Fal and Helford SAC: Subtidal Seagrass Condition Assessment 2015

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EXECUTIVE SUMMARY

A combination of drop-down/towed video (DD/TV) and diver surveys were carried out on the subtidal seagrass beds within the Fal and Helford Special Area of Conservation (SAC) between June and September 2015. The DD/TV surveys were carried out by Ecospan Environmental Ltd, and the diver surveys by Natural England. The results and conclusions drawn from both survey methods are reported here together.

The principal aim of the surveys was to obtain standardised biological information for the seagrass beds within the SAC, and to compare these data with previous studies for the purpose of condition monitoring of the seagrass sub-feature where possible. These surveys were intended to provide an ecological baseline for assessment of specific attributes to inform the condition from which to assess future change where previous data does not exist.

A number of difficulties and limitations were experienced when trying to compare the data collected in this study with historical data. This was primarily because of the lack of previous targeted studies but also because of different methods and sampling locations employed. As a result it has only been possible to make an assessment of the 'extent' attribute of the seagrass sub-feature (although the confidence applied to making direct temporal comparisons in extent was very variable between beds and largely dependent upon the source of the historical data).

Seagrass extent surveys were carried out at 16 different locations within the SAC, percentage cover data was gathered at 14 of those. Seagrass has been lost from small areas in the lower Percuil (at Polvarth Point) and in the Fal north of Trefusis Point. Temporal comparisons of extent could initially be perceived as showing extensions of all the remaining known seagrass beds in the SAC over time (in some areas the increase in mapped extent was quite substantial). However, this increase may be due to the full extent of seagrass having not been surveyed in previous studies as well as estimates/arbitrary bed extents having been previously mapped. It is possible that the extent of seagrass has actually increased in some areas, but this can't be confirmed given the data available, particularly as the percentage cover threshold used to delineate the 'edge' of a bed has not been defined in any of the previous studies

Diver surveys were carried out at 4 beds, 3 in the Fal and 1 in the Helford. The principal limitation in being able to make temporal comparisons for all the attributes measured using divers was the lack of historical data. The only firm data available was for the bed found between Polgwidden Cove and Toll Point in the Helford where plant density had been measured in 1997. However, different methods and sampling positions in 1997 prevented anything but broad comparisons from being made; these suggested that plant density has not changed substantially since 1997. Given that this limited data was only available for 1 of the 4 beds that were assessed for plant density, the overall condition of the attribute was assessed as unknown.

The absence of previous data at some beds and the application of different methods in others for recording leaf infection and epiphyte presence/abundance as well as leaf length made it impossible to make temporal comparisons for the remaining seagrass attributes. Consequently the condition of the leaf infection percentage cover, infection score, epiphyte score and maximum leaf length attributes is unknown. The presence of *Labyrinthula* sp. was

not confirmed in 2015 but 'leaf browning' has been used as an indicator of its presence and has been recorded in each of the four beds that were surveyed by divers.

With regard to identifying anthropogenic influences that are impacting on the ability of the seagrass sub-feature to achieve Favourable Condition, no definitive evidence of negative effects from anchoring or mooring (or any other human activity) were apparent in the Fal and Helford SAC. This may not necessarily be the case, and further targeted studies would be required in order to make a definitive conclusion.

A number of recommendations have been made to improve the quality and usefulness of data in future studies of the subtidal seagrass in the Fal and Helford SAC, to better inform the overall condition assessment of the feature.

1. INTRODUCTION

1.1 Study Area

The Fal and Helford Special Area of Conservation (SAC) is a complex site on the south coast of Cornwall comprised of the two ria systems of the Fal and Helford Rivers and adjacent Falmouth Bay. The rias receive a low freshwater input and therefore contain a notable range of fully marine habitats which are affected by the degree of wave exposure ranging from extremely sheltered within the inlets to the wave-exposed, tide-swept open coast[1]. The SAC encompasses a high diversity of marine habitats and species that are of national and international importance and was designated for the following Annex 1 habitats, as listed in the EU Habitats Directive:

- Sandbanks which are slightly covered by seawater all the time.
- Mudflats and sandflats not covered by seawater at low tide.
- Large shallow inlets and bays
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*)

Other Annex I habitats which are present as a qualifying feature, but not a primary reason for selection of the site as a SAC are estuaries and reefs.

Subtidal seagrass beds have been recorded on the sandbanks within the sheltered inlets and bays within the Fal and Helford SAC and are considered an important sub-feature of the 'Sandbanks which are slightly covered by seawater all the time' feature.

Seagrass beds are considered important not only as a habitat for a diverse community of species but also as nursery areas for various fish species, as stabilisers of sediment and as contributors to productivity[1]. Seagrass was once abundant and widespread around the British coasts, but serious declines have occurred, in particular as a consequence of a severe outbreak of 'wasting disease' in the early 1930s[2]. Recovery of seagrass beds since the 1930s has been slow and patchy, and this habitat is now considered a nationally scarce habitat in the UK, with the south-west providing an important stronghold[1].

The habitat in the Fal and Helford SAC is reported to support particularly rich and nationally important invertebrate communities at the mouths of the Fal and Helford estuaries, as well as in some of the smaller channels such as the Percuil River and Passage Cove[1].

Past studies [2 to 19] (which were carried out between 1985 and 2014) reported the most extensive seagrass beds within the SAC to be at sheltered inshore locations within the Helford River between Durgan and Toll Point, at Penarrow Point, along St. Mawes Bank between Carclase Point and East Narrows. The bed located within the Helford estuary between Durgan and Toll Point is one of the largest seagrass beds in Cornwall[8]. Another extensive bed has been previously mapped on the south bank of St. Mawes harbour between Amsterdam Point and Carricknath Point; this bed is considered to be the largest in the Fal[8]. Other known, but smaller seagrass beds have been found in the Helford River east of Passage Cove, at Polgwidden Cove (east of Durgan) and at Bosahan. In the Fal, smaller extents of seagrass have been recorded between Penarrow Point and Trefusis Point, and within the upper Percuil River and on the East and West side of Polvarth Point. The

seagrass extent data from past studies in the Fal and Helford have been collated and used as a basis for the 2015 surveys. These have been mapped in Figures 1 and 2.

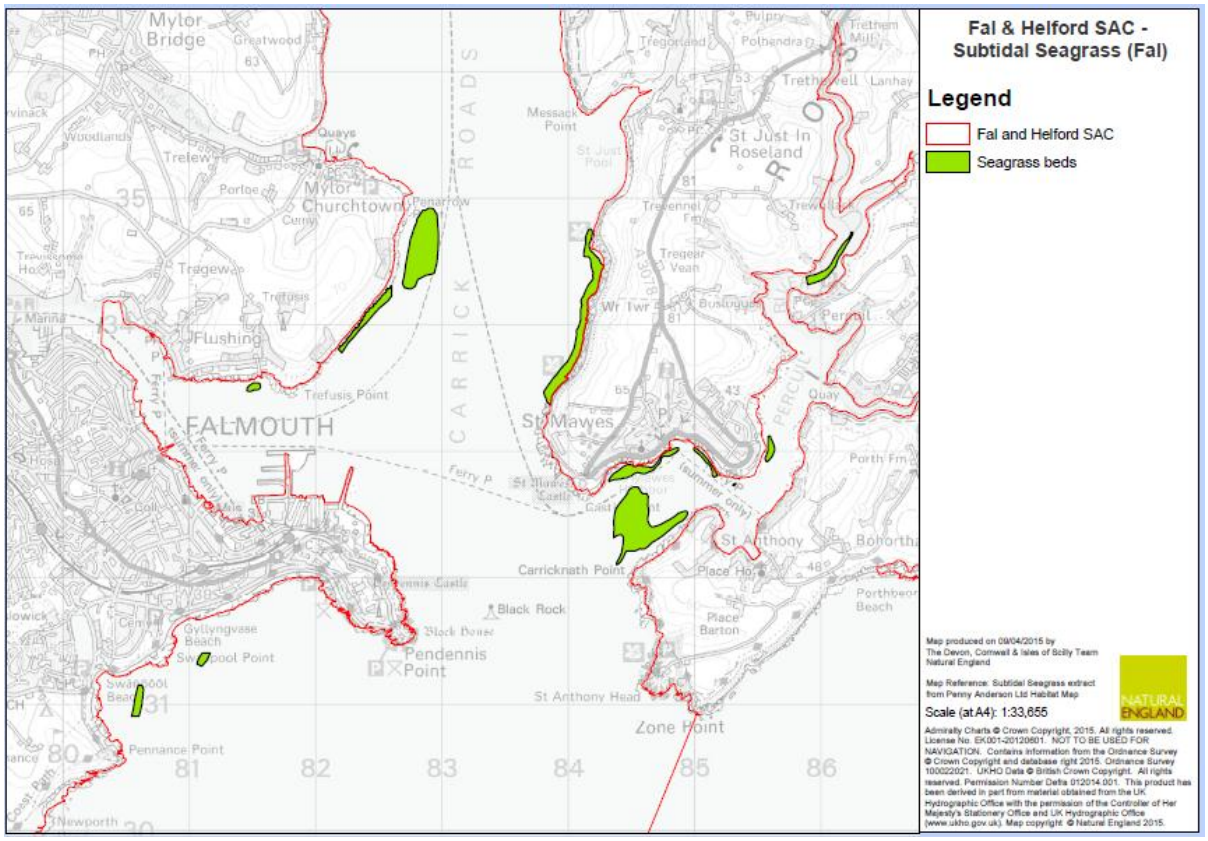

Figure 1. Collection of historical maps of subtidal seagrass beds within the Fal estuary, St.Mawes Bank and St.Mawes harbour.

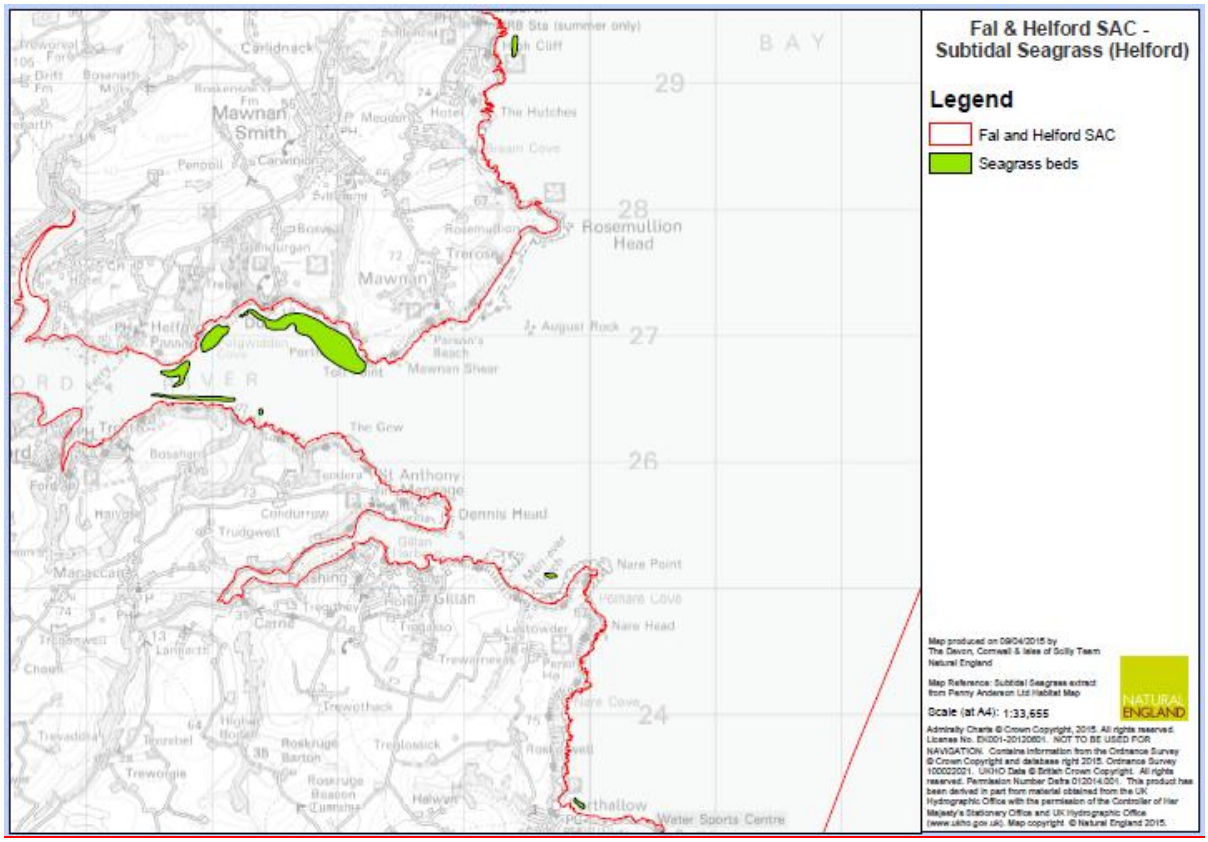

Figure 2. Collection of historical maps of subtidal seagrass beds within the Helford estuary.

1.2 Condition Monitoring of the Seagrass Bed Community Sub-feature of the Fal and Helford SAC.

Site Condition Monitoring is undertaken to inform the condition assessment of the designated features which are within a protected area, and to guide site management action where appropriate. Natural England has a duty to assess the condition of the SAC's features once every six years under the EC Habitats Directive 92/43/EEC. Such assessments start at the attribute level but take account of a number of key considerations to come to an overall decision, set out in the NE condition assessment method.

The Joint Nature Conservation Committee (JNCC) has established a series of common standards for the monitoring of sites of nature conservation interest. Natural England use the Common Standards Monitoring (CSM) guidance, along with other best practice and guidance available to ensure that a consistent approach is taken when monitoring such sites. Within the Fal and Helford SAC, the Sandbanks which are slightly covered by seawater all the time feature fall under the CSM guidance produced for inshore sublittoral sediment habitats[19].

For the purposes of monitoring, each feature or sub-feature of the SAC has an associated series of attributes and relevant measurable targets which indicate the condition of the feature at the site. These are outlined in Natural England's advice under Regulation 35[1]. A target is set for each attribute which is considered to correspond to the favourable condition of the feature. Those attributes which relate to subtidal seagrass in the Fal and Helford SAC are listed in Table 1 together with their individual targets and method of assessment applied within this study. A targeted condition assessment of the subtidal seagrass sub-feature has not been previously undertaken within the Fal and Helford SAC, but references to baseline data relating to each attribute are also listed within Table 1.

Table 1. Fal and Helford SAC seagrass favourable condition table

Sub-feature	Attribute	Measure	Regulation 35 Target	Baseline data	Methods applied in 2015 condition assessment
Seagrass bed communities	Extent	Area (ha) of seagrass bed communities measured twice during peak growth period twice during reporting cycle.	No decrease in extent from an established baseline, subject to natural change.	• Allen *et al*. 2014[3] • Anderson 2013[4] • Kendall *et al*. 2006[12] • Hocking and Tompsett 2002[7] • Cook 2000[6] • Moore *et al*. 1999[2] • Bunker 1992[2] • Rostron 1985 and 1987[8,9]	DD/TV
	Characteristic species density of *Zostera marina*	Average density measured during peak growth period twice during reporting cycle.	Average density should not deviate significantly from an established baseline, subject to natural change.	• Sutton and Tompsett 2000[13] • Hocking and Tompsett 2002[7]	DD/TV and diver survey
	Characteristic species – epiphytic community	Presence and abundance of epiphytic species measured during summer twice during reporting cycle.	Presence and abundance of epiphytic species should not deviate significantly from the established baseline, subject to natural change.	• Cook 2000[6] • Rostron 1985 and 1987[8,9]	Diver survey
	Presence of macroalgae including drift macroalgae within seagrass beds.	Percentage cover and species of macroalgae	Not applicable	• Kendall *et al*. 2006[12] • Hocking and Tompsett 2002[7] • Bunker 1992[5] • Rostron 1985 and 1987[8,9]	Diver survey
	Non-native species and pathogens	Proportion of leaves showing blackening as a proxy for presence of *Labyrinthula* sp. Presence of non-native species.	Not applicable	• Kendall *et al*. 2006[12] • Hocking and Tompsett 2002[7] • Sutton and Tompsett 2000[13] • Bunker 1992[5] • Rostron 1985 and 1987[8,9]	Diver survey
	Maximum leaf length	Maximum length of seagrass blades within quadrats (cm).	Not applicable	• Hocking and Tompsett 2002[7]	Diver survey

2. AIMS AND OBJECTIVES

The overall aims of the project were to:

- Develop a cost effective sampling strategy (that enabled analytical compatibility with historical survey data wherever possible) to assess the condition of the relevant attributes (as listed in Table 1) of all known sublittoral seagrass beds within the Fal and Helford SAC.
- Provide an assessment of the direction of ecological change by integrating data collected using DD/TV methods with those collected using diving methods, and comparing both sets of data with relevant historical studies where possible.
- Provide an ecological baseline for each attribute (from which to assess future change) where this did not exist.
- As far as possible identify any anthropogenic influences that are impacting on the ability of the sub-feature to achieve Favourable Condition.
- Provide an opinion on the overall assessment of the condition of seagrass within the SAC.

3. METHODS

3.1 Seagrass DD/TV survey

Prior to the survey, all available data on seagrass extent from historical studies and previous habitat mapping exercises was collated to ensure that all potential areas of seagrass beds were included within the survey areas.

For the smaller beds of seagrass for which the survey data was limited, a 100m buffer around the known positions was used as the survey area. For the larger more well documented beds a smaller buffer of approximately 40m was used. The survey area was transferred onto electronic charting software (Arc GIS and Seapro) for use on the survey vessel using 20m survey lines. An assessment of the seagrass percentage cover and/or extent was undertaken at 20m intervals along each line. As suggested by CEFAS statisticians in 2012, a triangular lattice design was applied within the target station transect structure to help elucidate extent and patchiness.

Table 2 outlines which beds required only extent to be assessed according to the tender document (where seagrass density ≥5%), and those which required both extent and percentage cover to be assessed. The survey areas and target stations that were used as a basis for the surveys have been plotted in Figures 3 to 14.

A 5% threshold was used to delineate the edge of the bed, this was based on the OSPAR definition of a '*Zostera* spp. bed' which states that plant densities should provide at least 5% cover to qualify[20]. In areas of seagrass where the percentage cover of 5% or greater extended beyond the delineated study areas the survey areas were extended in the field to encompass the full extent of each bed.

Table 2. Historically recorded subtidal seagrass beds and attributes that have been assessed using DD/TV in 2015.

Area	Bed Name	Attributes Measured using DD/TV
Fal	Percuil River (Upper and Lower)	Extent and % cover
	St. Mawes Harbour	Extent and % cover
	Amsterdam Point to Carricknath Point	Extent and % cover
	St. Mawes Bank	Extent and % cover
	Penarrow Point to Trefusis Point	Extent and % cover
	Flushing	Extent
Falmouth Bay	Gyllyngvase and Swanpool	Extent
	Meanporth	Extent
Helford	Polgwidden Cove to Toll Point	Extent and % cover
	East of Passage Cove	Extent and % cover
	Bosahan	Extent
South of the Helford	Gillan Creek	Extent
	Parbean Cove	Extent
	Porthallow Cove	Extent

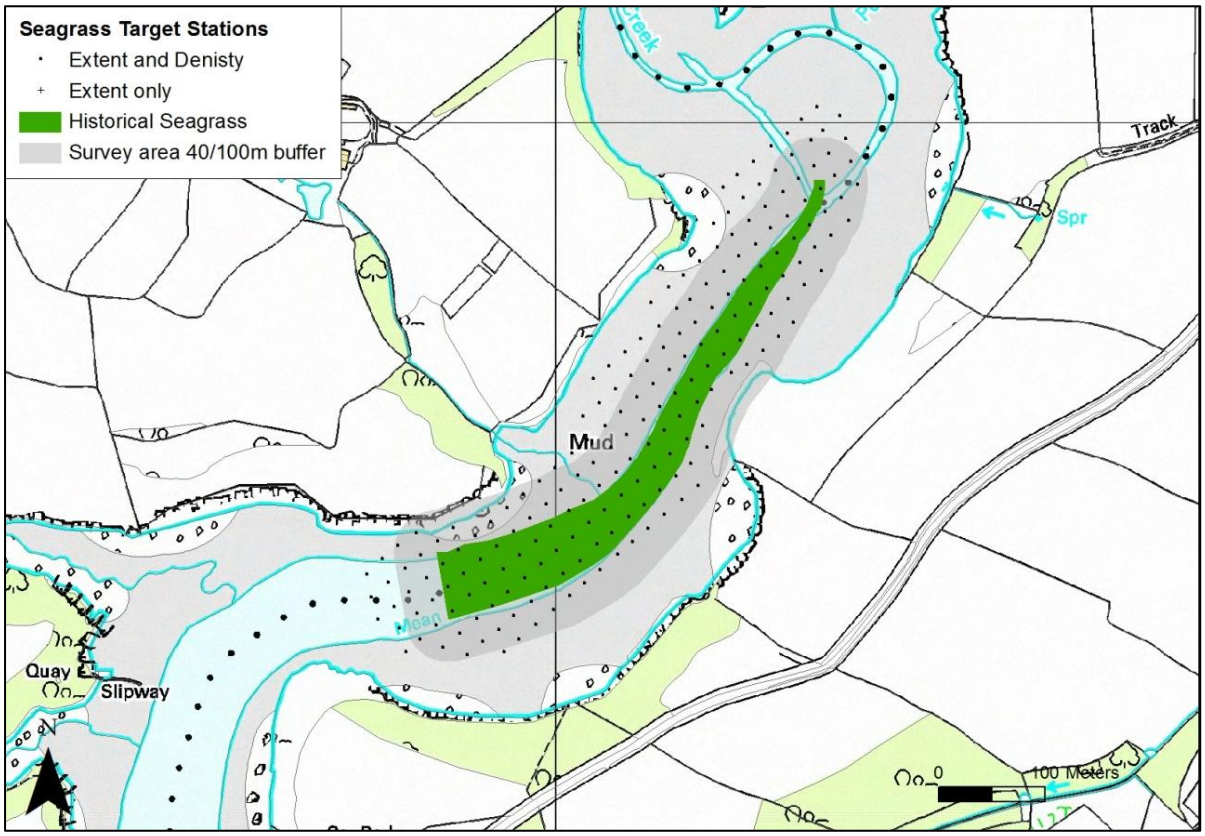

Figure 3. Upper Percuil survey area.

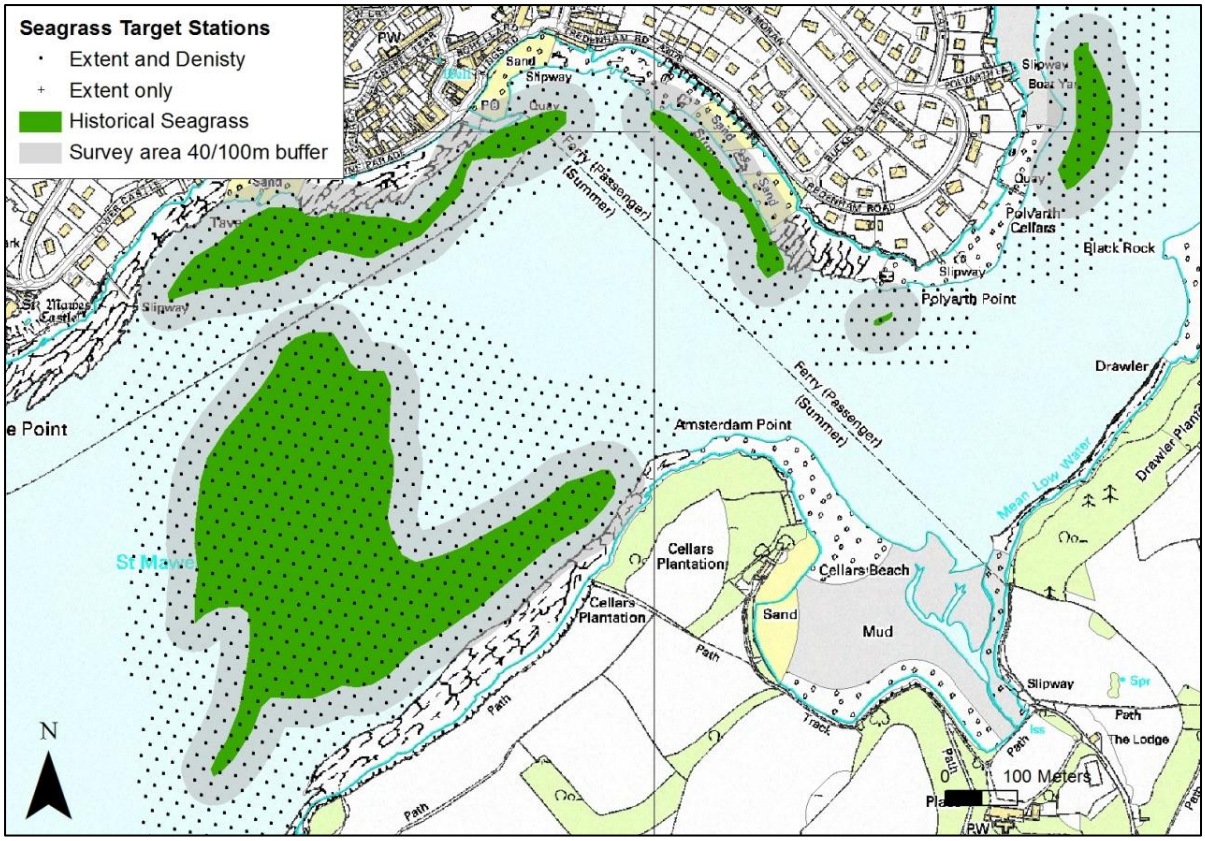

Figure 4. Lower Percuil, St. Mawes Harbour and Amsterdam Point to Carricknath Point survey areas.

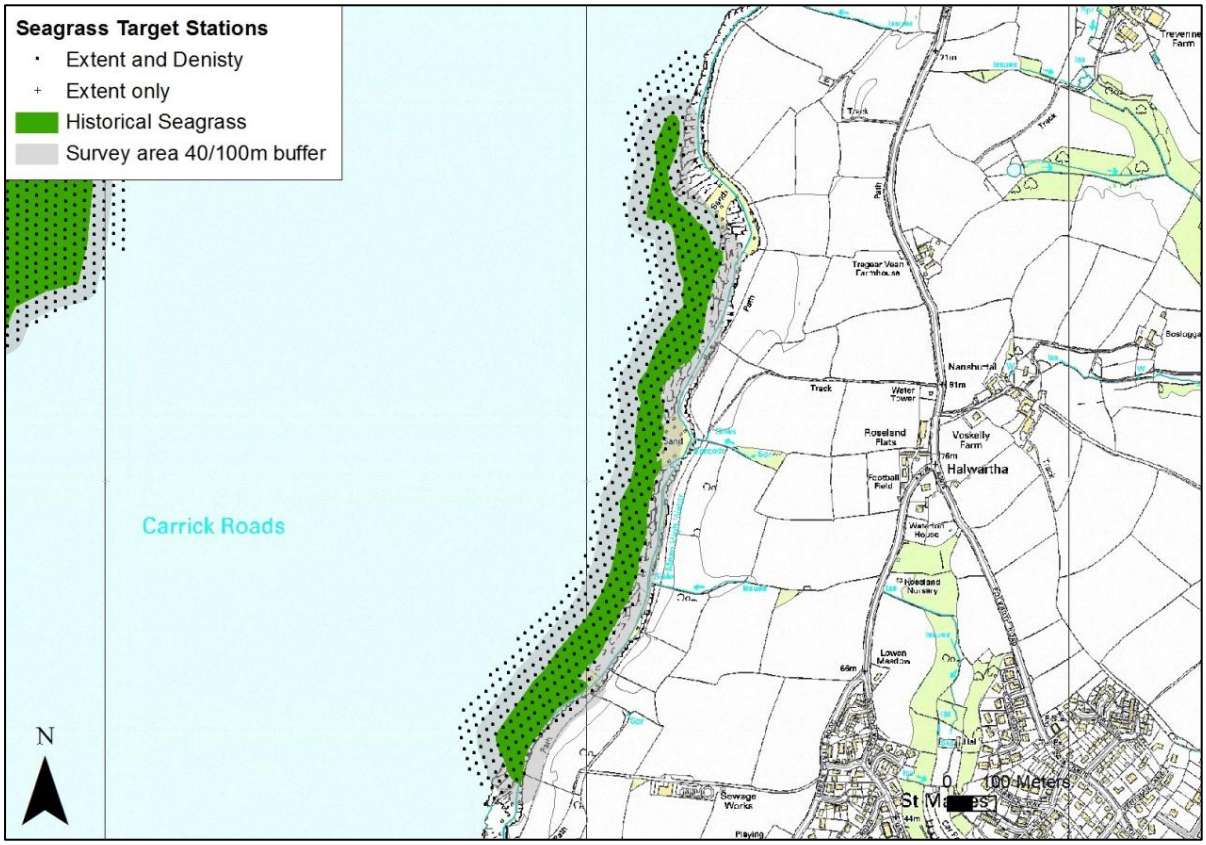

Figure 5. St. Mawes Bank survey area.

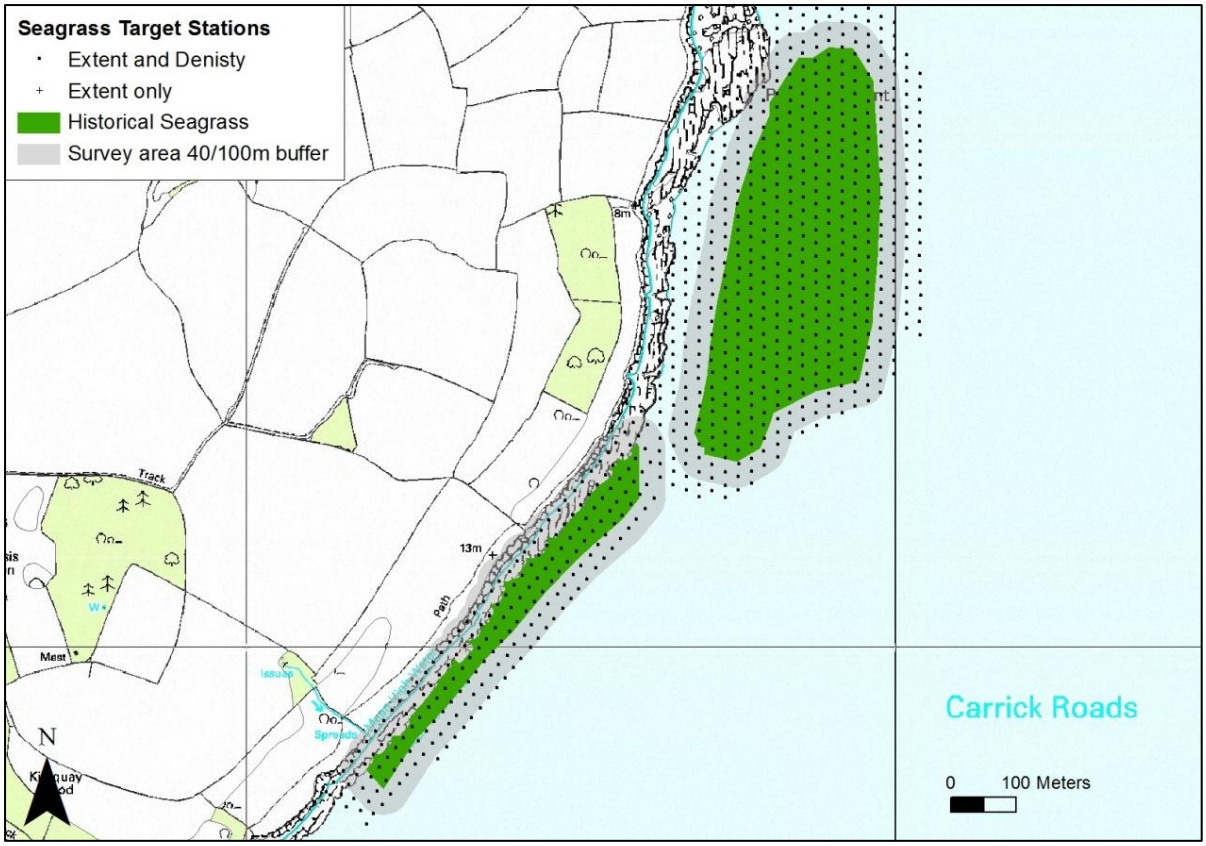

Figure 6. Penarrow Point to Trefusis Point survey area.

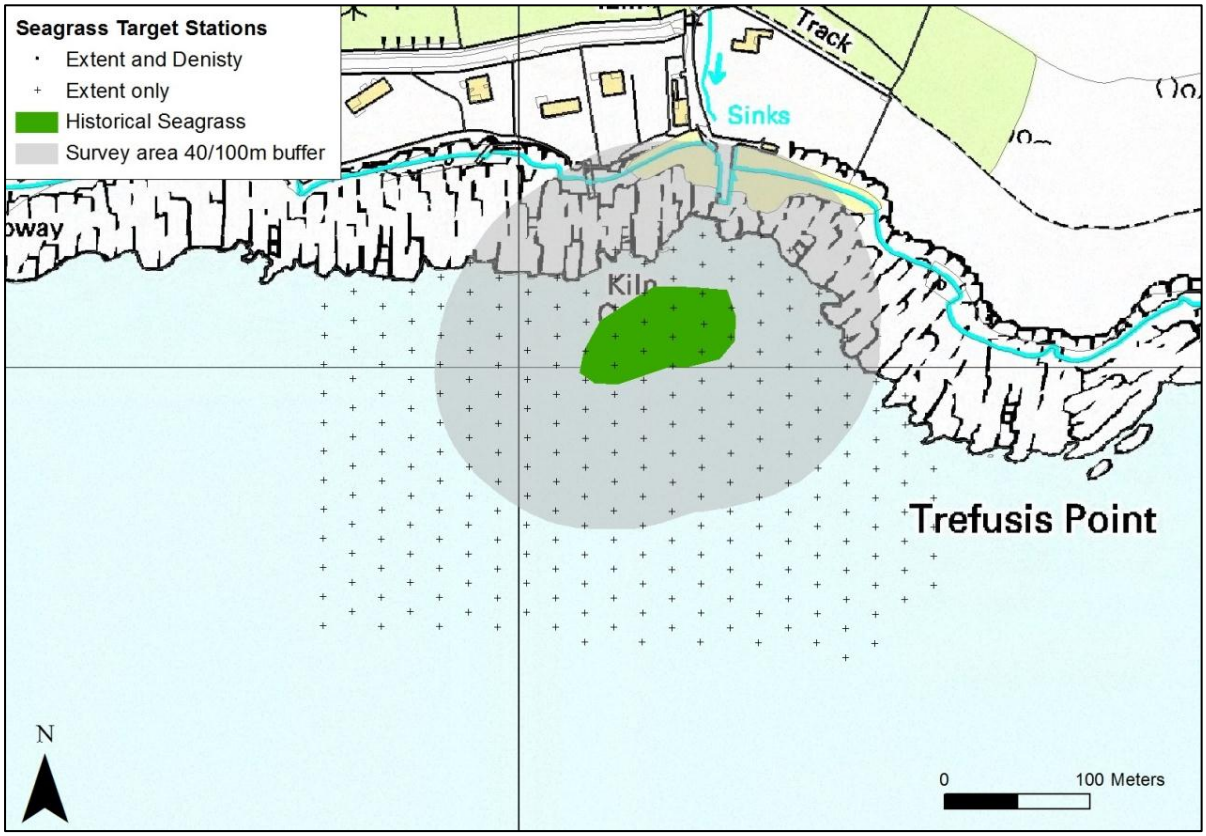

Figure 7. Flushing survey area.

