ENVISION MAPPING

Poole Harbour SPA Seagrass Assessment 2015

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1 Summary

1.1 Envision Mapping Ltd. (Envision) was contracted to undertake an underwater video survey for Natural England to obtain standardised biological information for the sublittoral seagrass bed supporting habitat of Poole Harbour SPA, and to enable comparison to previous datasets where possible.

1.2 A towed video survey was designed and carried out by Envision in Poole Harbour SPA in July 2015, alongside a diving survey carried out by Natural England in early August 2015, and the results of both surveys have been analysed and discussed in the following report.

1.3 The towed video survey collected information on the presence/absence and percent cover of seagrass to inform the assessment of the seagrass beds with regards to the extent and distribution of seagrass beds in the area, and also noted the nature of the substrate, the presence or absence of macroalgae, and any anthropogenic impacts or non-native species where possible. Two areas (Salterns Marina and Whitley Lake) were surveyed where data from previous surveys and digitisation of more recent aerial images suggested seagrass habitat was located, along with two further investigative areas.

1.4 The diver survey recorded information on the seagrass plant density and health along with notes on the substrate at 1 metre intervals on specific 50 metre long transects within each of the seagrass beds at Whitley Lake and Salterns Marina. The number of plants, maximum leaf length, number of leaves per plant, infection from the wasting disease *Labyrinthula*, and the level of epiphyte cover and presence of macroalgae and other non-native species were also recorded at 5m intervals along each transect.

1.5 The video analysis was undertaken by using frame captures at 5 second intervals from 6 hours and 32mins of video footage and recording the percent cover of seagrass, which was interpolated using natural neighbour analysis and presented as contour maps to result in polygons for different varying abundance of seagrass cover over the seagrass beds. The presence or absence of macroalgae (and in particular dense beds of macroalgae) was also plotted as points spatially, along with the presence of *Crepidula fornicata*, where it was possible to be identified from the video footage, and any anthropogenic impacts.

1.6 The diver data was summarised and represented spatially, showing the various datasets collected. Maximum leaf lengths for all plants were plotted in a size frequency histogram to examine the population structure within the seagrass beds.

1.7 The video analysis showed the extent of the seagrass beds within Poole Harbour to have an extent of 22 hectares, which is comparable with figures calculated in previous studies of seagrass extent.

1.8 Boundaries of extent derived from the towed video survey also appear consistent with previous surveys with the possibility of some slight extension shoreward in the Salterns Marina area.

1.9 The diver data has produced information which can act as a baseline for future studies on the condition assessment of the seagrass beds of Poole Harbour, but no previous detailed in-situ data were available for comparison.

1.10 The seagrass abundances derived from video survey appear to be comparable to that of Collins (2012) which similarly used towed video to assess the seagrass beds. The diver collected data for seagrass plant health showed leaf epiphyte scores and levels of infection at medium levels throughout the beds with occasional areas (three transects) showing heightened levels

2 Introduction

2.1 Envision Mapping Ltd. was contracted to undertake an underwater video survey for Natural England, with the primary goal of developing a cost effective sampling program to obtain standardised biological information for the sublittoral seagrass bed supporting habitat of Poole Harbour SPA, and enabling comparison to previous datasets where possible. The proposed survey methodology intended to improve upon previous survey design whilst providing similar quantitative data, and was structured to enable it to be easily repeated and adapted for future monitoring, should seagrass boundaries alter.

