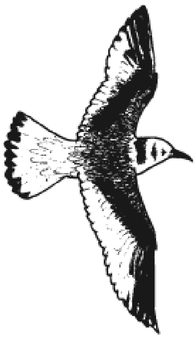
SOTEAG

Survey of the rocky shores

in Sullom Voe



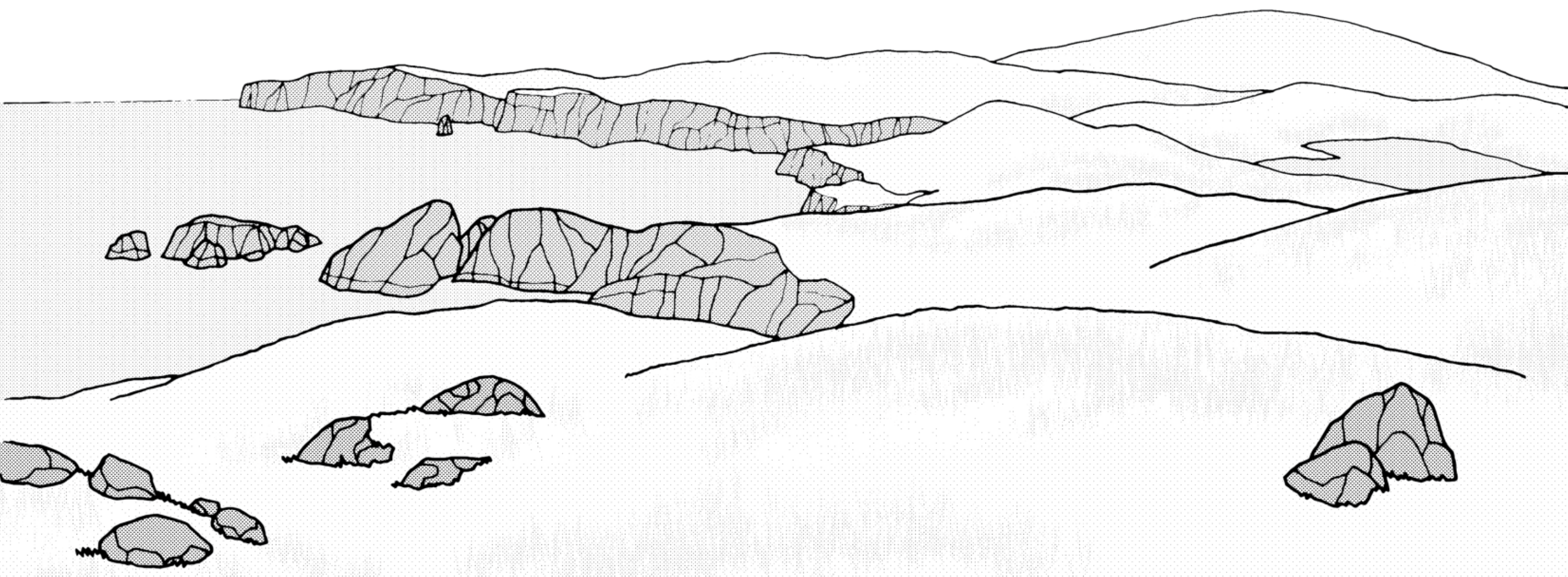
2025

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 2025

A report for SOTEAG

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Data access

Summary

Biological monitoring of rocky shore communities in Sullom Voe has been carried out annually since 1976. Annual reports to SOTEAG have described the ecological changes from year to year and assessed the effects of the oil terminal's operation on the intertidal reef communities. This report summarises the work carried out in July 2025 – the 48th annual survey since the programme's inception.

The 2025 survey was carried out with a methodology and strategy adopted in 1993. Earlier data is still directly comparable for analyses. Fifteen transects in Sullom Voe and ten reference transects outside the Voe were re-surveyed, and the abundances of all conspicuous species (algae, lichens and invertebrates) were recorded at five stations along each transect. A photographic record of each site was made.

The survey conditions in July 2025 were very good and all but one of the stations were thoroughly surveyed. One lower shore station was not uncovered by the tide, due to a change in the boulder shore profile.

Comparisons of recorded abundances, field notes and photographs from the 2025 survey with those from the 2024 survey and previous surveys have been carried out.

In 2025 the rocky shore communities at the twenty-five sites were generally similar to those surveyed in recent years. The most noteworthy features of interest are listed below:

- There was a notable increase in both numbers of records and average abundance of the beadlet anemone *Actinia equina*.
- Average densities of adult barnacles (*Semibalanus balanoides*) were still relatively low and many sites were still characterised by areas of bare rock. Combinations of relatively poor survival, patchy settlement and recruitment and slow growth may all be involved.
- A trend of increase in the numbers of records of the southern barnacle *Chthamalus stellatus* is apparent.
- Abundances of dogwhelks *Nucella lapillus* increased at almost every site and they were recorded from more stations in Sullom Voe than in any year since 1989.
- A twofold increase in numbers of records of the red alga *Membranoptera alata* has been seen in recent years. At some Sullom Voe sites where it now has a regular presence it had not been recorded prior to 2002.
- Dabberlocks *Alaria esculenta* is now routinely recorded at two sites where it was previously only an occasional presence.
- There was a notable decline in the average abundance of bladder wrack *Fucus vesiculosus* at Sullom Voe sites.
- Numbers of records of the green alga *Cladophora* have shown a slight trend of increase over the last 25 years in Sullom Voe.
- There was considerable recovery of the mid shore communities at the Kirkabister reference site in Vidlin Voe, following notable reductions caused by an unknown physical disturbance in 2024. But some species were still in relatively low abundance.

There was one reported pollution event in Sullom Voe during the past 12 months but it was confined to Sella Ness and Terminal activities appear to have had no impacts upon the rocky shore communities.

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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 marine biota of the rocky shores in Sullom Voe have been surveyed annually. It is thought to be one of the longest running surveillance programmes of rocky shore ecology anywhere in the world. The programme was designed to assess gross changes in the plant and animal populations with the survey sites centred on the environment around the oil terminal.

The survey methodology has been modified over this 49-year period, with various changes to the suite of sites and stations, but the species abundance data collected has remained comparable throughout.

This report describes the results of the survey in July 2025, highlighting changes that have occurred since the survey in August 2024. It discusses 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 also carried out every two or three years and was last carried out in 2024 during the same period of fieldwork as the rocky shore transect surveys (Moore et al. 2024). Appendix 2 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 field surveyors recording onto blank recording forms – i.e. with no reference to previous results. Following a review of the programme (Hiscock 1983), the methodology was changed in 1984. The survey then took the form of a rapid visual assessment of the shore 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 (usually 1981), 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 again to allow a more detailed and objective analysis of the data. The number of survey sites in Sullom Voe was reduced to fifteen, and five reference sites were established outside the Voe in Yell Sound. Full surveys, rather than rapid visual assessment surveys, were carried out at just five stations within each transect, representing the main biological zones of a rocky shore. This methodology has been used annually since 1993, but in 2017 five additional reference sites were established in Yell Sound (see Section 2.2.1).

The changes in sites, transect stations surveyed, survey month and survey personnel that have occurred over the 49 years of the SOTEAG rocky shore monitoring programme are summarised in Appendix 2.

2.2 Field survey, July 2025

Fieldwork was carried out by Jon Moore and Tom Mercer, with assistance from a St. Andrew's University Masters student, Betsy Conger, between the 8th and 16th July 2025. 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 details the sites and the transect stations surveyed, and Figure 1 shows the location of those sites. All 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 ten sites are distributed around Yell Sound, the Lunna peninsula and Vidlin Voe to act as reference sites for the natural changes that occur in rocky shore communities. Five of those reference sites have been within the monitoring programme since 1993, and a further five were added during the 2017 survey, following a review of the programme that highlighted the imbalance in the survey design. The additional sites (green dots in Figure 1) were chosen to improve the balance of the survey design (i.e. increased proportion of reference sites to Sullom Voe sites) and to better represent the environmental character and variability of the Sullom Voe sites. The site selection and establishment procedures are described in the 2017 annual report (Moore and Bunker 2017).

Access to sites was either by car and foot, or by boat as appropriate. ASML now supplies their own workboat, a 5.8m MCA coded RIB (*North Shore*). A hand-held GPS receiver and site location sheets, containing maps, colour photographs and written notes in laminated plastic, were used to aid site relocation. The majority of stations at the sites are now marked with stainless steel screws and washers which aid the detailed *in situ* 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 July 2025, with the stations surveyed on each transect. * = lower shore station not surveyed*

No.	Site name	Stations surveyed	Survey date	OS Grid Ref.
Sullom Voe sites				
1-1	W. of Mioness	15, 18, 21, 24, 27	09/07/2025	HU 41828 79071
2-3	Roe Clett	8, 11, 14, 17, 20	13/07/2025	HU 39437 78127
3-3	Noust of Burraland	1, 3, 5, 7, 10	12/07/2025	HU 37201 75186
3-4	Gluss Island East	6, 9, 11, 13, 15	09/07/2025	HU 37711 77551
3-5	S. of Swarta Taing	4, 7, 10, 12, 15	15/07/2025	HU 40160 77901
4-1	Grunn Taing	3, 5, 7, 9, 11	10/07/2025	HU 37942 78992
4-3	The Kames	5, 7, 9, 12, 15	15/07/2025	HU 38437 76459
4-6	Voxter Ness	5, 8, 10, 12, 14	12/07/2025	HU 36084 70089
5-1	S. of Skaw Taing	9, 12, 15, 18, 20	13/07/2025	HU 39621 78236
5-2	Jetty 3	5, 7, 9, 11, 13	12/07/2025	HU 38594 75578
5-5	Mavis Grind	3, 5, 7, 9, 12	08/07/2025	HU 34054 68462
6-1	Fugla Ayre	3, 5, 7, 9 *	12/07/2025	HU 37342 74182
6-2	S. of Jetty 2	3, 6, 9, 11, 13	12/07/2025	HU 39163 75089
6-12	Scatsta Ness (cleared)	2, 4, 6, 7, 8	16/07/2025	HU 38874 73544
6-13	Scatsta Ness (uncleared)	4, 5, 8, 10, 12	16/07/2025	HU 38976 73524
Reference sites				
2-9	Riven Noust	13, 17, 19, 22, 24	11/07/2025	HU 50774 73063
3-8	Vidlin Ness	5, 7, 9, 10, 12	14/07/2025	HU 47998 66267
3-12	Burgo Taing	3, 6, 9, 11, 13	16/07/2025	HU 37381 89088
6-11	Kirkabister	4, 6, 8, 10, 12	14/07/2025	HU 48460 66257
6-14	N. Burra Voe	4, 6, 8, 10, 12	16/07/2025	HU 37220 89378
New reference sites				
3-10	Ola's Ness	4, 7, 9, 11, 13	10/07/2025	HU 35332 83092
4-7	West Sandwick	1, 2, 3, 4, 5	11/07/2025	HU 44583 86955
5-8	West Lunna Pund South	1, 2, 3, 4, 5	15/07/2025	HU 47829 69044

6-3	Croo Taing	7, 9, 11, 12, 14	11/07/2025	HU 43282 78645
6-15	West Lunna Pund North	1, 2, 3, 4, 5	15/07/2025	HU 47926 69094

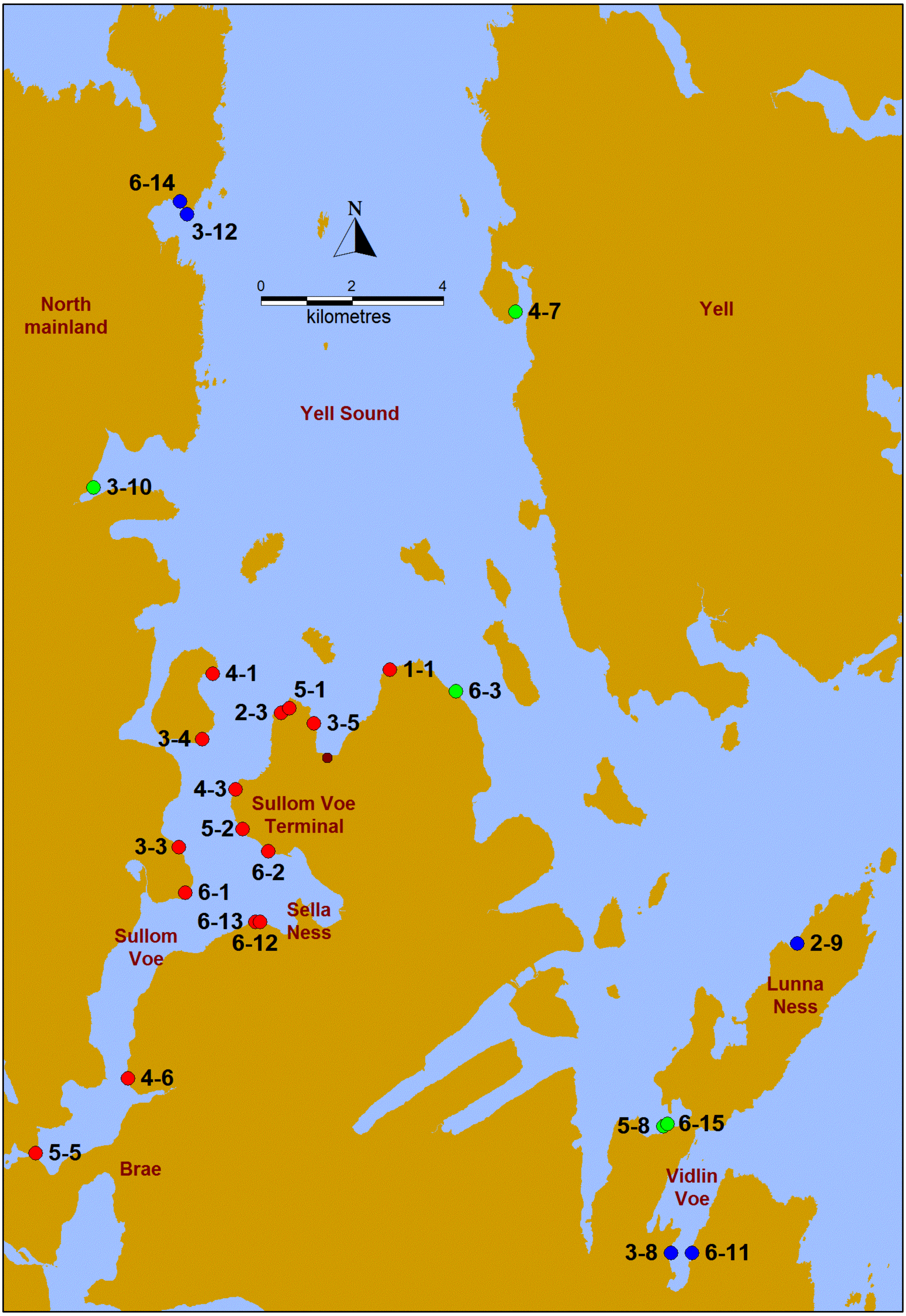


Figure 1 Location of rocky shore transect sites. Surveys of rocky shores in the region of Sullom Voe, Shetland, July 2025. ● Sullom Voe sites, ● old reference sites (established 1993), ● new reference sites (established 2017).