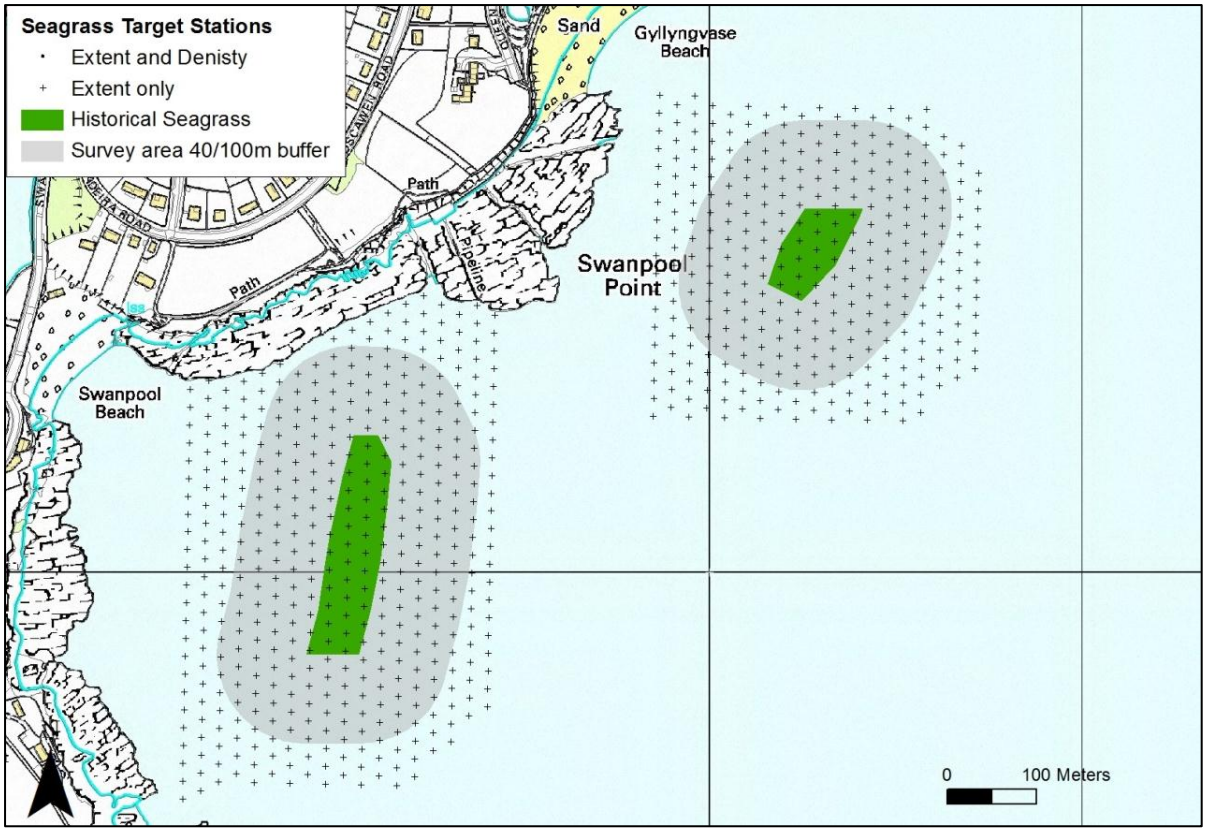

Figure 8. Gyllyngvase and Swanpool survey area.

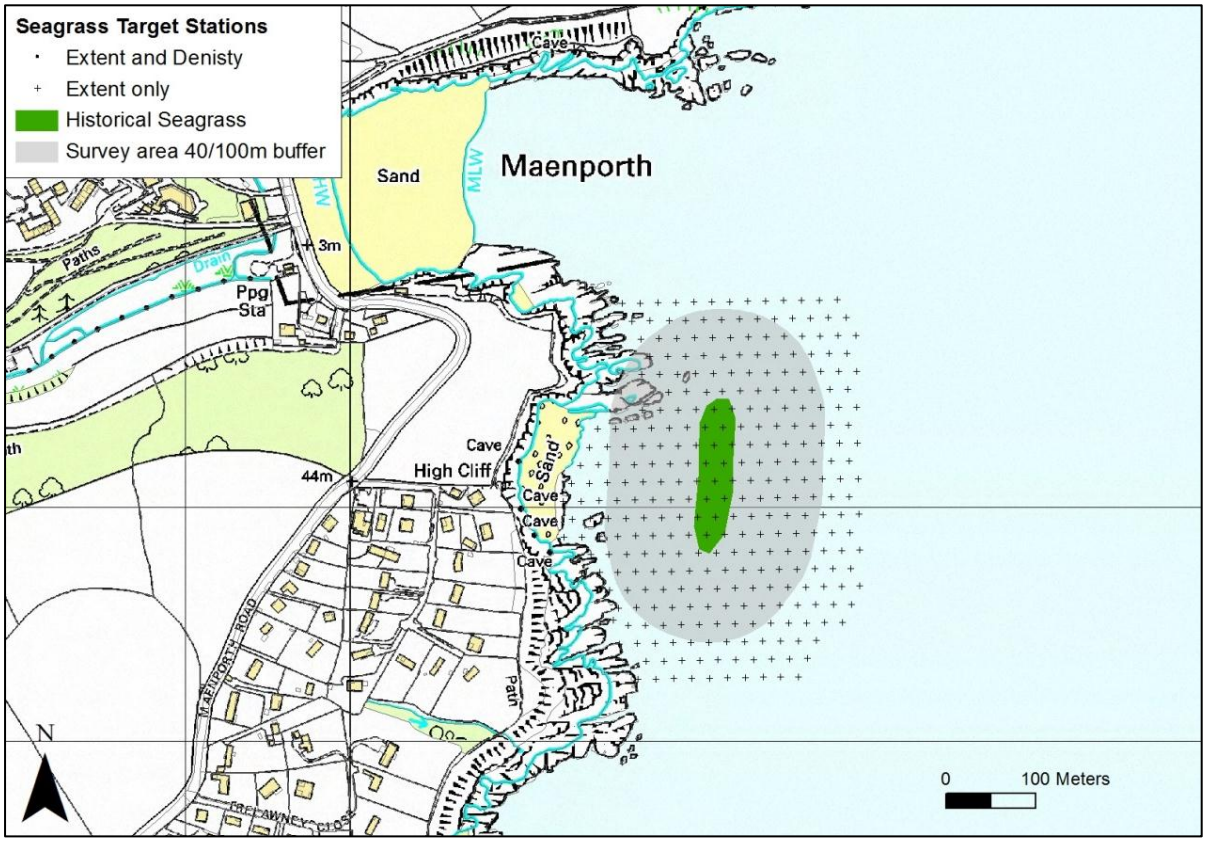

Figure 9. Maenporth survey area.

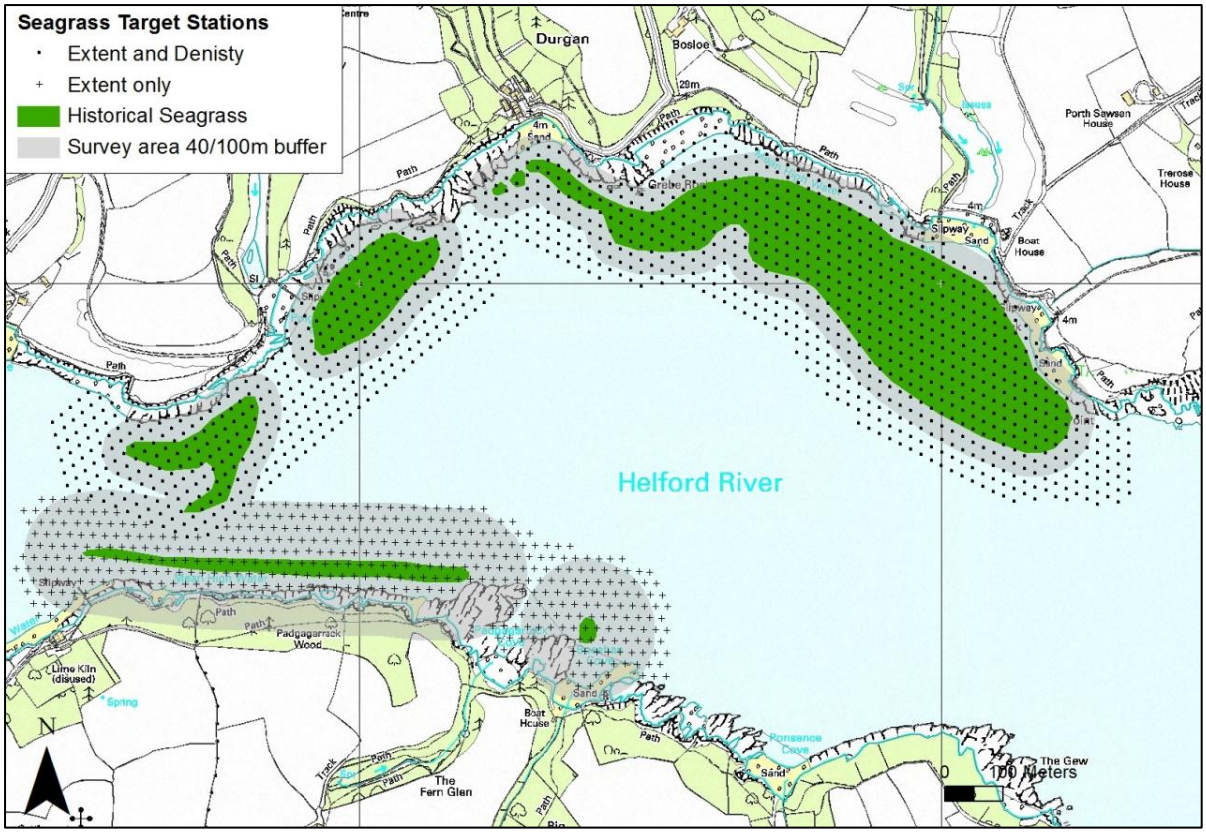

Figure 10. Polgwidden Cove to Toll Point, East of Passage Cove and Bosahan survey areas.

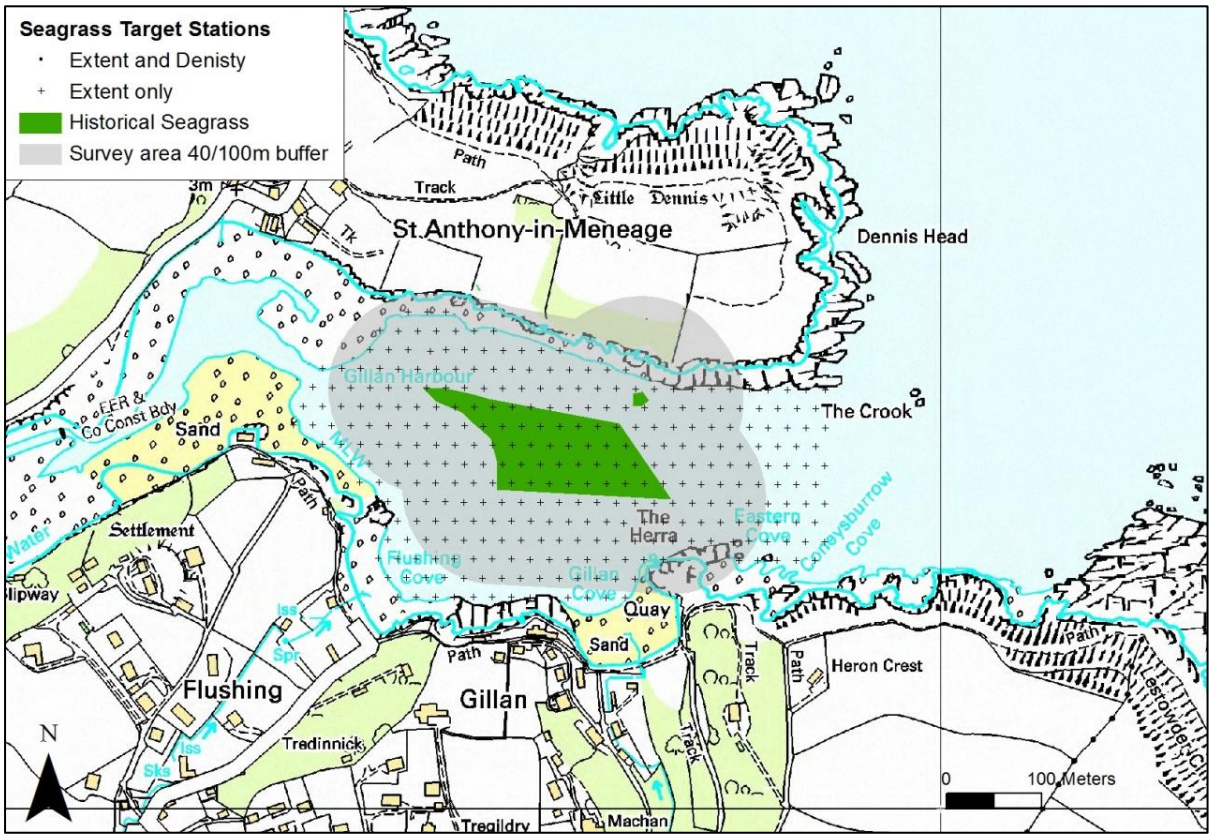

Figure 11. Gillan Creek survey area.

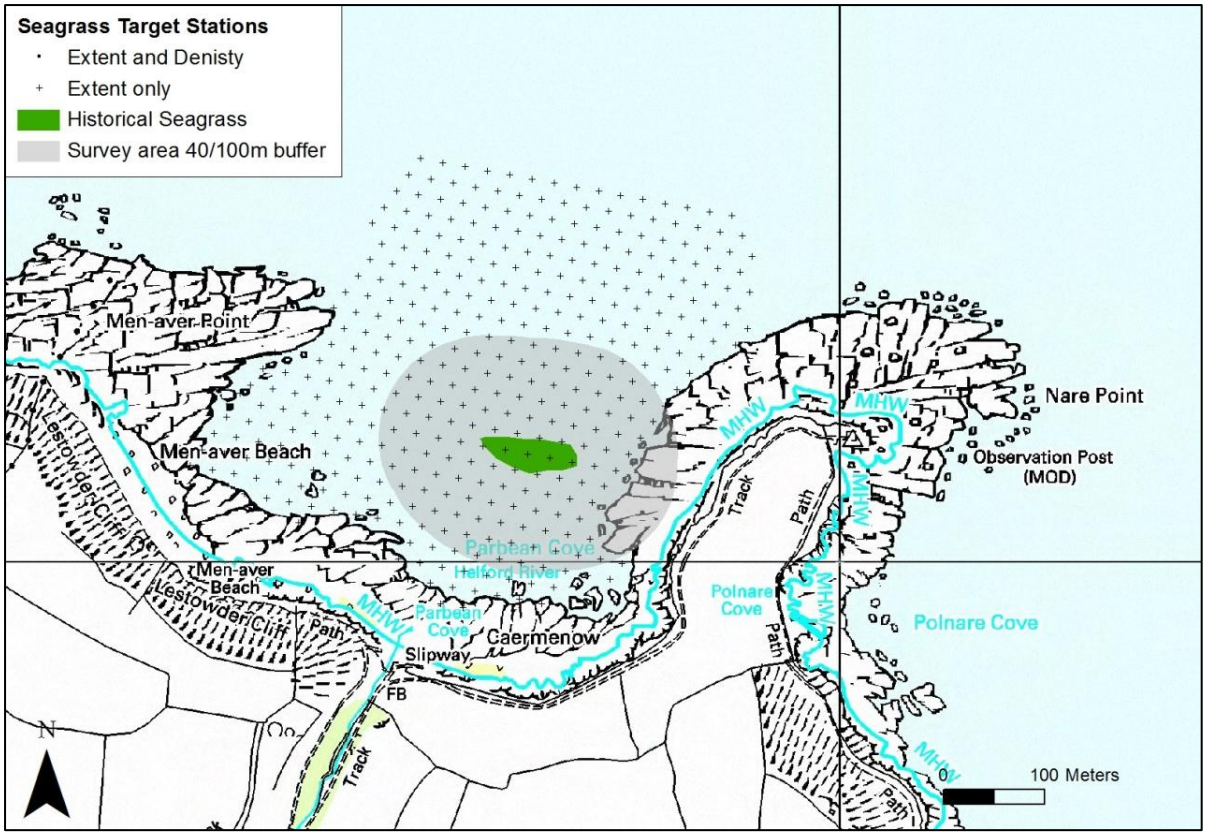

Figure 12. Parbean Cove survey area.

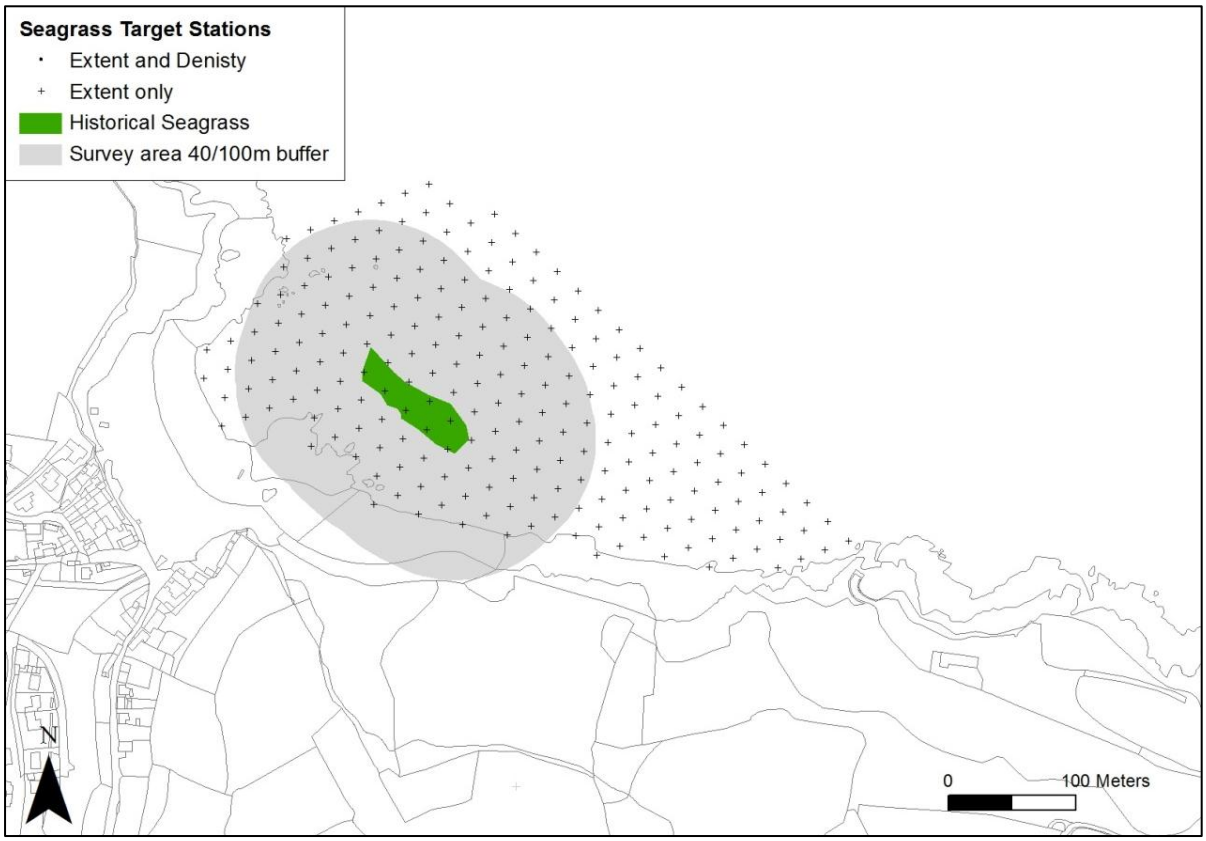

Figure 13. Porthallow Cove survey area.

The survey of the seagrass beds was undertaken using an adaptation of the towed video technique. In this technique a SeaPro high definition (HD) video camera and lights were attached under a heavy lead 'fish' in such a way that the camera pointed vertically downwards. The fish was attached to a wire and controlled by a hydraulic winch. The camera rig was then towed slowly (approx. 1-1.5 knots) guiding the camera above the seabed at the required depth to clearly distinguish the seagrass. The depth of the camera above the seabed was adjusted according to the underwater visibility and the depth of the seagrass being surveyed. The array was towed across the entire survey area in the same manner that a bathymetric survey would be carried out. Due to the relative weight of the fish and slow operating boat speed, the position of the fish was maintained directly under the attachment point to the boat at all times. Positioning was determined using standard survey software linked to a survey quality differential GPS.

The camera was deployed from Ecospan's 7.9m Maritime & Coastguard Agency (MCA) coded catamaran *Coastal Surveyor* which is equipped with the survey software, electronic charting packages and an extremely accurate positioning system (which is usually used for hydrographic surveys where this sort of accuracy is routinely required).

All standard survey information (survey team, area, dates, approximate underwater visibility, weather, vessel and unusual occurrences) were logged in the survey boat book. Additionally the number of moorings and anchored boats were recorded as far as possible. The following data was gathered from each target station on a pro-forma survey sheet:

- % cover of *Zostera* sp. per field of view.
- Station number (and position).
- Time.
- Observed anthropogenic influences such as litter, debris, mooring and anchoring noted (and quantified wherever possible).

3.1.1 DD/TV Survey Dates

The DD/TV surveys were carried out between the 17th of August and 23rd of September 2015. During this time three periods of favourable weather windows were selected to optimise underwater visibility (and therefore the quality of results) and ensure that safe manoeuvring of the boat close to shore was possible.

3.1.2 Quality Assurance

Ecospan Environmental Ltd has an ISO 9001 accredited quality management system to ensure that we work to the highest standards expected by our customers. We undertake all work in accordance with standard operating procedures and recognised national or international guidelines.

Within this project the HD footage from 5% of all stations where seagrass was present was selected for secondary verification and quality assessment.

3.2 Dive Survey

3.2.1 Locations and Settings of Sample Transects

The four areas of seagrass bed surveyed using diving methods were:

- Pennarrow Point to Trefusis Point (Fal).
- St. Mawes Harbour and Amsterdam Point to Carricknath Point (Fal).
- St. Mawes Bank (Fal).
- Polgwidden Cove to Toll Point (Helford).

The dive surveys were undertaken by buddy pairs who collected samples at pre-defined transects for surface analysis and recording. Given that the diver surveys were carried out prior to the DD/TV extent surveys, the transect locations were based on historical extent data. Target transects were spaced evenly across the historically mapped extent at each bed but precise positioning and sampling was random.

At each transect a weighted transect line of 50m was used and survey points were then placed at 5m intervals respectively. At each of the survey points, a 0.25m^2 quadrat (0.5m by 0.5m) was positioned such that the bottom right hand corner of the quadrat lay against the left hand edge of the measurement line every 5m. Once in position, all the plants within the bottom right hand quarter were then cut above the rhizomes and stored in a marked plastic bag for post dive analysis. Care was taken to ensure that all leaves were traced to the base and that only the plants with their rhizomes directly under the quarter square were taken. By taking plants only from one corner of the quadrat the destructiveness of the sampling strategy was minimised. The pre-determined strategy also removed the potential for diver bias when selecting the area within the quadrat to be sub-sampled.

Along each transect a second unsegmented quadrat was placed to the right hand side of the tape at metre intervals. The percentage cover within the 0.25m^2 quadrat (0.5m by 0.5m) was recorded according to the scale in Table 3. The number of plants were also counted and recorded within the unsegmented quadrat every 5m.

Table 3. Scale used to record % cover of seagrass during diving surveys

Score and description	% Cover
0 - No *Zostera* sp. present	0%
1 - Up to a quarter of quadrat contains *Zostera* sp.	1-25%
2 - Up to half the quadrat contains *Zostera* sp.	26-50%
3 - Over half the quadrat contains *Zostera* sp.	51-75%
4 - Almost all the quadrat contains *Zostera* sp.	76-100%

All diving fieldwork was undertaken by Natural England staff over a total of 5 days from the 22nd to the 26th of June 2015. The coordinates of the transect start and finish positions are provided in Table 4. Many of the recorded transect positions equated to transects greater than 50m when entered into ArcGIS. It was therefore assumed that the transect start positions were accurate which resulted in a level of uncertainty about the precise positions of quadrats along each transect. This was particularly relevant at Transect 1 on St Mawes bank where the start position was clearly inaccurate.

Table 4. Coordinates of the dive transects WGS84

Bed Name	Transect	Transect Start		Transect End		Date Surveyed
		Latitude (N)	Longitude (W)	Latitude (N)	Longitude (W)	
Penarrow Point to Trefusis Point (Outer)	1	50.173204	-5.041764	50.172890	-5.041256	22/06/2015
	2	50.172021	-5.042330	50.171680	-5.041861	22/06/2015
	3	50.171038	-5.042514	50.170717	-5.042025	22/06/2015
	4	50.170304	-5.042614	50.170030	-5.042049	22/06/2015
	5	50.169404	-5.042997	50.169017	-5.042634	22/06/2015
Penarrow Point to Trefusis Point (Inner)	1	50.167604	-5.045164	50.167252	-5.044723	22/06/2015
	2	50.166504	-5.045364	50.166858	-5.045806	23/06/2015
	3	50.165570	-5.045447	50.165160	-5.045723	24/06/2015
	4	50.165637	-5.047748	50.165393	-5.047146	25/06/2015
	5	50.164370	-5.049198	50.164114	-5.048612	25/06/2015
Polgwidden Cove to Toll Point	1	50.099431	-5.103538	50.099875	-5.103457	23/06/2015
	2	50.100198	-5.104704	50.100648	-5.104818	23/06/2015
	3	50.100715	-5.106505	50.101163	-5.106385	23/06/2015
	4	50.101298	-5.108171	50.101732	-5.108015	23/06/2015
	5	50.101432	-5.109988	50.101867	-5.110141	23/06/2015
	6	50.101032	-5.107355	50.101468	-5.107180	26/06/2015
St Mawes Harbour and Amsterdam to Carricknath Point	1	50.150485	-5.016862	50.150935	-5.016875	24/06/2015
	2	50.150952	-5.015345	50.151399	-5.015428	24/06/2015
	3	50.151602	-5.013161	50.152040	-5.013316	24/06/2015
	4	50.152369	-5.017312	50.152769	-5.017634	24/06/2015
	5	50.153069	-5.015978	50.153452	-5.016328	24/06/2015
	6	50.155403	-5.018012	50.155638	-5.018626	25/06/2015
	7	50.155736	-5.017412	50.155412	-5.016913	26/06/2015
St Mawes Bank	1	50.162186	-5.026452	50.162170	-5.025738	25/06/2015
	2	50.165820	-5.024779	50.165858	-5.024069	25/06/2015
	3	50.166636	-5.023720	50.166487	-5.023062	25/06/2015
	4	50.168104	-5.022945	50.168120	-5.023632	25/06/2015
	5	50.170321	-5.023212	50.170302	-5.022505	25/06/2015

3.2.2 Post Dive Analysis

The *Zostera* sp. plants were analysed post-dive at the end of each diving day (to ensure no degradation of the samples) for:

- Maximum leaf length
- Degree of infection with *Labyrinthula* sp.
- Abundance of epiphytes
- Number of plants
- Presence of invertebrate eggs
- Presence of flowering plants

Following training in order to ensure consistency, divers took each shoot collected and measured the longest leaf in that shoot using a tape measure, and recorded the length in centimetres (cm) as the maximum leaf length. Surveyors then assessed each intact leaf on

the shoot to estimate the percentage cover of browning and epiphyte cover and, using the scoring system outlined in Table 5, this was then recorded as a value between 0 and 5. Leaf browning was recorded as that caused by *Labyrinthula* sp. infection although culturing and isolation methods were not employed to prove *Labyrinthula* sp. infection. A photograph showing infection and epiphyte cover on a *Zostera* sp. plant is shown in Plate 1.

Table 5. Scoring system for leaf infection and epiphyte cover

Score	Description	% Infection
0	Uninfected/uncovered leaf	0
1	Minimal infection/cover apparent	1 - 2
2	Up to a quarter of leaf infected/covered	3 - 25
3	Up to half the leaf infected/covered	26 - 50
4	Over half all of leaf infected/covered	51 - 75
5	Almost all of leaf infected/covered	76 - 100

Plate 1. Photograph of *Zostera* sp. plant showing both clean leaves, browning as a result of infection and epiphyte Cover

4. RESULTS

All raw data and data plots are available in the GIS files which accompany this report.

4.1 Attributes Measured Using DD/TV

To qualify as a *Zostera* spp. 'bed', the OSPAR definition states that plant densities should provide at least 5% cover [20]. Given this threshold value, where percentage cover data was collected within a bed, all data ≥5% cover has been contoured using the schematic mapping and spatial analysis software Surfer 10 to enable patchiness/spatial configuration to be easily viewed. In order to make the percentage cover data easier to compare both spatially and temporally, the data has been categorised and described as follows:

Table 6. Percentage Cover Categories

% Cover	Description
5-25	Very Sparse
26-50	Sparse
51-75	Moderate
76-100	Dense

The raw data (percentage cover to the nearest 1%) from each target station that was used to create the contours has been plotted spatially and is presented in Appendix 1, the station coordinates are available in the associated GIS files for this project.

For all beds the total area of seagrass with a percentage cover of 5% or greater has been calculated and specified as the total area. The area for each category of percentage cover has also been calculated (using SURFER® 10) for each bed where percentage cover data was collected. At each of these beds the mean percentage cover has been determined by taking the percentage cover recorded at each station, and using all values of 5% cover or greater to calculate the mean.

4.1.1 Quality Assurance

HD recordings of seagrass at 5% of stations were subjected to secondary verification for quality control purposes by another surveyor who analysed the recorded video footage post-survey. The data collected in real-time was compared to the results produced by the secondary verification using the Bray-Curtis similarity index in the statistical software package PRIMER 6[21]. The mean similarity of the analysis between the surveyors before categorisation (e.g. to the nearest 1%) was determined to be 89% (see Appendix 2) whereas the categorised data returned a similarity of 92%.

4.2 Attributes Measured Using Diving Methods

The mean and range of each of the attributes measured using diving techniques (number of plants per m^2, % leaves infected, infection scores, epiphyte scores and mean maximum plant length) have all been provided for each dive transect to enable variability within beds to be gauged. An overall mean value and range for each attribute at each bed has also been calculated to simplify temporal comparisons within beds.

The range of values for all attributes have been taken from the raw data. To determine the density the raw data of plants per 0.0625 m^2 or per 0.25 m^2 has been multiplied by 16 and 4 respectively to give a density per m^2. For each of the attributes measured using divers, the

mean value from each transect has been calculated and used to derive the mean value within each bed. Given that the percentage cover data was categorised, the median of each category was used to derive overall mean values for each transect.

The method of calculating mean values has been used because of the inherent biology and patchy nature of the attributes within seagrass beds. This effect can also be seen in the data collected from the Fal and Helford which indicates that the data from quadrats within each transect is not totally independent i.e. quadrats *between* transects are not considered to be replicates of the same population. This has been demonstrated by carrying out T-tests on the mean attribute data collected from each transect at St. Mawes Harbour and Amsterdam Point to Carricknath Point. P values of <0.05 were produced for all attribute data, whilst p values of <0.001 were produced for all attributes except percentage of leaves infected and leaf infection score. The T-test results are tabulated in Appendix 3. These values indicate that data from different transects within the St. Mawes Harbour and Amsterdam Point to Carricknath Point beds are in fact significantly different.

4.2.1 Exploration of Correlations

The correlation between percentage cover and number of plants (as assessed in situ by divers) has been explored and resulted in an R value of 0.63 (only quadrats containing seagrass were analysed). This value indicates a moderately positive relationship between the two measures; however, the correlation was weakened by the categorisation of the percentage cover data into just 4 categories.

It was thought that infection and epiphyte growth could be expected to be found more frequently on older, longer leaves. This does not appear to be reflected in the data, however, as no meaningful correlation between mean longest leaf length and percentage of leaves infected was found in the data from this study (R= 0.13).

4.3 Percuil River (Upper and Lower)

Seagrass was absent from the survey areas in the Percuil River both in the upper reaches adjacent to Tregassick (Figure 3 Section 3.1) and in the lower reaches at Polvarth Point (Figure 4 Section 3.1).

4.4 St. Mawes Harbour

St. Mawes Harbour is located within the lowest reaches of the Percuil River on the northern bank. The beds at that location within the Fal have a south-easterly aspect and are afforded some shelter from St. Anthony Head, but they remain exposed to south-westerly swell. The seagrass in St. Mawes Harbour was found to be separated into three beds. Contour plots of the percentage cover at each of the beds in relation to the position of the dive transects are shown in Figure 14.

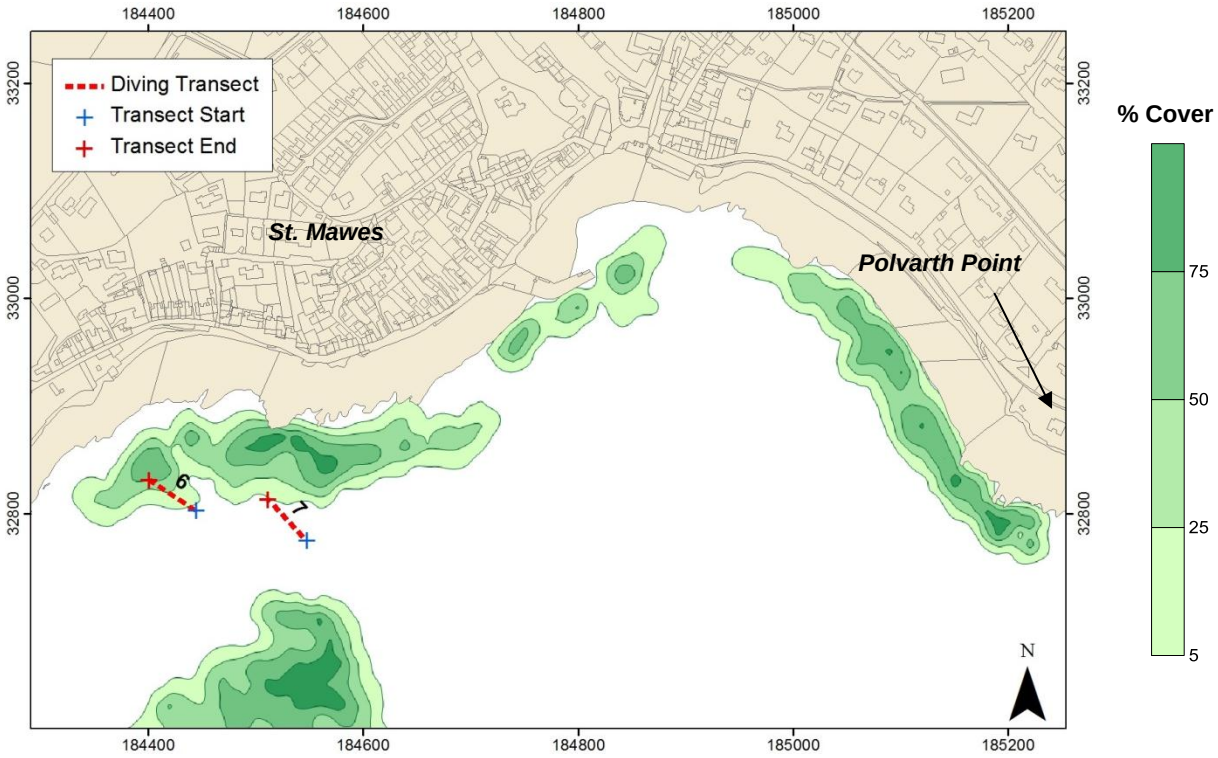

Figure 14. Contour plots of % cover of seagrass and locations of dive transects on beds in St. Mawes Harbour.

4.4.1 Attributes Measured Using DD/TV

In St. Mawes Harbour the total area of seagrass which met the OSPAR criteria[20] for a bed was 54,563 m^2, the overall mean percentage cover was 48%. The total area of seagrass in each category of percentage cover is listed in Table 7:

Table 7. Area of seagrass within each percentage cover category in St. Mawes Harbour.