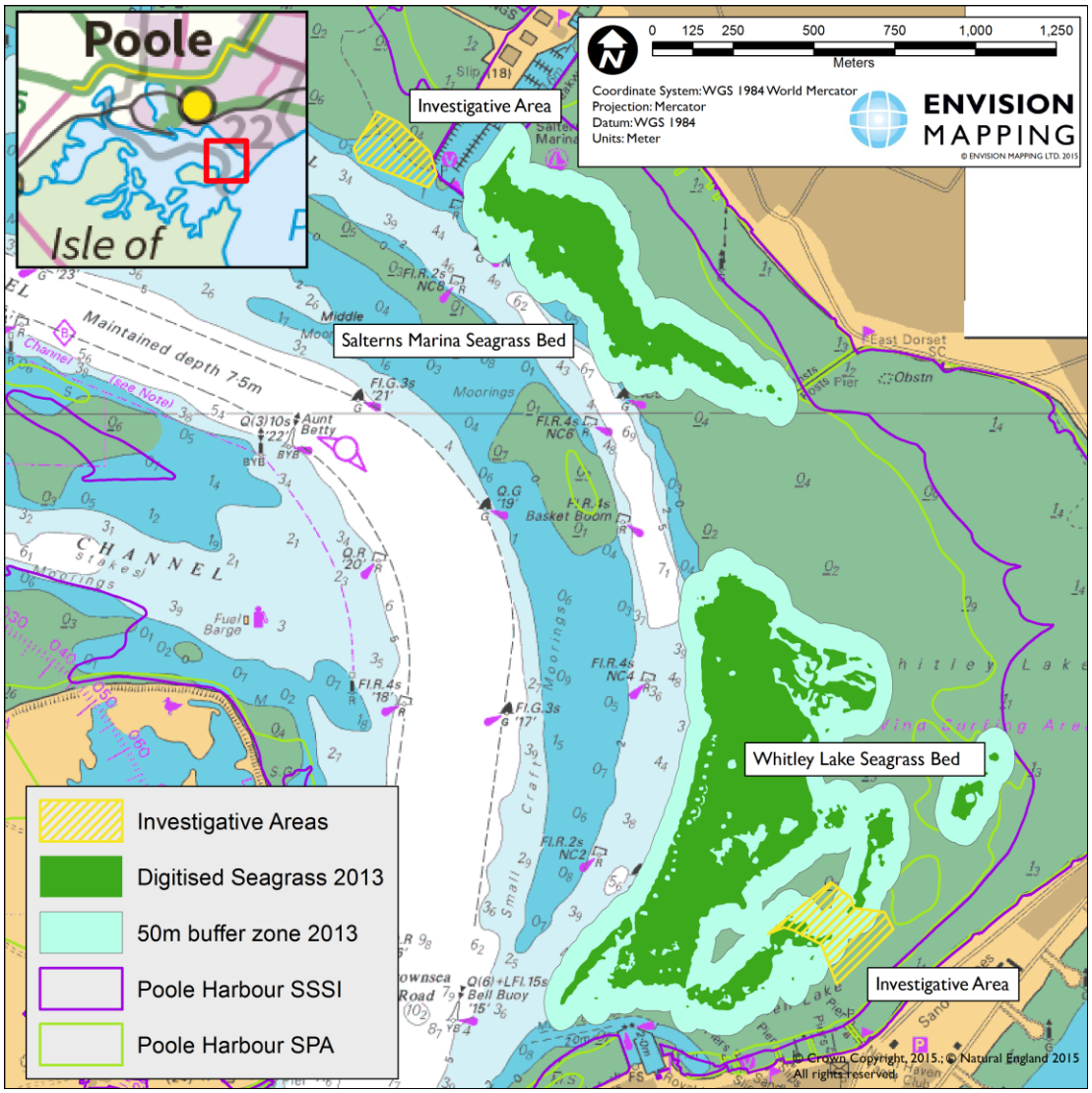

Figure 1 Poole Harbour SPA seagrass bed areas digitised from 2013 aerial photographs

2.2 Previous surveys of the seagrass beds between Salterns Marina and Whitley Lake (from 2008 and 2012 (Collins, 2013) used a video sledge system to collect extent and density data which was used, along with digitised aerial imagery (Figure 1), to plan a more robust and structured survey design to provide regular and consistent quantitative data that can be analysed systematically to produce robust results for seagrass condition assessment.

3 Methodology

3.1 The towed video survey was carried out in Poole Harbour SPA in July 2015 with a sampling plan as shown in Figure 2. Natural England also carried out a concurrent diving survey in the same areas in early August 2015, for which Envision have been contracted to analyse and report on the results. Video footage was successfully collected for the seagrass beds near Salterns Marina and at Whitley Lake, and for the two additional investigative areas.