The sites are termed 'transect sites': defined as a line of fixed stations, distributed at height intervals from supralittoral (lichen zone) to extreme low water. A fixed datum (pat of concrete, paint mark or other durable and conspicuous feature) 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 individual 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.

Originally, at the programme's inception, the fixed stations were located at equal intervals of 20cm vertical height (i.e. 1 tenth of the tidal range) from the fixed datum, with Station 1 at the top. Stations were originally established and relocated using a cross-staff level (Baker and Crothers, 1987) with a 20 cm leg. The number of stations on a transect varies between sites, from 10 (sites with no lichen zone) to 29 (W. of Mioness; wave exposed site with extensive lichen zone). However, as explained in Section 2.2.1, only five stations per transect are monitored annually in the current programme. [Note: for the reference transects established in 2017, only five fixed stations were established, without any attempt to measure 20cm intervals].

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, the weather, tides and time did not allow for this in 2025. The stations surveyed are listed in Table 1.

Precise relocation of the five monitored stations on each transect is achieved with a combination of methods that have evolved during the programme. Use of the cross-staff level gradually diminished as more and better photographs allowed detailed rock features at each station to be recognised more quickly. Videos, with verbal instructions, have also been made for many sites. Accurate tape measurements, from fixed markers, are also used routinely for some stations, particularly on the long boulder shore transects where the substrata is, to some extent, mobile. Then, in 2020 and 2021, the majority of the bedrock stations were marked with stainless steel screws and washers, allowing easier and more rapid relocation; though photographs, tape measurements and, rarely, the cross-staff level are still used.

On a few occasions time and tide constraints have resulted in an incomplete survey of a lower shore station (i.e. water covering the station). This happened again at Fugla Ayre in 2025 (see Sections 2.2.4 and 4.2). The missing data are tagged and explained in the metadata associated with the full dataset. As most of the data analyses are based on averages of the existing data, the effects of missing data are limited, but notes are applied where they can influence the results.

2.2.2 *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 station. The majority are identified to species level in the field, but some can only be reliably identified to higher taxonomic level (e.g. Genus or Family). Specimens are occasionally taken for later inspection with a microscope. 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 more gently sloping shores. Precise relocation can be difficult over the full 3 m length, but it is 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 Crothers (1987) (see 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. All plants and animals (except drift material) found within the defined area of the station at the time of the survey are recorded, even if their attachment is outside that area. This mainly affects recording of the large fucoids that may have their holdfasts outside the station, and the epiphytes that grow on them. It is therefore important that the abundance of large fucoids and their epiphytes is recorded first, before they are carefully moved aside to study the understorey algae and animals.

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. Highly accurate quantitative measurements of abundance are not achievable for most species in the available time; hence the assignment of a less precise categorical abundance score is quicker and achievable, even 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 is a lot greater than for 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.

2.2.3 Photography

Photographs were taken of each transect from different viewpoints and angles (usually similar to previous years) and close-ups of selected stations, using an Olympus Tough (TG5 or TG6) digital compact camera. Digital images (high resolution jpgs) were recorded and copies are filed with SOTEAG and ASML.

2.2.4 Survey conditions in 2025

The 2025 survey was blessed with very good weather which was a considerable relief after the last two years! The tides were also as predicted and all stations were surveyed thoroughly, except the lower shore at Fugla Ayre (see Sections 2.2.1 and 4.2).

2.3 Data analysis

The data from the survey were entered into a Microsoft Access database, with a bespoke data entry module, which holds the data from previous surveys. Each record comprises the species name and a taxonomic code adapted from the UK species directory (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. 1 = Rare and 4 = Common (see Appendix 1).

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

The majority of abundance data used in the analyses are assigned to taxa at the species level, but some are assigned to a higher taxonomic level to improve consistency of those data. A standardised procedure within the Access database aggregates all records for those selected taxa up to the defined taxonomic level; e.g. all records of *Ceramium* and related species are aggregated to Ceramiaceae (fine filamentous).

Tabulated exports from the database and simple graphical presentations were used to compare the 2025 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.

2.3.1 Calculation and graphical presentation of mean abundance

Because each abundance value is based on a semi-quantitative category, summing or averaging the numbers can give misleading results. 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 2). 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. This factor only affects the scale on the y-axis, not the shape of the lines.

Table 2 Median values used in calculations for each abundance category (see Appendix 1)

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

An inevitable feature of the graphs is that the average abundance for a species will tend to be higher in one dataset than the other, i.e. in Sullom Voe or in the reference sites. This may reflect a real difference in species distribution between those areas but may simply reflect a difference between the selected sites. Showing such differences is not the primary purpose of the graphs, which is to illustrate the temporal changes.

Whilst it should be appreciated that the methodology described above will introduce some errors into the data, the log 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 temporal changes 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. The calculations are applied as queries to the raw long-term monitoring data held in the Access database and the modifications have made it easier to identify trends and notable changes.

2.3.2 Other univariate analyses

In addition to the graphs of average abundance plotted from the above analysis, lines showing changes in the number of stations from which the species was recorded have also been plotted. Values for the latter are given on a second y-axis (on the right of the graph). The maximum number of Sullom Voe stations is 75 (15 sites x 5 stations). The maximum number of reference stations is 25 (5 sites x 5 stations). The maximum number of new stations is 25 (5 sites x 5 stations). The number of Sullom Voe records is therefore derived from three times as many stations as the reference stations, which inevitably means that those lines are positioned higher up the y-axis. As for the average abundance data, showing such differences is not the primary purpose of the graphs, which is to illustrate the temporal changes.

Data from the new reference sites have been included on graphs for selected species where they show interesting trends in recent years. The number of years given along the x-axis of the graphs varies between species, depending on their known (and reliable) inclusion in the survey. For example, epiphytic bryozoa (e.g. *Alcyonidium hirsutum*) were not surveyed before 1993. Also, the earliest year used is 1980, because Mavis Grind was only established in 1980 and the Scatsta Ness sites were only established in 1979.

Tables of summed abundance data are used to present selected results for multiple sites or species. Here, the numerical abundance categories have been summed, which can give misleading results – e.g. a value of 4 could be the sum of 4 records of Rare or a single record of Common. However, the potential for wrong interpretation is limited by the typical distribution patterns that each species has at each site. Colour shading is used to highlight changes in those abundances between years, sites and species. This shading is done using conditional formatting from Excel, with green shade for the lowest values, red for the highest values and a gradation of colours between, e.g.:

5	9	10	12	8	11	12	13	13	10	10	10	15	16	12	17	14	18

2.4 Data archive

The master data are held in two *Microsoft Access* database files, one for species abundance data (currently 123,687 records) and one for the photograph catalogue (currently 10,441 photos, including those from the dogwhelk monitoring), 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 copy of the databases, and an update each year, 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) (including scans of the slides and prints from the earlier surveys). Complete sets are held by ASML and SOTEAG.

Note: records are held in the database at the taxonomic level to which they were identified. However, for the purposes of long-term analysis, which often requires species data to be aggregated upwards to a more reliably identified taxon, a field in the species dictionary provides the taxon for these aggregations.

3 Results

3.1 Fluctuations in frequency and abundance of selected species

Table 3 provides a summary of abundance changes that occurred between August 2024 and July 2025 for 32 of the most characteristic taxa of these Shetland rocky shore communities.

Table 4 provides a summary of changes in numbers of records (from the 15 Sullom Voe sites only) over the last 29 years, for 66 of the most frequently recorded taxa. [Note: Comparable data for reference sites are not shown as there were too few sites and stations to provide good representation over that period].

Between them, those tables show that fluctuations in the frequency and abundance of most taxa occur every year and that some of them are substantial. Analyses and interpretation over the course of the programme have indicated that the majority of those fluctuations reflect natural variability, but there have been notable changes in some years, sites and species. The following sections describe the results for selected characterising species and others that have shown notable changes in the last year.

Graphs of mean abundance in this section have been prepared using a bespoke methodology described in Section 2.2.4.1. Interpreting these graphs is not straightforward because the source data for each line is calculated from a different number of stations, which complicates direct comparison between the lines. Thus, the main purpose of the graphs is to study the pattern of temporal changes on each line and between the lines, rather than the difference in their vertical position on the y-axis. The tables of summed abundances are also unconventional and have the potential to mis-represent some of the more detailed distribution patterns. However, the graphs and tables provide effective and concise means to summarise the main temporal changes. See Section 2.2.4.2 for more details.

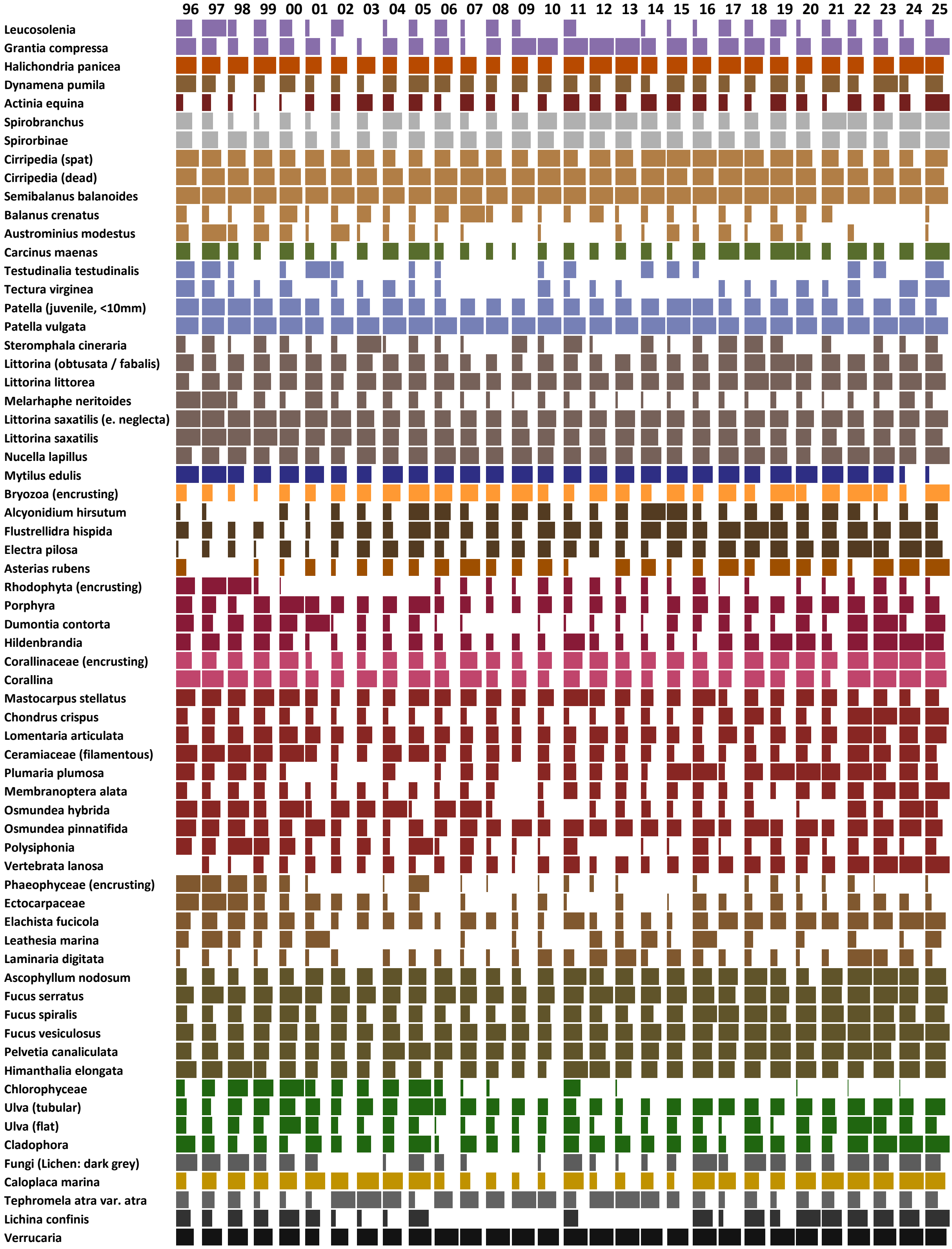
Appendix 1 provides the abundance scales used for each species. The fixed monitored stations, representing the five shore zones, are referred to in the text and some tables as follows: upper shore (A), upper middle shore (B), middle shore (C), lower middle shore (D), lower shore (E) and sublittoral fringe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

Table 3 Changes in categorical abundance of selected taxa between 2024 and 2025 at stations in Sullom Voe (left) and at reference stations (right) (including the 5 new reference sites). Values are the percentage number of stations, in each of the two groups, at which there was a change in abundance of one or more categories shown in the top row of the table. Example: Hildenbrandia reduced in abundance by 3 categories at 4% of Sullom Voe stations. Coloured data bars (using conditional formatting in Excel and scaled to a max of 40) have been added to highlight changes. Taxa are ordered to put those with overall more decreases at the top and those with overall more increases at the bottom.