% Cover	Area (m^2)
5-25 (Very Sparse)	26,808
26-50 (Sparse)	17,456
51-75 (Moderate)	9,778
76-100 (Dense)	521
5-100	**54,563**

Less than 1% of the total area of the beds were categorised as 'dense' (76-100% seagrass cover). The greatest cover of seagrass reported was 98% (see percentage cover raw data plot in Appendix 1) but the beds were noted as being extremely patchy, with percentage cover in the field of view often rapidly changing from 0% to 70%. The bed found adjacent to the harbour wall was particularly sparse and patchy.

With regard to anthropogenic activity, litter (primarily aluminium drinks cans) were occasionally seen in the camera footage. Boat moorings and anchored boats were mainly situated outside of the western extent of the bed found closest to Polvarth Point, but none were observed within the extent of the seagrass. The extent of seagrass in 2015 has been mapped over aerial images of St. Mawes Harbour that were taken in 2014 (Figure 15). The regular arrangement of moorings can be seen outside of the beds to the east, whilst a few anchored vessels can be seen mostly within the most western bed in St. Mawes Harbour.

Figure 15. Position of moorings in St. Mawes Harbour 2014 in relation to seagrass beds mapped in 2015.

4.4.2 Attributes Measured Using Diving Methods

The seagrass attribute data which was collected using diving techniques is summarised in Table 8. The data has been presented using mean values and ranges and is only available for Transect 6 because Transect 7 fell outside of the extent of the bed.

Table 8. Mean and range for each attribute measured using diving methods in St. Mawes Harbour.

Transect	Mean and Range Values									
	Quadrat 1 (0.0625 m^2)						Quadrat 2 (0.25 m^2)			
	n	Number of Plants (per m^2)	%Leaves Infected	Infection Score	Epiphyte Score	Max Plant Length (cm)	n	%Cover	n	Number of Plants (per m^2)
6	5 (6*)	74 (0-96)	18 (0-44)	0.2(0.0-0.7)	1.1 (0.3-2.2)	33 (26-40)	31 (20*)	31 (0-38)	6 (5*)	18 (0-64)

* Number of quadrats in which no seagrass was recorded

The data gathered at Transect 6 represents the western periphery of the beds in St. Mawes Harbour. The plant density and percentage cover values were therefore lower than would be expected if the full width of the bed had been sampled.

The percentage cover recorded by divers was comparable to that collected using DD/TV methods where two values of 20% and 25% cover were recorded at DD/TV stations that intersected with the dive transect. The slightly higher cover recorded by divers is likely to be an effect of the smaller sample area (0.25m^2 compared to approximately 2-8m^2 using DD/TV) and the particularly patchy nature of the seagrass distribution.

No flowering plants or attached eggs were recorded by the dive surveyors.

4.5 Amsterdam Point to Carricknath Point

Also situated in the lowest reaches of the Percuil River but on the southern bank (opposite St. Mawes Harbour) are beds of seagrass which stretch almost 750m southwest from Amsterdam Point to Carricknath Point. The eastern extent of the bed is relatively sheltered but the main body of the bed extends approximately 500m north-west towards the main river channel where it is exposed to south-westerly weather.

Contour plots of the percentage cover of seagrass between Amsterdam and Carricknath Points are shown in Figure 16 relative to the position of the dived transects.

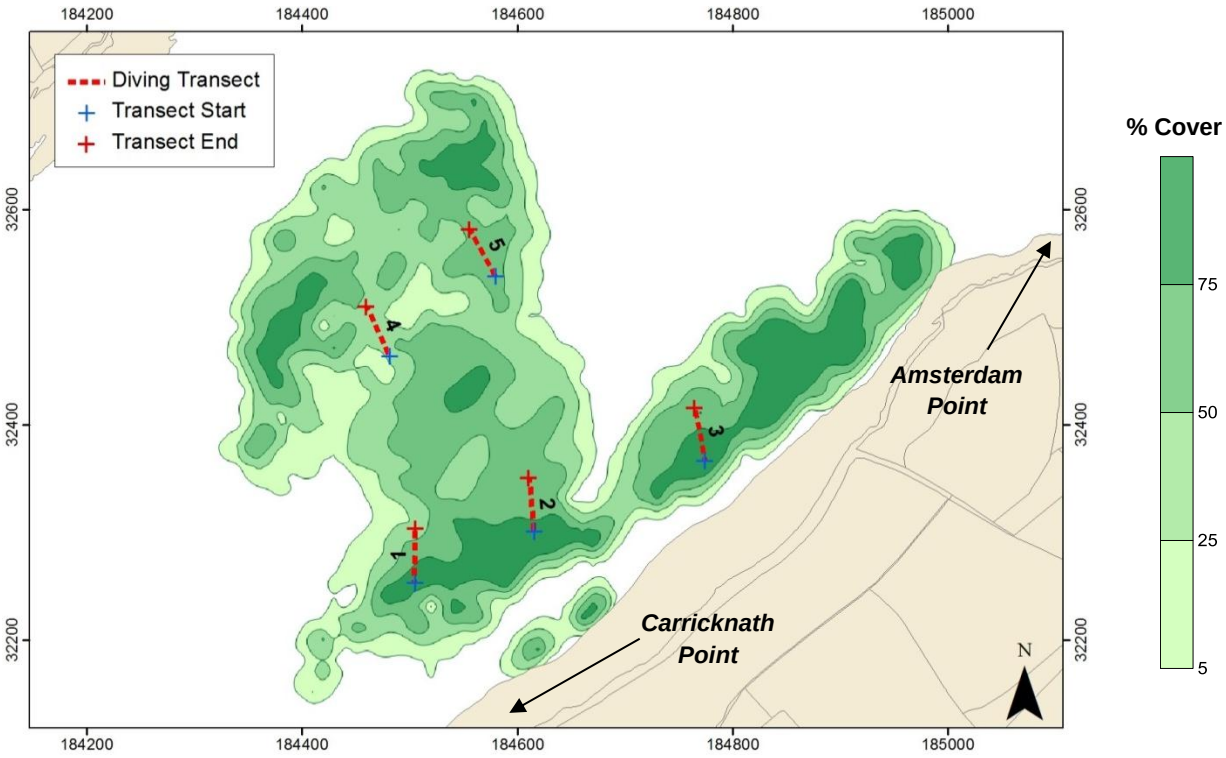

Figure 16. Contour plots of % cover of seagrass and locations of dive transects on beds between Amsterdam Point and Carricknath point.

4.5.1 Attributes Measured Using DD/TV

The total area of seagrass bed that was mapped between Amsterdam Point and Carricknath Point was 175,228 m^2, the overall mean percentage cover was 53%, slightly higher than those beds north of the main channel in St. Mawes Harbour. The total area of seagrass in each percentage cover category is listed in Table 9:

Table 9. Area of seagrass within each percentage cover category between Amsterdam Point and Carricknath point.

% Cover	Area (m^2)
5-25 (Very Sparse)	42,884
26-50 (Sparse)	56,649
51-75 (Moderate)	53,309
76-100 (Dense)	22,386
5-100	**175,228**

Just 13% of the total area of bed was considered to be 'dense' (76-100% seagrass cover). The highest percentage cover values were found within the more sheltered eastern extent of the bed where 80% cover or more was common (see raw data plot in Appendix 1). Elsewhere within the bed the percentage cover of seagrass was less consistent, often ranging from 5% to 80% cover.

A small amount of plastic litter was seen at a single DD/TV station and two fishing pots were noted within the extent of the bed, as were four moorings and one anchored yacht. Definitive evidence of mooring or anchor scarring was not apparent from the DD/TV survey. However, the identification of such impacts was difficult because the bed was large and patchy and given the multiple tasks and observations required by the DD/TV operator it was not possible to identify whether all of the patches of low seagrass density were due to natural variability. Furthermore moorings were avoided to prevent entanglement with the DD/TV rig which meant that there was less likelihood of observing such impacts. Although no definitive evidence of negative effects from anchoring or mooring was apparent, this may not necessarily be the case, and further targeted studies would be required in order to make a conclusion.

In Figure 17 the location of the moorings (within the eastern extent of the bed) as photographed in 2014 are shown in relation to the extent of seagrass mapped in 2015.

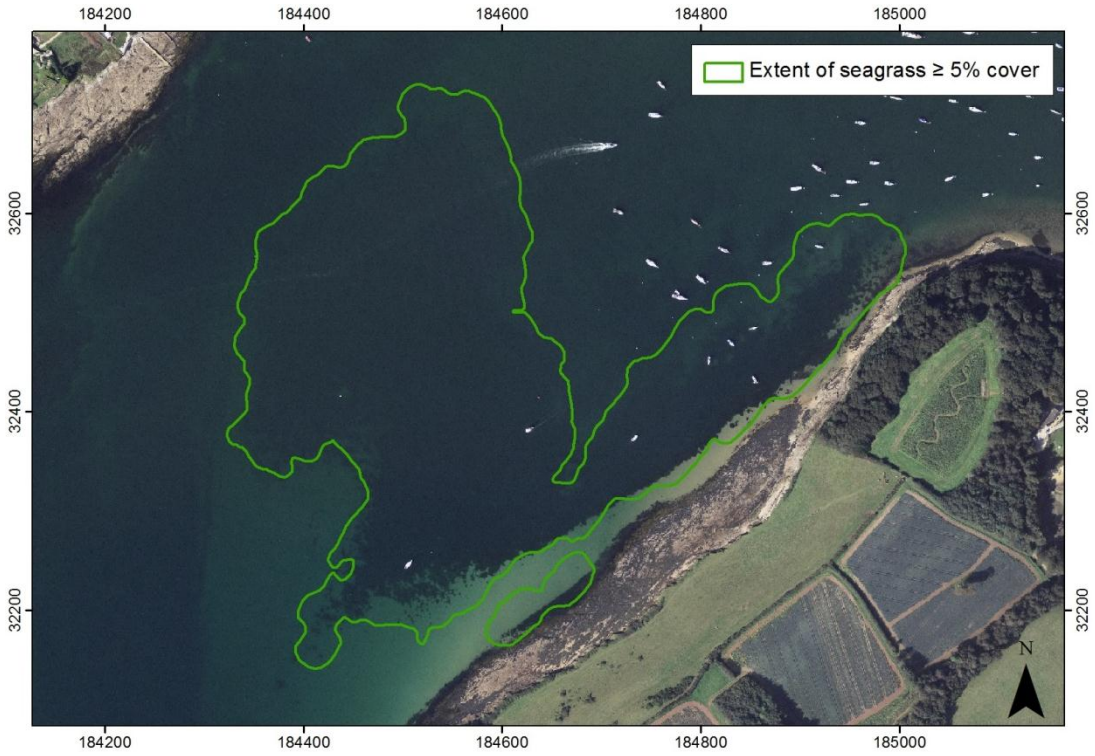

Figure 17. Position of moorings in 2014 in between Amsterdam Point and Carricknath Point in relation to seagrass beds mapped in 2015.

4.5.2 Attributes Measured Using Diving Methods

The attribute data which was collected using diving techniques is summarised in Table 10. The data has been presented using mean values and ranges for each dive transect.

Table 10. Mean and range for each attribute measured using diving methods between Amsterdam Point and Carricknath point.

Transect	Mean and Range Values									
	Quadrat 1 (0.0625 m^2)						Quadrat 2 (0.25 m^2)			
	n	Number of Plants (per m^2)	%Leaves Infected	Infection Score	Epiphyte Score	Max Plant Length (cm)	n	%Cover	n	Number of Plants (per m^2)
1	9 (2*)	127 (0-256)	27 (11-37)	0.3 (0.1-0.5)	1.6 (0.8-2.0)	40 (33-48)	47 (4*)	42 (0-88)	10 (1*)	91 (0-152)
2	10 (1*)	128 (0-224)	19 (4-41)	0.3 (0.1-0.7)	1.1 (0.8-1.7)	48 (38-61)	48 (3*)	40 (0-63)	10 (1*)	142 (0-216)
3	11	108 (16-192)	16 (0-31)	0.2 (0.0-0.5)	1.3 (0.7-1.8)	35 (8-43)	38 (13*)	38 (0-12)	10 (1*)	75 (52-108)
4	9 (2*)	42 (0-96)	19 (0-41)	0.3 (0.0-1.0)	1.0 (0.7-1.5)	31 (24-39)	50 (1*)	50 (0-38)	11	27 (12-68)
5	5 (6*)	22 (0-80)	21 (5-33)	0.3 (0.1-0.7)	1.7 (1.1-2.6)	42 (33-56)	51	51 (2-38)	11	42 (12-80)
Mean	**-**	**85.4 (0-256)**	**20 (0-41)**	**0.3 (0.0-1.0)**	**1.3 (0.7-2.6)**	**39 (8-61)**	**-**	**22 (0-88)**	**-**	**66 (0-216)**

* Number of quadrats in which no seagrass was recorded

The mean attribute values were largely comparable between transects except at Transects 4 and 5 where the number of plants per m^2 as assessed by both methods (cutting, and counting in situ) was less than half of that at the more sheltered transects closer to the shore. Conversely the mean percentage cover as assessed by divers was higher at Transects 4 and 5 although the maximum values were generally lower. The percentage of leaves infected and epiphyte scores were highest at Transects 1 and 5.

No flowering plants or attached eggs were recorded by the divers.

4.6 West of Carricknath Point

Although not included within the original tender, Ecospan Environmental Ltd. was asked to verify the presence/absence of seagrass in two areas to the west/south-west of Carricknath Point if time permitted. These areas were visited and two relatively small and very sparse satellite beds were found, the extent of which have been mapped (Figure 18). The percentage cover within these mapped areas was mainly around 10-15%, but occasionally densities of 25% were observed.

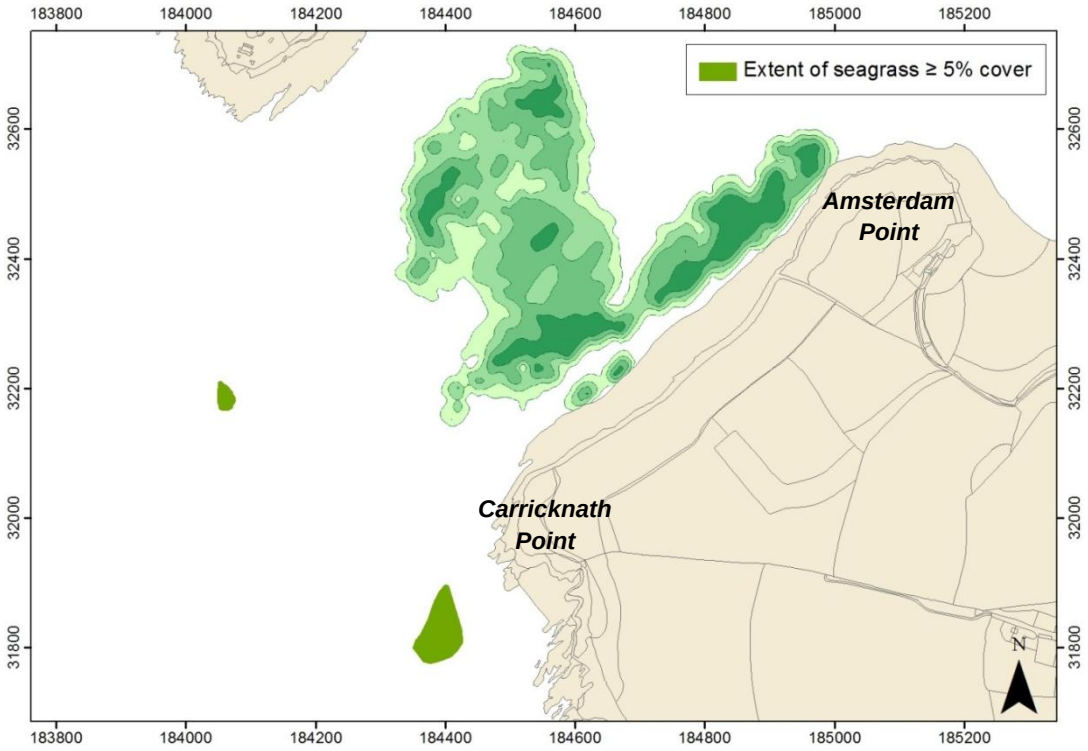

Figure 18. Extent of satellite seagrass beds to the west/south-west of Carricknath Point.

4.7 St. Mawes Bank

St. Mawes Bank is found in the Carrick Roads reaches of the Fal Estuary, on the eastern side which has a west to north-west aspect. The seagrass at St. Mawes Bank mostly formed a single continuous bed that extended for 1.6km in a north-south direction, but a small satellite bed was also found at the northern end. Contour plots of the seagrass percentage cover and location of dive transects are shown in Figure 19.

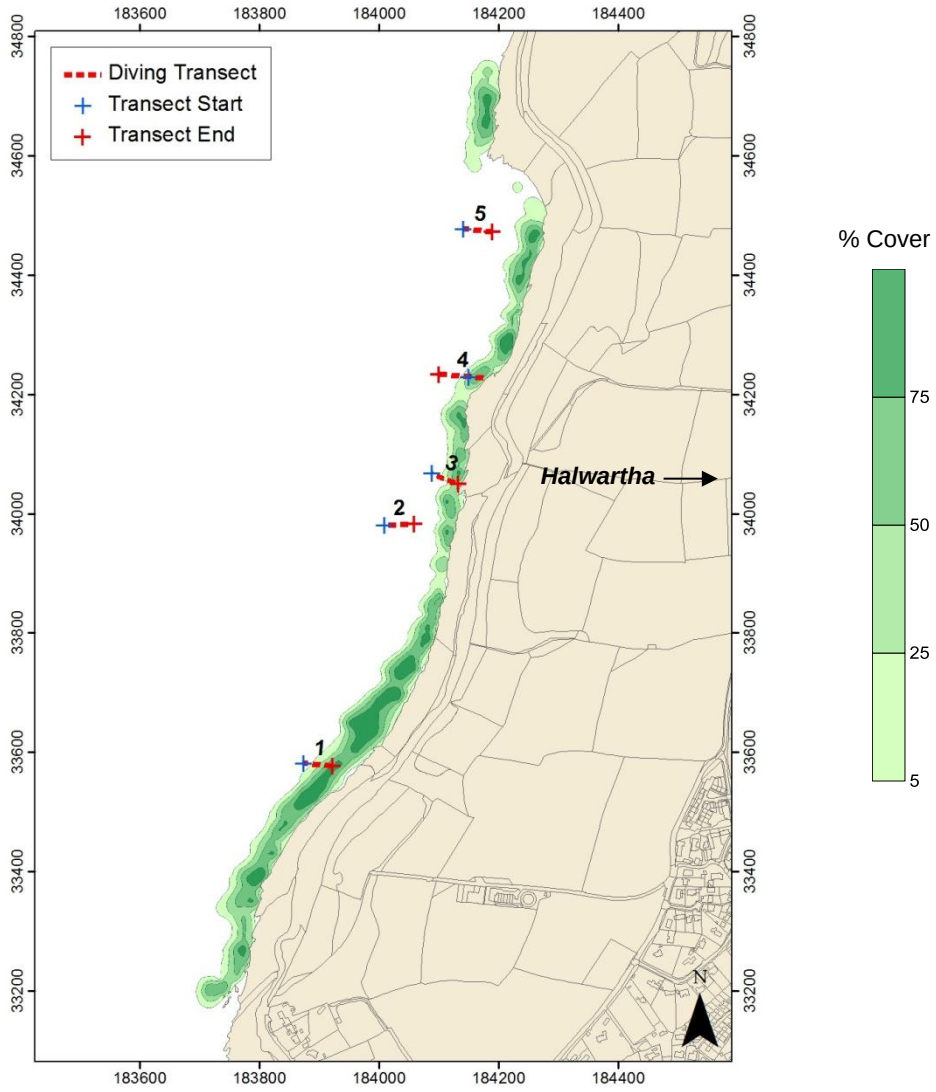

Figure 19. Contour plots of % cover of seagrass and locations of dive transects on beds at St. Mawes Bank.

4.7.1 Attributes Measured Using DD/TV

The total area of seagrass ≥5% cover at St. Mawes Bank was 81,398 m^2, the mean percentage cover within that total area was 63%. The area of seagrass within each percentage cover category is listed in Table 11:

Table 11. Area of seagrass within each percentage cover category at St. Mawes Bank.

% Cover	Area (m^2)
5-25 (Very Sparse)	29,811
26-50 (Sparse)	23,222
51-75 (Moderate)	20,084
76-100 (Dense)	8,281
5-100	**81,398**

The bed at St. Mawes Bank was very restricted and closely fringed littoral rock to the east and extensive maerl beds to the west, the seagrass rarely extended beyond 60m from the shore. At the outer periphery of the bed percentage cover values of 90% were frequently recorded which quickly dissipated to 0% within the space of 20m. 37% of the bed was considered to be 'very sparse' whilst just 10% was 'dense'.

A single aluminium drink can was the only litter observed on the bed. No moored or anchored vessels were seen in the area. A string of creel fishing pots were seen resting on live maerl approximately 20m outside the western edge of the bed in the area adjacent to the village of Halwartha.

4.7.2 Attributes Measured Using Diving Methods

The data collected by Natural England divers at two of the five transects that were surveyed at St. Mawes Bank have been summarised and presented in Table 12. Seagrass was absent from three of the transects (2, 3 and 5). Although Transect 3 appears to fall within the extent of the bed that was mapped using DD/TV methods, divers did not identify seagrass at that location. Transect 3 fell between stations visited using DD/TV methods therefore it is possible that the diving transect picked up a patch of seabed that was barren of seagrass between the DD/TV stations. It is also possible that that the actual dive transect started slightly further west than has been mapped in Figure 19 as the transect end point that was originally recorded by the dive boat skipper equated to a transect 110m long. The positions were subsequently amended under the assumption that transect start coordinates were accurate.

Table 12. Mean and range for each attribute measured using diving methods at St. Mawes Bank.

Transect	Mean and Range Values									
	Quadrat 1 (0.0625 m^2)						Quadrat 2 (0.25 m^2)			
	n	Number of Plants (per m^2)	%Leaves Infected	Infection Score	Epiphyte Score	Max Plant Length (Cm's)	n	%Cover	n	Number of Plants (per m^2)
1	5 (6*)	35 (0-144)	26 (0-55)	0.4 (0-1.1)	1.3 (0.8-1.6)	39 (26-60)	29 (22*)	11 (0-88)	6 (5*)	31 (0-140)
4	4 (7*)	45 (0-224)	14 (0-21)	0.2 (0-0.3)	1.8 (1.3-2.2)	46 (37-56)	16 (35*)	8 (0-63)	4 (7*)	31 (0-164)
Mean	**-**	**40 (0-224)**	**20 (0-55)**	**0.3 (0-1.1)**	**1.6 (0.8-2.2)**	**43 (26-60)**	**-**	**9 (0-88)**	**-**	**31 (0-164)**

* Number of quadrats in which no seagrass was recorded

The data suggests that plants were slightly more dense at the southern end of the bed at Transect 4. It also suggests that epiphytes were more prevalent at Transect 4 whilst *Labyrinthula* sp. infection was almost twice as prevalent at Transect 1. The mean percentage cover as recorded by divers was much lower than that recorded using DD/TV methods, this is probably because the transects did not cross the full width of the bed incorporating the full range of percentage cover from the bed core to the sparse peripheries. Sample size and seagrass patchiness may also have been a factor which contributed to the differences observed as previously discussed in Section 4.4.2.

Two flowering plants were recorded within a single quadrat on Transect 4. No fauna eggs were reported to be present.

4.8 Penarrow Point

Penarrow Point is also found in the Carrick Roads area of the Fal, but on the western side of the channel, opposite St. Mawes Bank where the shoreline has a more exposed easterly/south-easterly aspect. Historical data indicated that seagrass may also be found south of Pennarow Point towards Trefusis Point but this was not the case in 2015.

Contoured percentage cover data and positions of the dive transects in 2015 are shown in Figure 20.

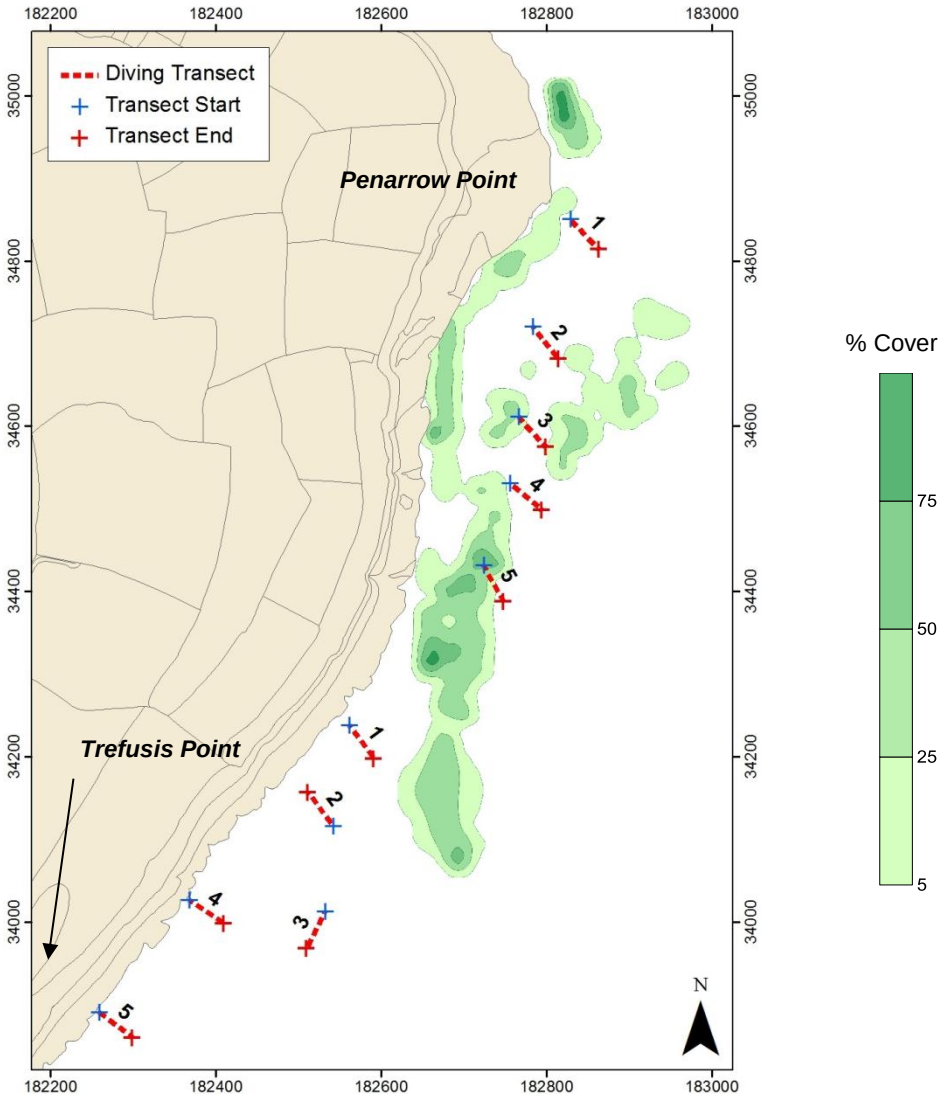

Figure 20. Contour plots of % cover of seagrass and locations of dive transects on beds at Penarrow Point.

4.8.1 Attributes Measures Using DD/TV Methods

The total area of seagrass which qualified as a bed at Penarrow Point was 74,788 m^2. The mean percentage of seagrass cover within that extent was just 34%. The total area of seagrass in each category of percentage cover is listed in Table 13.

Table 13. Area of seagrass within each percentage cover category at Pennarow Point.

% Cover	Area (m^2)
5-25 (Very Sparse)	47,476
26-50 (Sparse)	23,495
51-75 (Moderate)	3,303
76-100 (Dense)	513
5-100	**74,788**

The seagrass at Penarrow Point was extremely fragmented, 31% and 64% of the total area of bed was considered to be 'sparse' or 'very sparse' respectively. A single station was surveyed which had 100% cover of seagrass and a second had 90%. The percentage cover at all other stations was 75% or below (see raw data plot in Appendix 1).

Although the beds did not extend along the shore to Trefusis Point as expected, the seagrass did extend directly south from Penarrow Point further than expected. The southern extent of the beds was determined by depth as the beds ended abruptly where depths increased rapidly down a steep muddy sand bank.

With the exception of a single fishing pot, no other anthropogenic influences were noted within the extent of the seagrass beds at Penarrow Point.

4.8.2 Attributes Measured Using Diving Methods

The summary data for attributes surveyed by divers at Penarrow Point are presented in Table 14. Data is available for three transects in total (1, 4 and 5) within the northern bed at Penarrow Point, though only unsegmented quadrats fell on seagrass at Transect 4 and only segmented quadrats fell on seagrass at Transect 1. Dive Transects 3 and 5 intersected with the periphery of the beds as determined by DD/TV, and fell outside of the areas mapped as having 5% cover or greater at Transects 1 and 4. No seagrass was found within the transects numbered 1 to 5 to the south towards Trefusis Point.

Table 14. Mean and range for each attribute measured using diving methods at Penarrow Point.

	Mean and Range Values									
Transect	Quadrat 1 (0.0625 m^2)						Quadrat 2 (0.25 m^2)			
	n	Number of Plants (per m^2)	%Leaves Infected	Infection Score	Epiphyte Score	Max Plant Length (cm)	n	%Cover	n	Number of Plants (per m^2)
1	4 (7*)	13 (0-64)	15 (0-25)	0.2 (0-0.3)	2.3 (1.5-3.4)	45 (31-62)	0	-	-	-
4	0	-	-	-	-	-	2 (49*)	0.5 (0-12)	0	-
5	4 (7*)	15 (0-48)	8 (0-13)	0.1 (0-0.1)	0.8 (0.4-1.0)	29 (16-43)	18 (33*)	5 (0-38)	6 (5*)	19 (0-60)
Mean	**-**	**14 (0-64)**	**12 (0-25)**	**0.2 (0-0.3)**	**1.6 (0.4-3.4)**	**37 (16-62)**	**-**	**3 (0-38)**	**-**	**19 (0-60)$^{\Delta}$**

* Number of quadrats in which no seagrass was recorded

$^{\Delta}$ n = 1

Just four quadrats on each transect where post dive analysis was carried out contained seagrass, but a comparison of the data suggests that both leaf browning and epiphytes were more abundant at Transect 1. The mean maximum plant length was also greater at Transect 1. The frequency of seagrass in quadrats and mean percentage cover was greater at Transect 5 than at Transect 4, but an absence of seagrass from Transect 4 prevented a comparison of plant density in unsegmented quadrats.

No flowering plants or eggs were noted during the diving surveys.

4.9 Flushing

The seagrass bed at Flushing extended along the shore between the village of Flushing and Trefusis Point in the Fal estuary. Although mapping seagrass extent (where percentage cover was ≥5%) was the only objective for this bed, percentage cover data was collected and has been contoured and presented in Figure 21. No diving was carried out at this location.

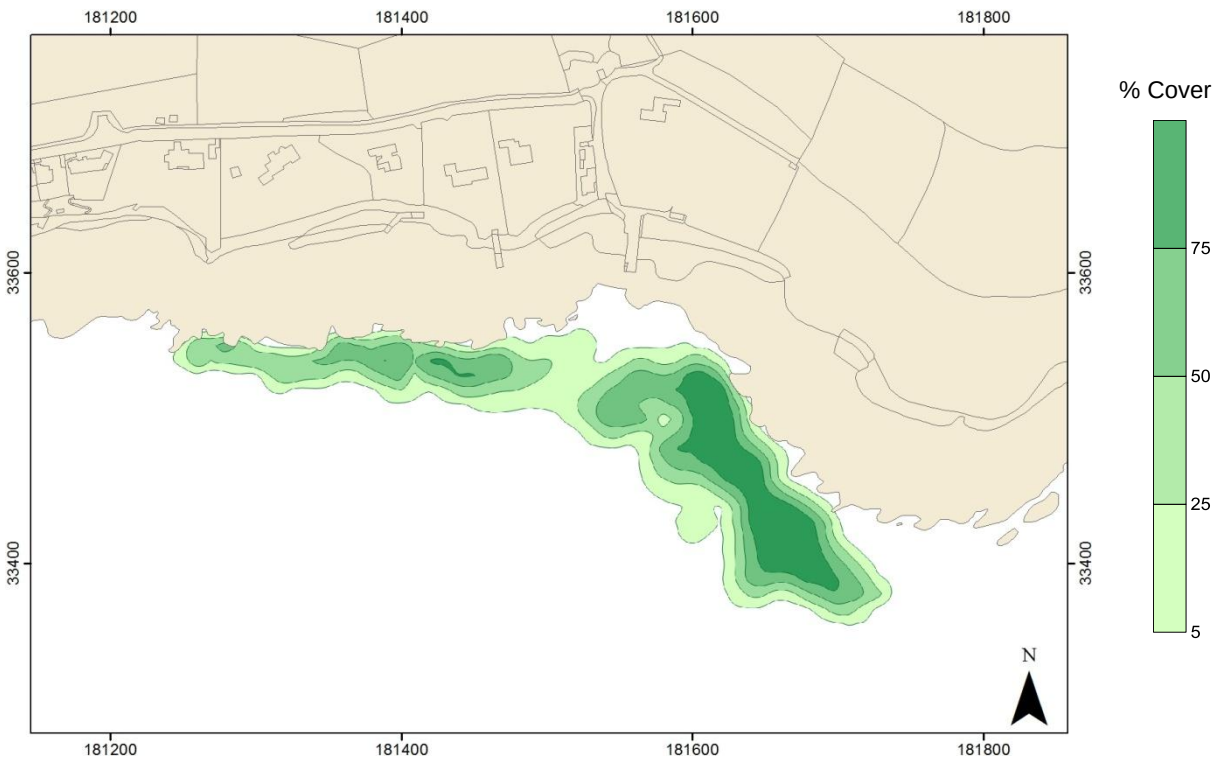

Figure 21. Contour plots of % cover of seagrass at Flushing.

The total area of seagrass which qualified as a bed at Flushing was 30,116 m^2. The total area of seagrass in each category of percentage cover is given in Table 15:

Table 15. Area of seagrass within each percentage cover category at Flushing.

% Cover	Area (m^2)
5-25 (Very Sparse)	10,595
26-50 (Sparse)	8,124
51-75 (Moderate)	6,380
76-100 (Dense)	5,017
5-100	**30,116**

The mean percentage seagrass cover within the extent of the bed at Flushing was 69%. This was the highest mean value of all the beds surveyed for percentage cover using DD/TV methods in this project. 17% of the bed was considered 'dense' and 35% 'very sparse'. 100% cover was most frequently recorded close the rocks towards Trefusis Point whilst the most sparse cover was observed at the outer extent of the bed (see percentage cover raw data plot in Appendix 1). The seagrass did not extend beyond 100m from the MLWS.

Six moorings were observed within the extent of the seagrass at Flushing but, for reasons previously discussed, there was no clear evidence of scaring of the seagrass by the associated chains. Figure 22 shows the location of moorings as photographed in 2014 in relation to the extent of seagrass mapped in 2015. No other evidence of anthropogenic activity was observed within the extent of the bed.