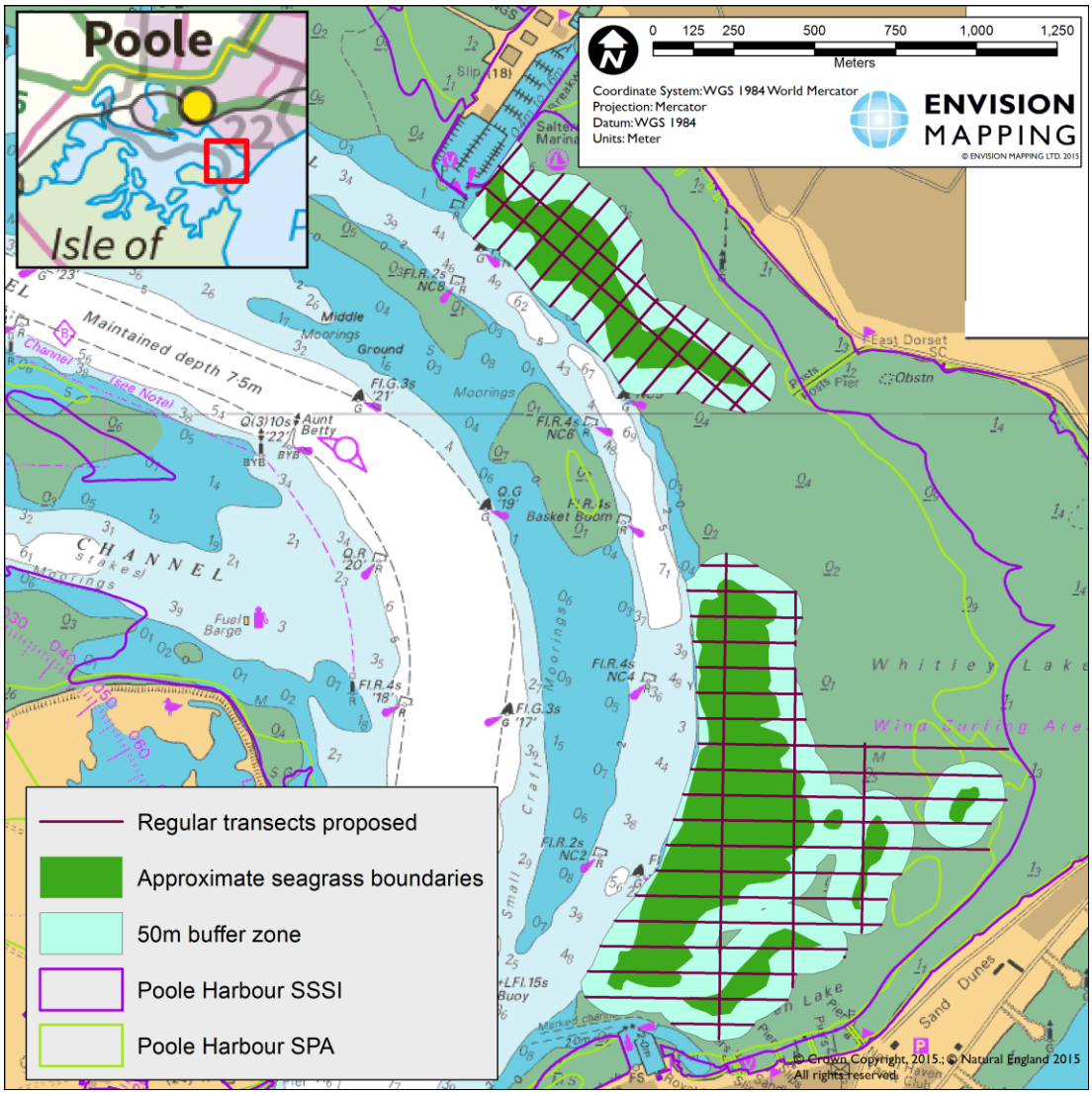

Figure 2 Poole Harbour SPA and seagrass bed with proposed transects indicated

Video Survey

3.2 The towed video survey was undertaken from Tuesday 21st July – Thursday 23rd July 2015. Two main areas of interest were surveyed – near Salterns Marina and Whitley Lake, with two additional investigative areas (Figure 1).

3.3 The series of video tows were collected at regular intervals using the planned transects shown in Figure 2 which resulted in transects shown in Figure 3, of between 20-50m, perpendicular to the longitudinal axis of the seagrass bed, with additional transects along the longitudinal axis. This grid sampling pattern enabled the seagrass cover throughout the bed to be sampled systematically, and also enabled the major seaward and landward boundaries to be delineated along with the limits of the seagrass bed along its length. In order to detect if any expansion of the seagrass beds had occurred between sampling periods a 50m buffer area was used around the previously identified seagrass bed boundaries.

3.4 A specifically designed small light-weight video frame/sled with a self-contained high definition camera (GoPro Hero3+ Black) mounted onto the frame was used (Plate 1). The system was also rigged with a high-resolution underwater (Sony CCD 500TVL) camera which was powered from the surface, and enabled real-time viewing and provided a duplicate record that was recorded digitally at the surface. A forward facing camera system was agreed with Natural England as the most appropriate for moving footage of seagrass. The system used specialist video lighting systems to provide an even spread of light over the area of interest. Quad-point laser scale indicators were also mounted on the frame, and a known, referenced field of view was established prior to survey, to allow for a consistent viewing area to be captured and analysed.

Plate 1 The camera system used for the video survey

3.5 A differentially corrected GPS (dGPS) system for recording position of the vessel was used which has a published accuracy of ±3 metre accuracy with differential correction. Position was logged continually during the survey operations and cable layback was recorded to enable camera position to the calculated. A GPS overlay was recorded onto the video footage to provide a permanent record of position during deployment.

3.6 At each survey area the video frame was deployed and ‘flown’ over the seafloor along the grid lines, the position of which was located using the dedicated dGPS and plotting system. As the average depth within the main survey areas was between 1 – 2m, the video frame was towed using only 5m of cable behind the boat. A speed of 1-2 knots allowed the sled to be ‘flown’ over the seabed and ensured a good quality image was captured. Where moorings or other obstacles were encountered, which were particularly prevalent in the Whitley Lake area, best efforts were made not to deviate significantly from the planned transect lines. The video recording was continuous over the transect lines, except where the sled had to be retrieved due to obstacles or a changeover of camera battery and cards was required. The locations of the transect lines surveyed are shown in Figure 4.

3.7 It should be noted that survey operations were conducted to collect as much footage of the seabed and seagrass beds as possible therefore the camera was left in water between transects and unusable footage was collected during these periods, no attempt was made to reduce this footage as efficiency of survey operations would have been compromised.