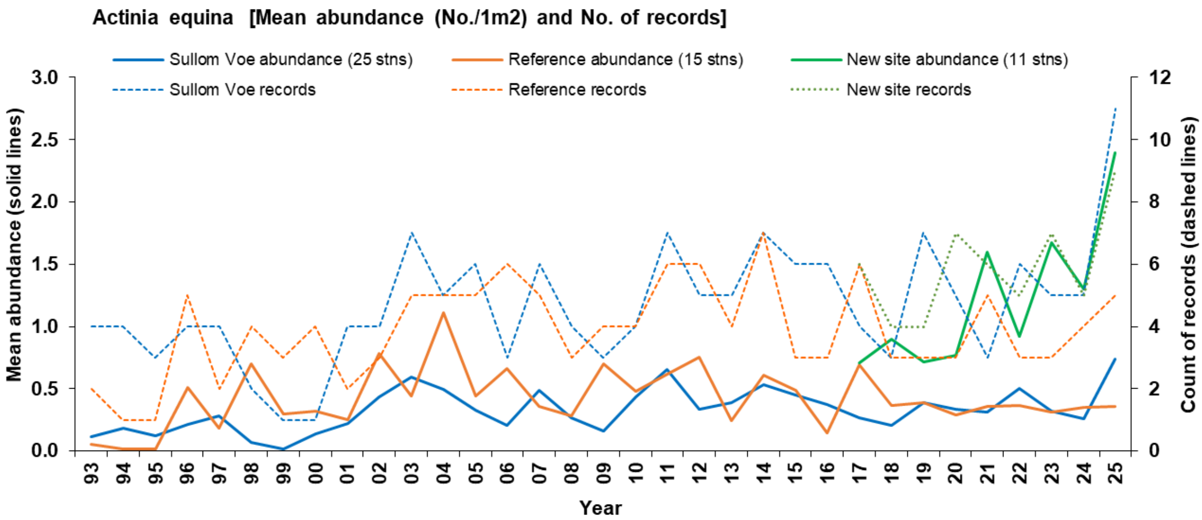
	Abundance changes in Sullom Voe stations											**Abundance changes in Reference stations**										
	-5	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**	**-5**	**-4**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**	**4**	**5**
Hildenbrandia			4	12	29	38	12	3	1				4	4	13	17	42	15	4	2		
Verrucaria			4	5	22	53	14	3						2	14	24	45	12		2		
Ulva (flat)				11	22	47	8	11						3	14	21	59		3			
Osmundea hybrida				23	14	55	5	5							9		73	18				
Pelvetia canaliculata					27	63	10								6	22	67	6				
Ceramiaceae (fine filamentous)				13	13	60	10	3	3					4	19	8	54		12	4		
Cirripedia (dead)				12	10	61	15	2						3	15	5	60	13	5			
Patella (juvenile, <10mm)	5		7	11	2	61	7	7						4	7	19	44	4	11	11		
Corallinaceae (encrusting)			2	8	29	45	12	2	2						12	15	45	18	6	3		
Lomentaria articulata				5	20	60	5	10						6	19	13	31	19	6	6		
Littorina saxatilis (neglecta)	1			7	10	63	6	10		1				3	5	8	75	8	3			
Littorina (obtusata / fabalis)	2	2	4	11	15	51	2	6	6		2			8	3	14	43	14	14	3	3	
Chondrus crispus			3	8	21	41	15	13						4	4	26	44	4	15	4		
Fucus vesiculosus		2	2	8	23	56	6	2	2				3		3	3	61	18	6	6		
Elachista fucicola				10	19	57	12	2							7		70	13	7	3		
Cladophora				6	13	67	4	8	2						11	19	46	8	14	3		
Mytilus edulis				2	8	87	2		2						3		86		10			
Fucus spiralis				2	5	83	5	5								13	71	8	8			
Littorina littorea		4	4	11	11	53	9	5	4					3	16	10	32	13	6	16	3	
Corallina			3	7	10	62	7	10						7	7	7	36	14	21	7		
Spirorbinae			3	6	10	52	10	10	6	3			4		4	12	58	15	4	4		
Semibalanus balanoides				5	12	62	20	2							5	7	63	16	5		5	
Patella vulgata		2		8	8	58	20	5							5	15	45	23	10	3		
Littorina saxatilis				8	4	56	16	8	7				2	4	15	2	46	17	7	4		2
Ulva (tubular)					9	67	16	5	3						9	12	56	7	12	2	2	
Porphyra			4	2	6	70	13	2	2	2				4	4		63	4	21	4		
Mastocarpus stellatus				2	7	80	4	4	2							5	77		5	9	5	
Osmundea pinnatifida			4	4	8	69	15										50	30	10	10		
Fucus serratus				3	17	64	6	6	3	3						19	48	10	14	5		5
Dumontia contorta				3		67	9	15	6						9		50	27	14			
Nucella lapillus	2	4		2	8	42	10	8	14	4	6				15	6	24	24	9	12	9	
Cirripedia (spat)			2		2	38	11	33	8	6	2						15	15	37	17	12	5

Table 4 Proportional changes in numbers of records of most frequently recorded taxa from sites in Sullom Voe (15 sites, 75 stations), 1996 to 2025. Length of coloured bars are calculated from the number of records in that year divided by the maximum number recorded in any year. Abundances recorded as Rare are excluded. Colours indicate different taxonomic groups.



3.1.1 *Actinia equina* (beadlet anemone)

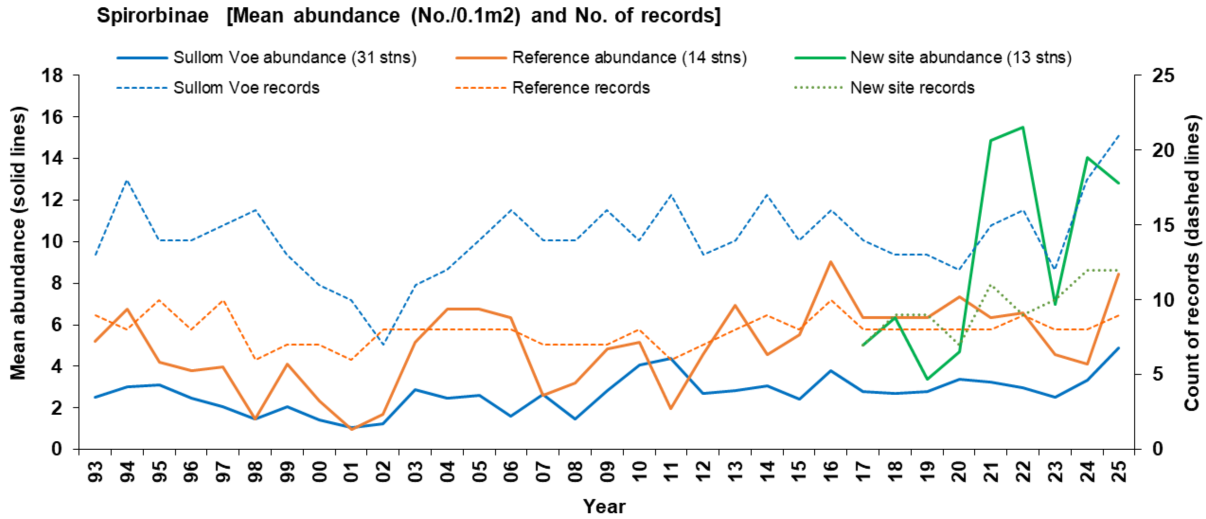
Beadlet anemones (see photo below) are frequent on the mid shore of many of the rocky shore sites but are mainly confined to damp crevices or under boulders within the defined monitoring stations. There was a large increase in both numbers of records and average abundance in 2025 (see graph below). The increases were seen at numerous sites, including many Sullom Voe sites and reference sites. This is despite the weather being generally warm and dry during the survey, which results in the anemones pulling themselves back into crevices and less conspicuous.



Beadlet anemone *Actinia equina* (*left*) at Riven Noust and Spirorbinae on *Fucus serratus* (right) from Kirkabister

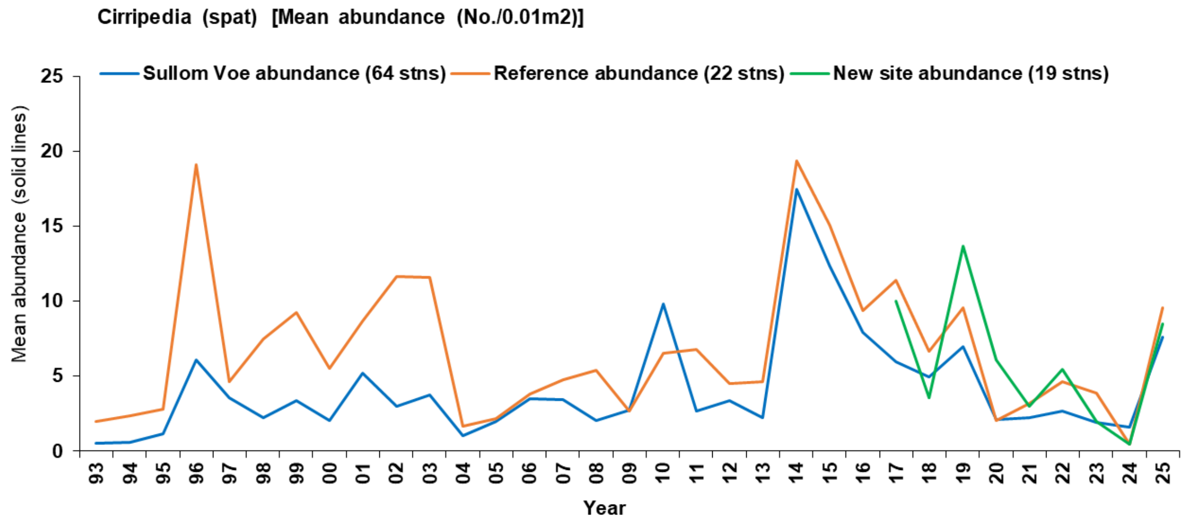
3.1.2 Spirorbinae (spirorbid worms)

Spirorbid worms (see photo above) are common intertidally and attach their tubes to various surfaces. Identification to species often requires microscopic inspection, so they are recorded at the sub-family level. Numbers of records and average abundance were relatively high in 2025, particularly at Sullom Voe sites and a few of the reference sites.

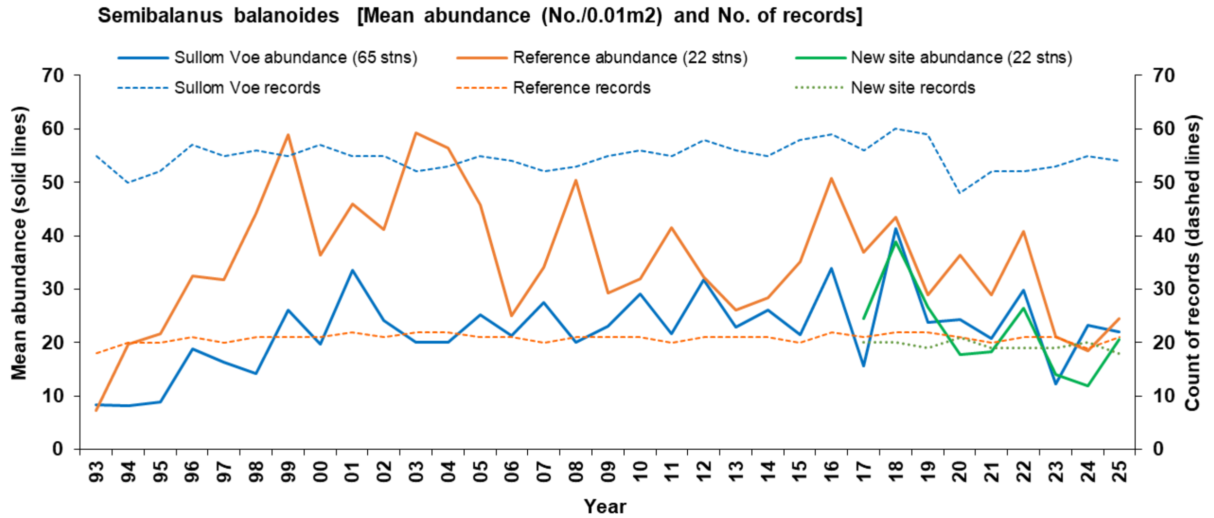


3.1.3 Semibalanus balanoides (barnacle)

The overall abundance of barnacle spat / juveniles was much higher during the 2025 survey than it had been in any surveys since 2019 (see graph below). This was at least partly a seasonal change, as the 2025 survey was relatively earlier than it has been since 2017.



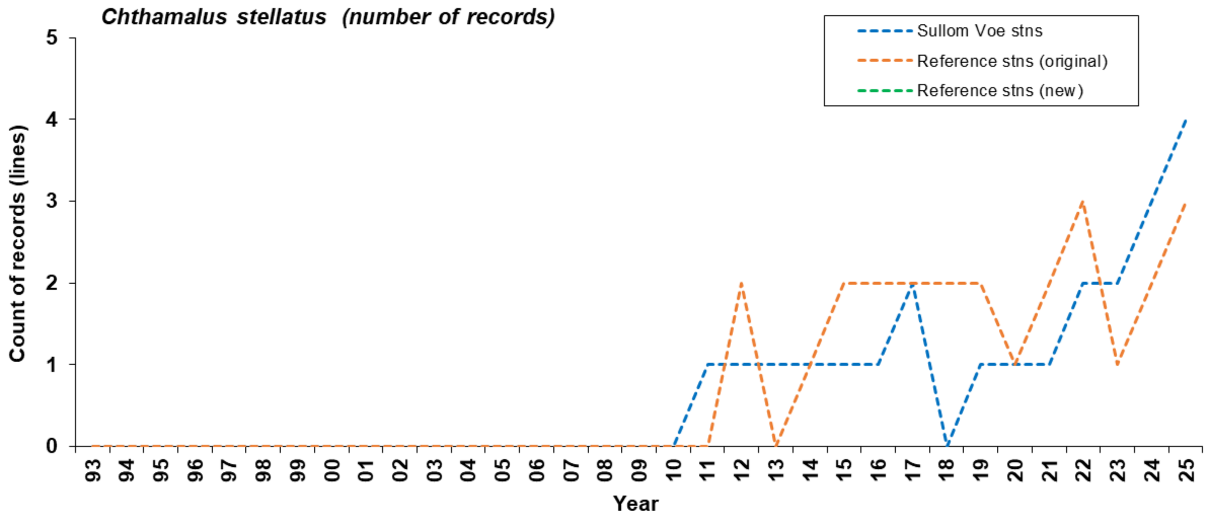
Average densities of adult barnacles (*Semibalanus balanoides*) picked up slightly in 2025, following the low numbers that were recorded in 2023 and 2024. However, many sites were still characterised by relatively large areas of bare rock where, in previous surveys, there had usually been high cover of barnacles. At many sites this appears to be due to relatively poor survival of the previous years' adults followed by slow growth of this years' recruits. At some sites there was also patchy settlement and recruitment.



Midshore station (D) at West of Mioness, with patchy barnacles (left); and *Chthamalus stellatus* at the Kames (right).

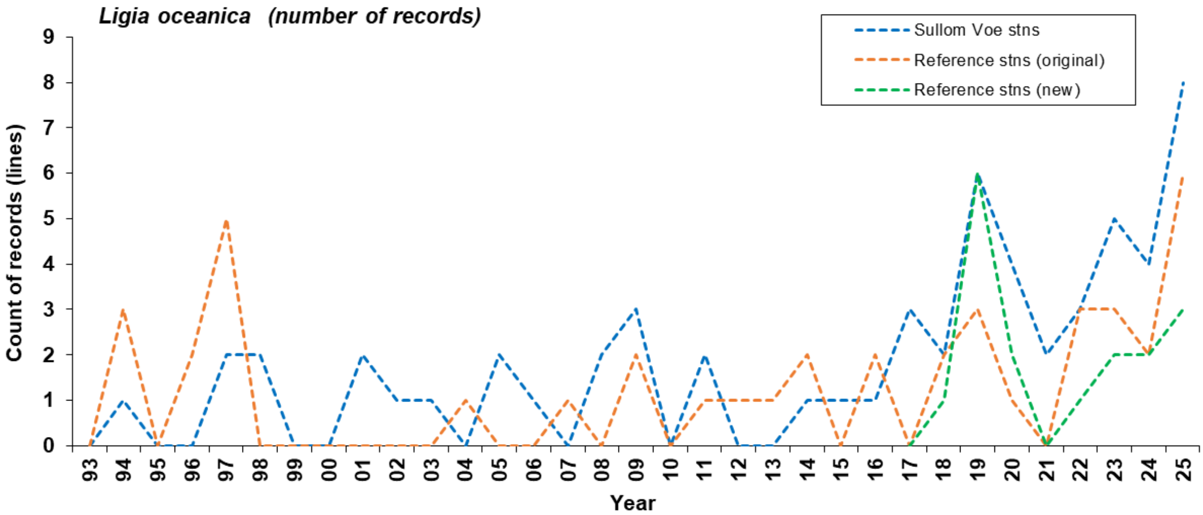
3.1.4 ***Chthamalus stellatus*** **(Poli's stellate barnacle)**

Numbers of records of *Chthamalus stellatus* (see photo above), at the northern edge of its geographic range in Shetland, appear to be showing a trend of increase (see graph below). They were recorded from a total of 7 stations at 4 sites in 2025. At West of Mioness they were Occasional to Frequent across the whole mid and upper eulittoral.