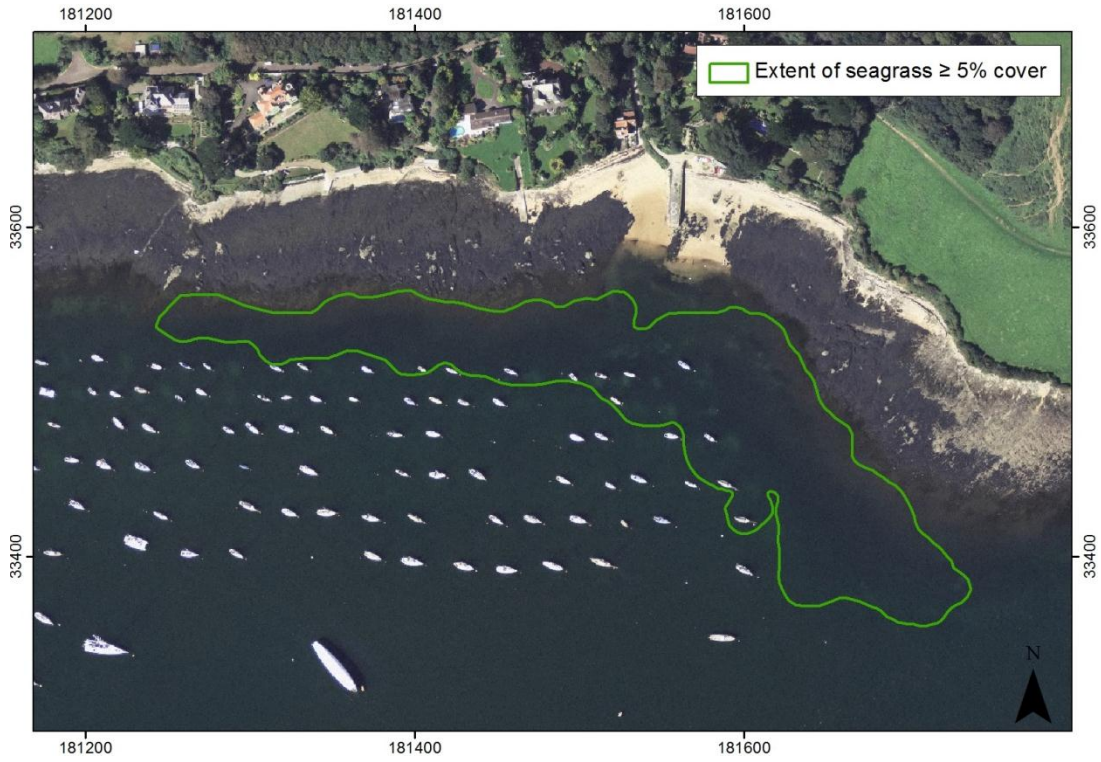

Figure 22. Position of moorings off Flushing in 2014 in relation to seagrass beds mapped in 2015.

4.10 Gyllyngvase and Swanpool

The seagrass beds of at Gyllyngvase and Swanpool are found just south of Falmouth between Pennance Point and Pendennis Point in Falmouth Bay. Again extent was the only attribute to be measured at these beds but additional percentage cover data was collected and has been contoured in Figure 23.

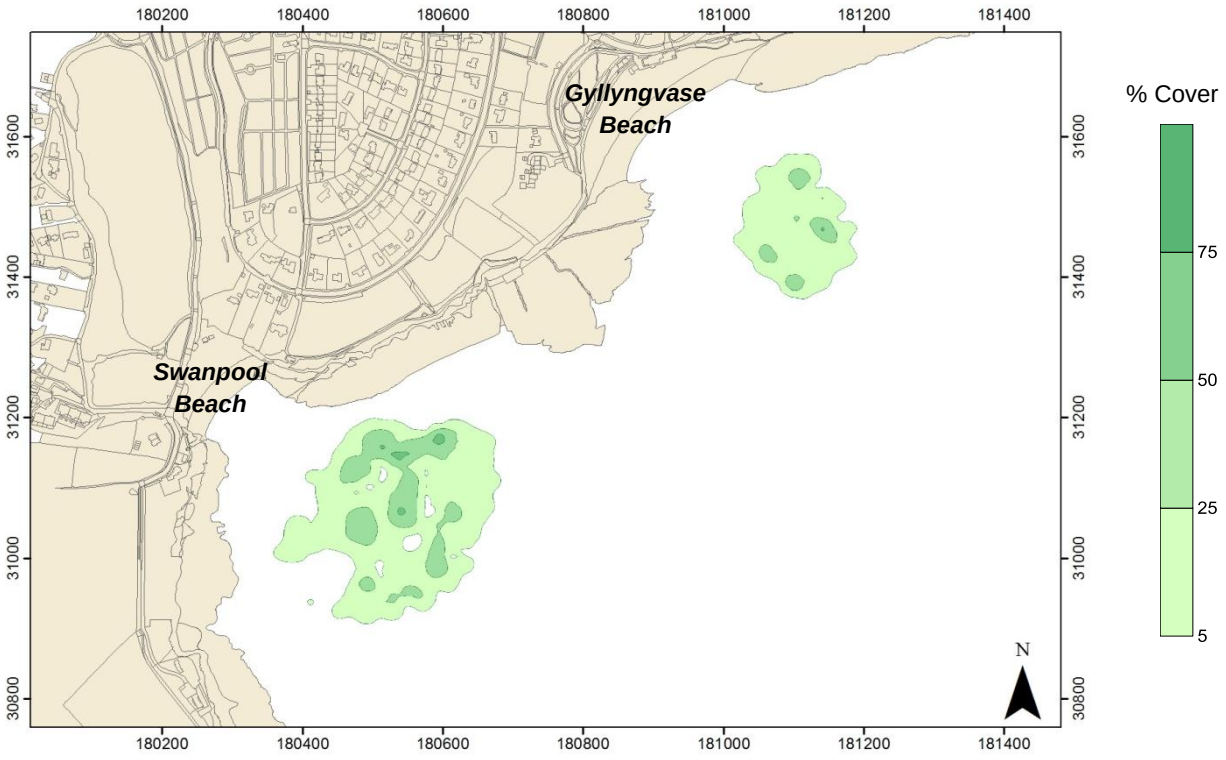

Figure 23. Contour plots of % cover of seagrass at Gyllyngvase and Swanpool.

The total area of seagrass ≥5% cover at Gyllyngvase and Swanpool was 23,999 m^2 and 60,301 m^2 respectively. The total area of seagrass in each category of percentage cover is given in Table 16.

Table 16. Area of seagrass within each percentage cover category at Gyllyngvase and Swanpool

% Cover	Area (m^2)	
	Gyllyngvase	Swanpool
5-25 (Very Sparse)	21,696	47,123
26-50 (Sparse)	2,300	12,997
51-75 (Moderate)	3	182
76-100 (Dense)	0	0
5-100	**23,999**	**60,301**

The mean percentage cover at Gyllyngvase and Swanpool was 18% and 21% respectively. Both beds were dominated by 'very sparse' cover which was noted as being very patchily distributed. The greatest percentage cover recorded was 70% at Swanpool and 65% at Gyllyngvase, both values were recorded at single stations (see raw data plot in Appendix 1).

A single anchored boat was observed just beyond the eastern extent of the bed at Gyllyngvase, but no other anthropogenic influences were noted.

4.11 Maenporth

The Maenporth bed extends approximately 950m north-northeast from the shallow waters adjacent to the village of Meudon to the beach at Maenporth. Extent was the only attribute that was required to be measured and has been plotted in Figure 24.

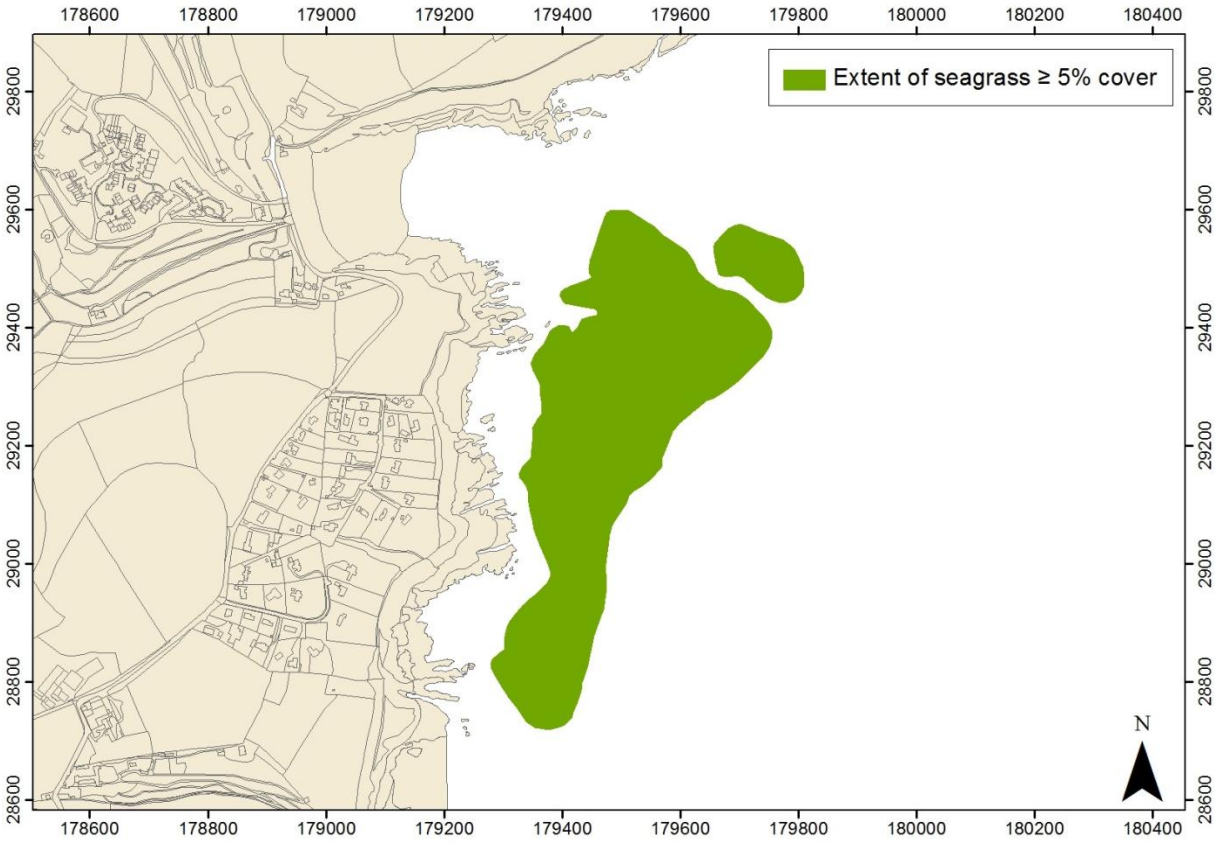

Figure 24. Extent of seagrass ≥5% cover at Maenporth.

The total area of seagrass bed (where cover ≥5%) equated to 185,624m^2. This total area was made up by a main bed and a much smaller satellite bed to the north. The percentage cover of seagrass observed was mostly around 10% to 15%, but occasional cover of up to 30% was noted.

A gill net was seen within the northern extent of the bed during the course of the survey. The net was visible in the underwater camera footage but did not appear to be interfering with the seagrass itself. No other anthropogenic activities were noted within the bed at Maenporth during the course of the survey.

4.12 Helford - Polgwidden Cove to Toll Point, East of Passage Cove and Bosahan.

Three separate beds of seagrass were mapped within the Helford estuary. The largest bed was that between Polgwidden Cove and Toll Point to the north of the main channel. There was a second smaller bed north of the channel just east of Passage Cove, and a third bed was mapped south of the channel at Bosahan. Additional percentage cover data was collected at Bosahan. The percentage cover contour plots for each of the three beds are shown collectively in Figure 25 and individually in Figures 26 and 28.

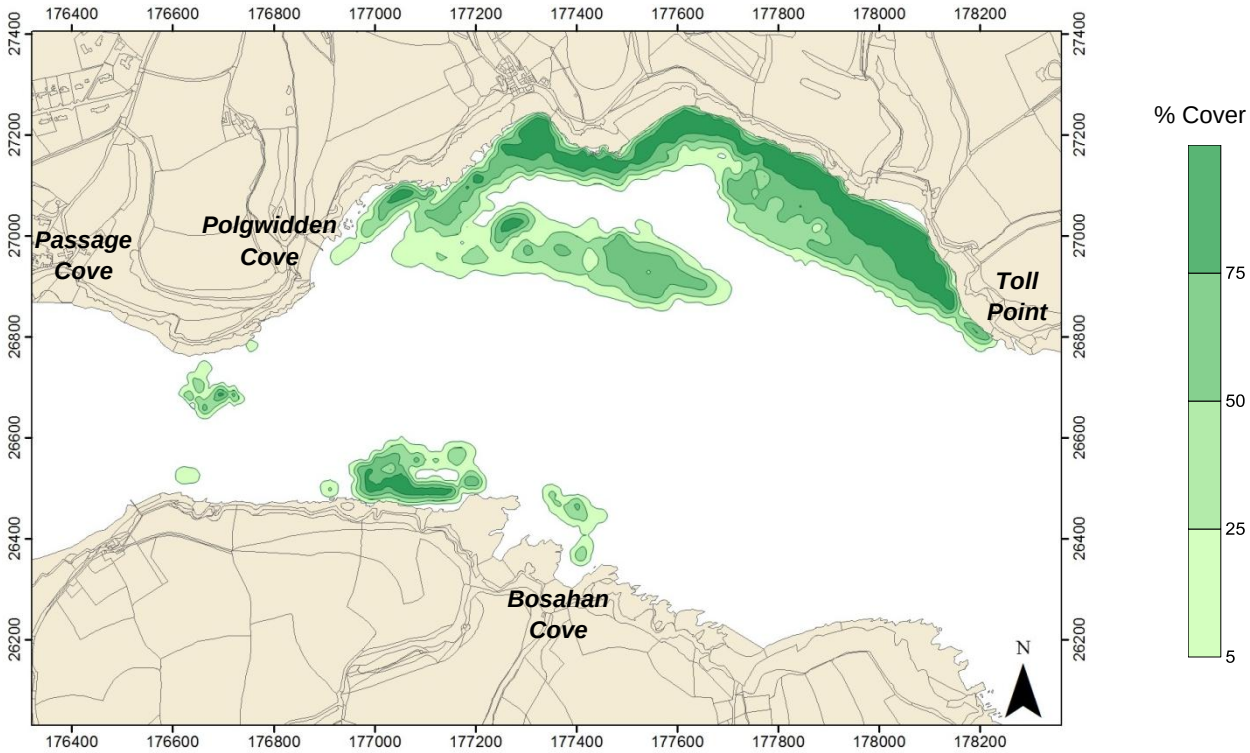

Figure 25. Overview of % cover of seagrass within the Helford.

4.12.1 Polgwidden Cove to Toll Point

The location of the dive transects in relation to the percentage cover contour plots in the Helford are shown in Figure 26.

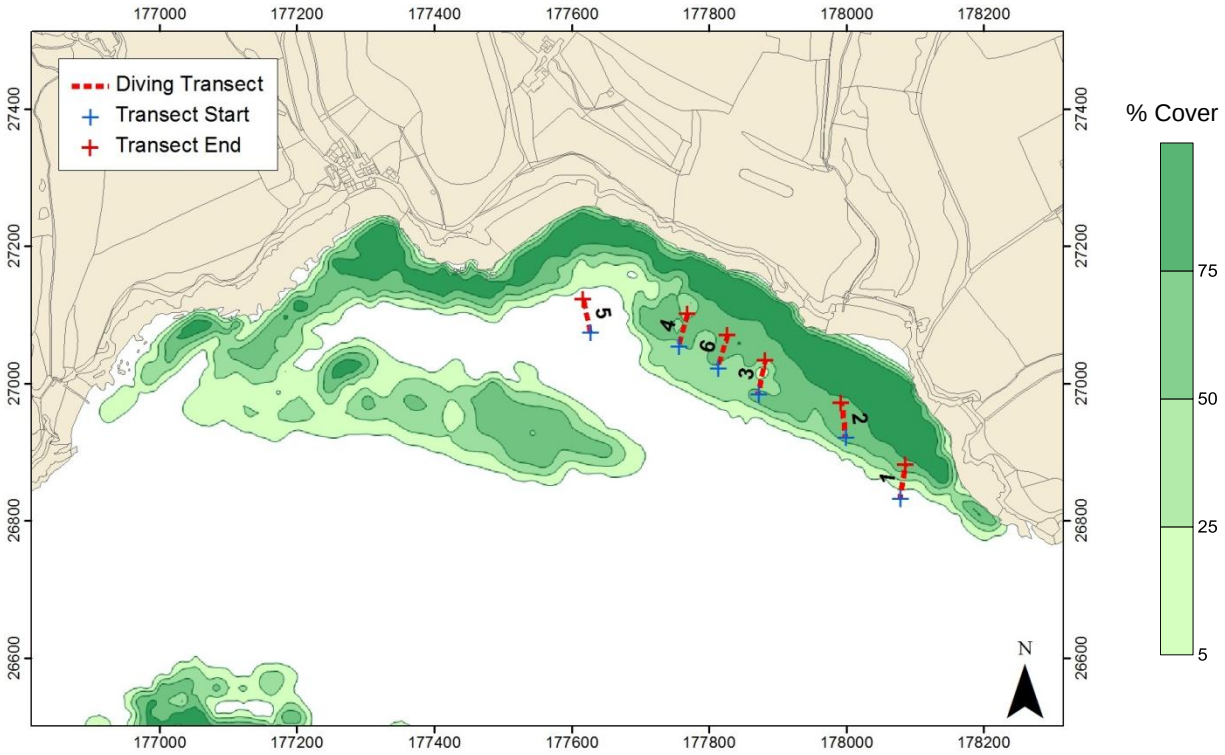

Figure 26. Contour plots of % cover of seagrass and locations of dive transects on seagrass between Polgwidden Cove and Toll Point in the Helford.

Attributes Measured Using DD/TV Methods

The total area of bed between Polgwidden Cove and Toll Point was 238,089m^2. The mean percentage of seagrass cover within that area was 58%. The total area of seagrass in each category of percentage cover has been calculated and is listed in Table 17.

Table 17. Area of seagrass within each percentage cover category between Polgwidden Cove and Toll Point.

% Cover	Area (m^2)
5-25 (Very Sparse)	70,595
26-50 (Sparse)	62,292
51-75 (Moderate)	60,062
76-100 (Dense)	45,149
5-100	**238,098**

The bed stretched approximately 1.3km from west to east. In general it was the most established and least patchy of all the beds surveyed in the SAC, but just 19% of the bed was mapped as 'dense' (≥76% cover). The highest percentage cover values were recorded adjacent to the sublittoral and littoral rock at the inshore extent of the bed, but 100% cover was found off the sandy beach just inshore of dive Transect 2 (see raw data plots in Appendix 1).

An extension of seagrass from the western extent of the bed towards the main channel and to the east was much more variable in terms of cover, values changed from 80% to 0% over the space of 20m.

Litter was recorded at one station. One anchored yacht and ten moorings were noted within the extent of the seagrass during the survey, but no definitive effects on the patchiness of the seagrass were identified. In figure 27 the extent of seagrass in 2015 has been mapped over aerial images taken of the moorings in the Helford in 2014.

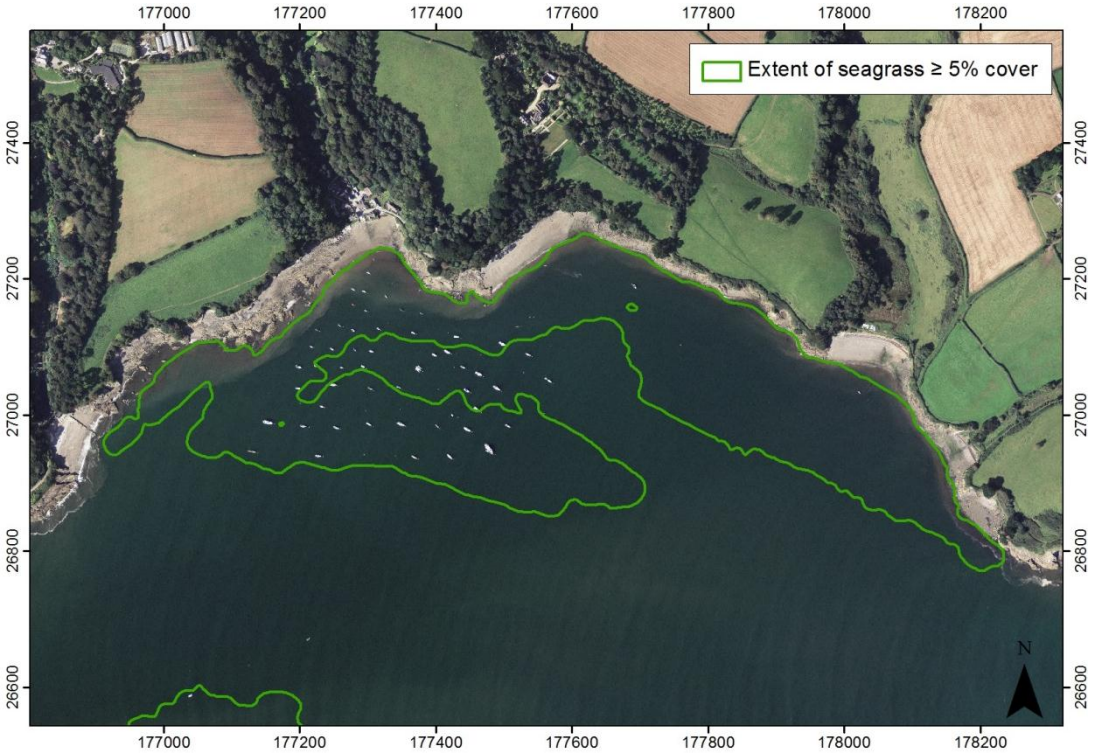

Figure 27. Position of moorings in the Helford estuary in 2014 in relation to seagrass beds mapped in 2015.

Attributes Measured Using Diving Methods

The data collected by divers at the six transects that were surveyed within the Helford estuary have been summarised in Table 18.

Table 18. Mean and range values for each attribute measured using diving methods between Polgwidden Cove and Toll Point in the Helford.

Transect	Mean and Range Values									
	Quadrat 1 (0.0625 m^2)						Quadrat 2 (0.25 m^2)			
	n	Number of Plants (per m^2)	%Leaves Infected	Infection Score	Epiphyte Score	Max Plant Length (cm)	n	%Cover	n	Number of Plants (per m^2)
1	6 (5*)	54 (0-144)	24 (11-36)	0.3 (0.2-0.7)	2.0 (0.8-3.1)	39 (25-50)	30 (21*)	8 (0-38)	8	35 (0-84)
2	10 (1*)	80 (0-160)	15 (0-30)	0.2 (0.0-0.4)	1.3 (0.7-2.1)	34 (26-43)	51	37 (12-63)	11	55 (40-88)
3	9 (2*)	47 (0-128)	19 (0-38)	0.3 (0.0-0.7)	1.0 (0.5-1.6)	40 (26-60)	48 (3*)	20 (0-38)	11	45 (12-80)
4	9 (2*)	71 (0-192)	12 (4-34)	0.2 (0.0-0.5)	0.9 (0.5-1.2)	36 (23-51)	30 (21*)	7 (0-12)	9	33 (0-76)
5	1 (10*)	16	40	0.6	1	50	0	-	0	-
6	11	71 (16-144)	8 (0-32)	0.1 (0.0-0.4)	1.0 (0.5-1.4)	41 (29-57)	6 (45*)	13 (12-38)	11	45 (20-60)
Mean	**-**	**54 (0-192)**	**20 (0-40)**	**0.3 (0.0-0.7)**	**1.2 (0.5-3.1)**	**40 (23-60)**	**-**	**17 (0-63)**	**-**	**43 (0-88)**

* Number of quadrats in which no seagrass was recorded

With the exception of Transect 5 which fell outside the extent of the bed (as defined by ≥5% cover) and taking into consideration the variable sample numbers between transects, the data appears to show that the density of plants was lowest at Transect 1 but also that the percentage of leaves infected and epiphyte scores were highest at Transect 1. The percentage cover as assessed by divers was also low at Transects 1 and 4.

The lower density and cover at Transect 1 was not unexpected given that the transect intersected with the periphery of the bed. However, at Transect 4 the number of quadrats sampled and low cover would suggest a patchiness in the distribution of seagrass that was not detected at the resolution of the DD/TV survey.

A single flowering plant was recorded at Transect 4. Fauna eggs were altogether absent.

4.12.2 East of Passage Cove and Bosahan

The percentage cover of seagrass recorded at individual stations east of Passage Cove and at Bosahan in the Helford has been contoured and plotted in Figure 28.

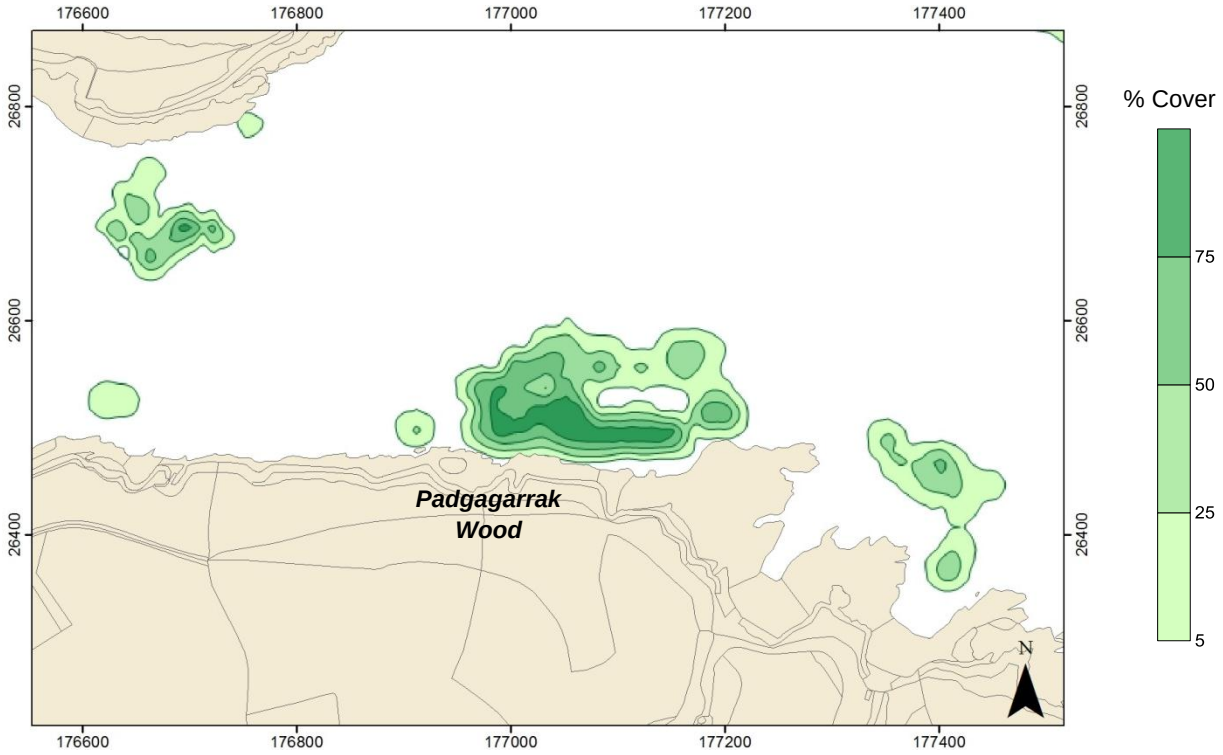

Figure 28. Contour plots of % cover of seagrass at beds East of Passage Cove and off Bosahan.

The total area of seagrass which qualified as beds east of Passage Cove and at Bosahan was 7,615 m^2 and 37,522 m^2 respectively, within each of these areas the mean percentage cover was 56% and 46%. The total area of seagrass in each percentage cover category is listed in Table 19.

Table 19. Area of seagrass within each percentage cover category at beds East of Passage Cove and off Bosahan in the Helford.

% Cover	Area (m^2)	
	East of Passage Cove	Bosahan
5-25 (Very Sparse)	4,748	19,533
26-50 (Sparse)	2,434	9,223
51-75 (Moderate)	427	5,927
76-100 (Dense)	5	2,838
5-100	**7,615**	**37,522**

Both beds were characterised mostly by 'very sparse' cover. East of Passage Cove the seagrass distribution was particularly intermittent with cover in the field of view changing from 100% to 0% within 10m. Between the patches of seagrass gravelly substrates were observed which were typical of tidally scoured conditions. The bed at Bosahan was also fragmented and comprised of four separate patches. The largest and most dense of the patches was found adjacent to Padgagarrak Wood where percentage cover values of 100% were recorded on the inshore periphery of the bed (see raw data plots in Appendix 1).

No anthropogenic activities were observed within the extent of these beds in the Helford.

4.13 Gillan Creek

The subtidal area within Gillan Creek was surveyed using DD/TV but no seagrass was identified.

4.14 Parbean Cove

Parbean Cove is located in Falmouth Bay, south of the Helford estuary. Percentage cover data as well as extent data was collected for the bed and is presented in Figure 29.

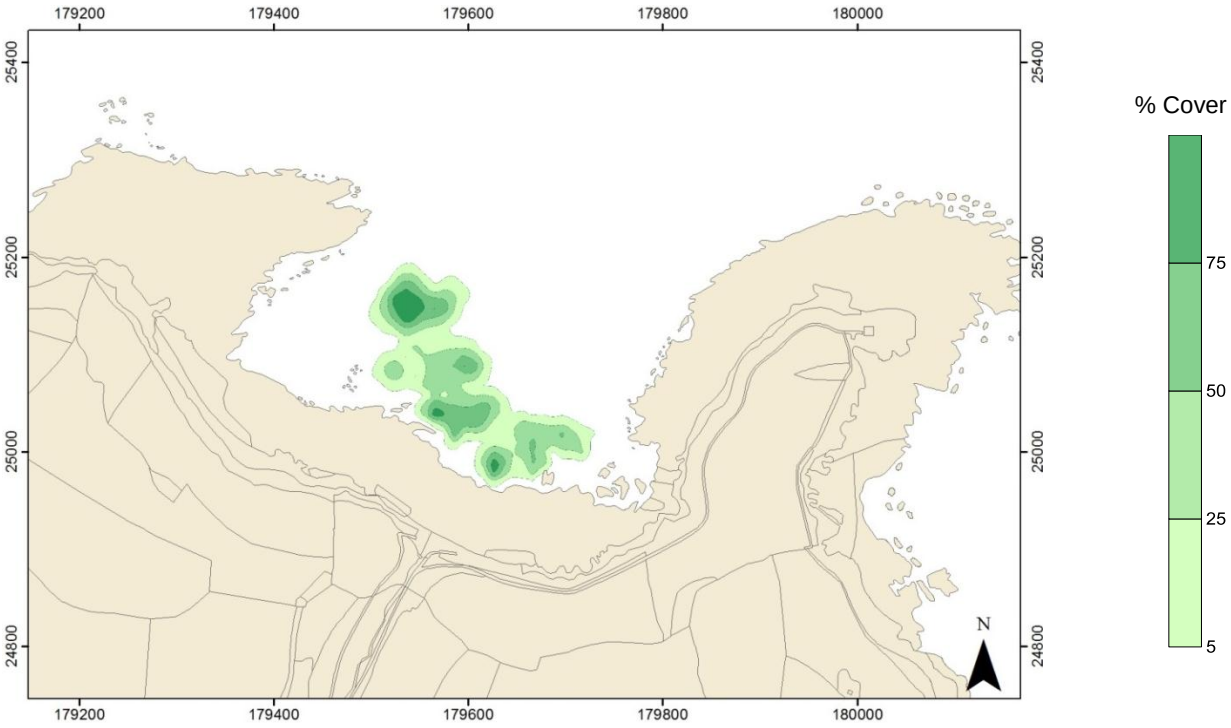

Figure 29. Contour plots of % cover of seagrass at Parbean Cove.

The total area of seagrass bed that was plotted from the target station data was 21,913m^2; the overall mean percentage cover was 58%. The total area of seagrass that was mapped in each percentage cover category is listed in Table 20.

Table 20. Area of seagrass within each percentage cover category at Parbean Cove.

% Cover	Area (m^2)
5-25 (Very Sparse)	10,393
26-50 (Sparse)	7,599
51-75 (Moderate)	3,112
76-100 (Dense)	809
5-100	**21,913**

The bed at Parbean Cove was mostly considered 'very sparse' or 'sparse' but cover of up to 100% was observed at the inshore extent of the bed and at the north-western periphery. The north-west extent of the bed was restricted by subtidal rock. Often dense patches of seagrass were found between outcrops of the rock which appeared to offer stability and shelter to the sandy substrates in the area.

Three moored boats were seen within the extent of the bed during the survey but there was no evidence of scarring. The position of moorings as photographed in 2014 is shown in relation to the extent of the seagrass in Parbean Cove in 2015 (Figure 30).

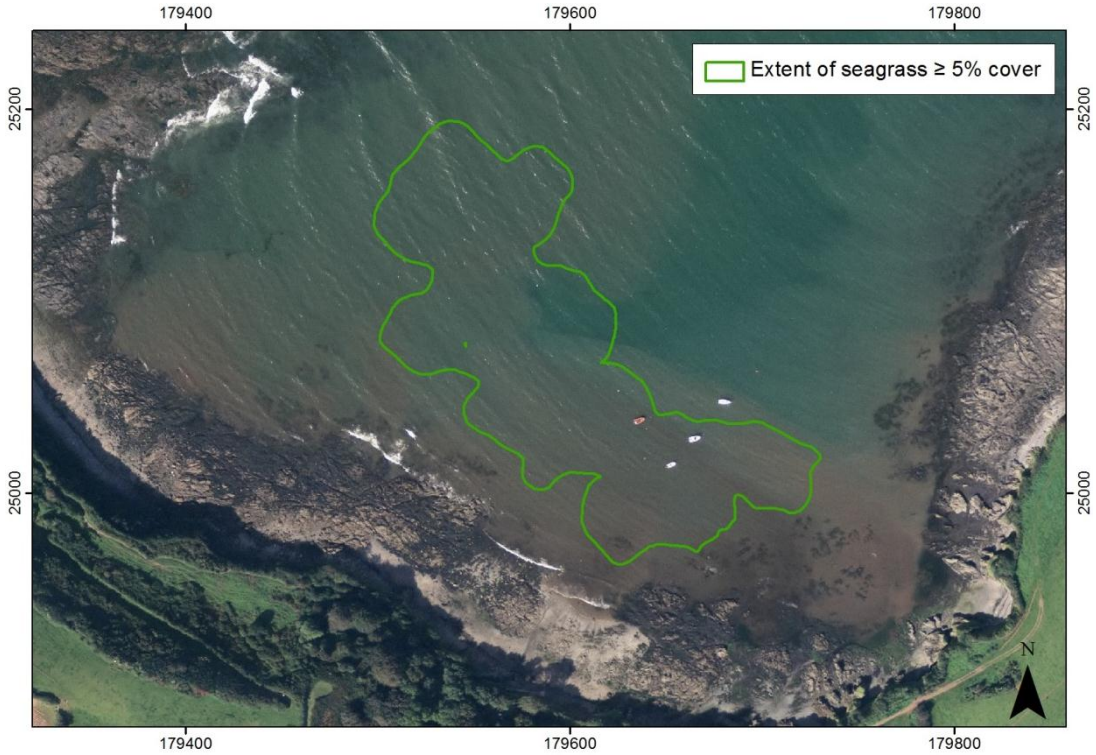

Figure 30. Position of moorings in Parbean Cove in 2014 in relation to seagrass beds mapped in 2015.

No other anthropogenic influences were identified during the surveys.

4.15 Porthallow Cove

Porthallow Cove is the furthest south of all the seagrass beds surveyed and is situated in Falmouth Bay close to Roskorwell. The extent of the bed has been plotted in Figure 31.