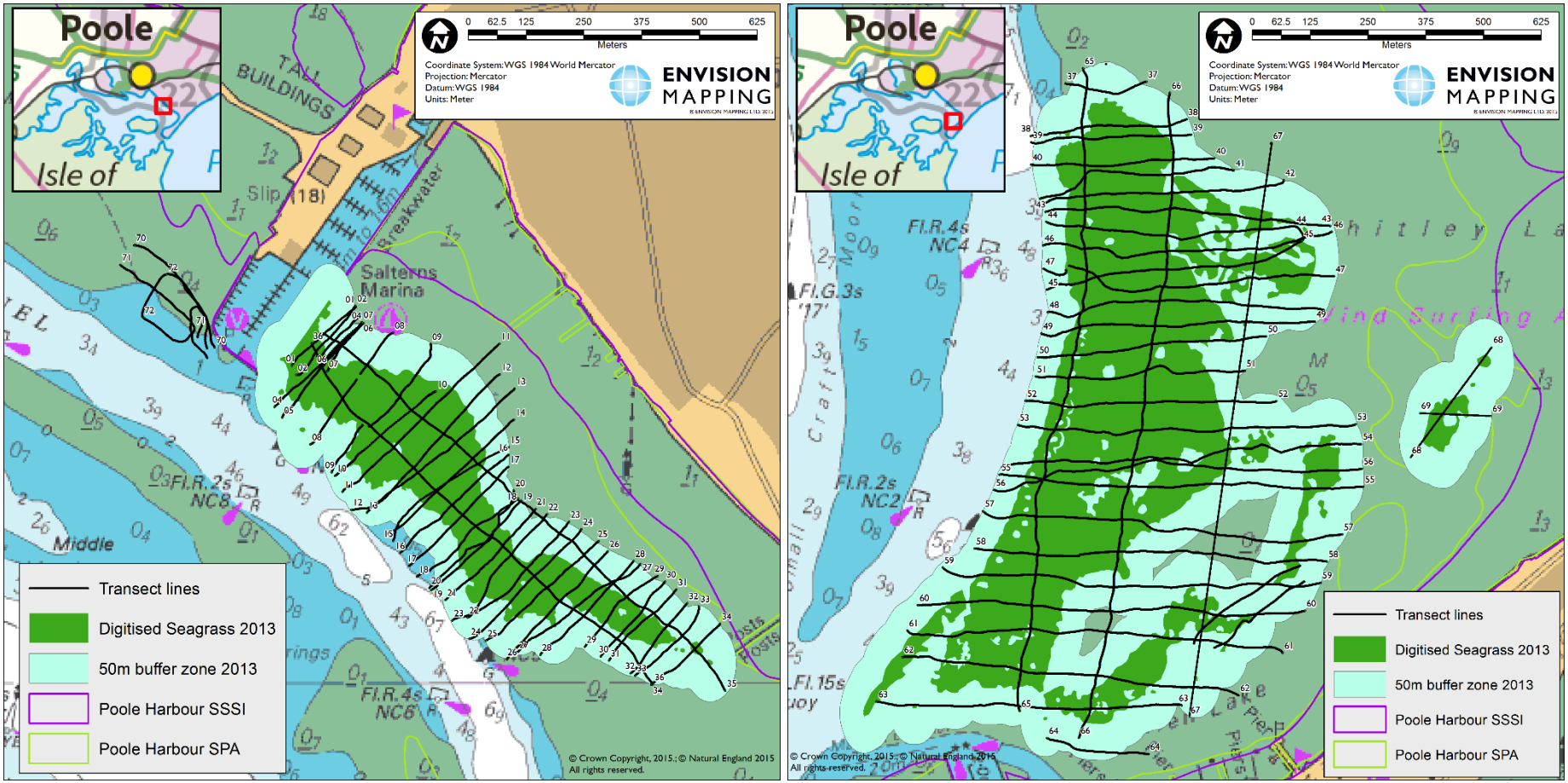

Figure 3 Video survey/transect lines surveyed in Poole Harbour, July 2015

Diver Survey

3.8 The dive survey was undertaken on three consecutive days from the 5-7th August 2015, with a wind speed of Force 4-5 on the first day creating a slight sea state, but dropping off on following days to Force 1-2 and a calm sea state by the 7th. The diving vessel 'Skin Deeper' was used as a diving platform, and 3 teams of two divers were used for each of the 50m transects, under the supervision of a Dive Supervisor. A member of Envision Mapping Ltd. staff joined the dive team on 6th August to observe the survey methodology and facilitate integration of the results.

3.9 Nine transects were surveyed at the Whitley Lake seagrass area, and six in the Salterns area (Figure 4), each with two divers recording seagrass attributes. Using a 0.5 x 0.5m quadrat, one member of each dive team recorded estimates of percentage cover of seagrass at 1m intervals along the transect, as well as notes on the substrate composition. The other diver team member recorded the number of seagrass plants in a quarter of a quadrat at 5 meter intervals as a measure of seagrass density. Each of these plants were then cut off just above the shoot base (to maintain integrity of the group of leaves for each plant) and collected in a clear plastic bag which was labelled with the transect name and distance from start of transect (0m, 5m, 10m etc.). The 5m plastic bags were then collected in a mesh bag and brought to the surface at the end of the dive for measurement of the number of leaves per plant, the longest leaf length per plant, and scoring on the level of leaf infection or epiphyte cover for each leaf on a 0-5 scale. Any flowering plants observed or eggs present on leaves were also recorded, and all the information was entered into spreadsheets for analysis. The following scales were used:

Table 1 Scales used for recording seagrass percent cover, sediment type, and level of leaf infection and epiphyte cover