3.1.5 *Ligia oceanica* (common sea slater)

Numbers of sea slaters was higher this year than in any previous survey (see graph below). It is assumed that this was largely due to the warm dry weather, but they were particularly frequent and active at many sites. In cold and wet conditions they hide away in crevices.

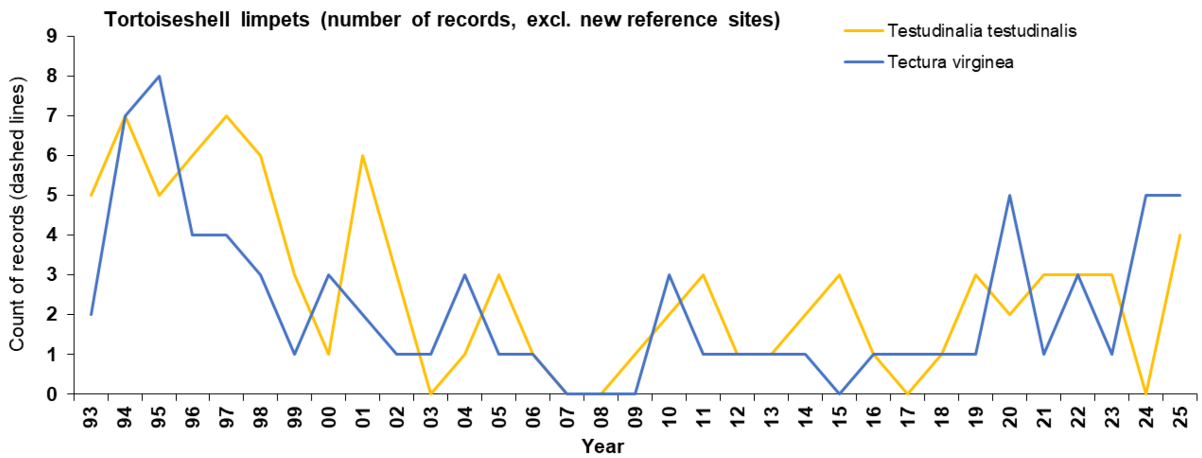


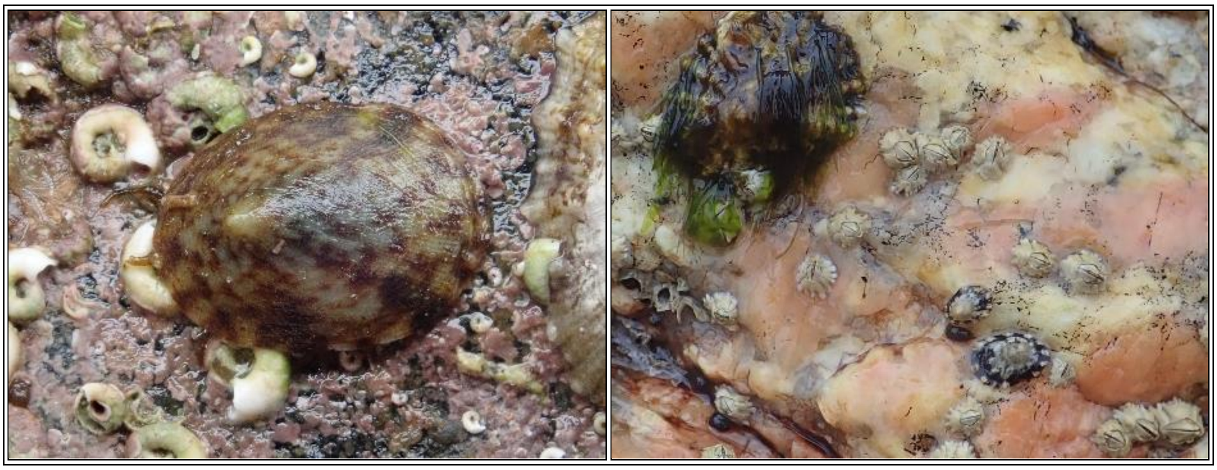
3.1.6 *Petrobius maritimus* (shore bristletail)

Several individuals of this fast-moving insect were noticed in the upper shore of at least three sites. this year. It is adapted to upper rocky shore habitats and mainly scavenges on detritus and some algae. It was only recorded from within one monitoring station (Voxter Ness Zone A) but was observed outside the stations at other sites. So, it is only mentioned here for interest because there are very few records from Shetland (only two in the NBN atlas and one previous record in the SOTEAG dataset (Swarta Taing in 1978)). Like *Ligia* (see above) it is assumed that their presence was helped by the warm dry conditions this year. Unfortunately, no photograph was captured.

3.1.7 *Testudinalia testudinalis and Tectura virginea* (tortoiseshell limpets)

Small numbers of these limpets (see photo of *T. testudinalis* below) are recorded from the lower shore of some sites and there were relatively large numbers of both in 2025, particularly at Kirkabister and Scatsta Ness (cleared). Records are of interest because *T. testudinalis* is a northern species while *T. virginea* is southern, so it is expected that the former will become less abundant as the latter increases. No trend is yet evident.

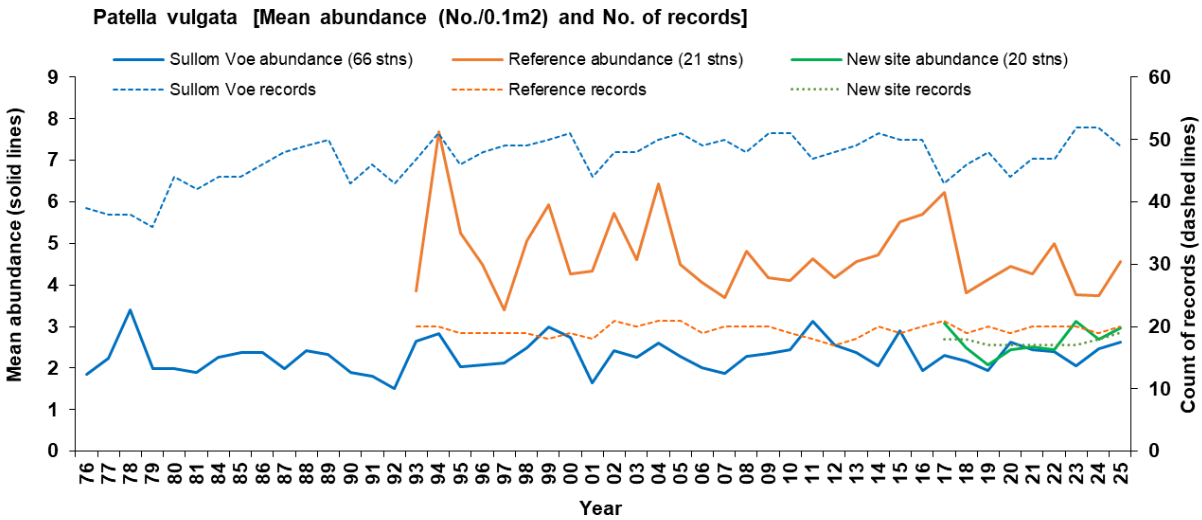




Testudinalia testudinalis at The Kames (left); and Patella vulgata, including juveniles, at West of Mioness (right).

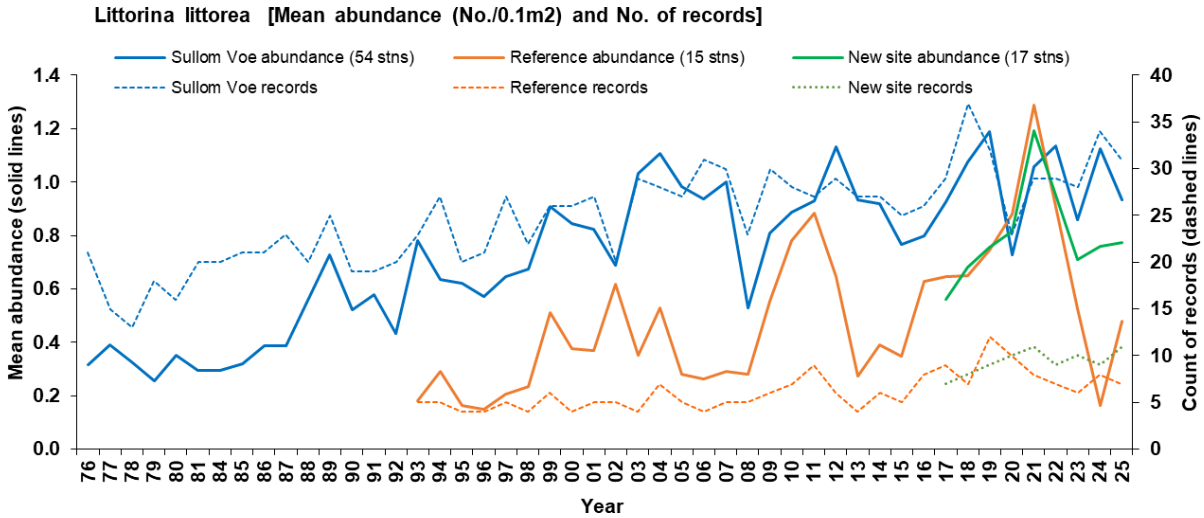
3.1.8 *Patella vulgata* (limpet)

The abundance of limpets increased slightly in 2025 (see graph below), following the high recruitment of juveniles in 2024. However, decreases were recorded at a few sites, particularly Scatsta Ness (uncleared) where substrata on the lower half of the shore has become increasingly mobile and less suitable habitat for limpets.



3.1.9 *Littorina littorea* (edible winkle)

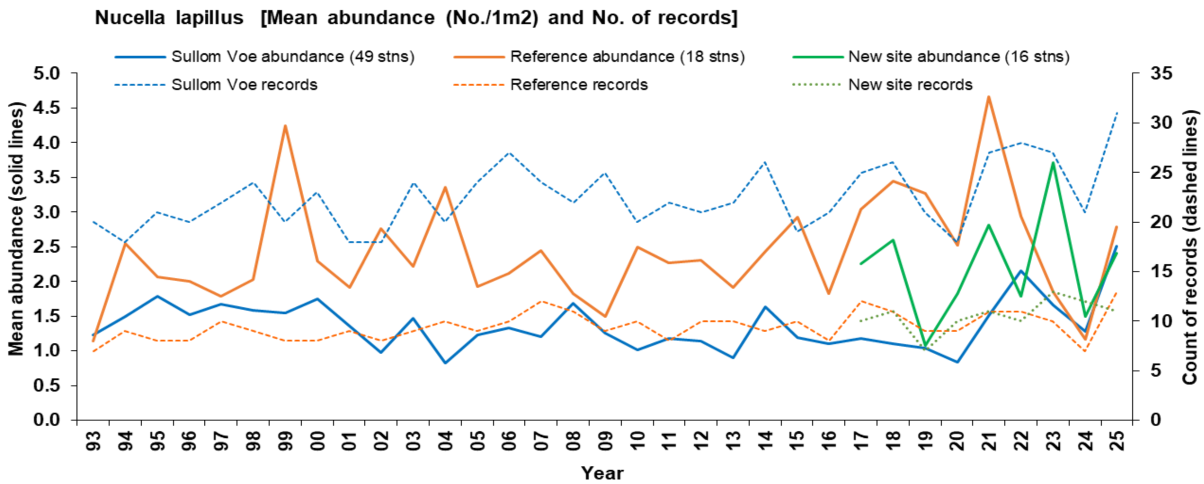
The 2024 report highlighted the large fluctuations that have sometimes occurred in edible winkle abundance and the substantial decline at Kirkabister and North Burra Voe in 2024 (see graph below). Numbers recovered at those two sites in 2025, but decreases were recorded from many of the Sullom Voe sites. Overall, however, abundances were still much higher than they were in the first decade of the monitoring programme.



Littorina littorea and *L. obtusata* on the midshore at Scatsta Ness (cleared) (left); and *Nucella lapillus* at Riven Noust (right).

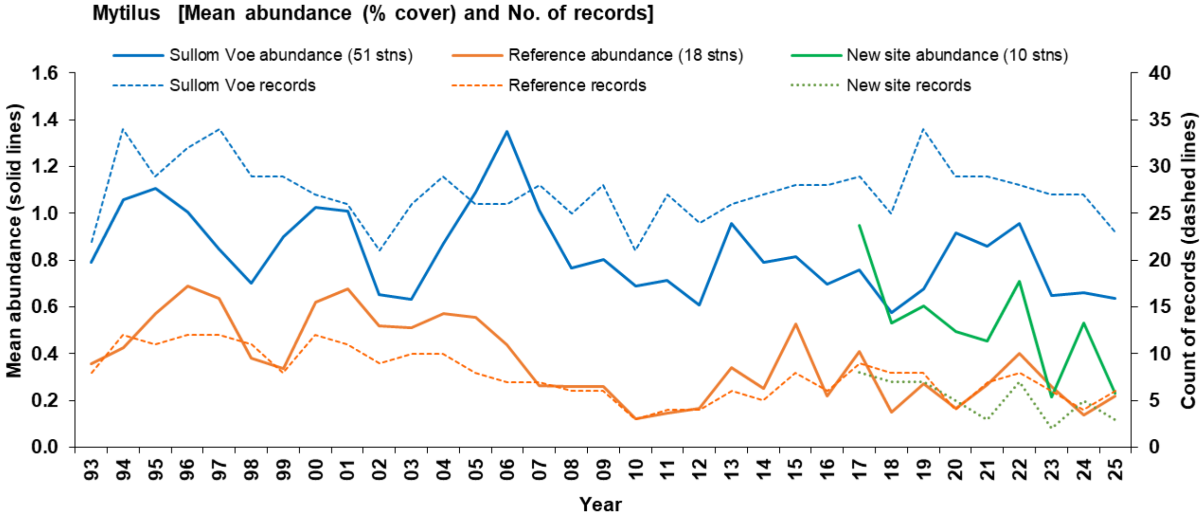
3.1.10 *Nucella lapillus* (dogwhelk)

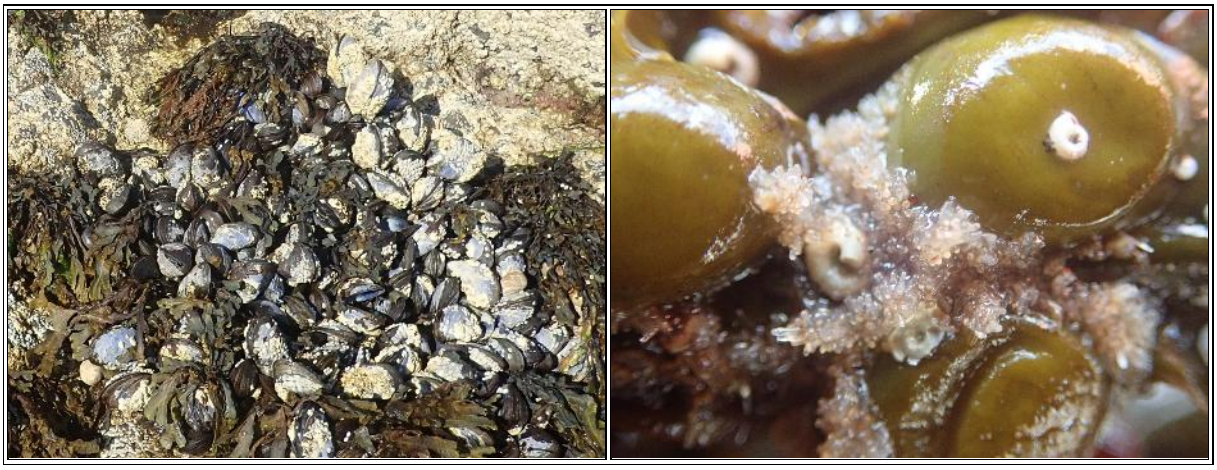
Abundances of dogwhelks (see photo above) increased at almost every site between 2024 and 2025; and they were recorded from more stations in Sullom Voe than in any year since 1989. They were also recorded at more reference site stations than in any year. It may not be coincidental that average abundance of *Fucus vesiculosus* had a notable decline in 2025. Previous reports have described a negative correlation between the two species due to the potential effect of fucoid cover on available feeding areas for dogwhelks. The changes are considered to be natural.