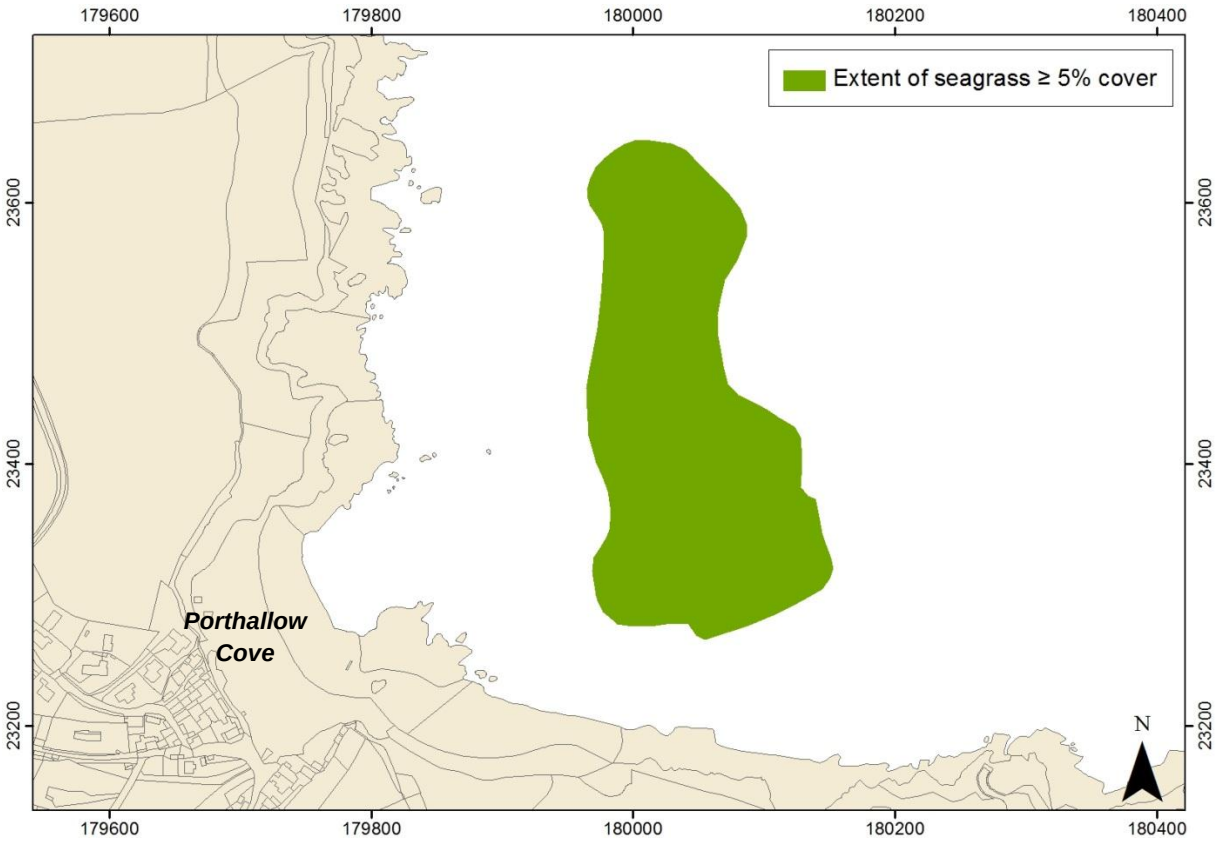

Figure 31. Extent of seagrass ≥5% cover at Porthallow Cove.

The seagrass at Porthallow was distributed almost 400m to the north from Porthallow Cove and covered a total area of the 46,661m^2. Only extent was surveyed but in general the percentage cover observed throughout the bed was 'very sparse' (0-25% cover).

No anthropogenic activities were observed within the extent of the bed.

5. DISCUSSION

5.1 Comparisons Between Seagrass Beds in the Fal and Helford SAC

A comparison of the mean percentage cover between beds (as determined using DD/TV methods) in Figure 32 shows that percentage cover was greatest at Flushing (69%) and lowest at Gyllngvase and Swanpool (18% and 21%) respectively. With the exception of the bed at Penarrow Point which is also relatively sparse, the remaining beds exhibited broadly similar mean percentage cover values.

The bed at Flushing happens to be one of the most sheltered beds in the SAC whilst those at Gyllngvase and Swanpool are the most exposed (both Gyllngvase and Swanpool are popular surfing beaches). It is likely that the exposure of the beds to the prevailing south-westerly weather and swell is a strong determining factor in the percentage cover of seagrass observed in a bed, as more sheltered stable substrates are likely to facilitate attachment and colonisation of plants and storm events are less likely to uproot rhizomes.

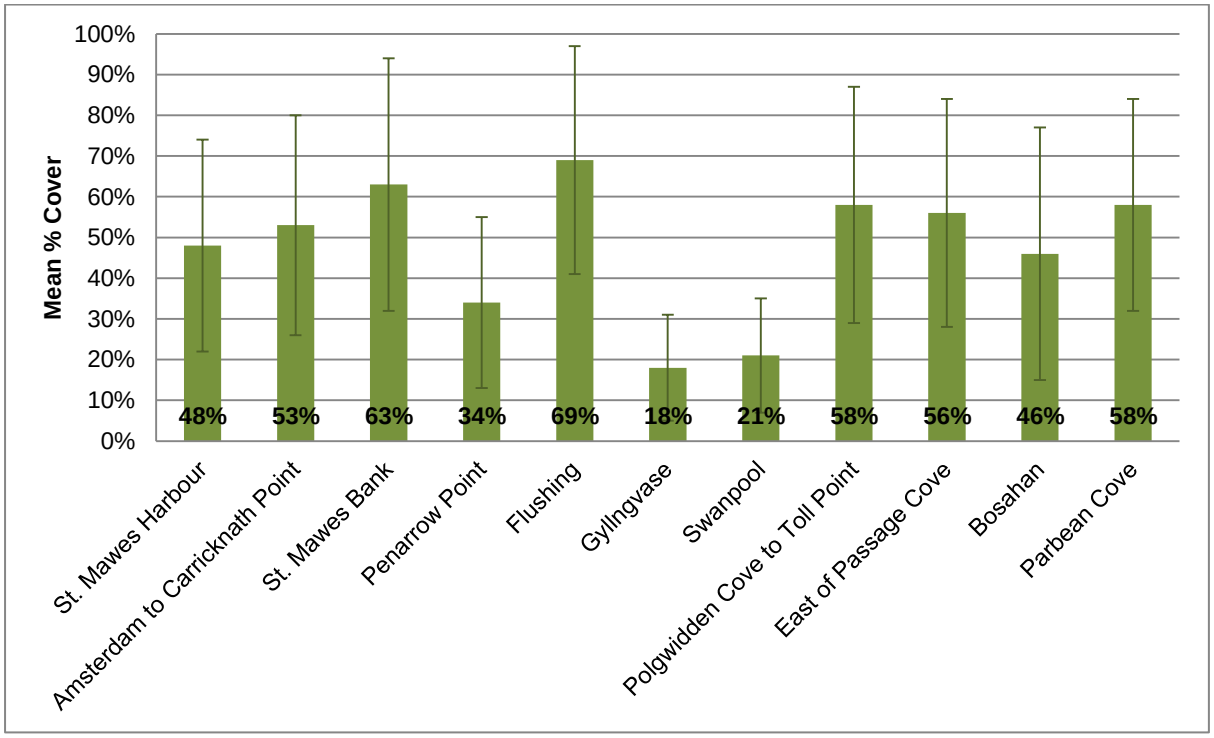

Figure 32. Mean percentage cover at all seagrass beds where the attribute was surveyed in the Fal and Helford SAC

The largest beds were found in the Helford between Polgwidden Cove and Toll Point, at Maenporth, and in the lower Percuil between Amsterdam Point and Carricknath Point (Figure 33). Large proportions of these beds were comprised of very sparse or sparse covers of seagrass. Although the percentage cover was not specifically surveyed at Maenporth, the percentage cover was noted by the surveyor as being mostly 10-15%. The beds in the Helford did however have over twice the area of 'dense' seagrass compared to the beds in the lower Percuil.

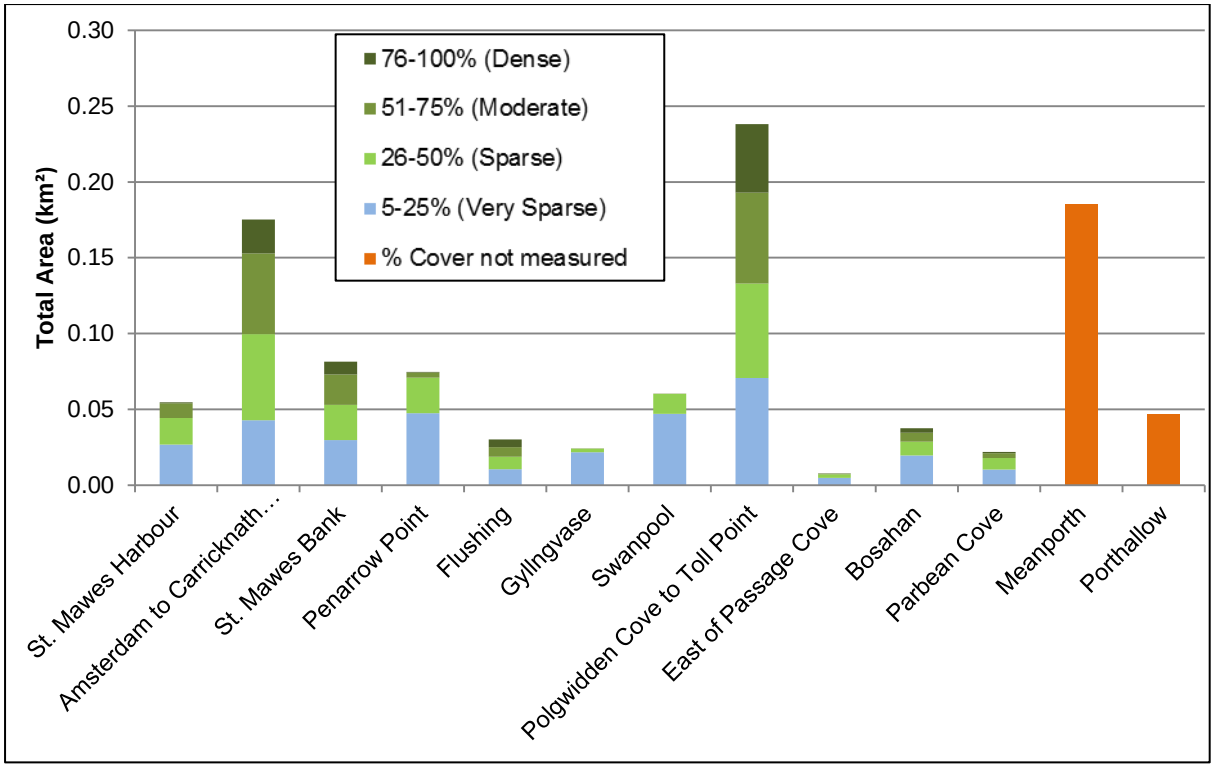

Figure 33. Total area and area of each category of percentage cover at all seagrass beds where the attribute was surveyed in the Fal and Helford SAC

Inferences have been drawn here by comparing attributes measured by divers between beds. However, these should be treated tentatively given the relatively limited sampling effort from which the data has been derived at many of the locations. Furthermore, given that the sampling effort was also variable between beds (e.g. the mean values have been drawn from different numbers of quadrats) the accuracy of the data from each bed will also be variable.

The greatest number of plants within an individual quadrat and the greatest mean number of plants per m^2 was recorded in the bed between Amsterdam Point and Carricknath Point (Figure 34.).

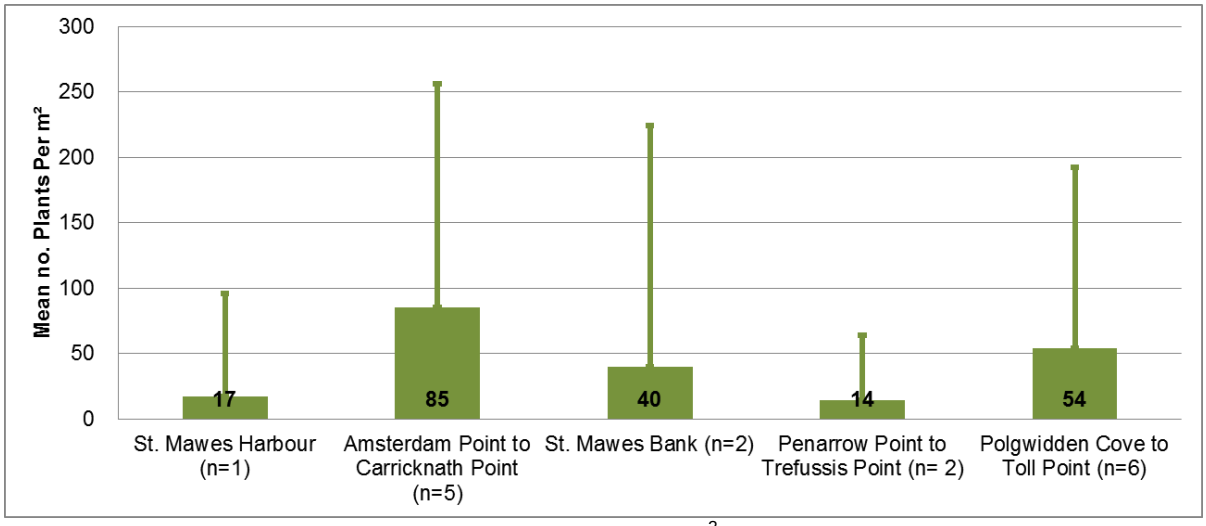

Figure 34. Mean (and maximum) number of plants per m^2 at seagrass beds in the Fal and Helford SAC (the minimum number of plants was zero at all beds).

The percentage of leaves infected was very similar between all of the beds assessed with the exception of at Pennarrow Point where both the mean and maximum percentages of leaf infection were almost half of that measured elsewhere (Figure 35).

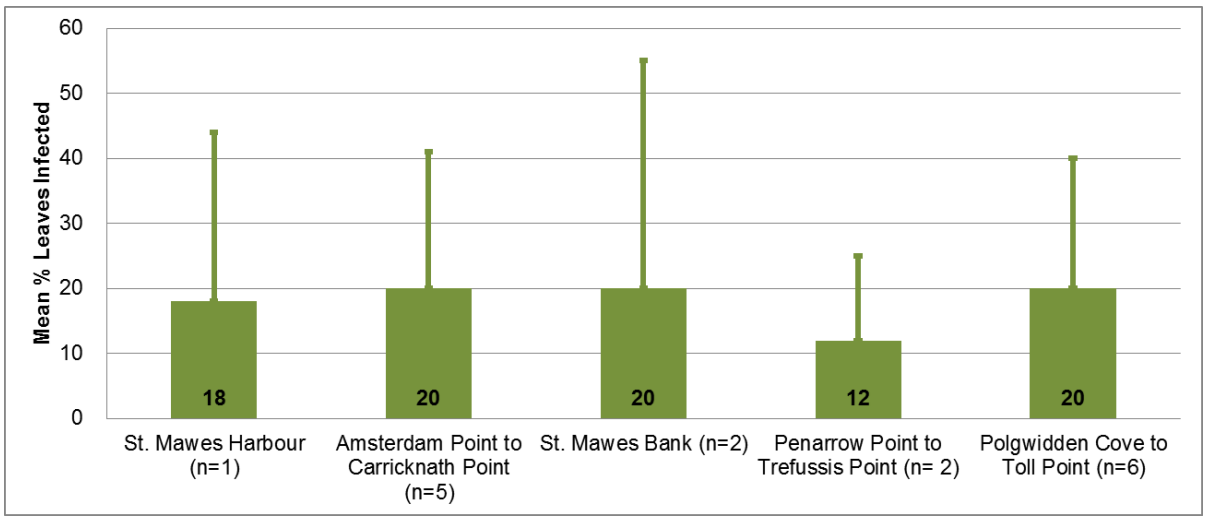

Figure 35. Mean (and maximum) % leaves infected at seagrass beds in the Fal and Helford SAC (minimum number of plants was zero at all beds).

The mean and maximum infection scores largely refelected the mean percentage leaves infected values (Figure 36).

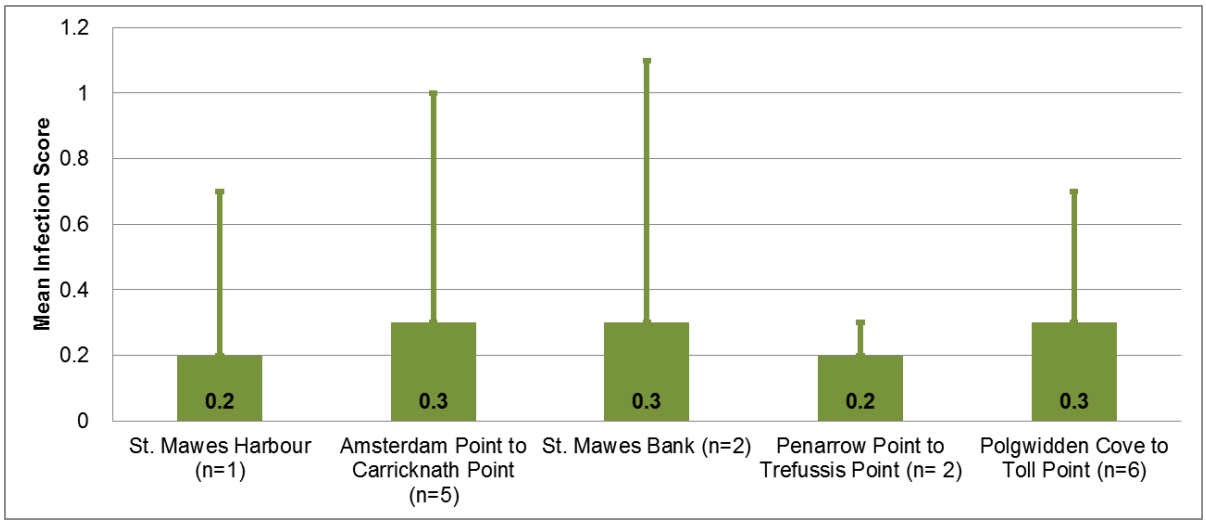

Figure 36. Mean (and maximum) infection score at seagrass beds in the Fal and Helford SAC (minimum score was zero at all beds).

The mean epiphyte score was greatest at Penarrow Point and St. Mawes Bank and lowest at St. Mawes Harbour (Figure 37). These values did not appear to correlate with the density of the seagrass at each of the beds (Figure 34).

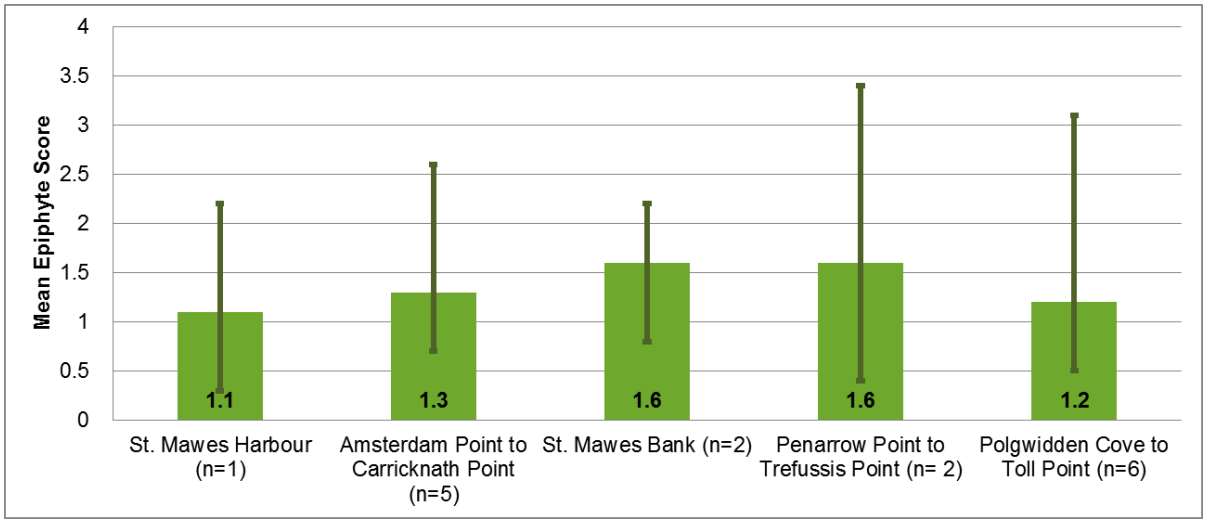

Figure 37. Mean of epiphyte scores (and range) at seagrass beds in the Fal and Helford SAC.

The mean maximum plant lengths were very similar between the five beds that were assessed (Figure 38). The range of lengths was smaller at St. Mawes harbour because data was derived from quadrats on a single transect at that bed.

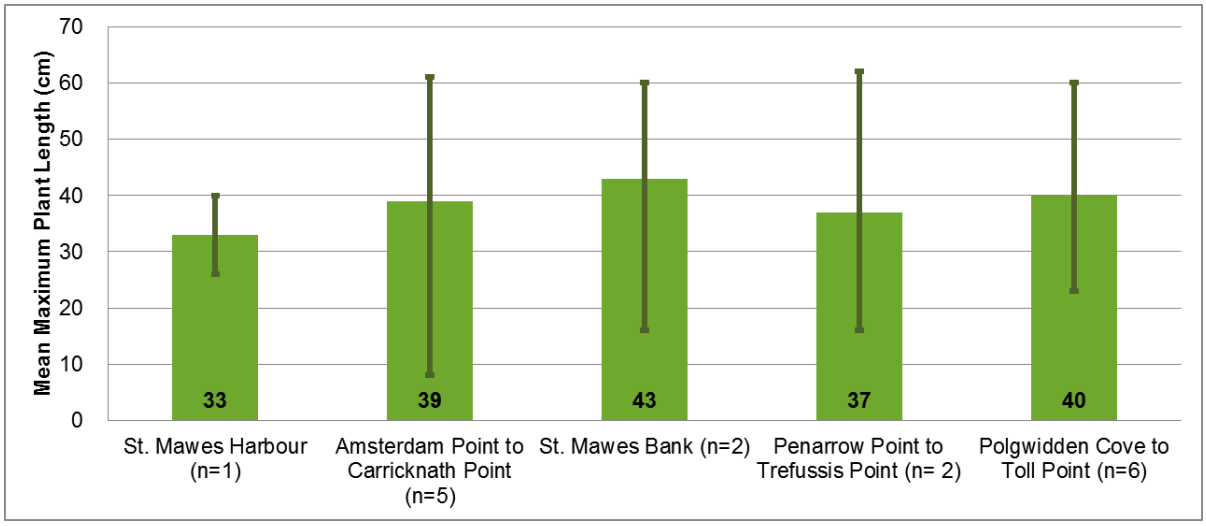

Figure 38. Mean maximum plant length (and range) at seagrass beds in the Fal and Helford SAC.

The mean percentage cover recorded in situ by divers was lowest at Penarrow Point and highest at St. Mawes Harbour (Figure 39). The ranges were very variable and reflect the patchy distribution of the seagrass within the beds. The smallest range was at St. Mawes Harbour where just 5 quadrats were sampled on one transect.

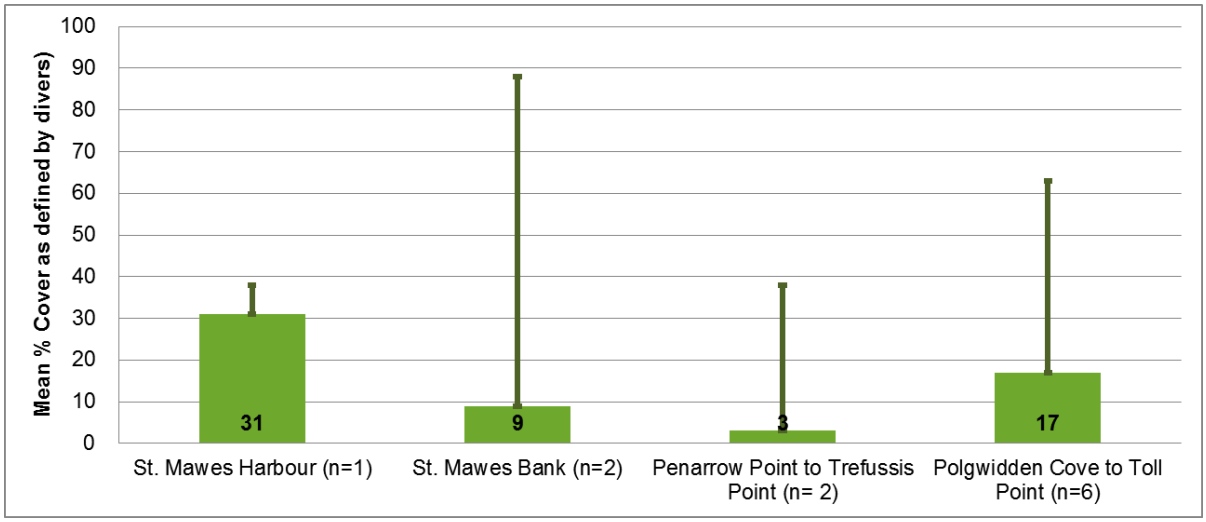

Figure 39. Mean and maximum % cover as determined by divers at seagrass beds in the Fal and Helford SAC (minimum value was zero at all beds).

As expected given the correlation between percentage cover and number of plants (R=0.63) the mean number of plants per m^2 generally reflected the mean percentage cover values and ranges (Figure 40.). This was not the case at St. Mawes Harbour however where the mean number of plants per m^2 was the lowest of all the beds, yet the mean percentage cover was the highest. This inconsistency was an effect of only half the transect having been placed over the bed which resulted in a higher proportion of zero values in the quadrats that were placed every 5m for assessment of plant number.

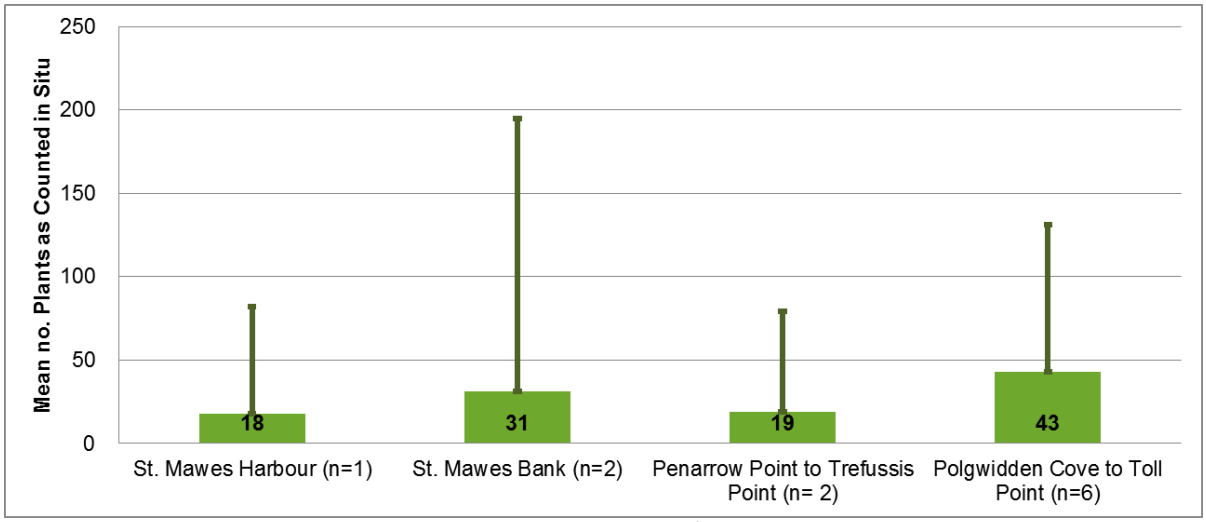

Figure 40. Mean and maximum number of plants per m^2 as determined by divers in situ (minimum value was zero at all beds).

5.2 Temporal Comparisons and Condition Assessment

The subtidal seagrass beds in the Fal and Helford SAC have fallen within the remit of a number of studies. However, very few of these studies have specifically targeted monitoring of the seagrass communities and consequently each have employed various methods, studied different locations and measured different attributes/parameters. Those studies which are most relevant to the Condition Assessment have been listed in Table 1 in Section 1.2.

The different methods employed in previous studies (and where relevant the associated limitations) make the direct comparison of results here difficult. This issue is compounded

by the fact that different monitoring positions were applied within each bed, all of which display a patchy spatial configuration. Consequently it is only possible to make broad comparisons with previous studies data.

5.2.1 Limitations of Data

A number of limitations were encountered when directly comparing data for all attributes measured; these are described in the proceeding sections:

5.2.1.1 Seagrass Percentage Cover and Extent

No previous studies have measured the percentage cover of seagrass in the Fal and Helford SAC in a consistent way. Although some percentage cover data was collected by Kendall *et al*, in 2006[12] at the beds between Amsterdam Point and Carricknath Point, a consistent method of describing the cover was not applied. This ranged from 'sparse' to 'dense' with no definition of these descriptors although a number of specific percentage cover values were recorded. Only broad comparisons can therefore be made with the data collected in 2015.

Although a number of historical studies have mapped the extent of the subtidal seagrass beds within the SAC, the percentage cover threshold used to delineate the 'edge' of a bed has not been defined in any of these previous studies. This means that a number of the seagrass bed boundaries have previously been estimated or arbitrarily assigned making direct temporal comparisons difficult. Given that different methods were employed between the studies and that different studies covered different beds, the confidence in making direct temporal comparisons was also very variable between beds and largely dependent upon the source of the historical data. A summary of the historical data used to map the historical extent of each bed has been provided in Table 21.

A final point to consider when comparing extent data is that the month during which the historical data was collected is often not known. It is therefore possible that any differences observed in extent may be at least in part due to the different stage of the growing season during which surveys were carried out.

Table 21. Historical data sources used to map seagrass extent (adapted from Anderson 2013[4])

Seagrass Bed	Primary source	Secondary source	Conflicting source	Comments
Bosahan	Moore, 1999 [2]	-	-	Feature categorised as seagrass bed in report, confirmation required due to lack of associated data.
Lower Percuil	Cook, 2000[6] in Hocking and Tompsett, 2002 [7]	-	Moore, 1999[2] - Sub-tidal mud communities	Diver survey used to categorise sub-feature.
St. Mawes Harbour	Hoskin 2012 *in* Anderson, 2013[4]	-	Moore,1999[2] and Davies, 1995[18] - Sub-tidal mud communities	Seabed imaging survey used to categorise sub-feature. Partial extent of habitat estimated due to lack of other nearby habitat records.
Amsterdam Point to Carricknath Point	Hoskin 2012 *in* Anderson, 2013[4], Kendal, 2006[12]. Moore, 1999[2]. Bunker, 1992[5]. Hocking and Tompsett, 2002.[7]	Cook, 2000[6]	Davies, 1995[18] - Sub-tidal sand and gravel communities	Seabed imaging survey used to categorise sub-feature, presence and extent confirmed by numerous other surveys in this region.
St. Mawes Bank	Cook, 2000 [6]	Hocking and Tompsett, 2002[7]. Howson, 2002[16]. MCS, 2012 [17]. Moore, 1999 [2].	Davies, 1995[18] - Sub-tidal sand and gravel communities	Multiple surveys report the presence of seagrass beds in this area. Eastern extent confined by low tide limit, western extent confined by presence of maerl beds in survey results, and confirmed by aerial photography.
Penarrow Point to Trefussis	Rostron, 1985 [9] and Hocking and Tompsett, 2002 [7]	Cook, 2000 [6] and Moore, 1999[2]	Davies, 1995[18]	Sub-features categorised from multiple diving surveys. Extent of feature estimated, and confined by other nearby features.
Flushing	Hocking and Tompsett, 2002 [7]	-	Moore, 1999[2]	Diver survey used to categorise feature. Extent of seagrass is estimated due to lack of other nearby features.
Gyllyngvase	Spalding Assoc., 2004 [14]	-	Davies, 1995[18] - Dead maerl	Sub-features categorised from acoustic profiling and seabed imaging surveys. Partial extent of habitat estimated due to lack of other nearby habitat records.
Swanpool	Spalding Assoc., 2004 [14]	-	Davies, 1995[18]	Sub-features categorised from acoustic profiling and seabed imaging surveys. Partial extent of habitat estimated due to lack of other nearby habitat records.
Maenporth	Hocking and Tompsett, 2002 [7]	-	Davies, 1995[18] - Sub-tidal sand and gravel communities	Dive survey showed presence of *Zostera marina* at a single point, so extent is arbitrary.
Polgwidden Cove to Toll Point	Hoskin, 2012 *in* Anderson, 2013[4], Allen *et al*, 2014 [3] and Hocking and Tompsett, 2002 [7]	Gainey, 1997[15].	Moore, 1999[2] - Mixed sediment communities	Seabed imaging survey used to categorise sub-feature. Area boundary is an estimate, extrapolated from a dive trasnectusing aerial photography.
East of Passage Cove	Hocking and Tompsett, 2002 [7]	-	Moore, 1999[2] - Live maerl	Extent estimated based on aerial photography.
Bosahan	Hocking and Tompsett, 2002 [7]	Gainey, 1997[15] and Rostron, 1987[9]	Moore, 1999[2]	Patchy presence of seagrass confirmed by multiple sources.
Parbean Cove	Hocking and Tompsett, 2002 [7]	-	Davies, 1995[18]	Small patch of sparse *Zostera marina* located during dive survey, single point record only, boundary is arbitrary.
Porthallow Cove	Hocking and Tompsett, 2002 [7]	-	-	Single point record showing presence of *Zostera marina* from dive survey. Arbitrary boundary due to lack of other local habitat records.

5.2.1.2 Attributes assessed by diving

The principal limitation in making comparisons for all attributes assessed by diving is the lack of available data. The only firm data available is for the bed between Durgan and Toll Point in the Helford where a mean value of 54 plants per m^2 (range of 0-112 plants per m^2) in 1997 was reported by Sutton and Tompsett in 2000[13]. Sutton and Tompsett[13] also recorded the average leaf length to be 49 cm, but given that the mean *maximum* leaf length was recorded in this study the data is only vaguely comparable. The precise sampling locations in 1997 are also not available. Therefore, particularly given the patchiness of the beds, any differences between this study and the historical data cannot definitively indicate changes (or otherwise) in bed attribute. Furthermore, sampling was undertaken throughout the growing cycle (March, April, May, June, July and October) which was in contrast to this study where diving surveys were carried out in July. Therefore it has only been attempted to make broad comparisons between the data collected in July 1997 and that collected during this study.

An overall estimated value of no more than 1-2 plants per m^2 was recorded by Cook 2000[6] between Amsterdam Point and Carricknath Point, but, when the transect used was superimposed on the extent of seagrass mapped in 2015 it was shown to fall outside of the area of seagrass defined as 'bed'.

With regard to *Labyrinthula* sp. infection data, only general comments on the absence of obvious signs of the disease are available for the bed between Amsterdam Point and Carricknath Point in the Fal[5,6]. The proportion of 'decayed blades' was recorded by Sutton and Tompsett[13] in 1997 in the Helford between Durgan and Toll Point, but as was the case for the other attributes measured in that study the sample position, month of sampling and differences in the methods used restricted the ability to make direct temporal comparisons with data from this study. A further point to consider is that the presence of *Labyrinthula* sp. has not been confirmed in 2015. The percentage of leaves infected and infection scores have been derived from observations of leaf 'browning'. Although the 'browning' has been considered likely to be caused by cell breakdown indicating the presence of *Labyrinthula macrocystis,* this may not be the case and natural plant decay may be responsible.

Although comparatively more data is available with regard to epiphyte cover (at St. Mawes[9], Amsterdam Point to Carricknath Point[5], Penarrow Point[6,9] and Bosahan[10]), again much of the information is restricted to general comments on the presence or absence of epiphytes. Bunker[5] did identify and record the abundance of epiphytes between Amsterdam Point and Carricknath Point according to a SACFOR scale, but it is not possible to make useful comparisons between his data and that which has been collected in 2015.

The results of this study will therefore largely provide a baseline from which to assess temporal changes in all the attributes measured using divers in this project. However, because a considerable proportion of the transects fell outside of the beds, this baseline will need to be strengthened in future by re-positioning the transects within the extent of the beds.

5.2.1.3 Comparisons of Seagrass Bed Extent

The historical data sources that have been used to delineate the extent of each of the seagrass beds prior to 2015 (as mapped in the following sections) are listed in Table 21, Section 5.2.1.

Percuil River

The DD/TV surveys in 2015 failed to find any seagrass in the Percuil River. There was a low confidence in the historical data for the bed in the upper reaches of the Percuil as although the area was mapped by Moore, 1999[2], the report includes no verbal description of the *Zostera* sp. communities in the area or any information on how or when the data was gathered. It is therefore possible that no seagrass previously existed at that location. However, it was known that seagrass was present in the lower Percuil where Cook 2000[6] reported small beds, highly patchy in nature concentrated to the north-east side of Polvarth Point (Figure 41). It can therefore be concluded with some confidence that the bed at Polvarth Point has disappeared.