Percent Cover Score/Description	% Cover	Leaf Infection / Epiphyte Cover Score	% Affected	Sediment Type	Code
0 No Zostera present	0%	0 Uninfected	0%	Sand	S
1 Minimal Zostera present	1-4%	1 Minimal infection apparent	0-2%	Shingle / Shells	H
2 Up to quarter of quadrat contains Zostera	5-25%	2 Up to quarter of leaf infected	3-25%	Rock	R
3 Up to half of quadrat contains Zostera	25-50%	3 Up to half of leaf infected	26-50%	Mixed	M
4 Over half of the quadrat contains Zostera	50-75%	4 Over half of leaf infected	51-75%	Macro Algae	A
5 Almost all quadrat contains Zostera	75-100%	5 Almost all of leaf infected	76-100%	Mud	Mud

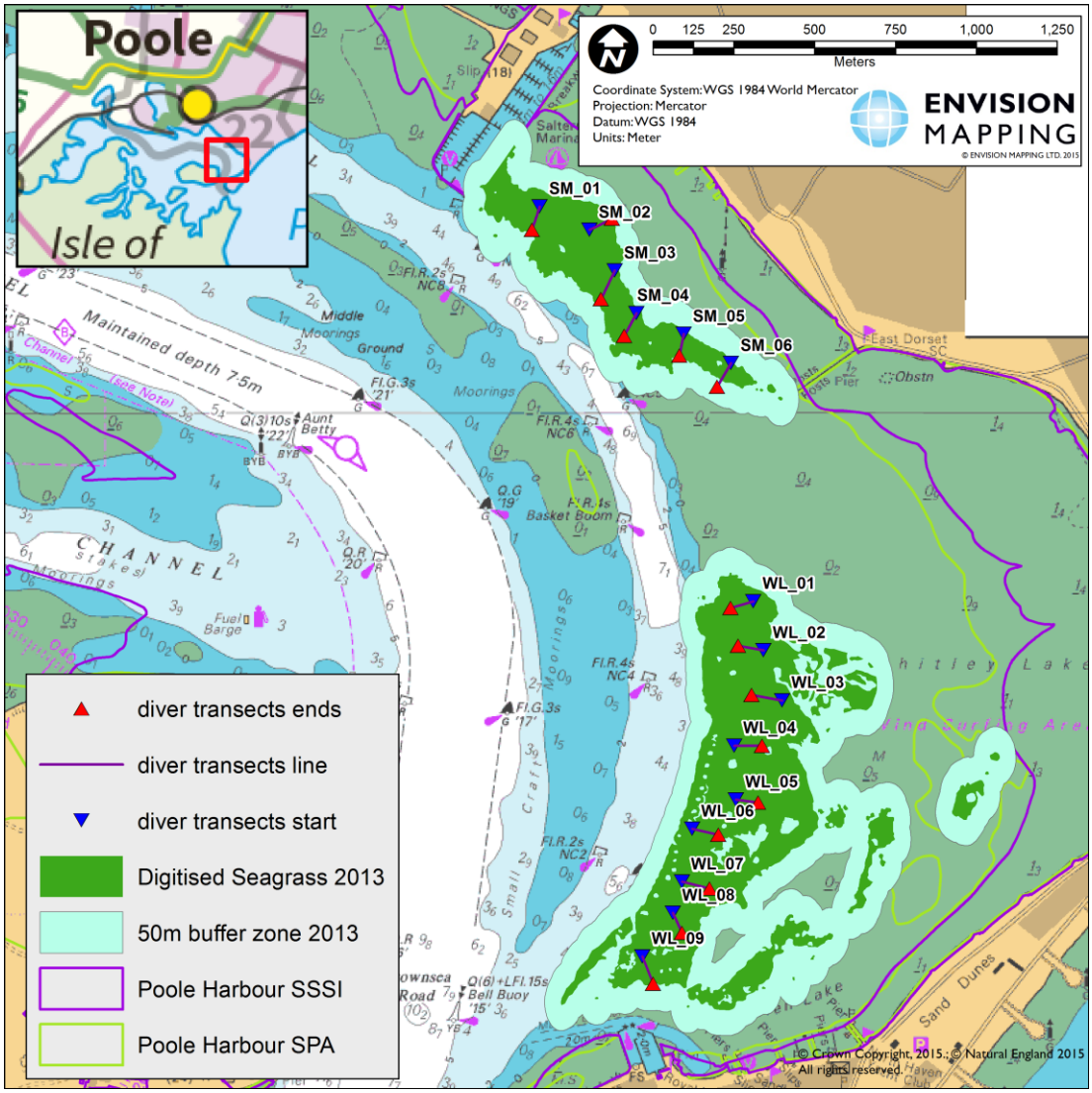

Figure 4 Diver Transect Locations in Poole Harbour

4 Analysis

Video analysis

4.1 Post-survey analysis of the video footage involved extracting information at 5 second intervals, which when coupled with the positional data, equated to distance intervals of approximately 5m (between 3 and 7m) depending on the speed of the vessel at the time. This generally resulted (dependent on transect length) in more than the 20-40 points per transect as agreed with Natural England in terms of sufficient sampling resolution.