3.1.11 *Mytilus* (mussels)

The recording protocol for mussels was changed in 2024 to differentiate between adults (see photo below) and juveniles. The data from the last two years has confirmed that a large proportion of the records (almost ¾) are of juveniles, often concentrated within crevices. Previous reports have highlighted the reduction in mussel abundance over the last 20 years – as shown in the graph below. Observations have suggested that the reduction was primarily of adults and that settlement of juveniles was not notably affected, but the data was not available to describe that. Future trends may now be differentiated.





Adult *Mytilus edulis* at Voxter Ness (left); and *Amathia imbricata* on *Fucus vesiculosus* at Kirkabister (right)

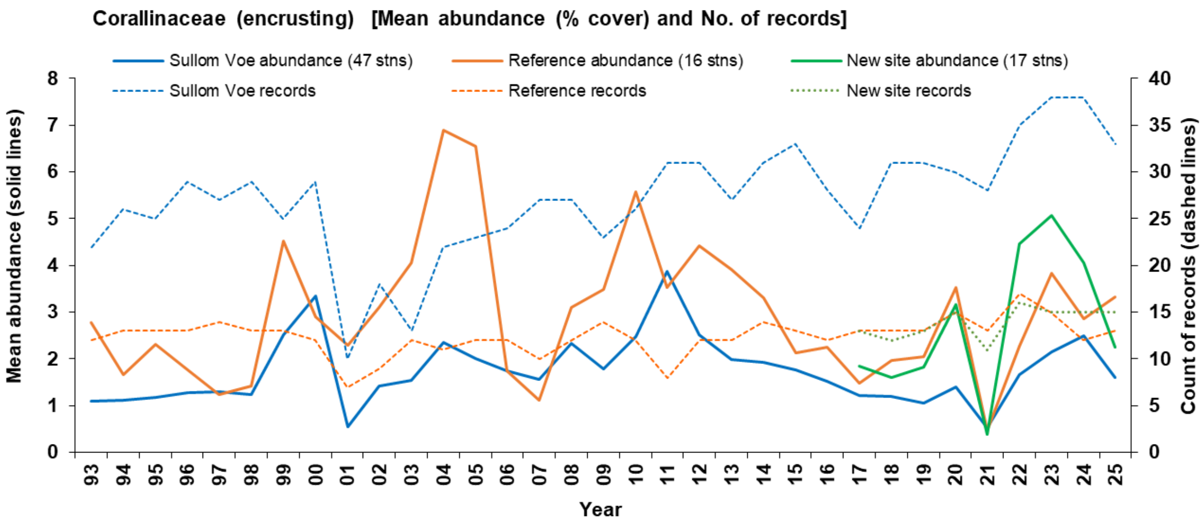
3.1.12 *Amathia imbricata* (bryozoan)

Amathia imbricata (see photo above) was recorded once in 2023 for the first time in many years. It was recorded again in 2024 at the same site (West Lunna Pund North). In 2025 it was recorded from four sites. It is uncertain whether this is a real increase or whether the surveyor is just noticing it more.

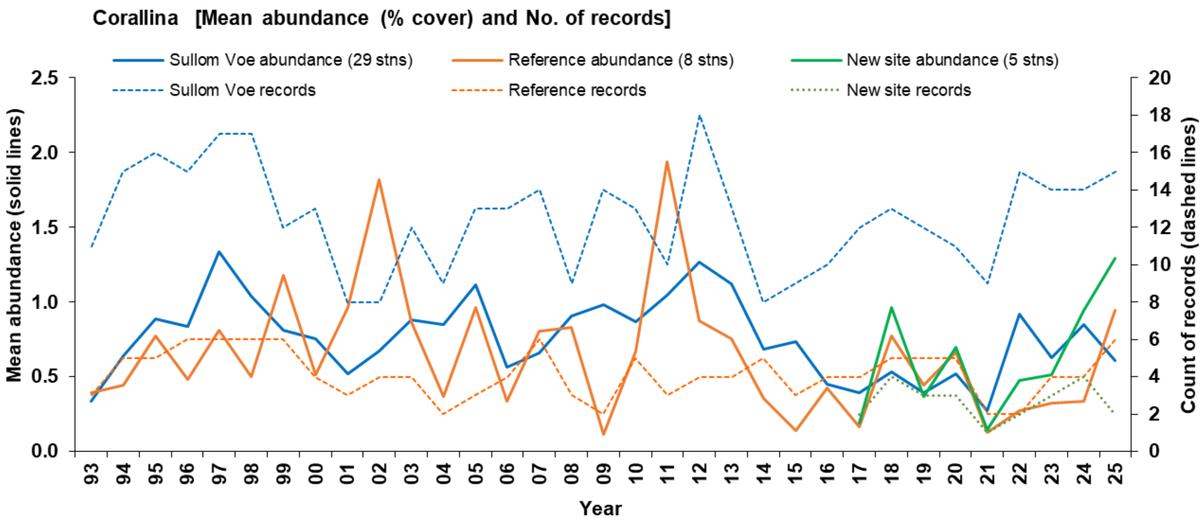
3.1.13 Encrusting coralline algae and *Corallina*

Encrusting coralline algae colonising the stainless steel marker screw on the low shore at South of Skaw Taing (right) and *Corallina* turf at West of Mioness.

The recorded abundance of encrusting corallines fluctuates more than expected for a slow growing plant, but its potential to grow over new surfaces is shown in the photograph above. The graph below shows that average abundance dropped back from its recent high points in 2023/24 to lower abundance in 2025.



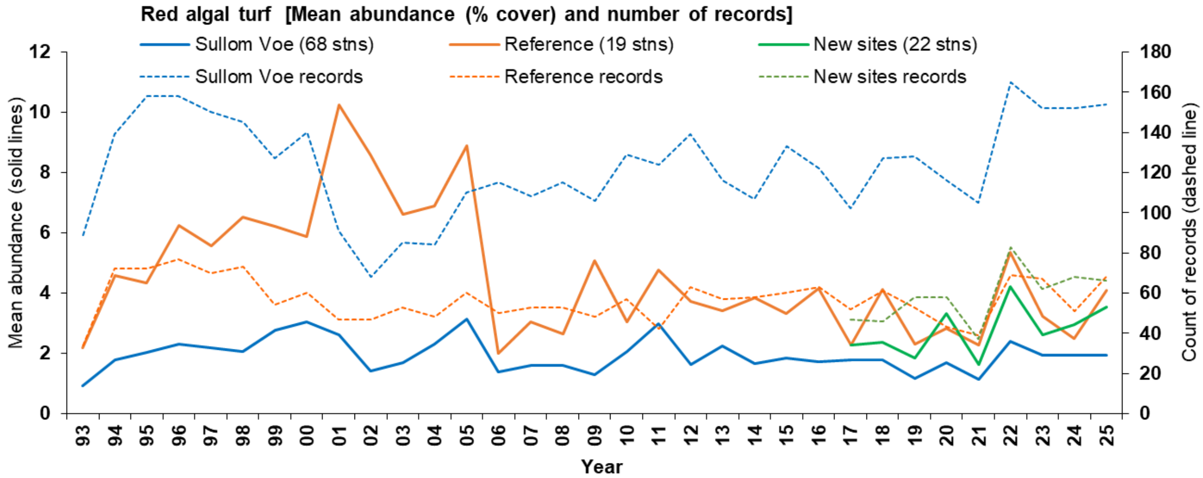
Interestingly, the average abundance of another coralline algae, the erect branching *Corallina* (see photo above), has been higher in the last two years, particularly at the reference sites (see graph below).



3.1.14 Other red algae (turf)

Mastocarpus stellatus at Roe Clett (left) and mixed red algal turf at Riven Noust (including *Lomentaria articulata* and *Membranoptera alata*) (right).

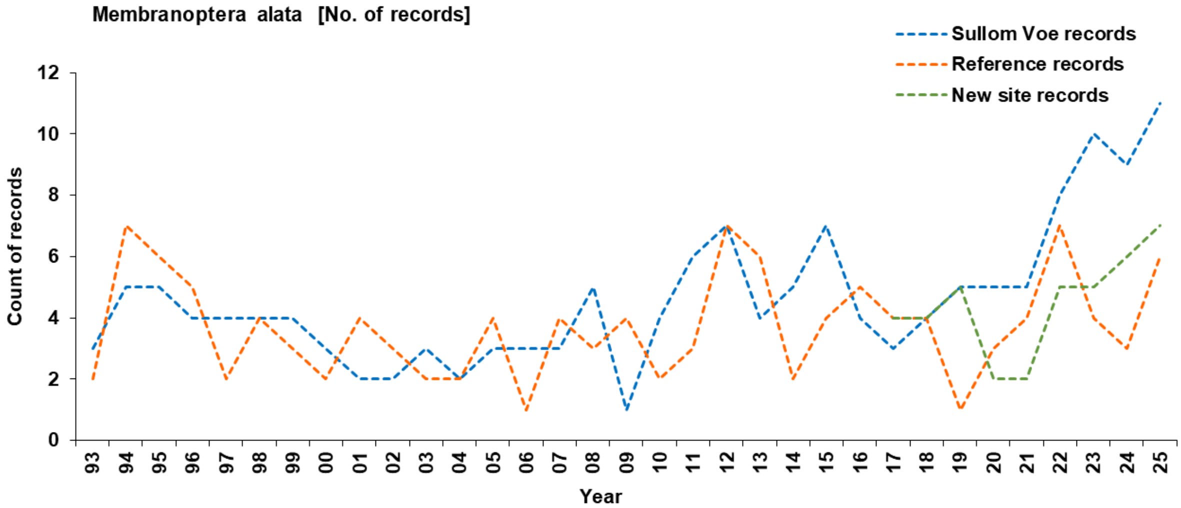
A large number of foliose and filamentous red algal taxa have been recorded from the monitoring sites, typically growing as a low turf in damp and shaded habitats on the shore (see photos above). The most abundant include *Mastocarpus stellatus* (False Irish moss), *Chondrus crispus* (Irish moss/Carrageen), *Vertebrata lanosa* (associated with the knotted wrack *Ascophyllum nodosum*), *Corallina* spp., *Osmundea pinnatifida*, *Lomentaria articulata*, *Polysiphonia* spp., other fine filamentous Ceramiaceae and *Dumontia contorta*. Individually, many of these red algal taxa can fluctuate in abundance from year to year (see table below graph), but the aggregated data in the graph below shows very little change in average abundance and numbers of records in recent years.



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

	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Dumontia contorta	19	31	3	11	9	15	7	4	3	1	7	2	6	7	5	20	11	13	8	9	14	6	26	27	7	24
Corallina	33	24	27	38	31	41	29	33	30	36	32	35	44	37	25	27	25	24	30	24	26	17	40	34	36	34
Mastocarpus stellatus	56	36	24	33	34	55	46	40	48	42	58	65	54	50	41	50	52	23	33	31	45	34	32	39	33	37
Chondrus crispus	22	16	14	23	12	16	18	14	27	21	21	14	21	22	28	18	18	35	37	29	23	17	50	42	43	42
Lomentaria articulata	18	19	13	15	12	19	18	14	13	11	18	20	20	18	19	14	8	14	7	12	16	12	19	12	18	17
Ceramiaceae (fine filamentous)	45	26	15	21	39	42	25	22	34	28	28	24	35	26	22	25	21	17	21	19	20	14	32	27	31	25
Plumaria plumosa	3	0	3	0	6	0	3	6	5	2	7	6	6	4	4	10	11	4	6	8	9	6	13	4	7	6
Membranoptera alata	8	5	6	9	6	11	6	8	9	1	7	13	16	10	9	15	10	6	8	7	10	10	16	19	18	20
Osmundea hybrida	25	7	19	20	27	3	24	18	9	0	6	0	7	9	9	6	7	5	8	0	3	2	12	7	19	9
Osmundea pinnatifida	19	30	13	14	9	19	17	20	21	24	20	33	28	21	24	23	22	19	27	15	23	13	22	23	26	23
Polysiphonia	20	13	13	17	11	33	8	16	8	5	3	20	2	4	4	4	20	6	8	15	15	5	16	15	6	13
Vertebrata lanosa	17	21	19	17	26	13	17	22	19	9	20	35	16	29	19	27	23	21	23	20	16	21	31	38	32	35

One red alga that has shown a notable change in recent years is *Membranoptera alata*, which has shown a twofold increase in numbers of records at Sullom Voe sites (see graph below). At some Sullom Voe sites, like Voxter Ness, where it now has a regular presence, it had not been recorded prior to 2002. Numbers of records also increased at reference sites but remained within previous levels.



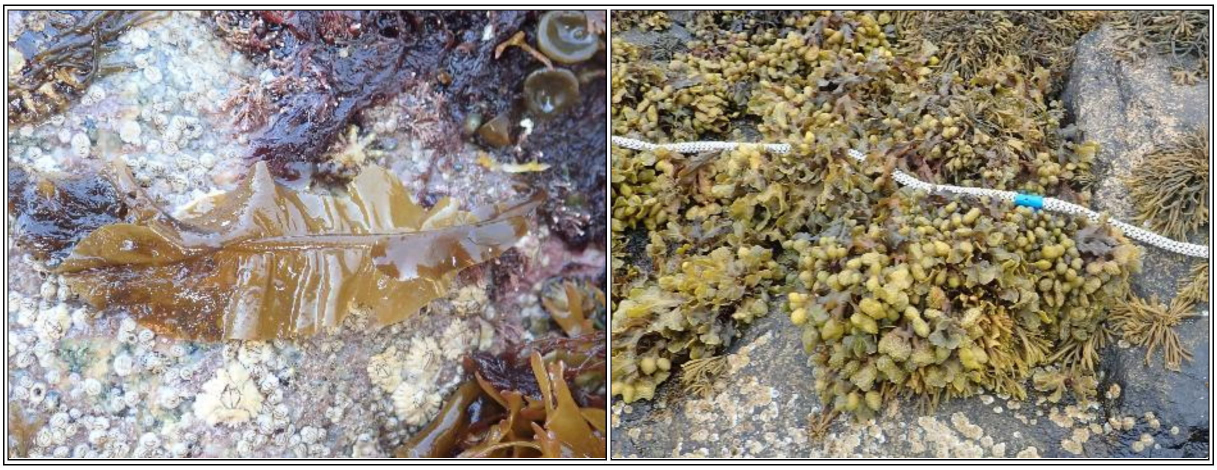
3.1.15 *Alaria esculenta* (dabberlocks)

Dabberlocks (see photo below), a large brown seaweed with a northerly distribution, has had an occasional presence on the lower shore of the most exposed sites, but is now routinely recorded at two sites: Roe Clett and Riven Noust.

