39
Croo Taing	6-3	11/7/17	17:10	0.50	0.65	1.03	1.62	1.94	2.19
Kirkabister	6-11	22/7/16	06:40	0.20	0.38	0.79	1.19	1.68	2.08
Scatsta Ness Cleared	6-12	24/7/16	19:57	0.50	0.72	0.94	1.32	1.58	2.05
Scatsta Ness Cleared	6-12	14/7/17	07:15	0.40	0.63	0.89	1.27	1.54	2.08
Scatsta Ness Uncleared	6-13	24/7/16	20:49	0.60	0.74	0.98	1.48	2.07	2.42
Scatsta Ness Uncleared	6-13	14/7/17	08:00	0.40	0.73	0.94	1.42	2.01	2.41
North Burra Voe	6-14	23/7/16	18:45	0.50	0.95	1.33	1.72	2.06	2.45
North Burra Voe	6-14	12/7/17	18:20	0.50	0.73	1.17	1.57	1.93	2.33
West Lunna Pund North	6-15	12/7/17	07:00	0.20	0.56	0.95	1.37	1.71	1.95

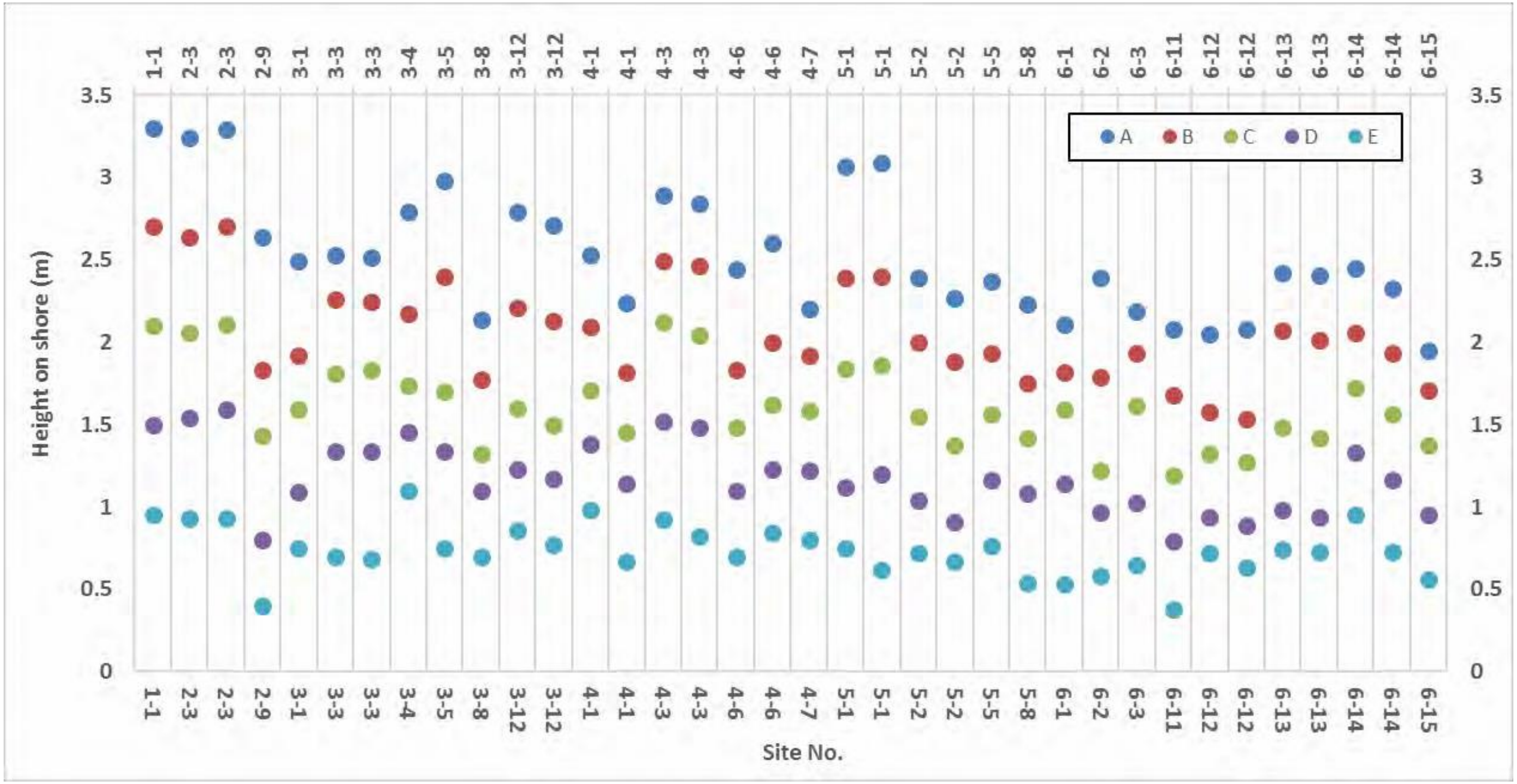


Figure 2 Heights on shore, relative to chart datum, of fixed stations at SOTEAG rocky shore transect sites, from levelling in July 2016 and July 2017.