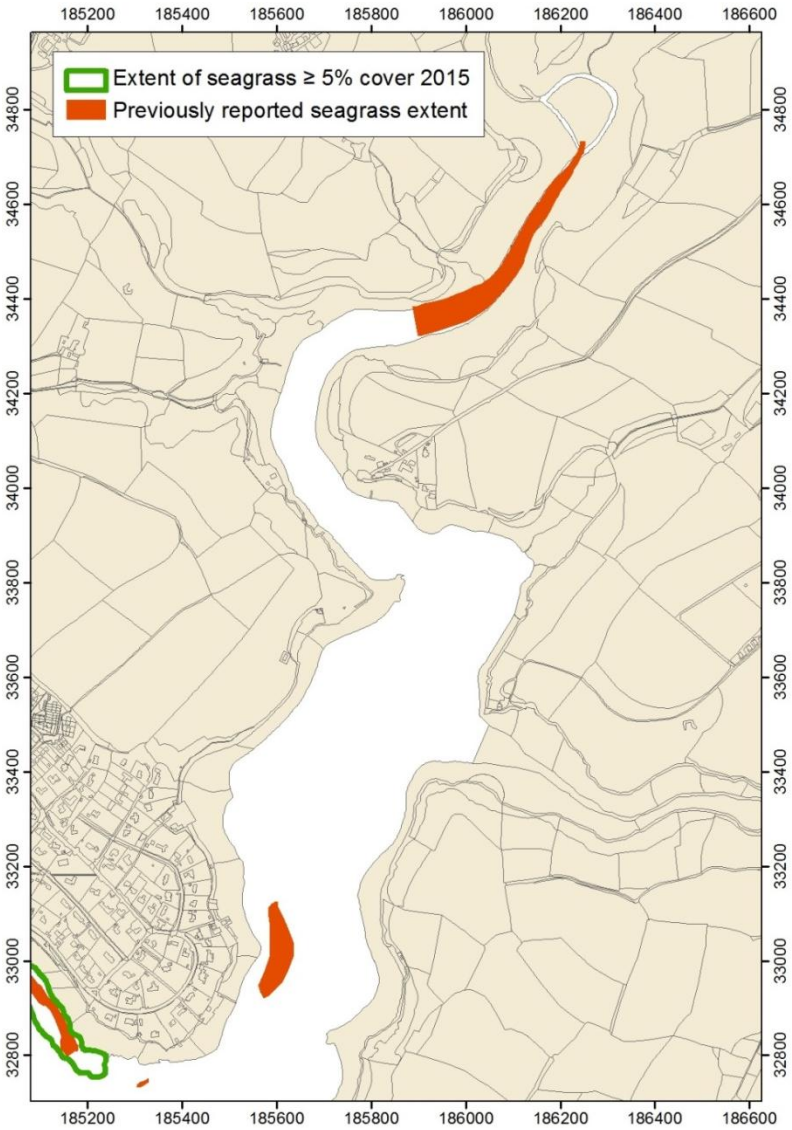

Figure 41. Map of historically reported seagrass extent in the Percuil River.

St. Mawes Harbour

The extent of seagrass in St. Mawes Harbour was mapped by Anderson in 2013[4] (Figure 42). The original source of this data is in the form of an unpublished report (Hoskin, 2012) which is not available. By comparing the extent reported in 2012 with that collected in this study it would suggest that the seagrass beds in St. Mawes Harbour have not changed greatly since 2012. The bed to the west appears to have potentially increased in size, but given that the methods used (including the percentage cover threshold used to delineate the periphery of the bed) are not available, it is not possible to draw any definitive conclusions with regard to changes in extent.

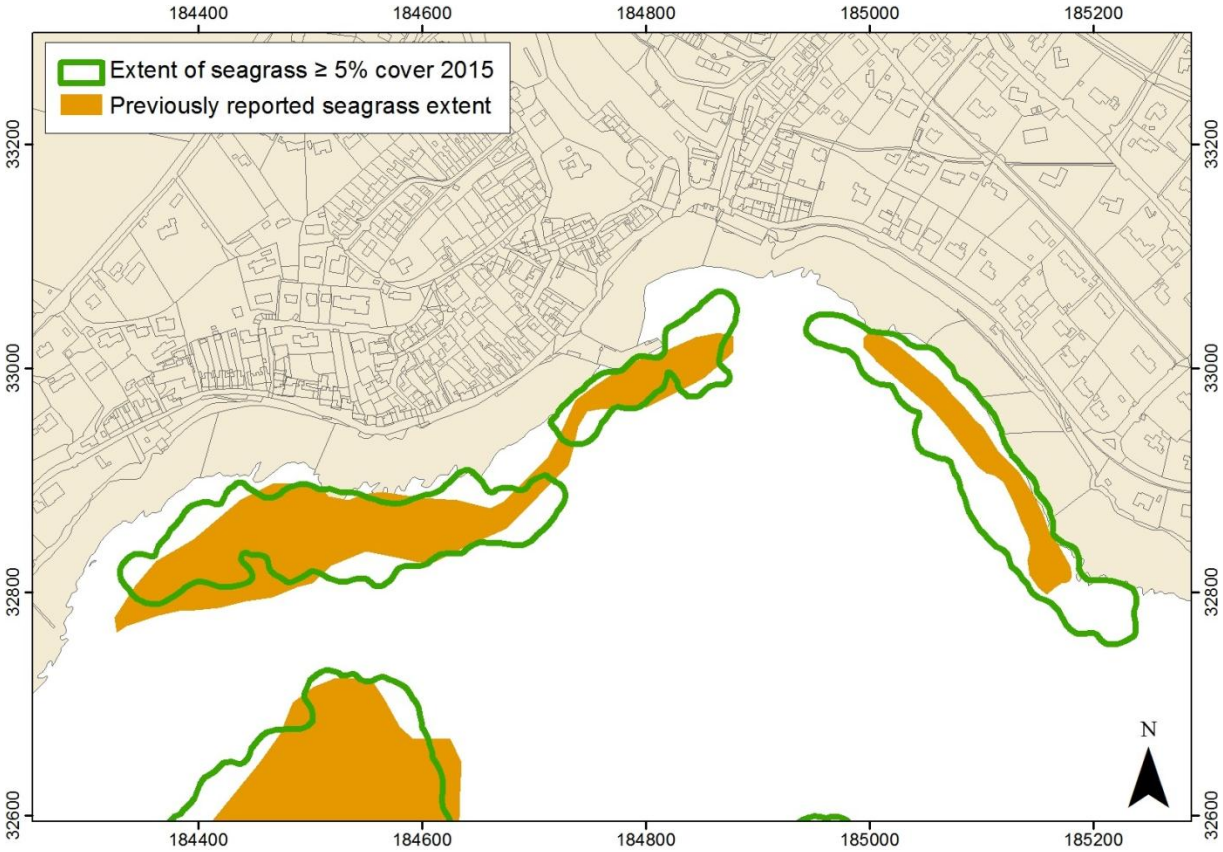

Figure 42. Map of historically reported seagrass extent in St. Mawes Harbour plotted alongside extent in 2015.

Amsterdam Point to Carricknath Point

The beds between Amsterdam Point and Carricknath Point have been mapped in numerous studies (Table 21). As previously mentioned these studies did not state the percentage cover that was used to define the periphery of a bed, and therefore only broad comparisons can be drawn. There is relatively high confidence in the data however given the similarities between the studies regardless of methods applied. The extent mapped by Hoskin 2012 *in* Anderson 2013[4] and Kendall 2006[12] have been plotted in Figure 43 which shows that the extent of seagrass has not altered substantially since 2006.

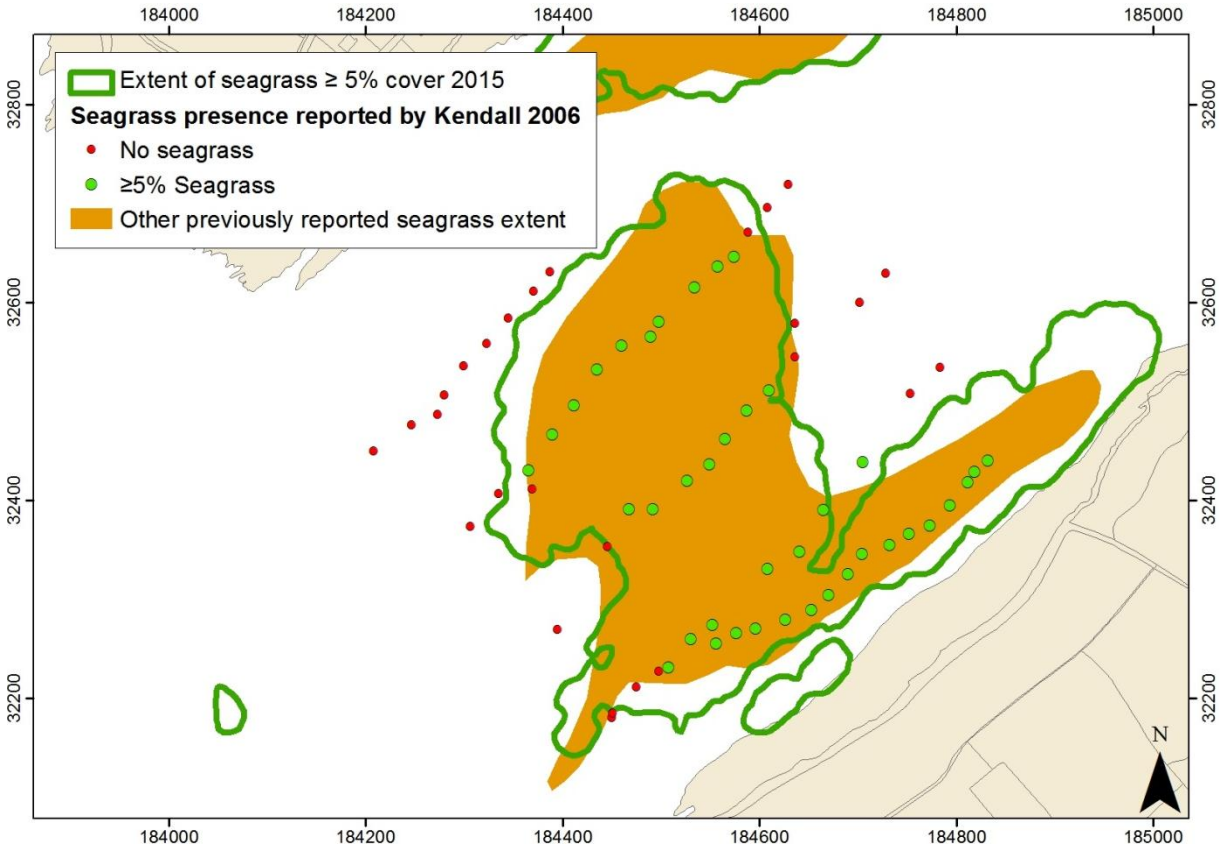

Figure 43. Map of historically reported seagrass extent between Amsterdam Point and Carricknath Point plotted alongside extent in 2015.

St. Mawes Bank

Multiple surveys have reported the presence of seagrass at St. Mawes Bank (Figure 44). Again, there is relatively high confidence in the historical data particularly in terms of the western extent of the bed which has been supported by aerial photography. However, the southern extent of the bed was previously mapped by Cook 2000[6] and happens to coincide with the last dive transect which was surveyed for maerl during that study. Therefore, the apparent extension in the southern extent of the bed in 2015 is not thought to represent a real increase in extent, but instead is an effect of the study area being extended to incorporate the full extent of the bed in 2015. Therefore the extent of the bed at St. Mawes Bank is not thought to have altered much since at least 1999.

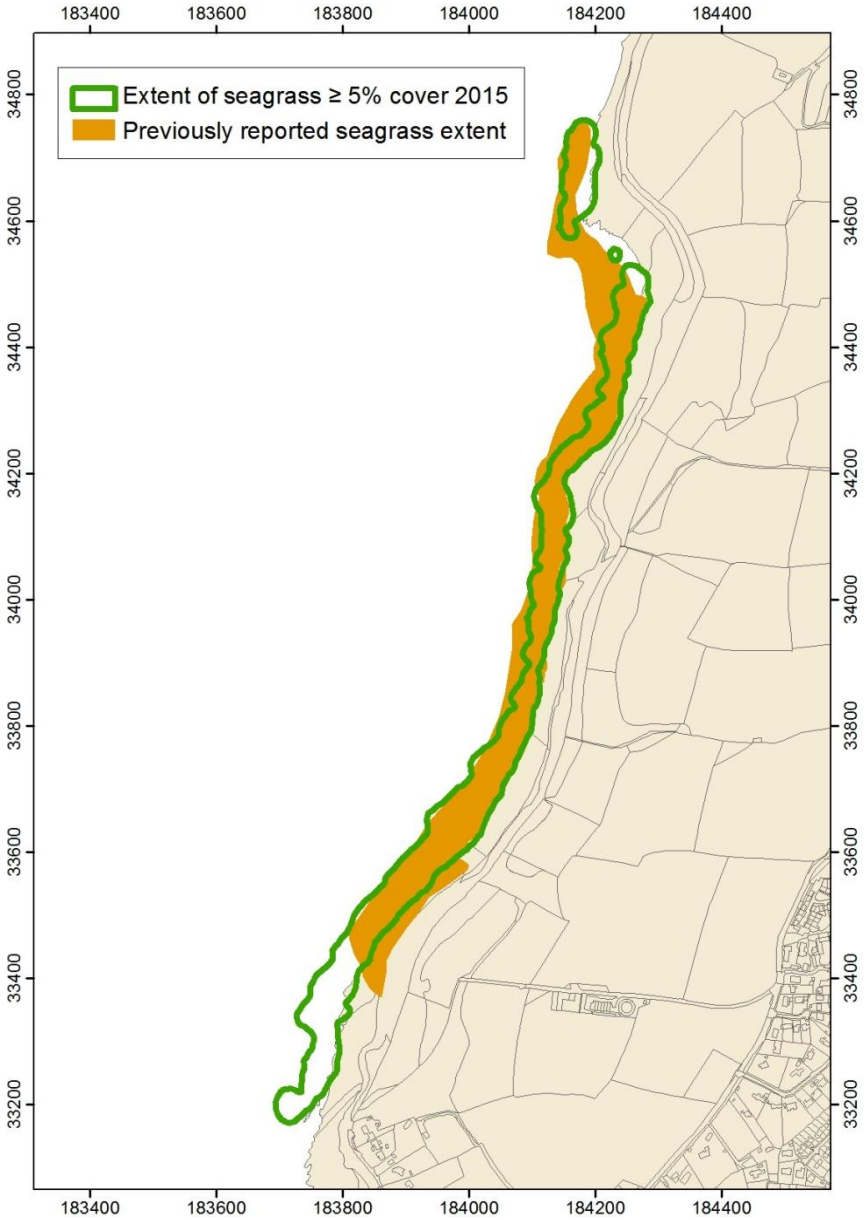

Figure 44. Map of historically reported seagrass extent at St. Mawes Bank plotted alongside extent in 2015.

Penarrow Point

There is moderately low confidence in the southern extent of the seagrass shown south of Pennarow Point in Figure 45 as, although seagrass was reported on a dive transect in 1985[8], the extent of the seagrass was subsequently extrapolated from that single transect. There is slightly more confidence in the data from the northern extent of the bed, but given the methods employed, and the highly patchy nature of the seagrass at Penarrow Point, it is quite possible that the full extent of the seagrass wasn't mapped in 2000[6]. This is particularly likely for the inshore extent of the bed which is separated from the satellite beds further off the coast. The extent of the 'core' of these satellite beds as reported by Cook in 2000[6] does however appear to correspond broadly with those mapped in 2015 (the red squares in Figure 45 show the northern and southern extent of the core reported in 2006). More specific comparisons cannot be made because methods for defining the edge of the bed were not outlined in 1999.

Given the information available, it does appear that seagrass has disappeared from the area towards Trefusis Point. It is not possible to ascertain with any certainty whether the inshore and southern extent of the beds at Pennarrow Point are extensions of the bed since 1999, or whether these areas were previously unsurveyed and therefore unrecorded. However, the satellite beds of the coast at Penarrow Point do not appear to have changed substantially since 1999.

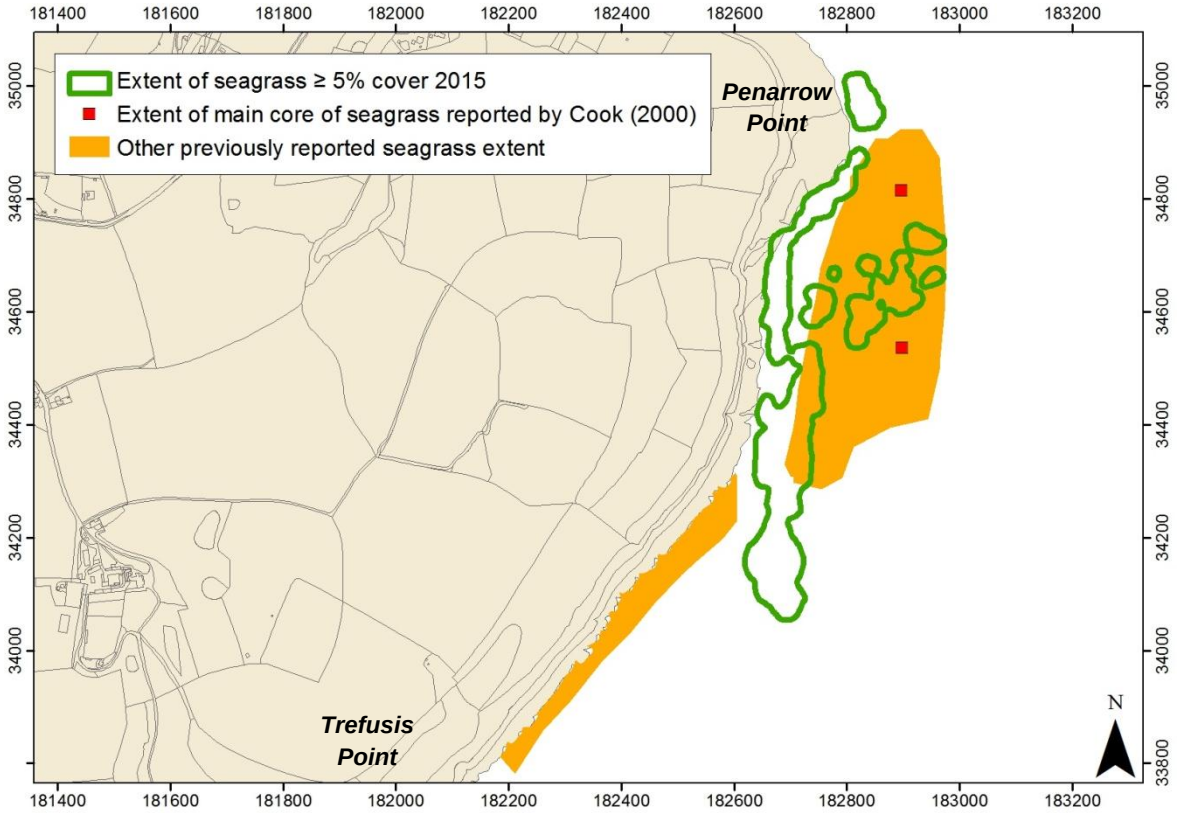

Figure 45. Map of historically reported seagrass extent between Penarrow Point and Trefusis Point plotted alongside extent in 2015.

Flushing

The presence of seagrass at Flushing was confirmed by a single surveyor during a night dive in 1983, but the extent of the bed as shown in Figure 46 is thought to have been largely estimated. Therefore, although there appears to have been a substantial increase in the extent of the seagrass beds, confidence that this increase is real, is very low.

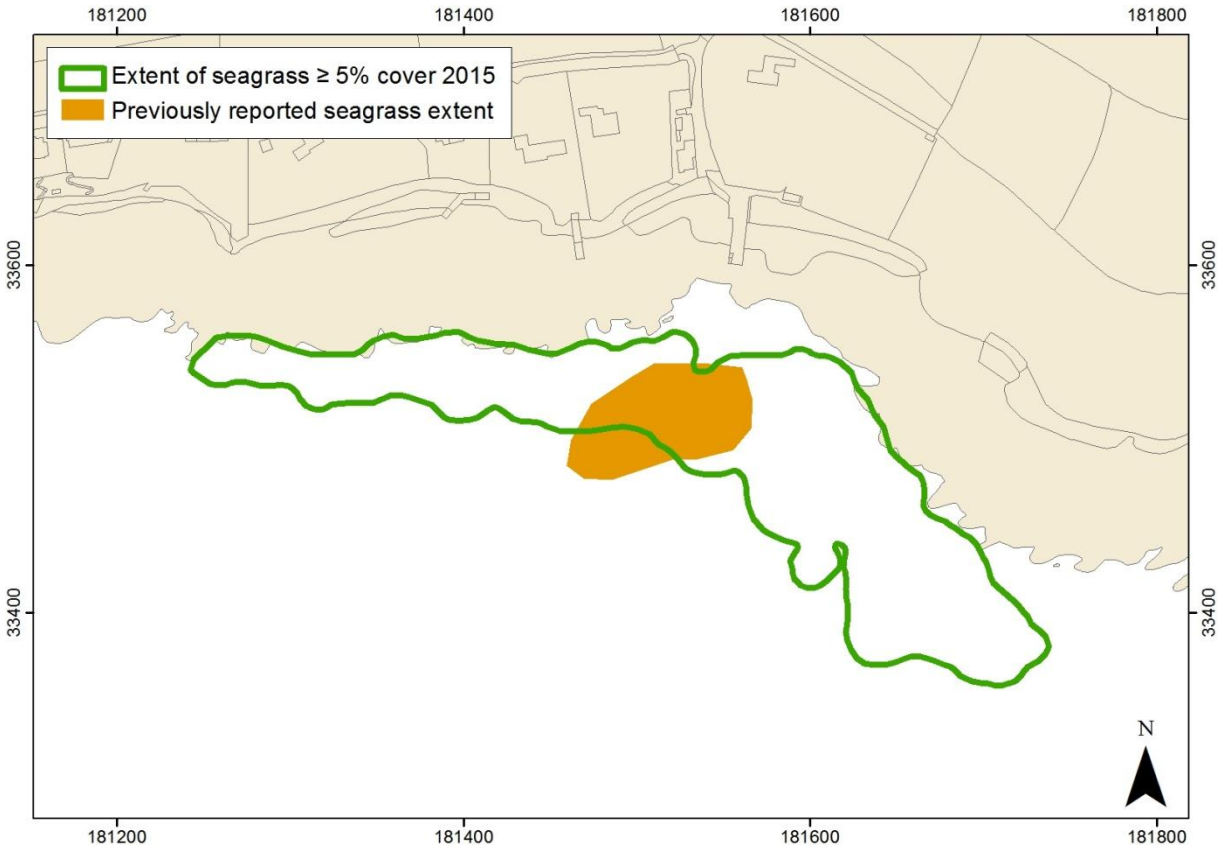

Figure 46. Map of historically reported seagrass extent at Flushing plotted alongside extent in 2015.

Gyllyngvase and Swanpool

The previous extent of seagrass at Gyllyngvase and Swanpool was derived from acoustic profiling and video imaging surveys in 1995 and 2004 that primarily targeted kelp, boulder, rock and maerl communities. The extent of the seagrass in 2005 (Figure 47) was therefore partially estimated due to lack of other nearby habitat records. As a result it has not been possible to draw definitive conclusions about the apparent increase in extent since 2004[14].

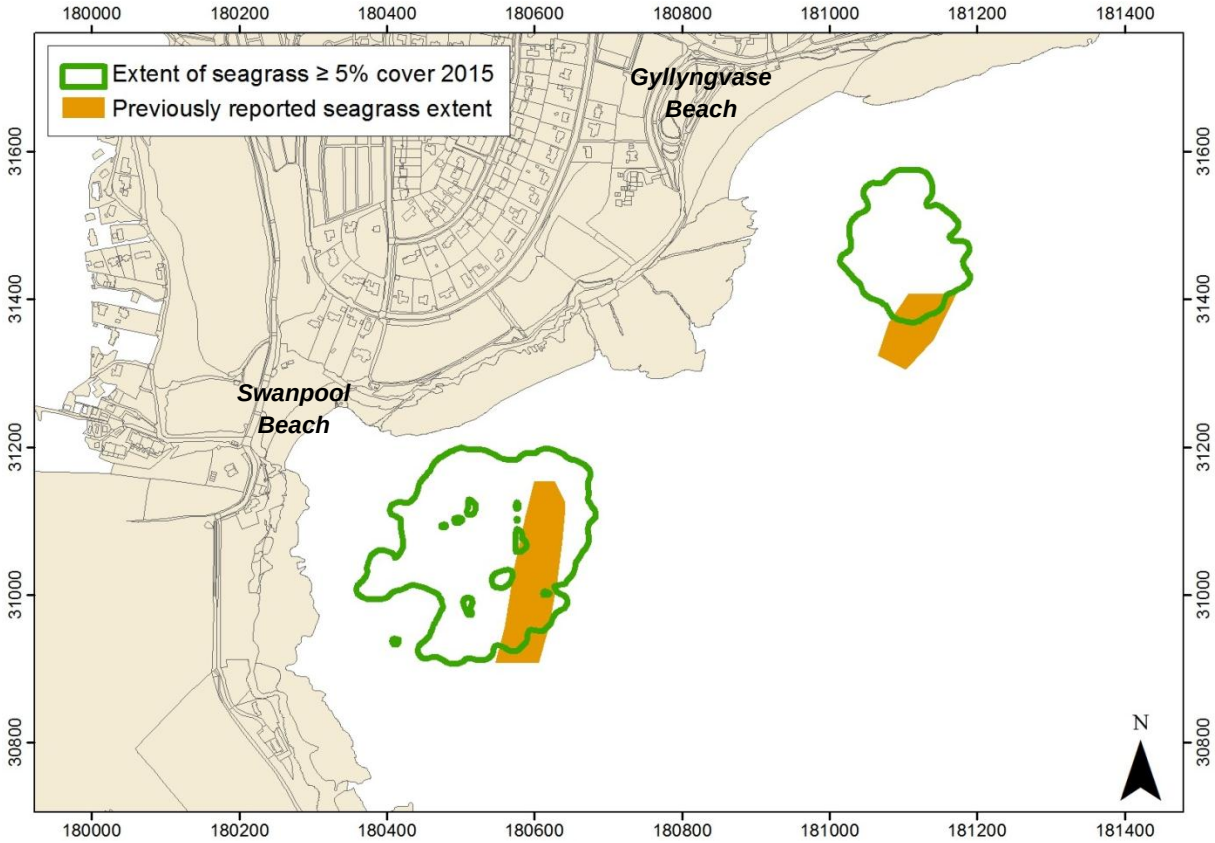

Figure 47. Map of historically reported seagrass extent at Gyllyngvase and Swanpool plotted alongside extent in 2015.

Maenporth

The bed extent reported by Hocking and Tompsett in 2002[7] in Figure 48 has been derived from a single point where seagrass was recorded. The method used to extrapolate the point into a habitat polygon has not been defined, so the historical extent is arbitrary. No meaningful temporal comparisons of extent can therefore be made for the bed at Maenporth.

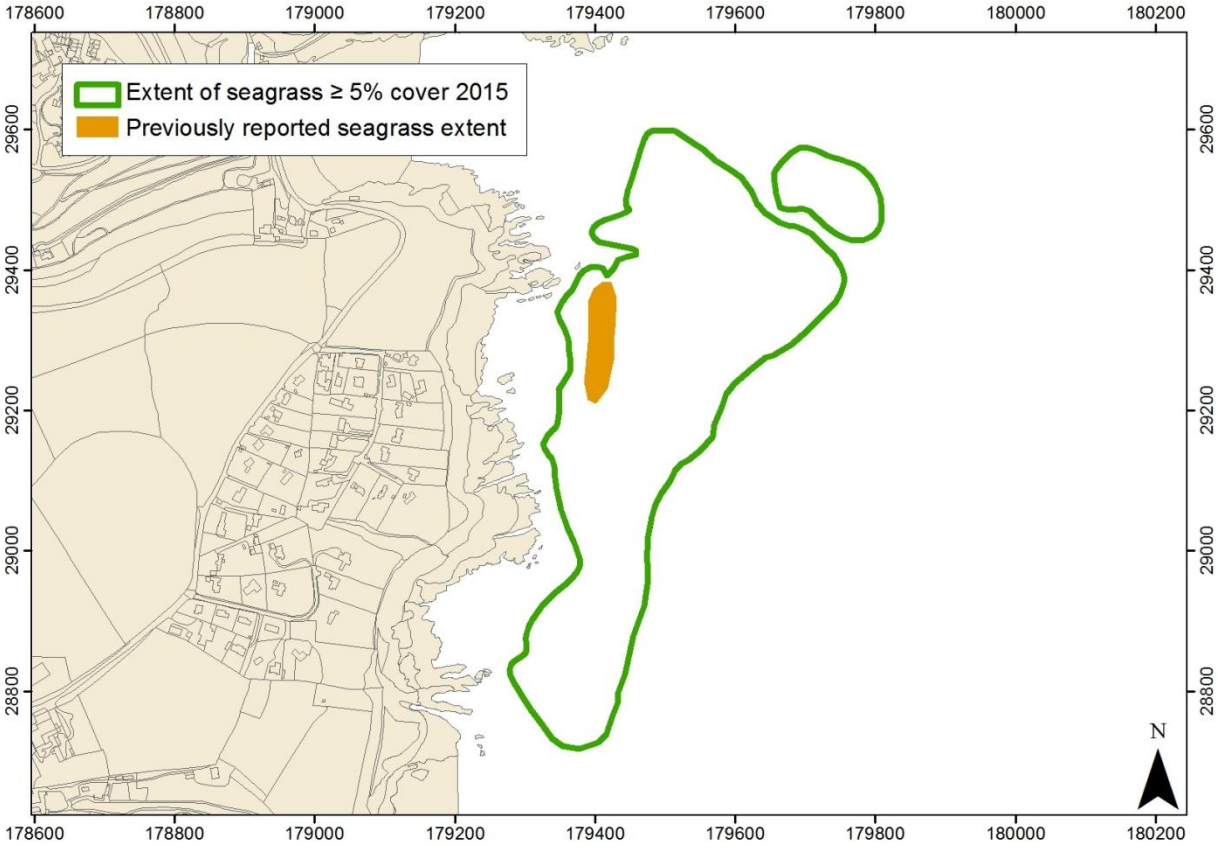

Figure 48. Map of historically reported seagrass extent at Maenporth plotted alongside extent in 2015.

Polgwidden Cove to Toll Point

There is moderate to high confidence in the historical extent data which has been mapped in Figure 49. Confidence is lower at the western end of the bed where at least some of the data was extrapolated from a single transect using aerial photography. The projection of seagrass from the western extent of the bed towards the east may not have been previously mapped because of the greater water depth in that area, which may could prevented the full extent of the bed from being viewed in the aerial images. Aerial imagery is also likely to have only been sufficient to distinguish the most dense areas of seagrass leaving the more sparse areas (that were still >5% cover) undetected. This is a likely scenario as the densest areas mapped in 2015 broadly correspond with the historical data. There is higher confidence in the data for the main body of bed to the east as in 1997 the bed was surveyed using 8 diving transects[13]. However, reports of the seagrass starting 'at the Spring High Water Mark i.e. the rocks' do not correspond with the historical extent that has been mapped (though this description does fit more closely with that which was observed in 2015) so much of the temporal difference observed may be due to positioning errors. It was reported in 2000 that the seagrass was spreading upstream to the west across Durgan Beach[7] but specific methods on how this was determined are not available.

Given the data available it has not been possible to determine whether the differences in extent represented in Figure 49 are real representations of an increase in extent, or an effect of the different mapping methods applied. However, it can be said with some certainty that

the beds have not declined markedly in extent between Polgwidden Cove and Toll Point since 2000.

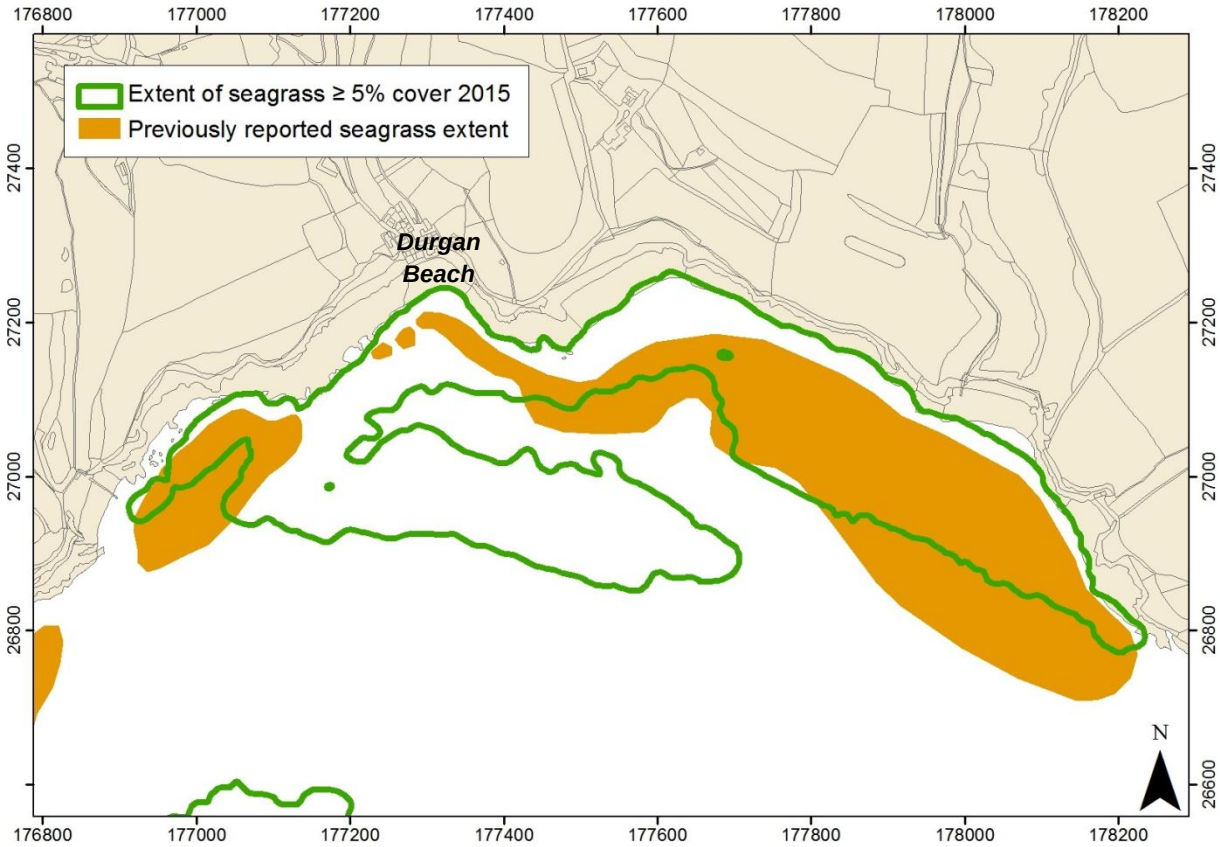

Figure 49. Map of historically reported seagrass extent between Polgwidden Cove and Toll Point plotted alongside extent in 2015.

East of Passage Cove and Bosahan

The extent of seagrass east of Passage Cove was reported in 2001[7]. No methods on how the extent was determined are available but it is thought that the beds were potentially mapped from a boat by the local water bailiff. A number of studies have reported seagrass at Bosahan Cove[7,9,13]. Divers have described the beds there as sparse and intermittent measuring just a few meters, the largest of which was around 30 m^2[13]. It is thought that the historical extent shown in Figure 50 is a representation of the general area over which the seagrass was observed during these studies rather than an accurate representation of extent.

Due to a limit of the detail discussed above, it has not been possible to come to a conclusion regarding changes in extent of seagrass east of Passage Cove and at Bosahan. However, given the written descriptions of the beds at Bosahan, it is possible that the beds have increased in extent in that area since 1998.