Abundance of Alaria esculenta in selected stations, 1976-2025 (Scale 11 in Appendix 1) (colour shading to highlight differences; grey cells = no survey)

Site name	Stn	76	77	78	79	80	81	84	85	86	87	88	89	90	91	92	93	94	95	96	97	98	99	00
W.of Mioness	E	0	1	2	2	1	2	2	2	1	2	2	0	0	0	0	0	1	1	0	0	2	0	0
Roe Clett	E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	2
Riven Noust	D		0														0	0	1	1	0	0	0	0
Riven Noust	E		0	0	0	0											0	0	0	1	0	1	0	0

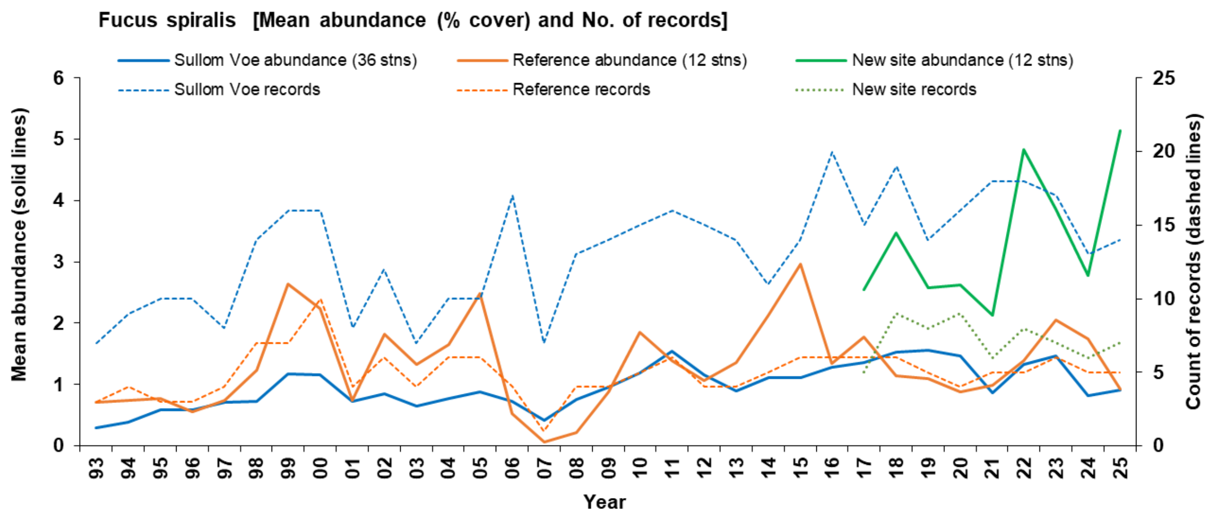
Site name	Stn	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
W.of Mioness	E	0	0	0	0	0	0	1	0	0	1	0	2	0	0	0	2	2	0	0	0	2	0	0	0	0
Roe Clett	E	0	0	0	0	0	0	1	1	0	3	0	0	1	0	1	2	0	1	1	0	1	3	2	3	2
Riven Noust	D	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	2	0	0	0	1	0	0	2
Riven Noust	E	2	0	0	3	0	1	2	4	3	1	0	0	4	1	4	3	0	0	1	3	3	4	3	3	3



Alaria esculenta at Roe Clett (left) and *Fucus spiralis* (with *Pelvetia canaliculata*) at Ola's Ness (right).

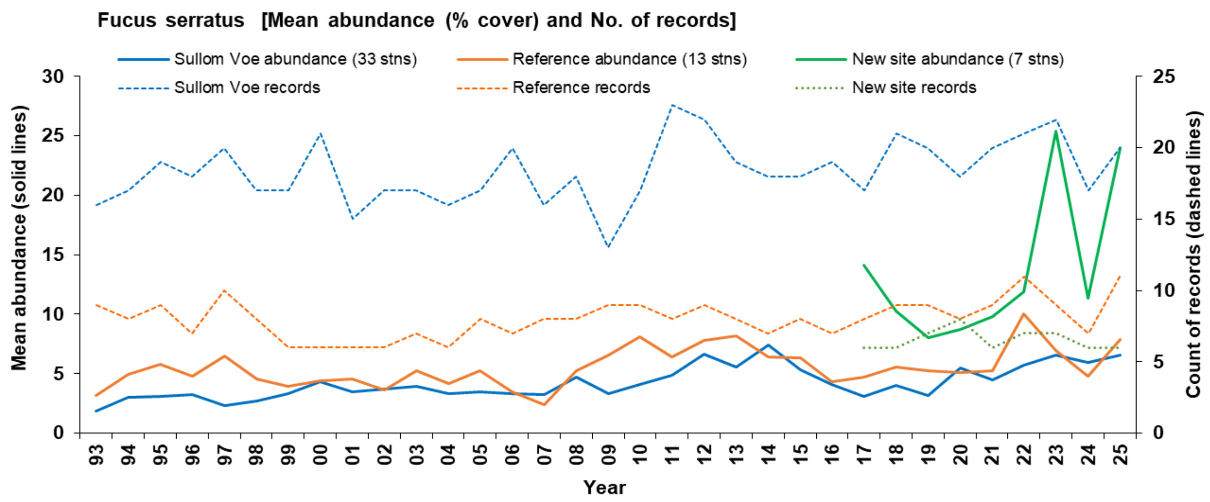
3.1.16 *Fucus spiralis* (spiral wrack)

Monitoring reports from the last two years have described the progressive gradual increase in abundance of this upper shore fucoid, but also the potential for it to fluctuate surprisingly quickly, with little or no synchrony between sites in some years. This is again shown in the graph below which highlights large fluctuations in average abundance at the new reference sites, while there was relatively little change across the Sullom Voe sites and other reference sites. Inspection of the data shows notable increases at both Ola's Ness (see photo above) and Croo Taing.



3.1.17 *Fucus serratus* (serrated wrack)

Average abundances of serrated wrack have not fluctuated greatly at the majority of sites in recent years and the changes that have been recorded were usually more subtle than suggested by the graph below. The large fluctuations shown in the graph for the new reference sites was largely caused by apparent changes at one site: Croo Taing. The lower shore stations (D and E) at that site are characterised by medium sized boulders, with dense fucoids on their tops. They can be difficult to survey consistently and the fucoids can lie in different directions when the tide falls.

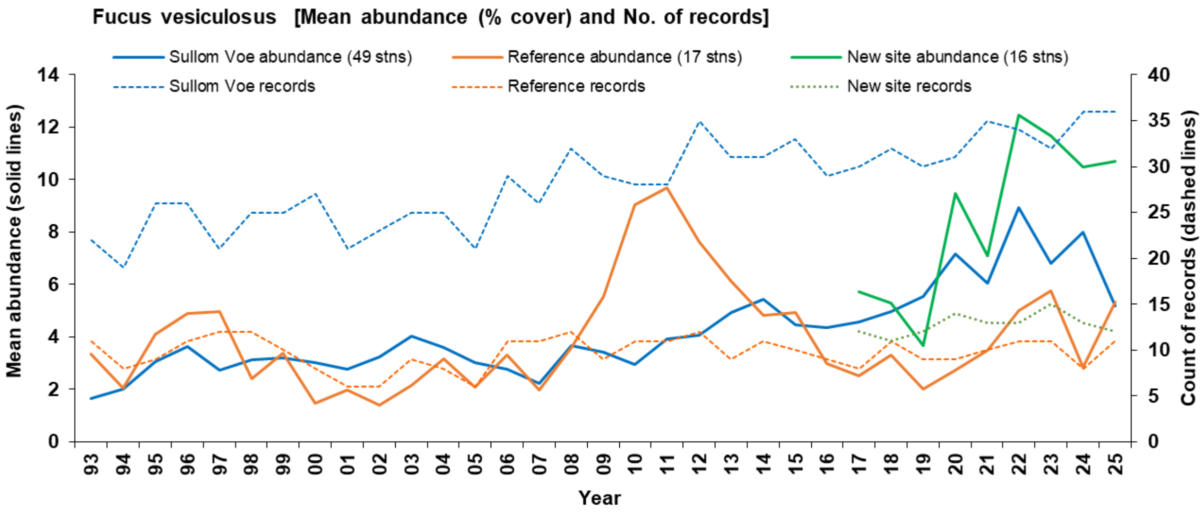


The photograph below shows *Fucus serratus* thalli with long bladders at the ends of some fronds. This species does not normally have air bladders, so it may be a hybrid with one of the other fucoids.

Fucus serratus, with long bladders, at Kirkabister (*left*) and *F. vesiculosus at Scatsta Ness* (right).

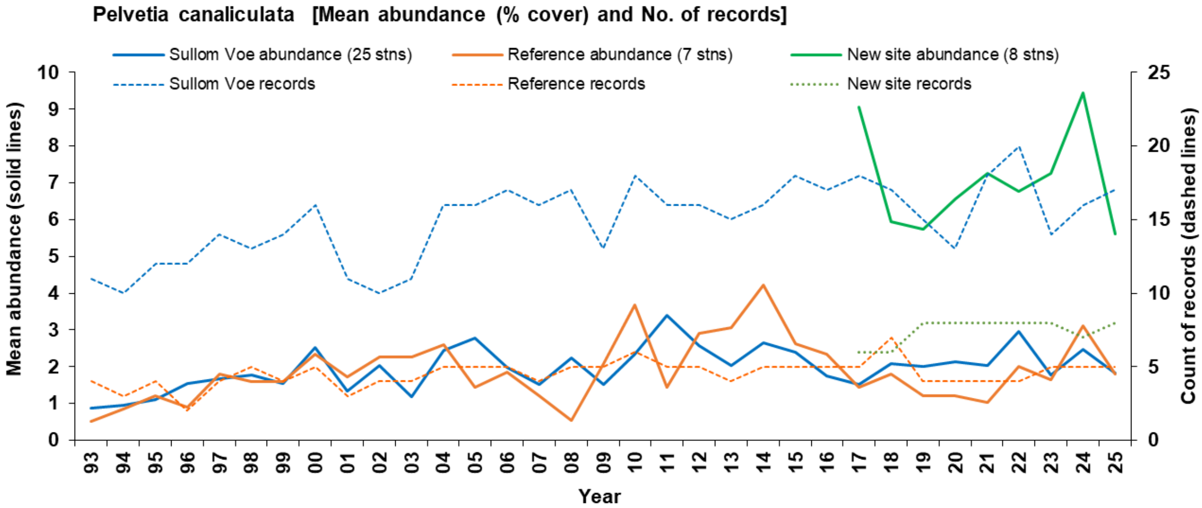
3.1.18 *Fucus vesiculosus* (bladder wrack)

There was a notable decline in the average abundance of bladder wrack (see photo above) at Sullom Voe sites in 2025. The decreases were seen at numerous sites and many are visible in the photographs; but they are considered to be natural fluctuations. The increased abundance at reference sites, shown in the graph, is largely due to the recovery of fucoid cover at Kirkabister (see Section 3.2.2).