4.2 Seagrass presence and absence were recorded along with seagrass percent cover, using the same scales as for the recording of diver data (Table 1). Additionally, the nature of seabed substrate, predominant habitat type and presence of macroalgae or shells were noted where possible.

4.3 Dense patches of algae with almost 100% cover were also recorded, as these appeared to form a distinct biological community from the seagrass beds. These were recorded as 'algal beds' which differentiates these records from those where the presence of any macroalgae within seagrass beds was recorded.

4.4 The presence of any other conspicuous species (Crepidula) or obvious anthropogenic influences (i.e. rubbish/debris, anchoring or mooring impacts) were recorded as separate fields.

4.5 These data were tabulated in a spreadsheet and also with GIS to plot the presence and absence and percentage cover along each of the transect lines. As each record is also, in effect, a point sample, full coverage maps of seagrass cover were also produced using natural neighbour interpolation, and compared with the previous data from 2008 data.

4.6 This allowed for the extent of the seagrass bed to be calculated and used as a baseline value for comparison with future years monitoring data, and which can be compared with previous data.

4.7 Patchiness of the seagrass beds was also calculated using a patchiness index, based on methods used in Montefalcone *et al.* (2010). Patchiness was calculated for fixed periods of data with the number of Present/Absent transitions recorded. The distance between transitions of presence and absence were measured and the mean length of patches were also calculated along with the average percentage cover within the patches for statistical analyses.

Diver Data Analysis

4.8 The diver data was collected to gain information and set a baseline for the condition of the attributes listed below

- Mean density (plants per metre square, m^2)
- Maximum leaf length
- Epiphyte community
- Presence of wasting disease *Labyrinthula* sp. and non-native species
- Presence or absence of macroalgae

4.9 Methods for assessing percentage cover used Braun-Blanquet (BB) Scale as described in Jupp *et al.,* 1996 with the estimates of wasting disease and epiphyte cover following Burdick *et al*. 1993.

4.10 Plant density was recorded at 5m intervals, by counting the number of plants in a quarter of a 0.5m x 0.5m quadrat, and therefore these records were multiplied by 16 to calculate the number of plants per m^2. These were then plotted spatially to show the variation of plant density along each transect.

4.11 Maximum leaf length was recorded for each plant collected at 5m intervals along each transect, and all values were then plotted in a size frequency histogram to examine the nature of the populations at both Salterns Marina and Whitley Lake sites, and also for the entire seagrass population for Poole Harbour. Whitley Lake sites had mean maximum leaf length of 37.4cm (n = 960, s = 15.2 cm) and Salterns Marina sites a mean maximum leaf length of 30cm (n = 1151, s =14.7 cm) with a combined mean maximum leaf length for the two site being 33cm (n=2111, s=15.4cm).

4.12 The epiphyte community was measured by recording the epiphyte cover for each leaf using the 0-5 score detailed in Table 1 but amended to use coverage of epiphytes rather than seagrass coverage. These score values were then summarised for each 5m interval by calculating the average epiphyte score, and plotted spatially along each transect to examine incidence and level of epiphyte growth.

4.13 The incidence of infection was recorded for each leaf of each plant collected by measuring the percent blackening of leaves as a proxy for the presence of wasting disease *Labyrinthula* and again used the 0-5 scale, amended to use coverage of disease rather than seagrass coverage, to represent this. The infection scores were again averaged for each 5m interval along the transects. However, the percentage of leaves per plant that were infected was felt to reflect the variation amongst the sites more accurately, and this value was used and averaged for each 5m interval and similarly plotted spatially to reveal incidence of infection over the seagrass bed areas.

5 Results

Video Analysis

5.1 Video footage was successfully collected for the seagrass beds near Salterns Marina and at Whitley Lake, and for the two additional investigative areas, as represented in Figure 3. Still images were extracted from the video footage at 1080p resolution and at regular intervals (every 5 seconds) and were of suitable quality for analysis.

5.2 A total of 4,716 images were extracted and processed, which the majority of image being analysed apart from the following exceptions:

- As the video was recorded continuously some images contained operational footage such as take boards or deployment and retrieval images and these were noted and are included with an ‘unanalysed category’ (306 images).

- Occasionally footage (287 images) was collected when the sled was too far from the seabed, often in deeper water or as the system was being deployed and these image were also marked as unanalysed and were given a “null” score for seagrass presence.

- Seagrass blades sometime obscured the lens briefly (the lens was cleared during survey operation if the lens was obscured for any length of time) and again 21 images were marked as unanalysed and given a “null” seagrass score.

5.3 Figure 5 shows the frequency of each seagrass percentage cover score (Table 1) which was produced from the video processing.

5.4 The scores associated with each image have been plotted geographically and the distribution of these is shown in Figure 6.