Appendix 4 Chronology of personnel changes and methodology during SOTEAG rocky shore monitoring programme

Contractors: Oil Pollution Research Unit, Field Studies Council Research Centre, Cordah Ltd., BMT Cordah Ltd., Aquatic Survey & Monitoring Ltd.

Survey staff: Annette Little (AL), Tony Thomas (AT), Ben James (BJ), Christine Howson (CH), David Emerson (DE), David Levell (DL), Francis Bunker (FB), Frank Fortune (FF), Harry Goudge (HG), Heather Howcroft (HH), John Addy (JA), Jenny Baker (JB), John Crothers (JC), John Hartley (JH), Jon Moore (JM), Keith Hiscock (KH), Kingsley Iball (KI), Lou Luddington (LL), Peter Taylor (PT), Sue Hiscock (nee. Hainsworth) (SH), Tom Mercer (TM).

Sites: No. of sites within Sullom Voe and adjacent part of Yell Sound + No. of reference sites (*dogwhelks* refers to the associated monitoring of dogwhelks; see Moore and Gubbins 2015)

Year	**Contractor**	**Survey staff**	**Sites**	**Stns**	**Methods** (see Moore 2013 for explanation)	**Month**
1976	OPRU	JB, KH, SH, DL, JA, JH	30 + 4	All	Full survey	May
1977	OPRU	JB, SH, KH, JC, DE, AT	34 + 9	All	Full survey	May
1978	OPRU	KH, JC, AT, AL	18 + 2	All	Full survey	May
1979	OPRU	KH, AT, DE, HH	21 + 2	All	Full survey	May
1980	OPRU	KH, JC, DE, AT	25 + 2	All	Full survey	May
1981	OPRU	KH, DE, AT, KI	25 + 2	All	Full survey	May/June
1982	Not surveyed					
1983	Not surveyed					
1984	OPRU	KH	25	All	Rapid survey	August
1985	OPRU	KH	25	All	Rapid survey	August
1986	OPRU	KH	25	All	Rapid survey	August
1987	OPRU	CH	23	All	Rapid survey	August
1988	FSCRC (OPRU)	CH, AL	23	All	Rapid survey, reestablishment of 6 transects	August
1989	FSCRC (OPRU)	AL, TM	23	All	Rapid survey, reestablishment of 2 transects	August
1990	FSCRC (OPRU)	JM, PT	23	All	Rapid survey	August
1991	FSCRC (OPRU)	JM, PT	23	All	Rapid survey (+ dogwhelks)	August
1992	FSCRC (OPRU)	PT, JM	23	All	Rapid survey	July/Aug
1993	FSCRC (OPRU)	JM, PT	15 + 5	5	Full survey (+ dogwhelks)	August
1994	FSCRC (OPRU)	JM, AL	15 + 5	5	Full survey	August
1995	FSCRC (OPRU)	JM, AL	15 + 5	5	Full survey (+ dogwhelks)	August
1996	OPRU	JM, AL	15 + 5	5	Full survey	August
1997	OPRU	JM, AL	15 + 5	5	Full survey (+ dogwhelks)	August
1998	Cordah	JM, BJ	15 + 5	5	Full survey	August
1999	Cordah	BJ, JM	15 + 5	5	Full survey (+ dogwhelks)	July/Aug
2000	Cordah	JM, BJ	15 + 5	5	Full survey	August
2001	BMT Cordah	FF, JM	15 + 5	5	Full survey (+ dogwhelks)	July/Aug
2002	BMT Cordah	FF, JM	15 + 5	5	Full survey	July
2003	BMT Cordah	FF, JM	15 + 5	5	Full survey	July/Aug
2004	BMT Cordah	JM, FF	15 + 5	5	Full survey (+ dogwhelks)	July/Aug
2005	BMT Cordah	JM, FF	15 + 5	5	Full survey	July
2006	ASML	JM, CH	15 + 5	5	Full survey	August
2007	ASML	JM, LL	15 + 5	5	Full survey (+ dogwhelks)	July/Aug
2008	ASML	JM, CH	15 + 5	5	Full survey	August
2009	ASML	JM, CH	15 + 5	5	Full survey (+ dogwhelks)	August
2010	ASML	JM, CH	15 + 5	5	Full survey	July/Aug
2011	ASML	JM, HG	15 + 5	5	Full survey (+ dogwhelks)	August
2012	ASML	JM, CH	15 + 5	5	Full survey	July
2013	ASML	JM, CH	15 + 5	5	Full survey (+ dogwhelks)	July
2014	ASML	JM, CH	15 + 5	5	Full survey	July/Aug
2015	ASML	JM, CH	15 + 5	5	Full survey (+ dogwhelks)	July
2016	ASML	JM, TM	15 + 5	5	Full survey	July
2017	ASML	JM, FB	15 + 10	5	Full survey	July