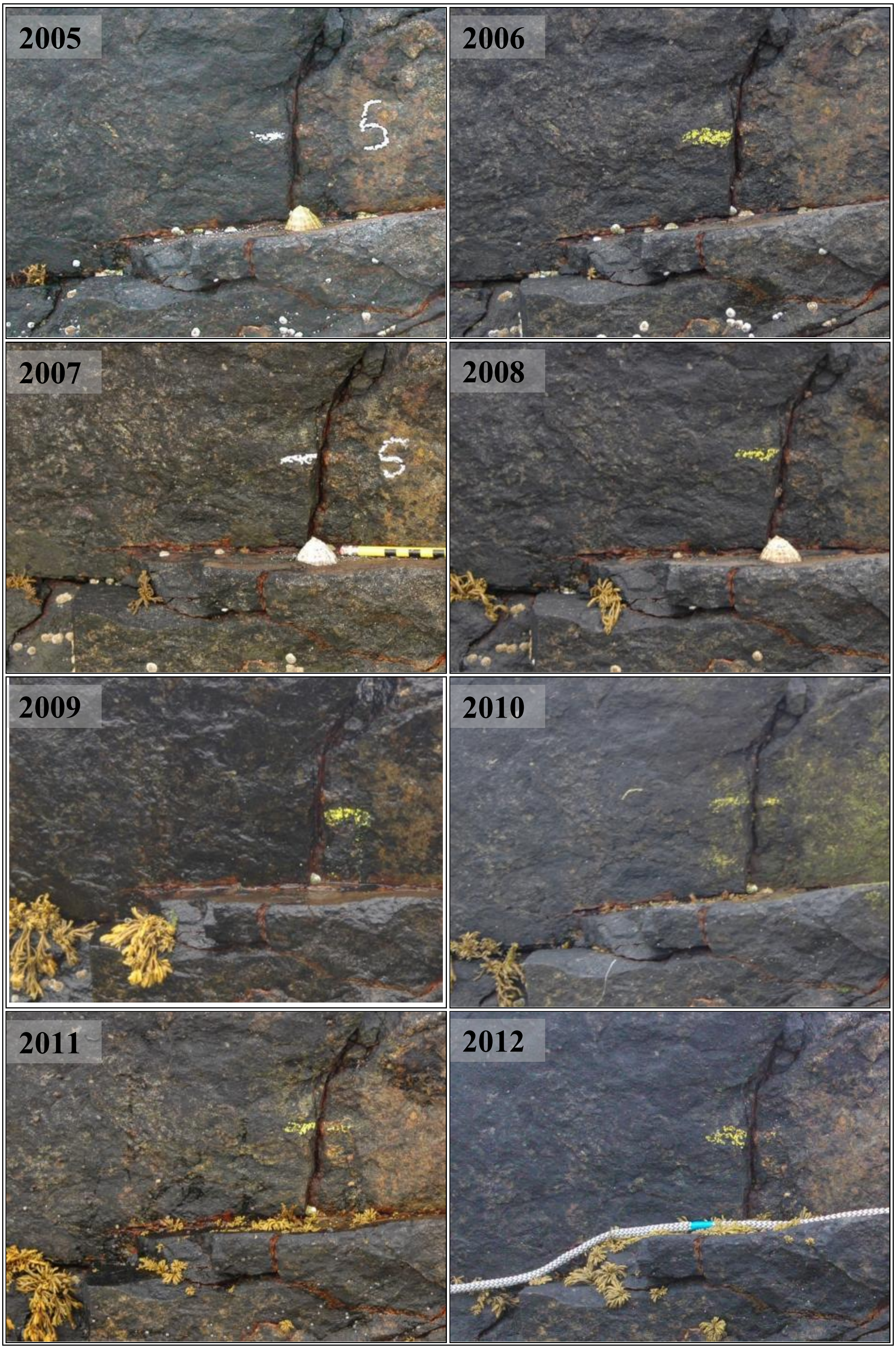


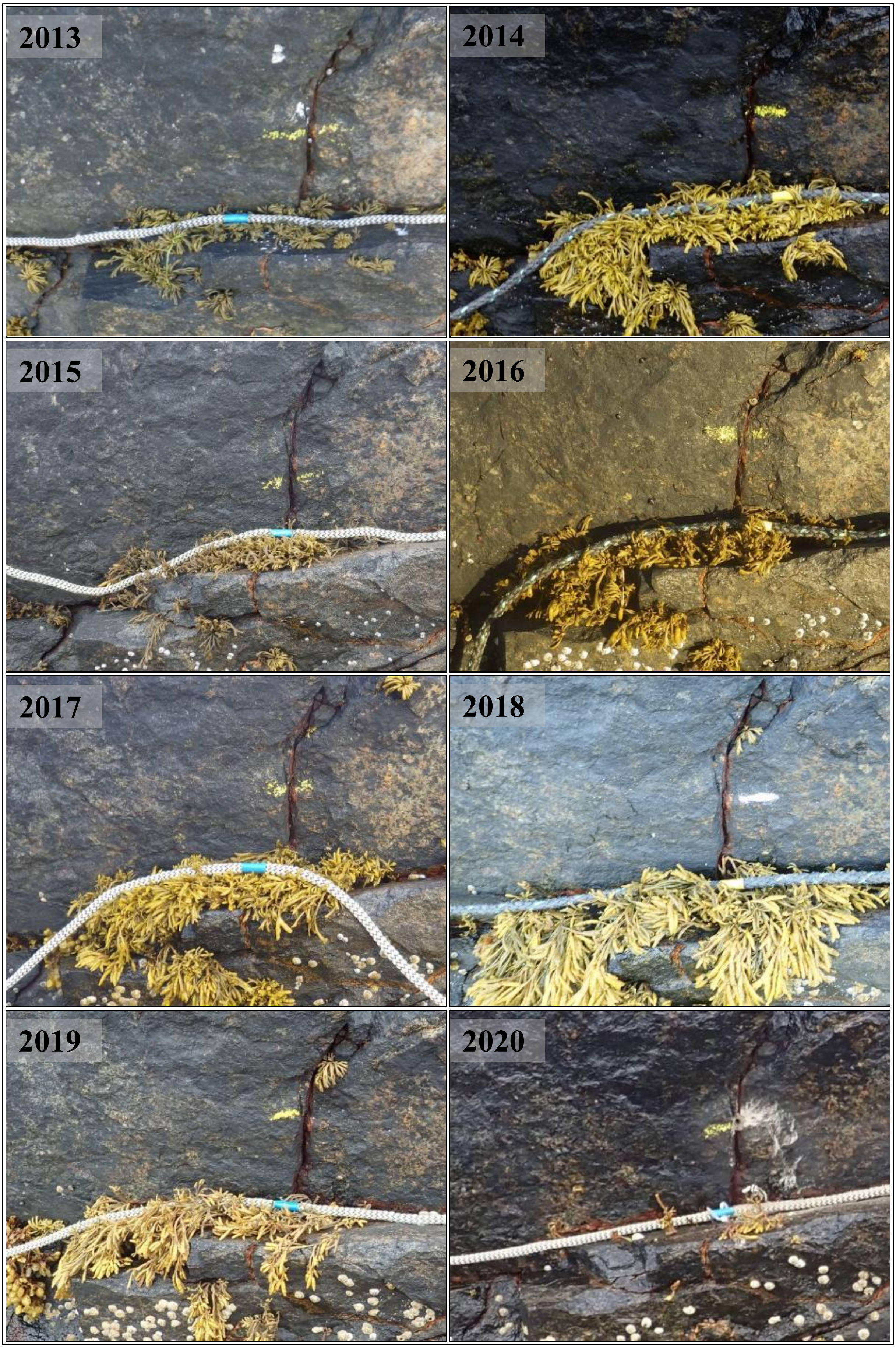
3.1.19 *Pelvetia canaliculata* (channelled wrack)

Average abundances of channelled wrack were relatively low in 2025 following the highs of 2024 (see graph below), but abundances at individual sites remained within the normal range of fluctuations and there were no apparent trends.



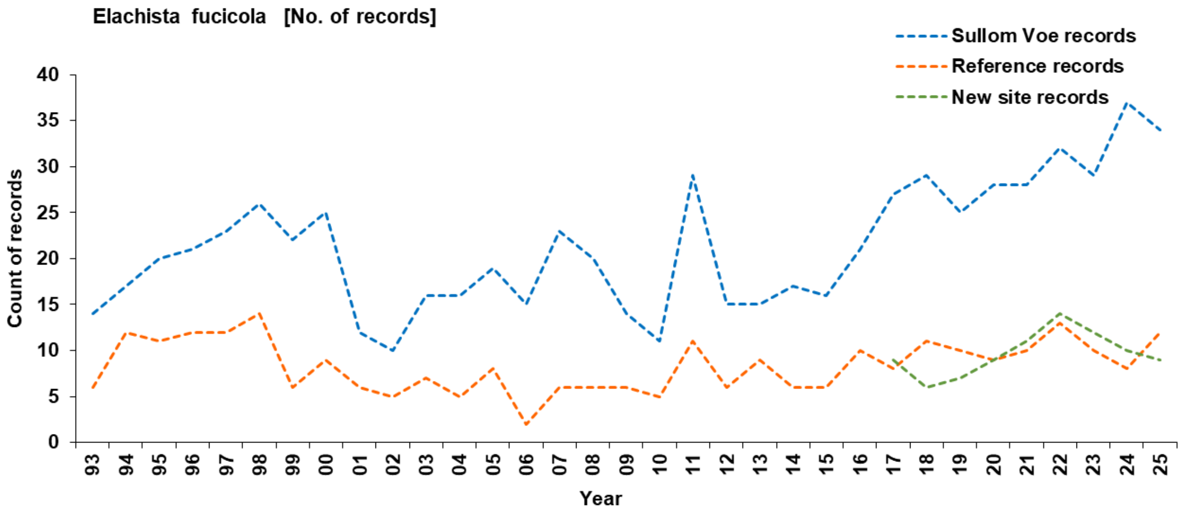
A time series of 21 photographs from Vidlin Ness station A is shown on the next three pages – they have been cropped to show the same area every year from 2005 to 2025 and highlight the natural settlement, growth and die back of *Pelvetia*. It is included here for interest.

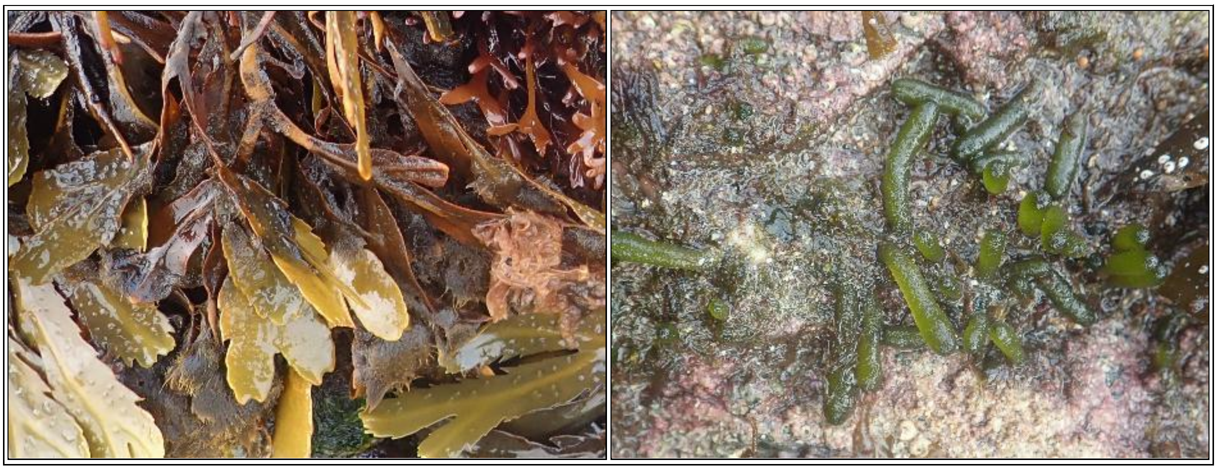

2005
2006
2007
2008
2009
2010
2011
2012


2013
2014
2015
2016
2017
2018
2019
2020

3.1.20 *Elachista fucicola* (brown alga)

Elachista fucicola is a filamentous brown alga that grows as an epiphyte on the fronds of some fucoid algae, forming distinctive tufts (see photo below). Abundance is difficult to estimate, but numbers of records have gradually increased at Sullom Voe sites over the last 13 years (Note: the peak in 2011 may have include some other misidentified filamentous brown algae). Numbers of records at reference sites have not increased to the same extent.

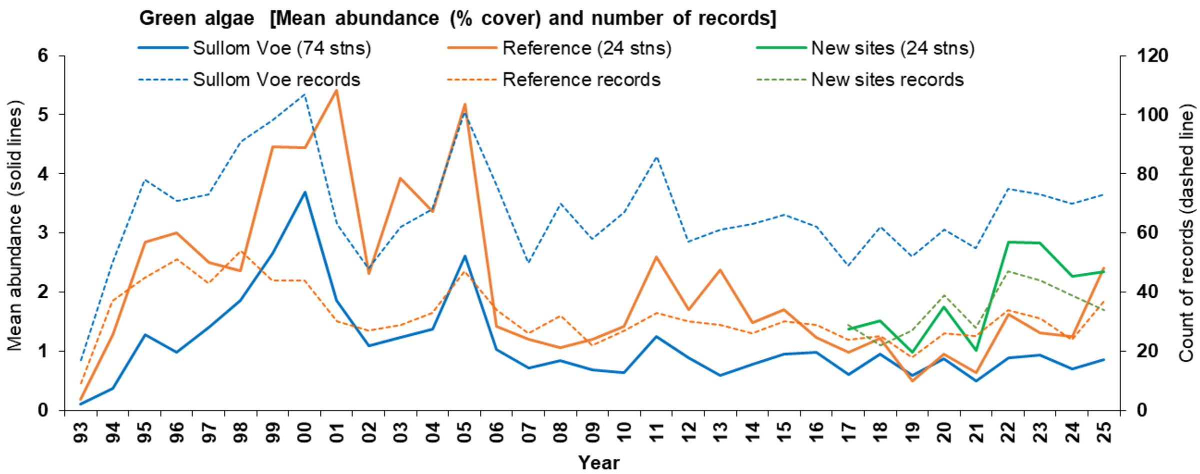




Elachista fucicola on Fucus serratus at Burgo Taing (left) and Codium at North Burra Voe (right).

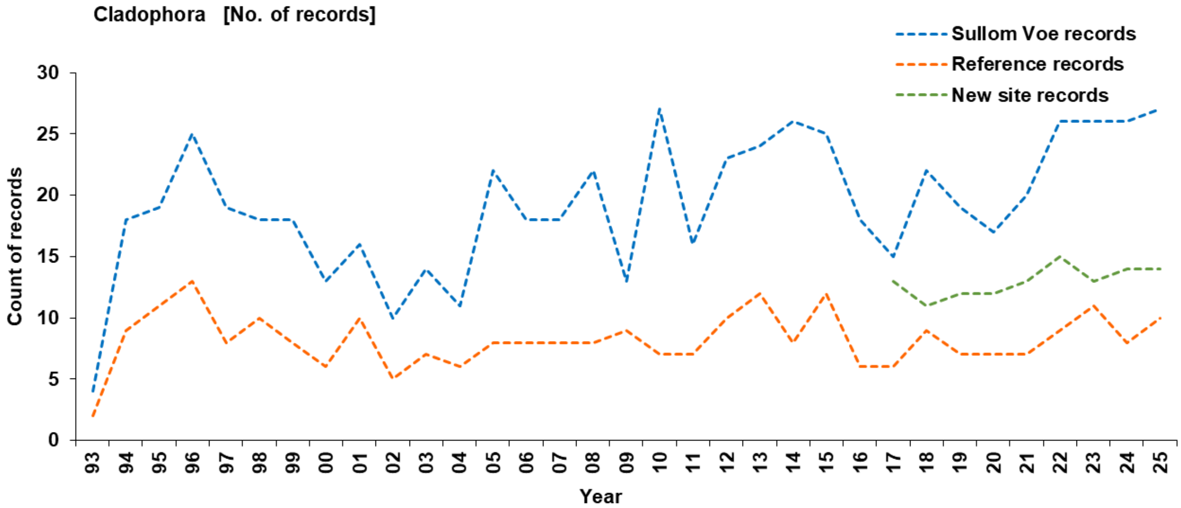
3.1.21 Green algae

The abundance of green algae (as an aggregate group) fluctuated slightly, up and down, at many sites and stations (see graph below), but the only notable change was at the reference site Kirkabister (see Section 3.2.2) where physical disturbance of the shore allowed opportunistic *Ulva* (tubular) to flourish.



Codium (see photo above) is infrequently recorded on any of the transect sites, and is not common in Shetland, but is a conspicuous species of interest. It was recorded from two sites in 2025.