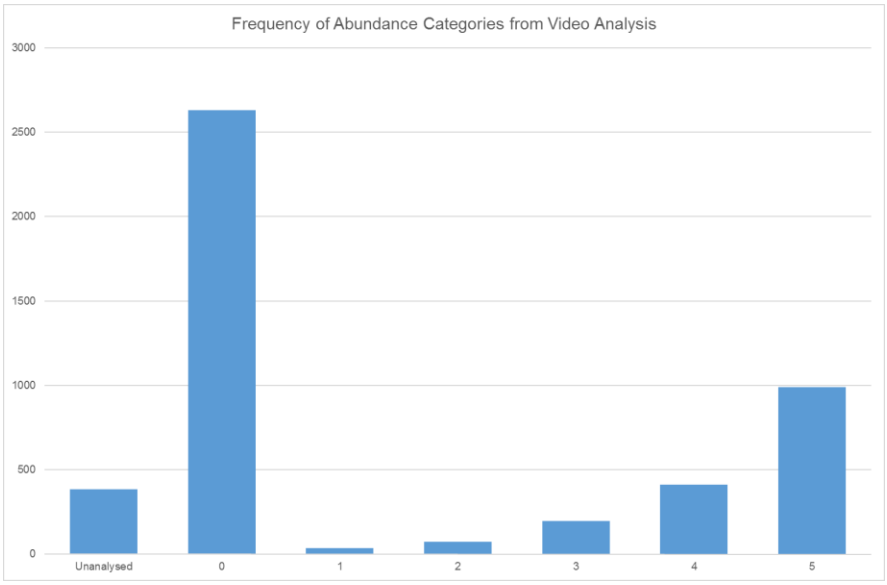

Figure 5 Frequency for seagrass percentage cover scores (Table 1) and unanalysied images from video footage.

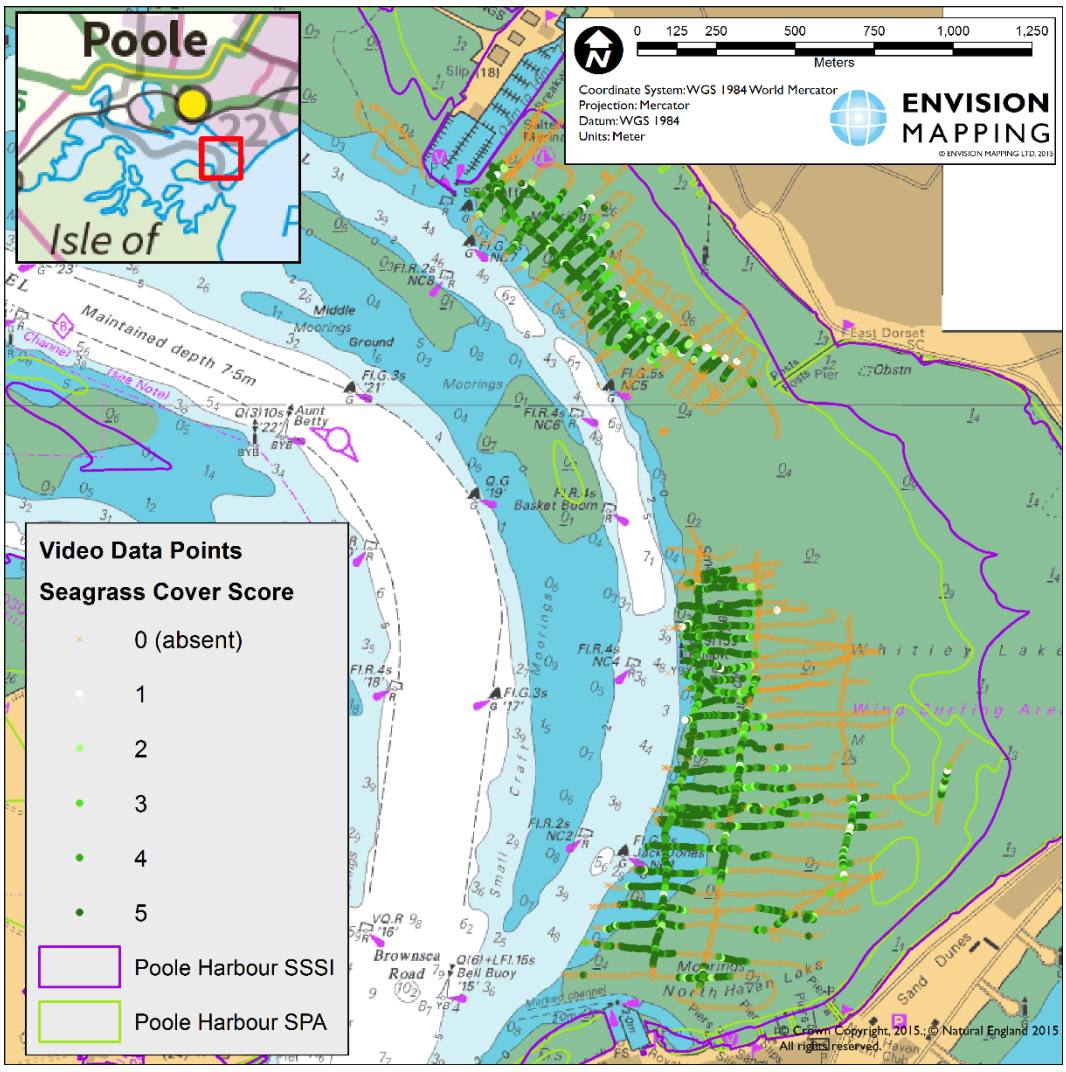

Figure 6 Seagrass percent cover scores from video data to show spatial distribution of data

Seagrass Distribution

5.5 Using the plots of seagrass percent cover scores, it was possible to use interpolation (natural neighbour analysis) to produce maps showing the boundary of seagrass beds and the coverage of seagrass within these. Seagrass bed boundaries where defined using a threshold value of 2 from the coverage scores, which is equivalent to >5% seagrass cover, and where coverage was equal or greater than this then the area was deemed to be seagrass bed.