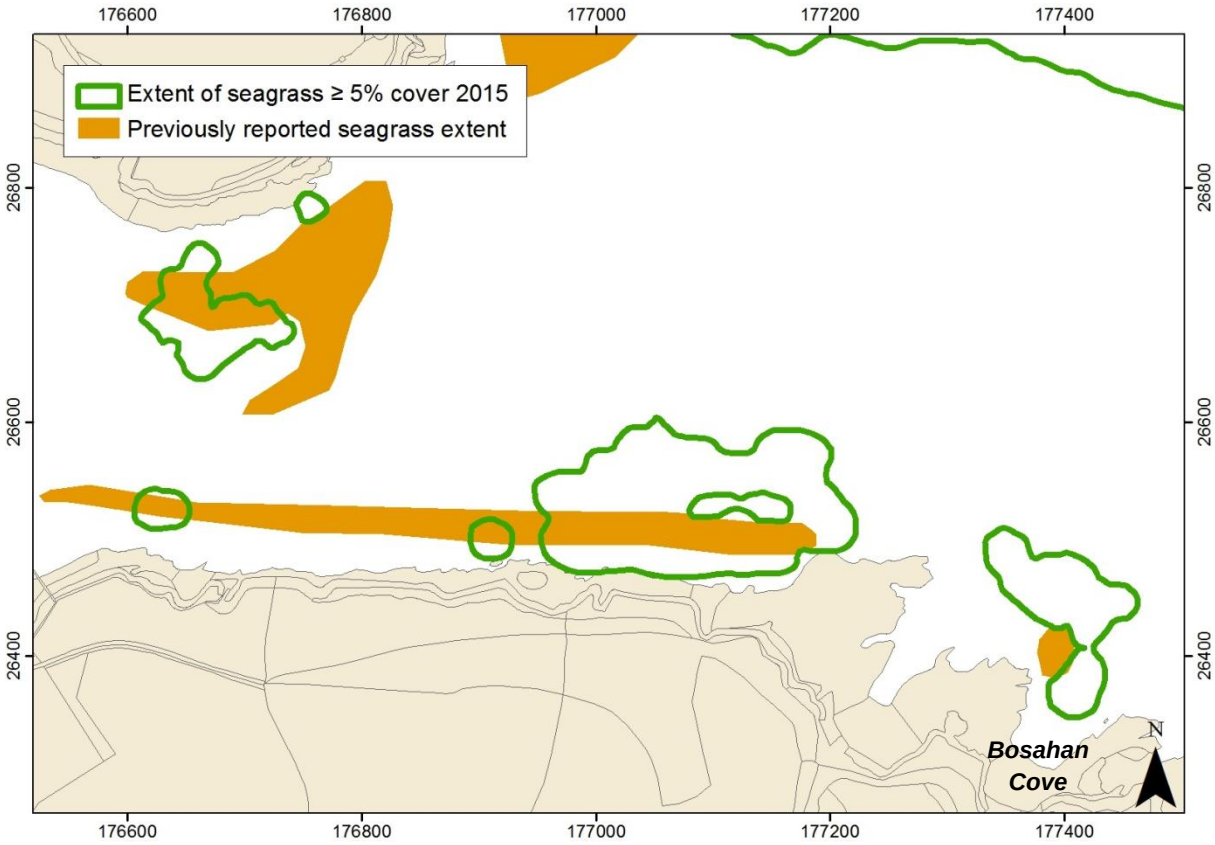

Figure 50. Map of historically reported seagrass extent east of Passage Cove and at Bosahan plotted alongside extent in 2015.

Gillan Creek

A single record of subtidal seagrass in Gillan Creek was made in 1986[7] (Figure 51) but no information on the extent was noted and the confidence in the record in uncertain. No subtidal seagrass was found within Gillan Creek in 2015.

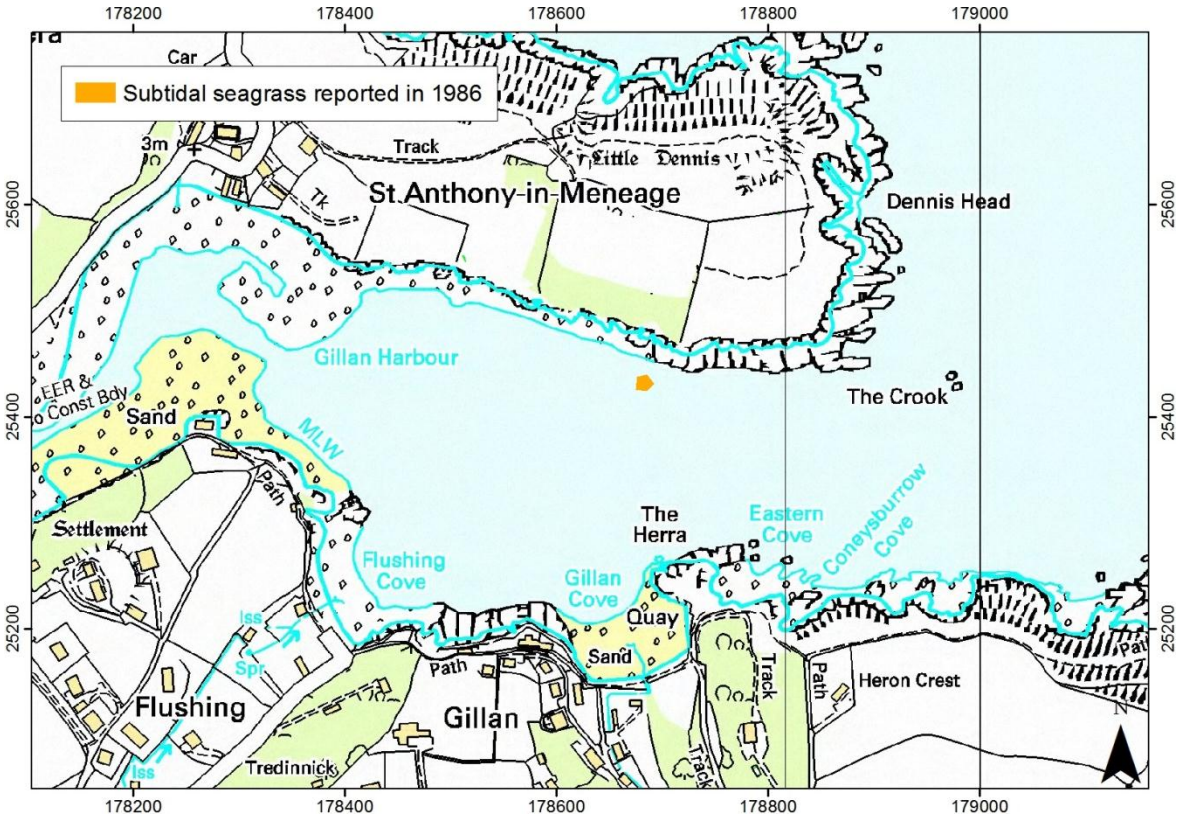

Figure 51. Map of historically reported seagrass extent in Gillan Creek.

Parbean Cove

The previous extent of seagrass in Parbean Cove represented in Figure 52 has been derived from a single point record in 2001[7] where the bed was described as a few metres square and very sparse. The extent that has been mapped is therefore arbitrary. Methods on how the position was determined are not available and, as such, it is not known whether the bed has shifted inshore since 2001 or whether there were inaccuracies in positioning in 2001. It is also not known whether the full extent of the bed was observed previously (which would indicate that the bed has increased in size substantially since 2001) or whether the patchy nature of the bed led the observer to believe that the bed was more restricted in size than it actually was at that time.

Given the limited historical data available it has not been possible to come to a conclusion regarding temporal change of seagrass extent at Parbean Cove.

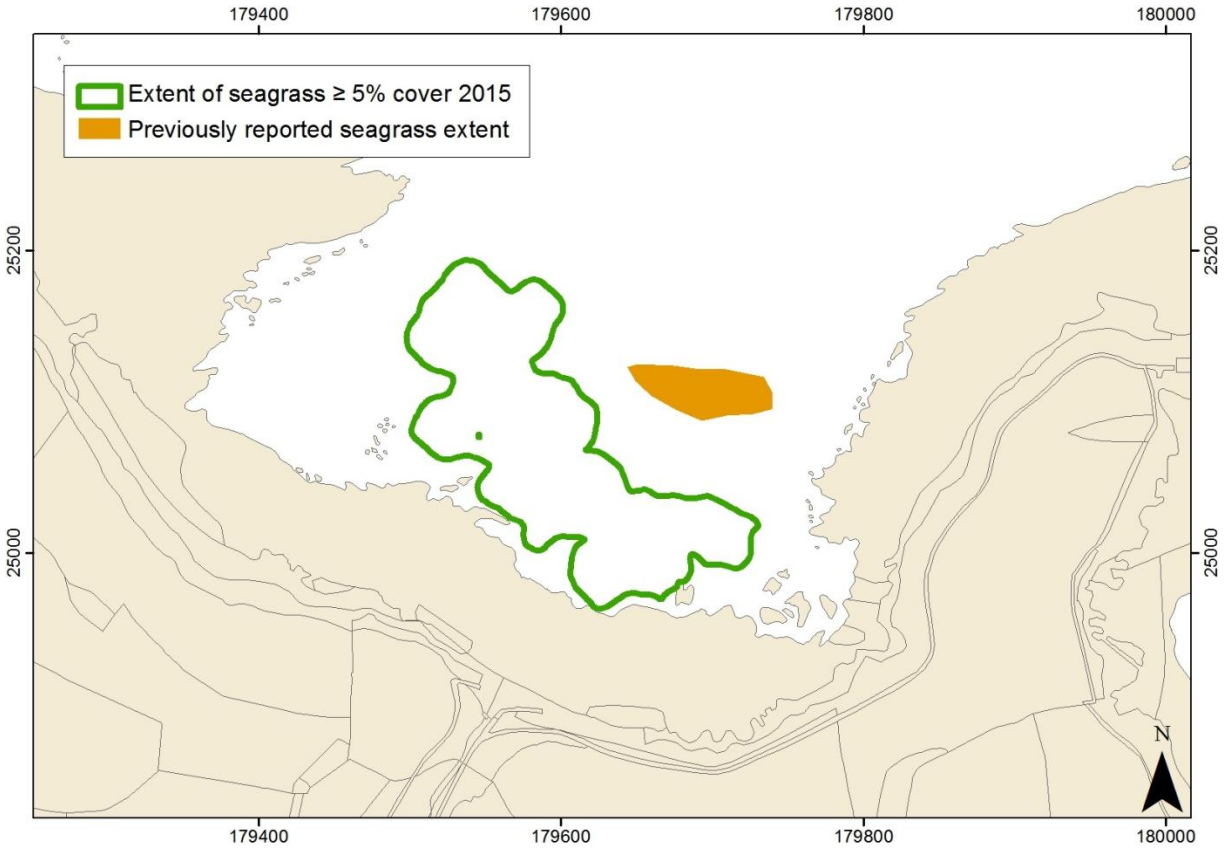

Figure 52. Map of historically reported seagrass extent in Parbean Cove plotted alongside extent in 2015.

Porthallow Cove

The historical extent of seagrass in Porthallow Cove represented in Figure 53 has been derived from a single point record. This record was made in 1999[7] and the position and extent was estimated by a yachtsman who pulled up seagrass on his anchor. It has not been possible therefore to make useful temporal comparisons regarding the extent of seagrass in Porthallow Cove.

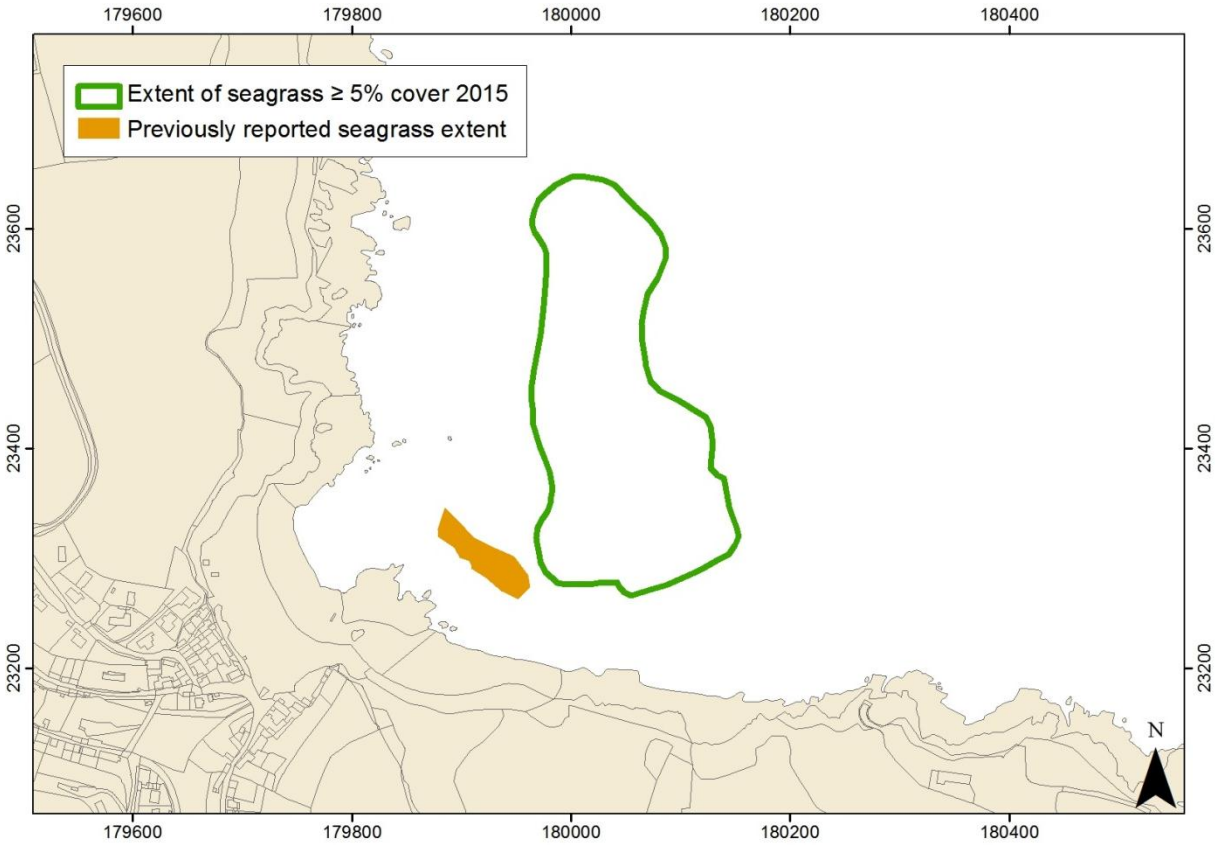

Figure 53. Map of historically reported seagrass extent at Porthallow Cove plotted alongside extent in 2015.

5.2.1.4 Comparisons of Plant Density

As discussed in section 5.2.1.2 the only firm plant density data available is for the bed between Polgwidden Cove and Toll Point in the Helford. There, a mean value of 53 (range: 0-104) plants per m^2 was recorded in July 1997 by Sutton and Tompsett[13] from up to 6 quadrats on 8 separate transects. A broad comparison with the mean data collected at the same bed in July 2015 using post-dive (57 (0-197) plants per m^2) and *in-situ* methods (43 (0-88) plants per m^2) suggests that plant density has not changed substantially since 1997. The raw data and precise sampling locations from 1997 are not available however and as such, particularly given the patchiness of the beds, these comparisons cannot be used to conclude changes or otherwise in bed attribute.

5.2.1.5 Comparisons of Plant Length

The only leaf length data available is that which was reported by Sutton and Tompsett in 2000[13]. This data only relates to average leaf length rather than mean maximum leaf length however, and the precise methods employed in the 1997 survey are unknown.

An average leaf length of 48cm (range: 37-76cm) was calculated using the July data only from 1997 (as reported in 2000[13]). In comparison, the mean *maximum* leaf length in 2015 which was 40cm (range: 23 - 60cm). Due to the differences in data discussed above and the lack of sampling positions in 1997, this apparent decrease in plant leaf length in 2015 may not be real.

5.2.1.6 Comparisons in Occurrence of Leaf Infection

Both Bunker [5] and Cook [6] noted no obvious signs of *Labyrinthula* sp. during their surveys of the bed between Amsterdam Point and Carricknath point in 1992 and 1999. Cook[6] also noted the absence of signs of wasting disease at Penarrow Point in 1999.

If confidence can be given to both the previous surveys observations and the observations of *Labyrinthula* sp. in 2015 (despite specimens having not been cultured or isolated to prove), then it would suggest that the occurrence of *Labyrinthula* sp. at Amsterdam Point and Pennarrow Point has increased in the last 15 years or so.

Conversely, if the percentage of 'decay' recorded by Sutton and Tompsett in July 1997 between Durgan and Toll Point (where a mean value of 30% and range of 0-50% was derived), is compared with the mean value of 20% 'browning' (and range of 0-40%) that has been recorded in 2015, then it could be deduced that the presence of *Labyrinthula* sp. has declined in the Helford since 1997.

Given that the same methods and sampling positions were not applied between studies and infection was not specifically monitored in earlier studies, no firm comparisons or conclusions can be drawn with regard to the occurrence of *Labyrinthula* sp. at any of the beds surveyed in 2015.

5.2.1.7 Comparisons of Epiphyte Cover

Although comparatively more historical data is available with regard to epiphyte cover in the Fal and Helford SAC again much of the information is restricted to very general comments on their presence. The presence of epiphytes was noted at St. Mawes Harbour[9], between Amsterdam Point and Carricknath Point[5], at Penarrow Point[6,9] and Bosahan[10]. This data corresponds with the presence at all the beds surveyed in 2015.

5.2.1.8 Anthropogenic Influences

One of the main objectives of this study was to identify as far as possible anthropogenic influences that are impacting on the ability of the sub-feature to achieve Favourable Condition. No extensive abundances of macroalgae and/or drift macroalgae were observed in any of the seagrass beds surveyed, and the invasive brown algae *Sargassum muticum* was also not recorded anywhere in the SAC.

It was not possible to definitively identify anchor or mooring scarring during the course of DD/TV surveys. One of the main problems encountered within the Fal and Helford SAC in 2015 was that seagrass was very often patchily distributed (sometimes ranging from 0-100% cover within a few meters), and it was not possible to determine whether the patches void of seagrass were a result of natural variation or anchor scarring. Although moorings were easy to locate, passing directly over them whilst traversing between the percentage cover stations was avoided to prevent the DD/TV rig from snagging or entangling with the associated chains and ropes (particularly in windy conditions or when the sea state reduced the manoeuvrability of the boat). Another obstacle in assessing the effects of anchoring and mooring upon the condition of the sub-feature was the absence of a baseline from which to

assess the changes caused by these activities. The Regulation 35 document states that attributes “should not deviate significantly from an established baseline, subject to natural change”. Therefore, although no definitive evidence of negative effects from anchoring or mooring activity was apparent in the Fal and Helford SAC, this may not necessarily be the case, and further targeted studies would be required in order to come to a conclusion. However, if the DD/TV methods employed in 2015 are repeated in future then a notable increase in the patchiness of the beds should be revealed, but these methods will not necessarily link patchiness with anthropogenic activity without further targeted studies.

5.2.1.9 Summary of all Attributes and Condition Assessment

A summary of comparisons of mean data (where available) for seagrass attributes that have been monitored in 2015 are presented in Table 22 together with a recommendation for the attribute condition status (and confidence level) where possible.

Table 22. Summary of attributes and an assessment of the condition of the subtidal seagrass beds within the Fal and Helford SAC

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Seagrass bed community: Extent	**The historical data sources that have been used to map the extent of each of the seagrass beds prior to 2015 are listed in Table 21, Section 5.2.1. The confidence in the data usefulness of comparisons for each area has also been described in Section 5.2.2**	**Total area of seagrass bed including percentage cover from 5-100%:**	The percentage cover of seagrass in 2015 is broadly consistent with that expected given the historical data available. The only certain loss in extent of seagrass is that from the lower Percuil, and possibly Trefusis Point. However, the extent of many other beds has remained the same or potentially increased in recent years resulting in an overall increase in extent of seagrass within the SAC compared to that previously reported.	**Favourable Condition** - Moderate confidence
	Upper Percuil : 21,271 m^2	Upper Percuil: 0 m^2		
	Lower Percuil: 8,153 m^2	Lower Percuil: 0m^2		
	St. Mawes Harbour: 34, 705 m^2	St. Mawes Harbour: 54,563 m^2		
	Amsterdam to Carricknath Point: 140,731 m^2	Amsterdam to Carricknath Point: 175,228 m^2		
	St. Mawes Bank: 89,677 m^2	St. Mawes Bank: 81,398 m^2		
	Penarrow Point to Trefusis Point: 145,987 m^2	Penarrow Point: 74,788 m^2		
	Flushing : 5,183 m^2	Flushing: 30,116 m^2		
	Gyllyngvase: 6,213 m^2	Gyllyngvase: 23, 999 m^2		
	Swanpool: 13,891 m^2	Swanpool: 60,301 m^2		
	Maenporth: 6,037 m^2	Maenporth: 185,624 m^2		
	Polgwidden Cove to Toll Point: 162,266 m^2	Polgwidden Cove to Toll Point: 238,098 m^2		
	East of Passage Cove: 17,243 m^2	East of Passage Cove: 7,614 m^2		
	Bosahan: 15,925 m^2	Bosahan: 37,522 m^2		
	Gillan Creek: <20 m^2	Gillan Creek: 0 m^2		
	Parbean Cove: 2,441 m^2	Parbean Cove: 21,913 m^2		
	Porthallow Cove: 2,496 m^2	Porthallow Cove: 46,661 m^2		
	Total: 637,533 m^2	*Total: 103,7825 m^2*		

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Characteristic species density of seagrass (*Zostera marina*): % Cover	**Although percentage cover was recorded to some degree by Kendall *et al* in 2006[12] between Amsterdam Pont and Carricknath Point, it has not been possible to manipulate the data to make useful comparisons with the 2015 mean data.**	**Mean percentage cover of seagrass:** St. Mawes Harbour: 48% - Sparse Amsterdam to Carricknath Point: 53% - Moderate St. Mawes Bank: 63% - Moderate Penarrow Point: 34% - Sparse Flushing: 69% - Moderate Gyllyngvase: 18% - Very sparse Swanpool: 21% - Very sparse Maenporth: Not measured Polgwidden Cove to Toll Point: 58% - Moderate East of Passage Cove: 56% - Moderate Bosahan: 46% - Sparse Parbean Cove: 58% - Moderate Porthallow Cove: Not measured	Due to the absence of past data at most beds in the SAC and given the variables in methods and data produced by the 2006 and 2015 studies, it is has not been possible to make meaningful temporal comparisons.	**Not possible to assess.**

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Characteristic species density of seagrass (*Zostera marina*): No. plants per m^2	**Previous data is only available for Polgwidden Cove to Toll Point and comes from a study by Sutton and Tompsett that was reported in 2000[13], but for the reasons previously discussed in section 5.2.1.2, the comparability of this data is limited.**	**Mean number of plants per m^2 and range where the first set of values have been derived from post dive analyses and the second from in situ counts:**	Given the variables in methods and data produced by the 2000 and 2015 studies, it has not been possible to make meaningful comparisons between the data, although between Polgwidden Cove and Toll Point the density data does seem to be similar.	**Not possible to assess.**
		St. Mawes Harbour: 74 (0-96) / 18(0-64)		
		Amsterdam to Carricknath Point: 85 (0-256) / 66 (0-216)		
		St. Mawes Bank: 40 (0-224) / 31 (0-164)		
		Penarrow Point: 14 (0-64) / 19 (0-60)		
		Flushing: Not measured		
		Gyllyngvase: Not measured		
		Swanpool: Not measured		
		Maenporth: Not measured		
	Polgwidden Cove to Toll Point July 1997: 53 (0-104) plants per m^2	Polgwidden Cove to Toll Point: 57 (0-192) / 43 (0-88)		
		East of Passage Cove: Not measured		
		Bosahan: Not measured		
		Parbean Cove: Not measured		
		Porthallow Cove: Not measured		

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Non-native species and pathogens	**Bunker[5] and Cook[6] noted no obvious signs of *Labyrinthula* sp. between Amsterdam Point and Carricknath point in 1992 and 1999. Cook[6] also noted the absence of signs of wasting disease at Penarrow Point in 1999. The % of 'decayed blades' between Polgwidden Cove and Toll Point in Jully 1997 was recorded by Sutton and Tomspett[13] but for the reasons previously discussed in section 5.2.1.2, the comparability of this data is limited.**	**Mean % leaves infected and ranges:**	Given the variables in methods and data produced between the previous studies and 2015 surveys, it has not been possible to make meaningful comparisons between the data.	**Not possible to assess.**
	St. Mawes Harbour: No data.	St. Mawes Harbour: 18 (0-44)		
	Amsterdam to Carricknath Point: No obvious signs of *Labyrinthula* sp.	Amsterdam to Carricknath Point: 20 (0-41)		
	St. Mawes Bank: No data	St. Mawes Bank: 20 (0-55)		
	Penarrow Point to Trefusis Point: No obvious signs of Labyrinthula sp.	Penarrow Point: 12 (0-25)		
	Flushing : No data	Flushing: Not measured		
	Gyllyngvase: No data	Gyllyngvase: Not measured		
	Swanpool: No data	Swanpool: Not measured		
	Maenporth: No data	Maenporth: Not measured		
	Polgwidden Cove to Toll Point: 24 (0-34)	Polgwidden Cove to Toll Point: 20 (0-40)		
	East of Passage Cove: No data	East of Passage Cove: Not measured		
	Bosahan: No data	Bosahan: Not measured		
	Parbean Cove: No data	Parbean Cove: Not measured		
	Porthallow Cove: No data	Porthallow Cove: Not measured		

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Characteristic species epiphytic community – Epiphytic community	**Previous studies in which the presence of epiphytes were recorded included Cook, 2000[6], Bunker 1992[5], Rostron 1985[9] and Rostron 1987[10].**	**Mean epiphyte scores and ranges:**	**Given the variables in methods and data produced between the previous studies and 2015 surveys, it has not been possible to make meaningful comparisons between the data.**	**Not possible to assess.**
	St. Mawes Harbour: Epiphytes recorded as present	St. Mawes Harbour: 1.1 (0.3-2.2)		
	Amsterdam to Carricknath Point: Epiphytes recorded as present	Amsterdam to Carricknath Point: 1.3 (0.7-2.6)		
	St. Mawes Bank: No data	St. Mawes Bank: 1.6 (0.8-2.2)		
	Penarrow Point to Trefusis Point: Epiphytes recorded as present	Penarrow Point: 1.6 (0.4-3.4)		
	Flushing : No data	Flushing: Not measured		
	Gyllyngvase: No data	Gyllyngvase: Not measured		
	Swanpool: No data	Swanpool: Not measured		
	Maenporth: No data	Maenporth: Not measured		
	Polgwidden Cove to Toll Point: No data	Polgwidden Cove to Toll Point: 0.3 (0-0.7)		
	East of Passage Cove: No data	East of Passage Cove: Not measured		
	Bosahan: Epiphytes recorded as present	Bosahan: Not measured		
	Parbean Cove: No data	Parbean Cove: Not measured		

Attribute	Previous studies and results	2015 study results	Assessment of attribute	Recommended Condition Status and Confidence in assessment
Maximum leaf length.	**A study by Sutton and Tompsett in 2000[13] recorded the average leaf length at the bed between Polgwidden Cove and Toll Point . No data exists for the remaining beds.**	**Maximum plant lengths and ranges:**	Given the variables in methods and data produced between the previous study and the 2015 survey, it has not been possible to make meaningful comparisons between the data.	**Not possible to assess.**
		St. Mawes Harbour: 33 (26-40)		
		Amsterdam to Carricknath Point: 39 (8-61)		
		St. Mawes Bank: 43 (26-60)		
		Penarrow Point: 37 (16-62)		
		Flushing: Note measured		
		Gyllyngvase: Not measured		
		Swanpool: Not measured		
		Maenporth: Not measured		
	Polgwidden Cove to Toll Point: Overall average leaf length =74 cm.	Polgwidden Cove to Toll Point: 40 (23-60)		
		East of Passage Cove: Not measured		
		Bosahan: Not measured		
		Parbean Cove: Not measured		
		Porthallow Cove: Not measured		

6. CONCLUSIONS

From the data collected in 2015, it is concluded that the location and aspect of seagrass beds together with the consequent exposure to prevailing south-westerly weather and swell is probably a strong determining factor in the percentage cover of seagrass observed.

The largest beds were found in the Helford between Polgwidden Cove and Toll Point and in the Fal between Amsterdam Point and Carricknath Point. Large proportions of these beds were comprised of very sparse (5-25%) or sparse (26-50%) covers of seagrass. The beds in the Helford did however encompass over twice the area of 'dense' seagrass compared to the beds in the Fal.

The apparent extension (and repositioning) of seagrass beds over time may be due to the full extent of seagrass having not been mapped in previous studies, as well as estimates/arbitrary bed extents having often been previously assigned to single, or very limited, data points. Accurate positioning data for historical records was also not always available. It can be said with some certainty however, that the seagrass beds which were previously reported at Trefusis Point and in the Lower Percuil in 1999, have since disappeared.

The principal limitation in being able to make temporal comparisons for all diving-measured attributes was the lack of available historical data. The only firm data available was for the bed between Polgwidden Cove and Toll Point in the Helford where plant density had been measured in 1997. However, different methods and a lack of accurate sampling positions in 1997 prevented anything but broad comparisons from being made. These suggested that plant density has not changed substantially since 1997. Given the lack of previous data regarding the abundance of epiphytes, it has not been possible to make useful temporal comparisons with the epiphyte score data. This is also the case for the maximum leaf length data.

It has also only been possible to make very tentative comparisons between the data gathered by divers at different beds within the SAC in 2015. This is because the sampling effort was mostly relatively limited and the effort between beds was variable (e.g. the mean values have been drawn from different numbers of quadrats), therefore accuracy of the data from each bed was inconsistent. A number of observations were made however. The percentage of leaves infected was very similar between all of the beds assessed with the exception of at Pennarrow Point where both the mean and maximum percentages of leaf infection were almost half of that measured elsewhere. The mean epiphyte score was greatest at Penarrow Point and St. Mawes Bank and lowest at St. Mawes Harbour. The occurrence of epiphytes did not appear to correlate with the density of the seagrass at each of the beds. The mean maximum plant lengths were very similar between the five beds that were assessed.

The presence of *Labyrinthula sp.* was not confirmed in 2015 but its presence has been indicated by 'leaf browning' in each of the four beds surveyed using diving methods. Given that infection (as indicated by leaf 'browning') was not specifically monitored in previous studies, no useful temporal comparisons or conclusions can be drawn with regard to the occurrence of *Labyrinthula sp*. at any of the beds surveyed in 2015.

The invasive algae *Sargassum muticum* was not observed during surveys, and no extensive abundances of macroalgae and/or drift macroalgae were observed in any of the seagrass

beds. Although no definitive evidence of negative effects from anchoring or mooring activity was apparent in the Fal and Helford SAC, this may not necessarily be the case, and further targeted studies would be required in order to make a definitive conclusion.

Both the DD/TV and diving methods applied within this study are valuable in measuring different attributes when assessing the condition of seagrass beds. There is scope for using DD/TV methods only to indicate seagrass density which provides a much broader scale and better spatial assessment. However, such an assessment would provide a lower resolution measure, and consequently, changes in density (particularly in beds which have longer plant lengths) would need to be sufficiently large to be detected using DD/TV methods alone.

It is recommended that the subtidal seagrass beds within the Fal and Helford SAC are assessed as being in *Favourable Condition* for extent. It has not been possible to assess the condition of the remaining attributes due to a lack of previous data with which to make temporal comparisons.

7. RECOMMENDATIONS FOR FUTURE CONDITION ASSESSMENT OF THE SUBTIDAL SEAGRASS SUB-FEATURE IN THE FAL AND HELFORD SAC

A number of recommendations are suggested for future condition assessment of the seagrass beds in the Fal and Helford SAC, these are:

- It is understood that the diving surveys had to be carried out prior to the DD/TV surveys in 2015 because the procurement process prevented the DD/TV surveys from being commissioned earlier in the year. In future however, diving surveys should be carried out following the DD/TV extent surveys so that the extent of the bed can be accurately located and targeted. This is less important in beds which have reliable baseline data, but is crucial when collecting quality temporally comparable data for baseline studies. Where procurement systems do not enable the DD/TV surveys to be carried out first in the same year, the diving surveys should be delayed until the following year. Although this does not represent the ideal scenario, it is far more likely that better data would be collected.
- When dive surveyors assess percentage cover within a quadrat an estimate of the cover to the nearest 1% should be made. Data can then be categorised at a later point if desired. However, by categorising in the field resolution is lost and the power to carry out statistical analysis for temporal change is much reduced, as is the ability to draw correlations from the data. By recording cover to the nearest 1%, the extent of the bed (as defined by the OSPAR Commission) as determined by divers can also be compared to that measured using DD/TV methods.
- Due to the ambiguities associated with using ‘leaf browning’ as an indicator of the presence of *Labyrinthula* sp., subsamples should be taken to definitively conclude the presence of the pathogen at each bed. Where budgets permit, a sufficient number of leaf samples should be taken to explore the correlation between ‘leaf browning’ and *Labyrinthula* sp. infection. If the correlation is found to be high then more confidence can be given to observations of ‘leaf browning’ as an indicator of *Labyrinthula* sp. infection in future studies.
- The methods for recording the position of the 50m dive transects should be altered to improve the accuracy of the transect start and end positions.
- Given that seagrass often occurs in depths of less than 10m above chart datum and the tidal range in the Fal and Helford SAC is in excess of 4m, if depth data is

collected and is intended to be of use in spatial and temporal analyses it should be corrected to chart datum.

- To increase the sample size and subsequent accuracy of data relating to the number of plants per m^2, surveyors should continue using an additional larger quadrat size (50 cm x 50 cm) and count plant shoots in situ. This is recommended because the added precision of carrying out counts post dive is not considered to be sufficiently beneficial to offset the disadvantages of the smaller sample size which results from using a smaller quadrat.
- In order to enable future data to be compared directly with the 2015 baseline, all methods and analysis should be replicated as far as possible, but only where doing so does not preclude the ability to collect more useful data for future analysis.
- In order to ensure that more rigorous temporal statistical analysis can be carried out on any future data collected, the diving survey design should be altered to include a minimum of 5 replicates (transects) within each bed. These additional replicates could be taken from Trefusis Point where no seagrass was found in 2015.
- Where comparable baseline data does exist, the same diving monitoring transects should be used in future surveys. This is particularly important in patchy beds where attributes can vary significantly within the same bed.
- Sampling seagrass attributes at the same time of year is crucial for ensuring that any changes detected are real temporal changes and not an effect of different growth periods.