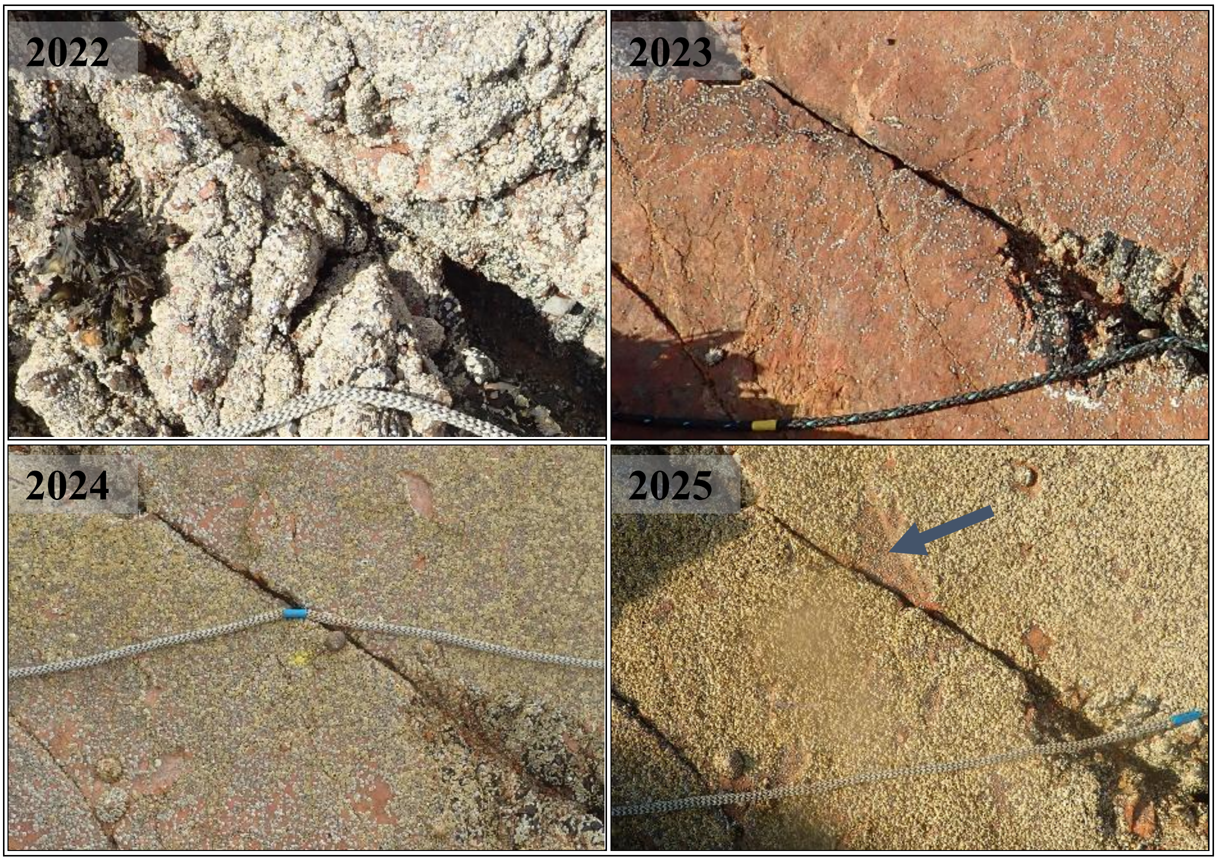
Numbers of records of *Cladophora*, primarily *C. rupestris* but also *C. sericea*, *C. albida* and *C. prolifera*, have shown a slight trend of increase over the last 25 years at the Sullom Voe sites (see graph below).



3.2 Changes at specific sites

3.2.1 The Kames

Colonisation continues on the fresh rock surface in the mid shore station (D) at the Kames, following the 2022/23 rockfall (see photos below). There were no additional species within the affected area since 2024 and there was no apparent colonisation by algae, though *Fucus vesiculosus* and other algae were still present elsewhere in the station.



Colonisation of fresh rock surface in mid shore station D at The Kames, 2022 to 2025. Arrow indicates where another small flake of rock has fallen away since the 2024 survey.

3.2.2 Kirkabister

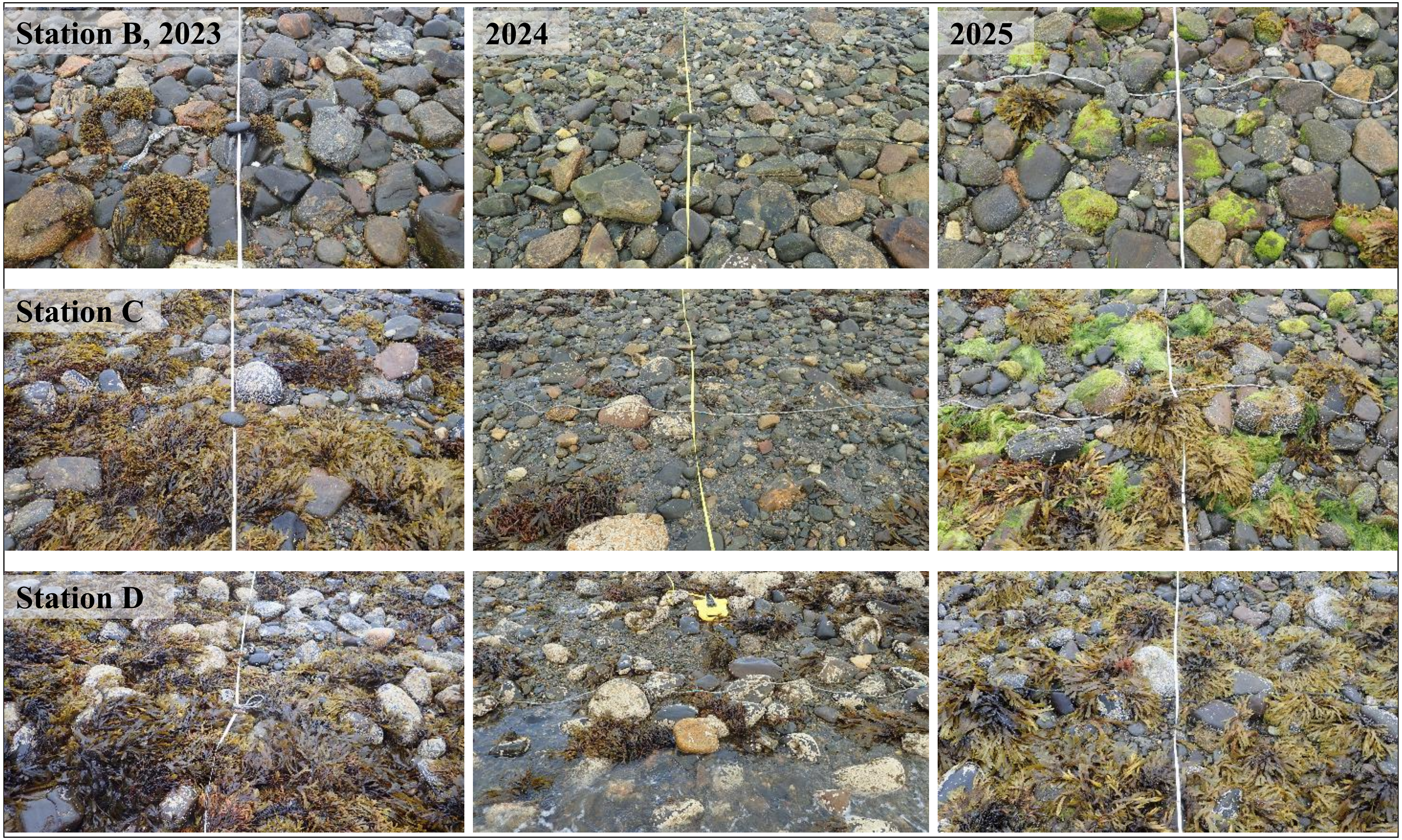
Kirkabister is a boulder/cobble shore on Vidlin Voe and one of the reference sites that was originally established in 1977, dropped from the programme in 1981, re-established in 1993 and monitored annually to date.

The 2024 survey found that there had been a considerable conspicuous loss of fucoid algae from the mid shore, and notable reductions in the abundance of many algae and animals from stations A (upper shore) to D (lower mid shore). The changes were likely caused by physical disturbance, and it is now presumed this was due to some human activity, possibly mechanical. Unfortunately, the lower shore station (E) was not surveyed in 2024 as it wasn't uncovered by the tide, but the physical disturbance is not thought to have affected that zone.

The data and photographs from the 2025 survey show considerable recovery and growth. Abundance of many species was still lower than 2023 (see table below), and stations B and C were characterised by a high cover of ephemeral green algae (see photographs below) – often an indicator of disturbance and ongoing succession.

Abundance of selected species in Kirkabister stations A to E, 1994-2025. Colour formatting to highlight differences and changes. ns = no survey

	Stn	94	95	96	97	98	99	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Pelvetia canaliculata	A	0	0	0	1	1	0	1	0	3	0	3	3	3	2	2	3	2	2	3	1	3	1	3	1	1	0	0	0	0	0	2	1
Fucus spiralis	B	0	4	3	4	5	6	3	0	0	5	5	5	4	0	1	4	5	5	5	5	6	5	4	5	4	4	4	4	4	4	0	0
Ulva (tubular)	B	0	0	0	0	0	1	2	0	0	0	0	3	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	3
Semibalanus balanoides	C	4	3	4	4	4	4	3	5	5	5	5	4	3	4	4	4	3	4	4	4	4	4	4	4	4	3	3	4	4	3	3	4
Patella vulgata	C	4	3	5	4	3	4	4	4	4	4	4	4	3	4	2	3	3	3	3	4	3	3	4	4	2	2	3	3	4	3	2	2
Littorina littorea	C	4	4	4	4	5	4	4	5	6	5	6	5	5	4	3	7	5	6	6	4	4	4	5	6	3	5	5	6	5	5	2	5
Littorina (obtusata / fabalis)	C	6	5	5	6	5	7	4	4	5	4	4	5	5	4	4	5	5	6	5	5	4	5	6	5	5	4	5	5	5	4	2	2
Fucus vesiculosus	C	6	6	6	6	6	7	5	5	5	7	7	7	6	4	4	6	7	6	6	7	7	6	7	7	7	6	7	6	7	6	2	4
Ulva (tubular)	C	0	1	0	2	1	0	0	0	0	0	0	3	0	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4
Actinia equina	D	1	1	0	0	5	0	3	0	5	3	4	2	4	3	0	0	3	3	4	0	3	3	2	2	3	0	0	2	3	2	0	0
Spirorbinae	D	4	3	3	3	0	4	3	0	3	4	4	4	4	3	0	4	4	3	4	5	4	4	4	4	4	4	4	4	4	4	2	4
Semibalanus balanoides	D	4	4	4	4	4	4	4	5	5	5	5	5	4	4	5	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
Patella vulgata	D	5	4	4	4	4	6	4	4	5	5	5	6	4	3	4	4	3	4	4	4	4	4	4	4	3	4	4	5	4	4	3	2
Littorina littorea	D	3	2	3	3	3	4	6	4	6	4	5	3	3	4	5	4	5	5	6	3	5	3	5	5	6	4	5	6	5	4	3	4
Littorina (obtusata / fabalis)	D	5	5	5	5	5	5	3	4	3	5	4	5	4	4	3	3	3	5	5	3	4	4	4	5	5	5	5	5	5	4	0	3
Nucella lapillus	D	0	0	0	1	0	0	0	0	0	0	3	4	6	3	3	2	0	3	4	4	3	4	0	3	5	4	5	4	4	4	0	3
Steromphala cineraria	D	3	4	4	4	3	2	2	0	3	0	2	0	3	4	4	0	0	0	2	0	2	0	0	3	0	0	3	3	4	0	0	3
Fucus vesiculosus	D	4	5	4	5	4	5	4	5	4	3	5	5	4	4	5	6	7	6	6	6	7	5	5	5	6	4	4	4	4	5	4	5
Fucus serratus	D	5	5	5	5	5	6	5	5	4	6	4	5	4	4	4	5	5	3	5	5	5	6	4	4	4	6	5	5	6	5	0	5
Ulva (tubular)	D	2	2	3	0	2	3	2	0	3	3	3	3	1	3	1	0	0	0	0	2	0	0	0	0	0	0	0	0	1	2	0	2
Semibalanus balanoides	E	3	2	3	0	2	0	3	2	2	2	4	3	2	3	4	2	4	3	3	3	4	0	4	3	4	4	4	4	3	4	ns	3
Patella vulgata	E	3	2	4	2	3	0	2	0	3	0	3	2	0	3	4	3	3	2	0	0	3	0	3	2	2	2	0	4	2	2	ns	3
Steromphala cineraria	E	3	2	5	5	3	0	3	3	0	2	2	4	2	5	4	4	4	0	0	0	2	0	5	3	0	3	3	2	5	0	ns	4
Fucus serratus	E	7	6	6	5	7	0	5	7	7	6	7	7	4	4	5	6	7	6	5	6	7	0	6	6	7	7	6	5	7	6	ns	6



Photographs of Kirkabister stations B, C and D, in 2023, 2024 and 2025.

4 Discussion

4.1 Changes in rocky shore communities

There were few notable changes in rocky shore communities around Sullom Voe between August 2024 and July 2025. All of the fluctuations described in the results sections are considered to be natural and within typical levels for those shores and the survey methodology.

4.2 Fugla Ayre lower shore

The lower shore station on this boulder shore transect has not been fully surveyed since 2019, due initially, it was thought, to poor tides on the day of the survey. It is now appreciated that the lower shore profile has changed at this site, so that the tape measurements used for relocation are now marking a location that is deeper than the station should be. It will be appropriate to re-survey the shore profile (using a cross-staff or water pipe level) and re-establish the lower shore station in 2026.

4.3 Effects of terminal operations and oil spills

During the period 1st August 2024 to 31st July 2025 there was one pollution incident reported within Sullom Voe – approximately 400 litres of red diesel was unintentionally discharged into the water at Sella Ness (inner tug jetty), in February 2025. The diesel dispersed naturally, with no recoverable product or shoreline impact observed (Shetland Islands Council, pers. comm.).

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

5 References

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Appendix 1 Abundance scales used for intertidal organisms

Adapted slightly from Baker & Crothers 1987 (page 170).

R = Rare, O = Occasional, F = Frequent, C = Common, A = Abundant, S = Super abundant, E = Extremely abundant. The letters are converted to a numerical scale, from 1 = Rare to 7 = Extremely abundant, for database storage and for some numerical analyses (see methods sections).

1. Live barnacles (record adults, spat, cyprids separately); *Melarhaphe neritoides; Littorina saxatilis (ecotype 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	**7. *Spirobranchus* 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
2. *Perforatus perforatus – not applicable in Shetland*	**8. Spirorbinae** 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
3. *Patella* spp. 10 mm+, *Littorina littorea* (juv. & adults), *Littorina obtusata/fabalis* (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	**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
4. *Littorina 'saxatilis', Patella* <10 mm, *Anurida maritima, Hyale nilssoni* and other amphipods, *Littorina obtusata/fabalis* 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	**10. Flowering plants, lichens, encrusting coralline algae** 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
5. *Nucella lapillus* (>3 mm), *Steromphala* sp., *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	**11. Algae (non-encrusting)** 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
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	**Other animal species**: record as percentage cover or approximate numbers within 0.01, 0.1 or 1 m^2

Appendix 2 Chronology of personnel changes and methodology during SOTEAG rocky shore monitoring programme

Contractors: Oil Pollution Research Unit (OPRU), Field Studies Council Research Centre (FSCRC), Cordah Ltd., BMT Cordah Ltd., Aquatic Survey & Monitoring Ltd. (ASML)

Survey staff: Anne Bunker (AB), Annette Little (AL), Tony Thomas (AT), Betsy Conger (BC), Ben James (BJ), Christine Howson (CH), Cait Moore (CM), 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), Kirsten Laurenson (KL), Kristofer Wilson (KW), 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 *et al.* 2024)

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

Year	Contractor	Survey staff	Sites	Stns	**Methods** (see Moore 2013 for explanation)	Month
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, KL	15 + 10	5	Full survey (5 additional reference sites)	July
2018	ASML	JM, TM, CM, KL	15 + 10	5	Full survey (+ dogwhelks)	August
2019	ASML	JM, FB, CM, KW	15 + 10	5	Full survey	August
2020	ASML	JM, TM, CM	14 + 10	5	Full survey	August
2021	ASML	JM, AB	15 + 10	5	Full survey (+ dogwhelks)	August
2022	ASML	JM, TM	15 + 10	5	Full survey	July/Aug
2023	ASML	JM, TM	15 + 10	5	Full survey	July
2024	ASML	JM, TM	15 + 10	5	Full survey (+ dogwhelks)	August
2025	ASML	JM, TM, BC	15 + 10	5	Full survey	July