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APPENDIX 1: Percentage Cover Raw Data Plots

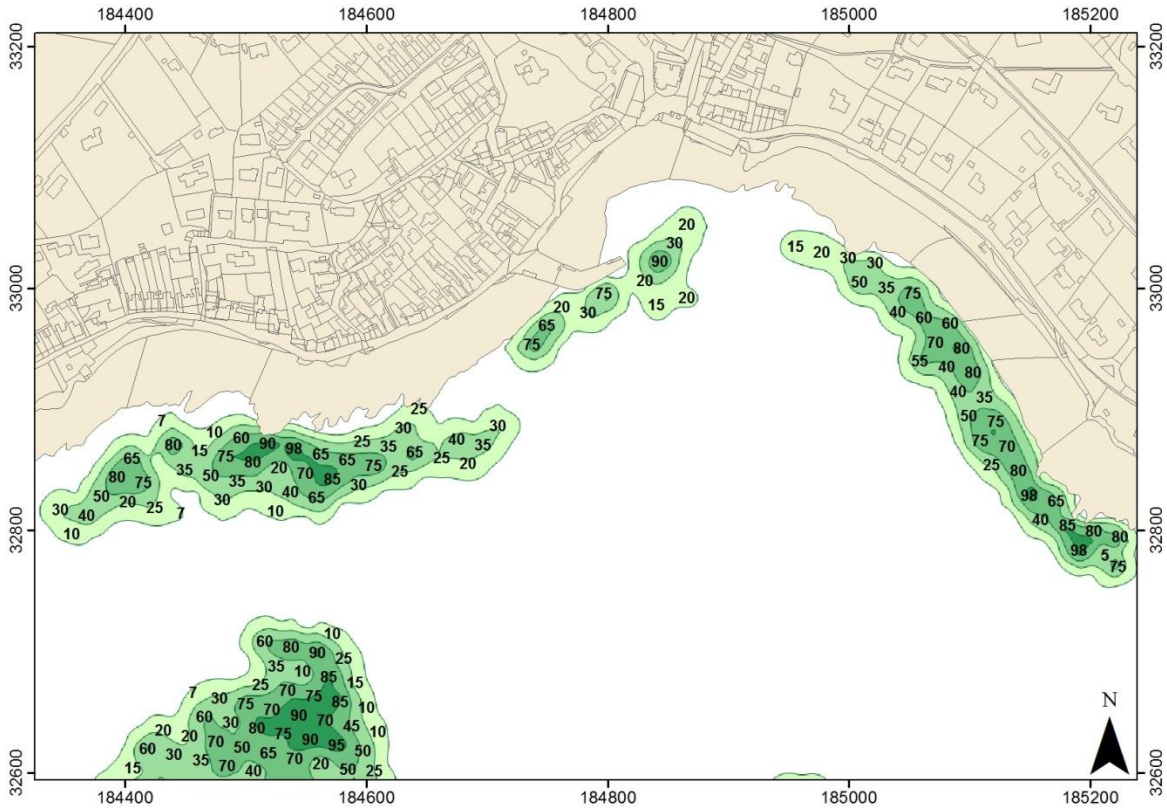

Figure 54. Percentage cover raw data plot - St. Mawes Harbour

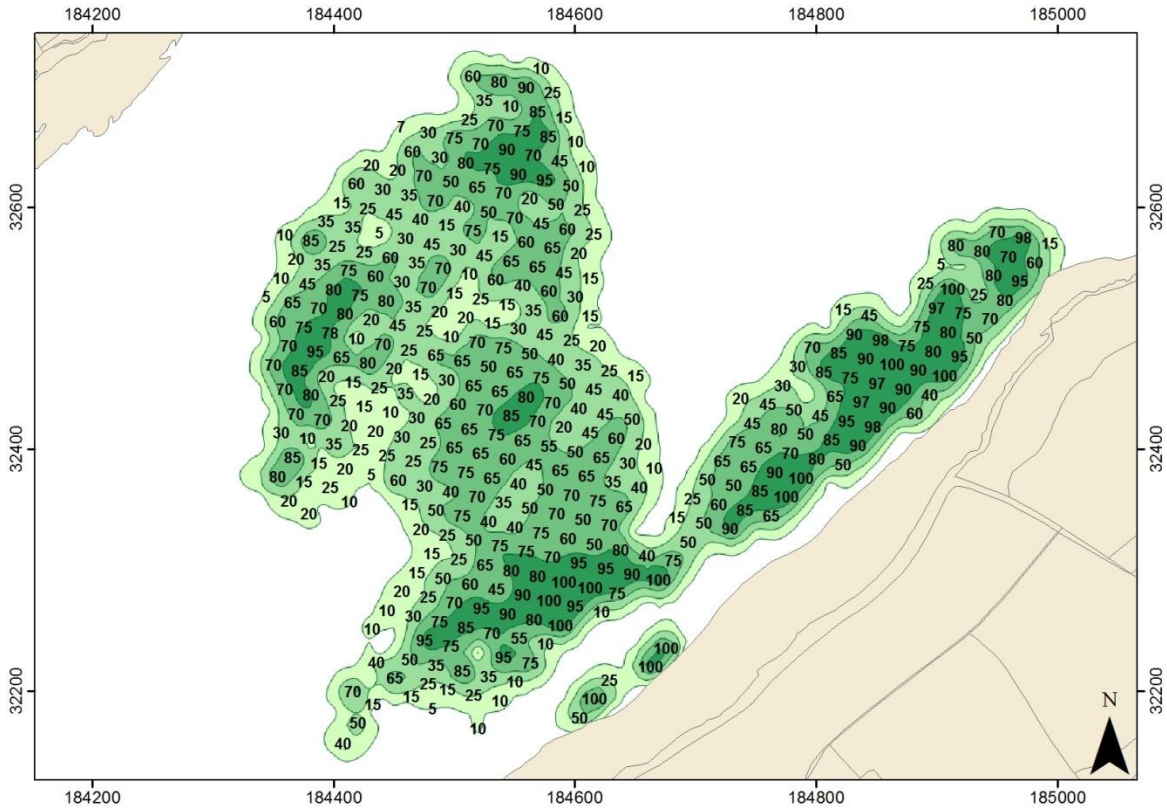

Figure 55. Percentage cover raw data plot - Amsterdam Point to Carricknath Point.

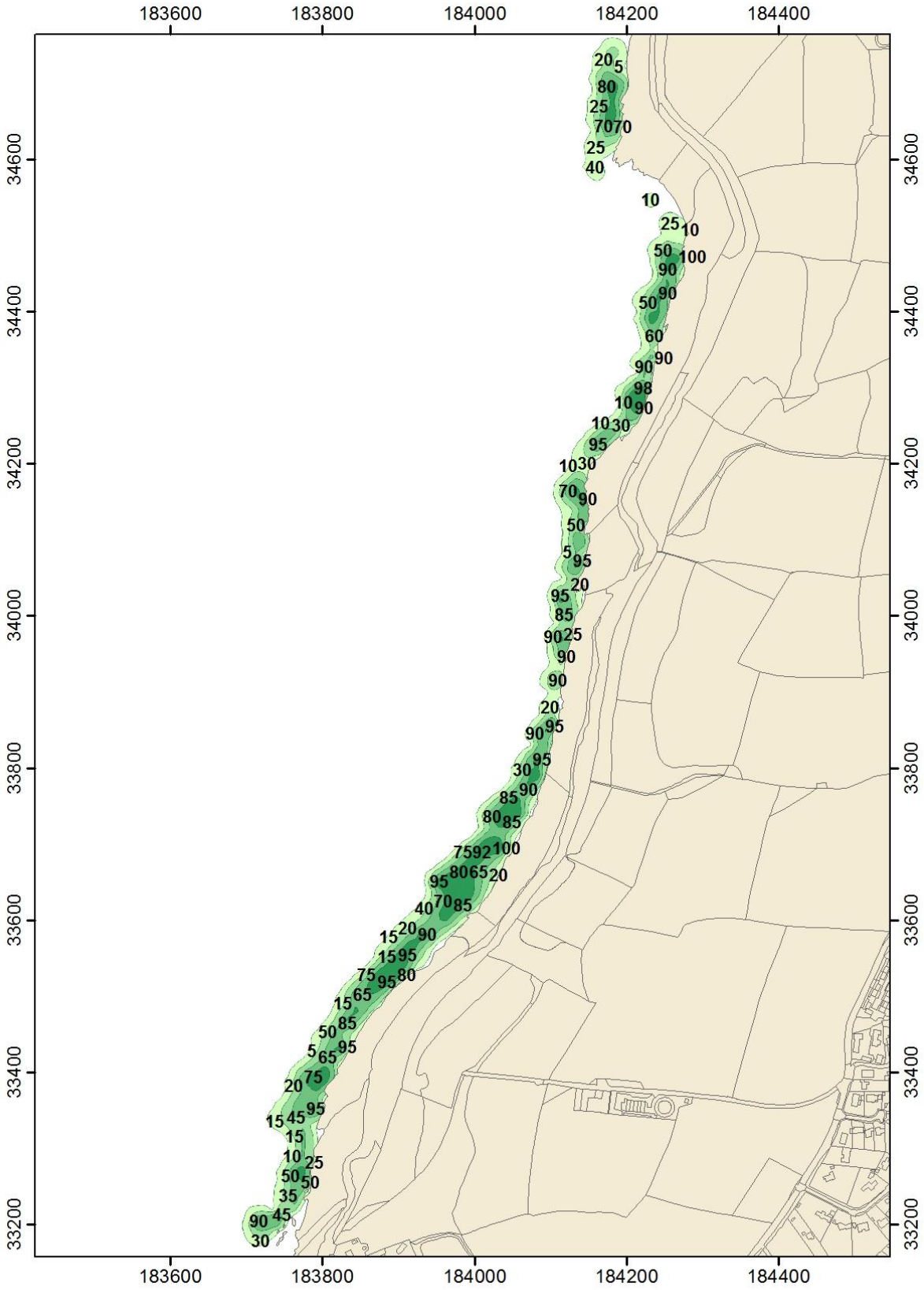

Figure 56. Percentage cover raw data plot - St. Mawes Bank.

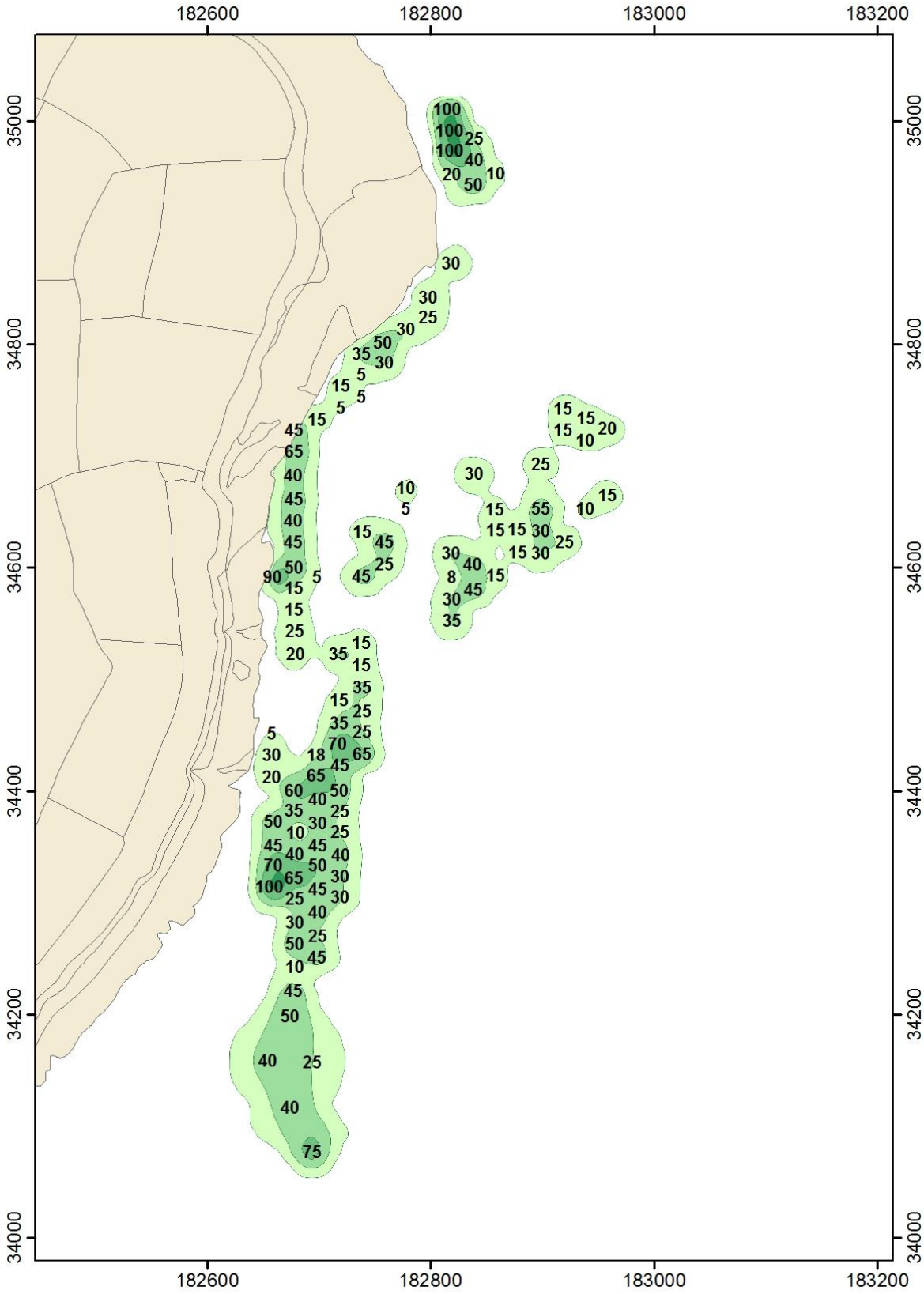

Figure 57. Percentage cover raw data plot - Penarrow Point to Trefusis Point.

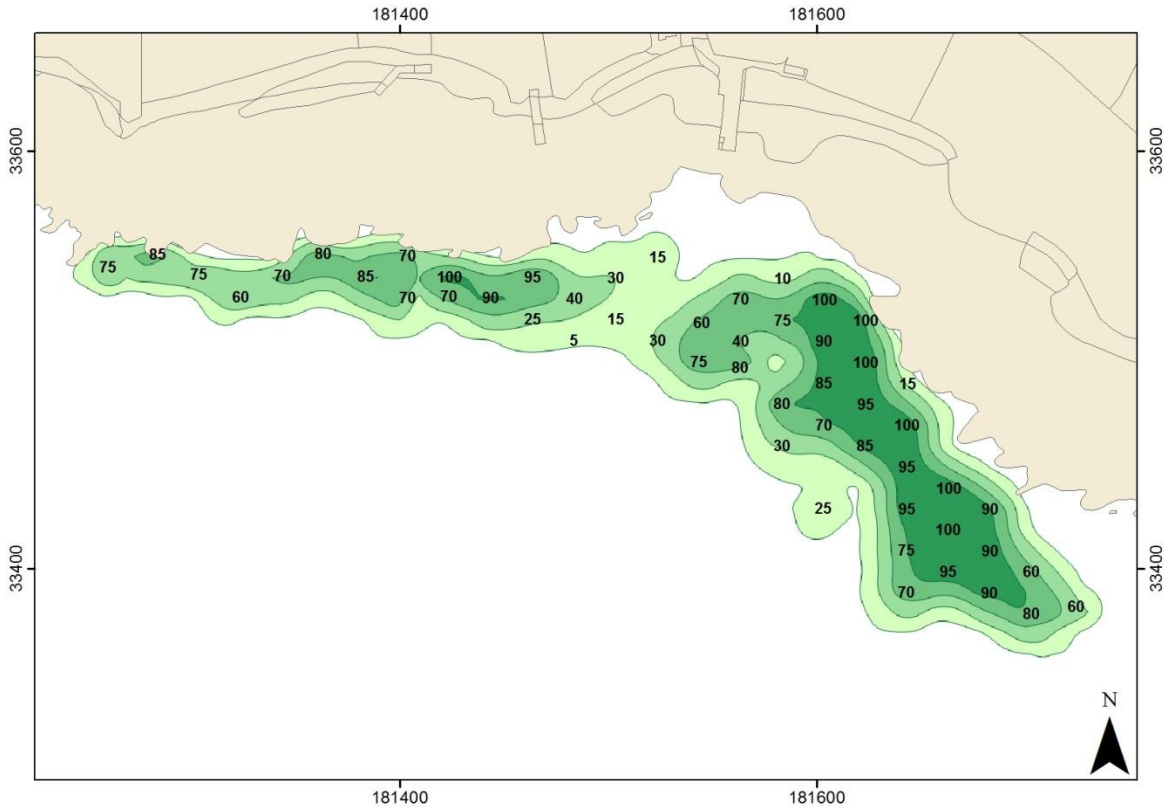

Figure 58. Percentage cover raw data plot - Flushing.

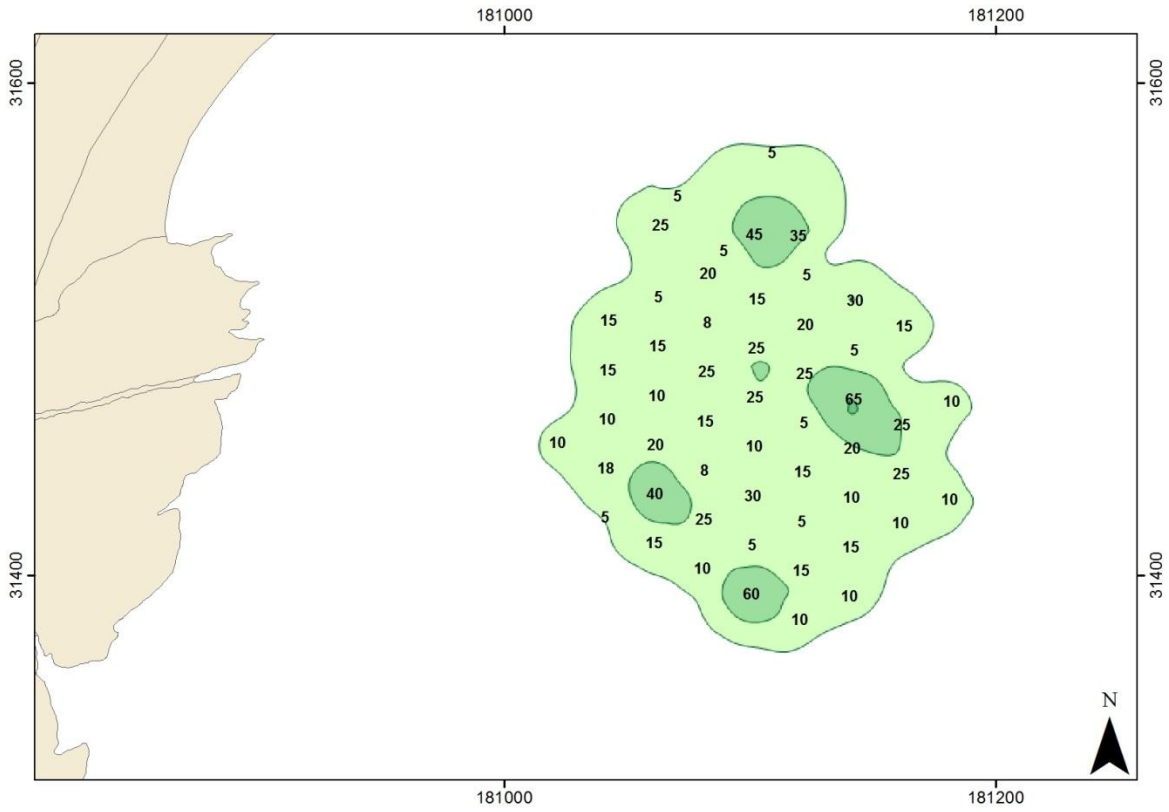

Figure 59. Percentage cover raw data plot - Gyllyngvase.

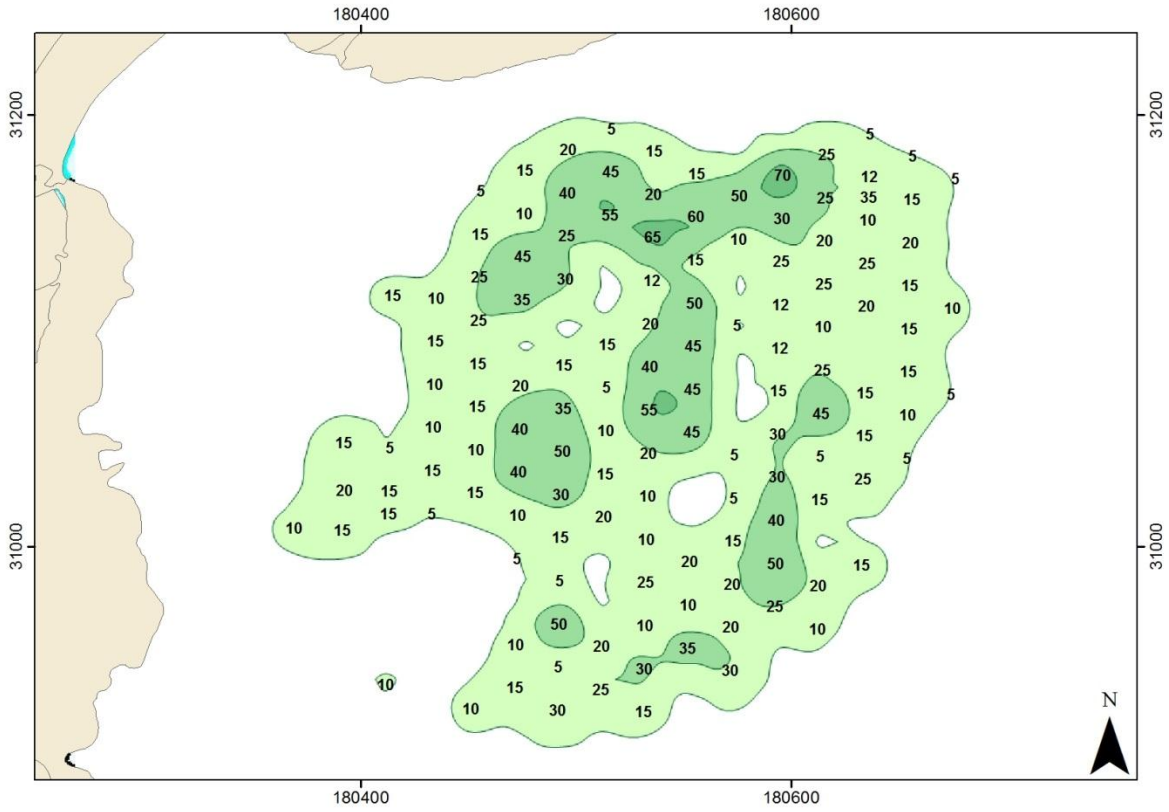

Figure 60. Percentage cover raw data plot - Swanpool.

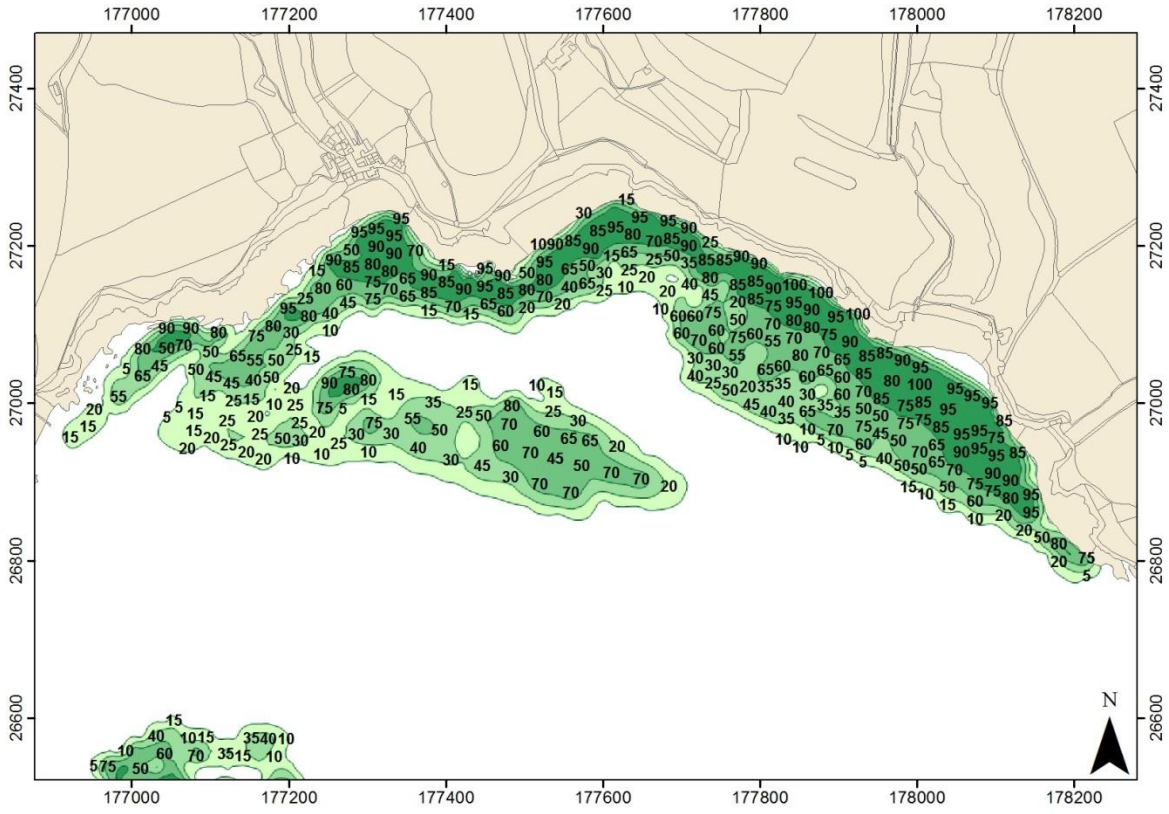

Figure 61. Percentage cover raw data plot - Polgwidden Cove to Toll Point.

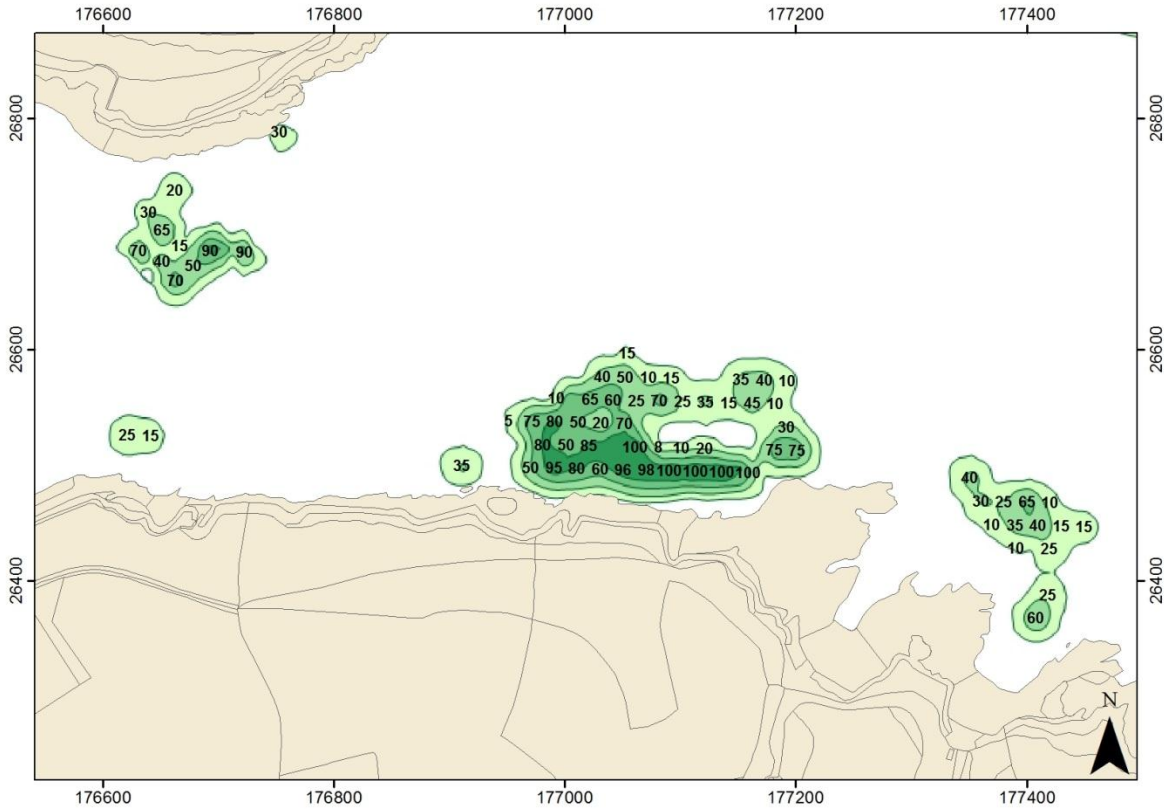

Figure 62. Percentage cover raw data plot - East of Passage Cove and Bosahan.

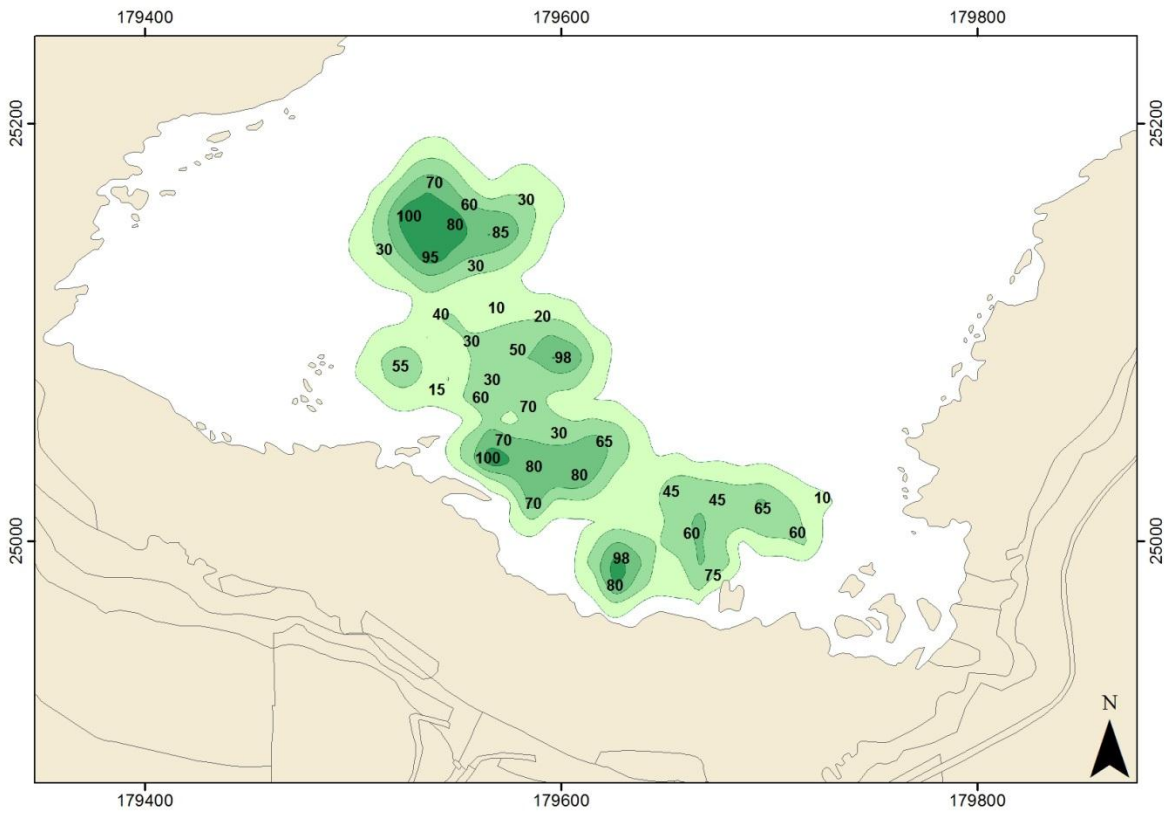

Figure 63. Percentage cover raw data plot- Parbean Cove

APPENDIX 2: Quality Control Analysis Results

	% Seagrass Cover			
Station	**Real time data**	**Secondary verification of video footage**	**Categorised real time data**	**Secondary verification of categorised data**
F304	10	15	Very sparse	Very sparse
F182	65	80	Moderate	Dense
F143	75	40	Moderate	Sparse
F577	75	55	Moderate	Moderate
F116	80	25	Very sparse	Dense
F197	80	50	Dense	Sparse
F34	85	60	Dense	Moderate
F106	85	55	Dense	Moderate
F117	85	85	Dense	Dense
F18	90	95	Dense	Dense
F152	90	60	Dense	Moderate
F187	90	70	Dense	Moderate
F326	90	55	Dense	Moderate
F443	90	98	Dense	Dense
F37	95	85	Dense	Dense
F51	95	90	Dense	Dense
F82	95	75	Dense	Moderate
F114	95	100	Dense	Dense
F231	95	50	Dense	Sparse
F7	100	90	Dense	Dense
F12	100	100	Dense	Dense
F20	100	95	Dense	Dense
F58	100	100	Dense	Dense
F61	100	95	Dense	Dense
F808	15	5	Very sparse	Very sparse
F937	15	15	Very sparse	Very sparse
F1077	20	20	Very sparse	Very sparse
F1149	20	35	Very sparse	Sparse
F791	25	25	Very sparse	Very sparse
F1075	25	30	Very sparse	Sparse
F1089	25	15	Very sparse	Very sparse
F923	45	40	Sparse	Sparse
F1084	50	45	Sparse	Sparse
F793	60	55	Moderate	Moderate
q7	5	5	Very sparse	Very sparse
q9	20	10	Very sparse	Very sparse
q53	20	10	Very sparse	Very sparse
q26	40	35	Sparse	Sparse
q54	70	35	Moderate	Sparse
F442	85	40	Dense	Sparse
D50	10	10	Very sparse	Very sparse
D497	15	15	Very sparse	Very sparse
D22	30	20	Sparse	Very sparse
D31	45	30	Sparse	Sparse
D47	25	25	Very sparse	Very sparse
D139	30	15	Sparse	Very sparse
E45	5	5	Very sparse	Very sparse
E434	25	15	Very sparse	Very sparse
E54	30	10	Sparse	Very sparse
E231	90	90	Dense	Dense
E308	90	100	Dense	Dense
E325	95	100	Dense	Dense
E389	95	100	Dense	Dense
E331	20	20	Very sparse	Very sparse
E153	100	100	Dense	Dense
E502	100	75	Dense	Moderate
C354	35	35	Sparse	Sparse
C411	20	15	Very sparse	Very sparse
D96	35	10	Sparse	Very sparse
D261	8	5	Very sparse	Very sparse
Bray-Curtis Similarity	**89%**		**92%**	

APPENDIX 3: T-test probabilities for the differences between mean attribute data at transects. Significant differences (p<0.05) are in red italics.

		Transect 1	Transect 2	Transect 3	Transect 4	Transect 5
Number of *Zostera* sp. plants per m²	Transect 1	-	-	-	-	-
	Transect 2	0.964	-	-	-	-
	Transect 3	0.545	0.403	-	-	-
	Transect 4	*0.007*	*0.000*	*0.002*	-	-
	Transect 5	*0.001*	*0.000*	*0.000*	0.144	-
	Transect 6	*0.001*	*0.000*	*0.000*	0.066	0.742
Mean % leaves infected	Transect 1	-	-	-	-	-
	Transect 2	0.107	-	-	-	-
	Transect 3	*0.013*	0.496	-	-	-
	Transect 4	0.179	0.934	0.489	-	-
	Transect 5	0.333	0.686	0.289	0.775	-
	Transect 6	0.238	0.894	0.771	0.863	0.723
Mean infection score	Transect 1	-	-	-	-	-
	Transect 2	0.343	-	-	-	-
	Transect 3	*0.042*	0.389	-	-	-
	Transect 4	0.869	0.602	0.228	-	-
	Transect 5	0.662	0.779	0.313	0.860	-
	Transect 6	0.427	0.897	0.654	0.647	0.775
Mean epiphyte Score	Transect 1	-	-	-	-	-
	Transect 2	*0.003*	-	-	-	-
	Transect 3	*0.030*	0.252	-	-	-
	Transect 4	*0.001*	0.260	*0.045*	-	-
	Transect 5	0.667	*0.011*	*0.048*	*0.006*	-
	Transect 6	0.088	0.839	0.461	0.759	0.157
Mean max plant length (cms)	Transect 1	-	-	-	-	-
	Transect 2	*0.005*	-	-	-	-
	Transect 3	0.215	*0.002*	-	-	-
	Transect 4	*0.001*	*0.000*	0.242	-	-
	Transect 5	0.457	0.179	0.185	*0.011*	-
	Transect 6	*0.044*	*0.002*	0.707	0.437	0.113

Further information

Natural England evidence can be downloaded from our **Access to Evidence Catalogue**. For more information about Natural England and our work see **Gov.UK**. For any queries contact the Natural England Enquiry Service on 0300 060 3900 or e-mail **enquiries@naturalengland.org.uk**.

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