5.6 Figure 7 shows the boundaries of seagrass beds within Salterns Marina area and Whitley Lake area, and Figure 9 shows the abundances of seagrass cover, based on percent cover scores.

5.7 No seagrass was recorded within the two areas which were surveyed as investigative areas, one area north of Salterns Marina and the other at the eastern edge of the Whitley lake seagrass bed (Figure 1).

5.8 Natural neighbourhood interpolation was chosen over inverse distance weighted interpolations as the prediction and boundaries drawn using natural neighbour are consistent with the data points entered and there is limited extrapolation within the process therefore leading to boundaries which adhere to the input data more faithfully. Natural neighbourhood interpolation is also better suited to categorical values, such as the seagrass abundance scores rather than continuous variables such as percentage cover or abundance counts.

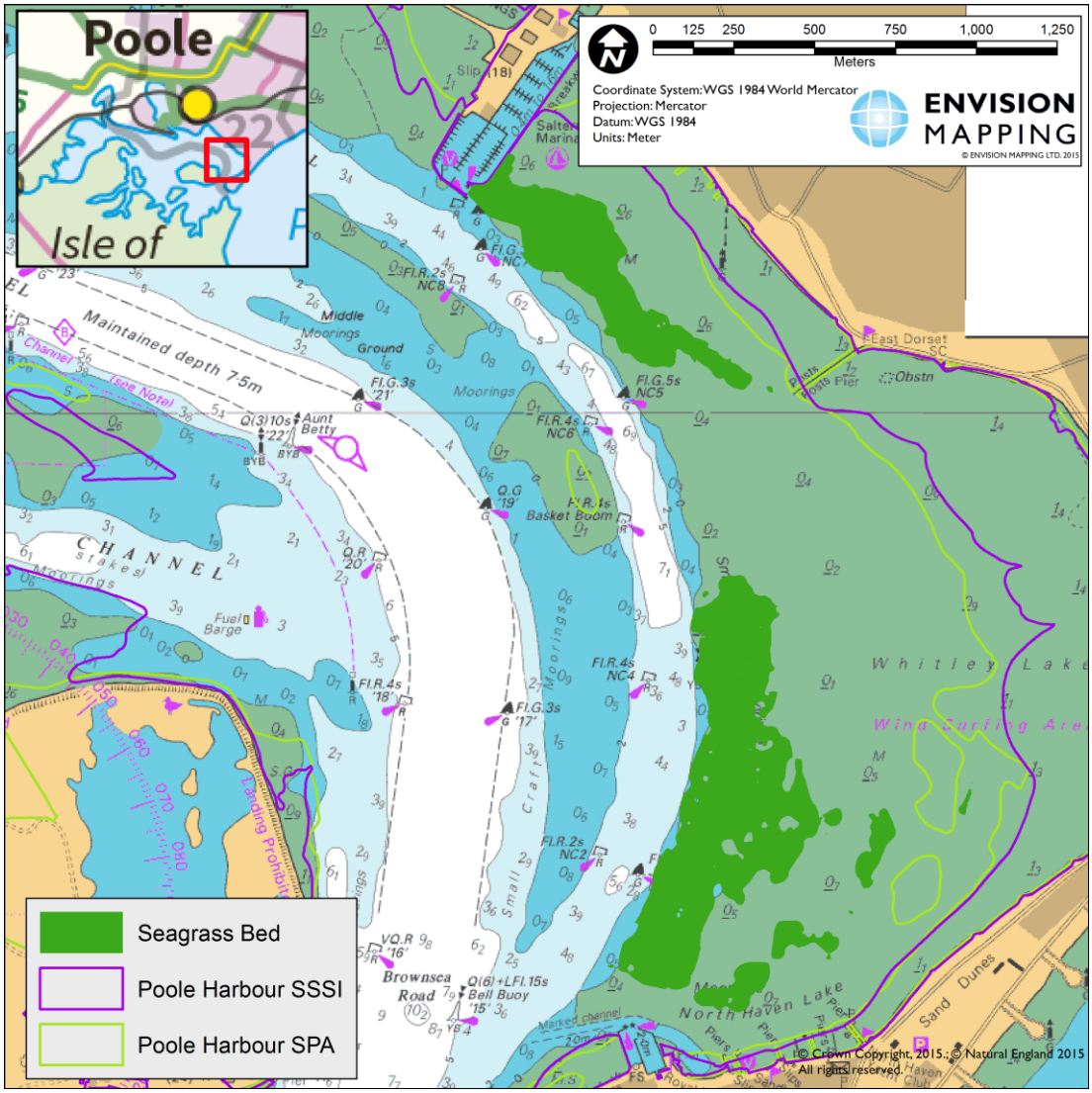

Figure 7 Boundaries of seagrass bed as determined from towed video footage

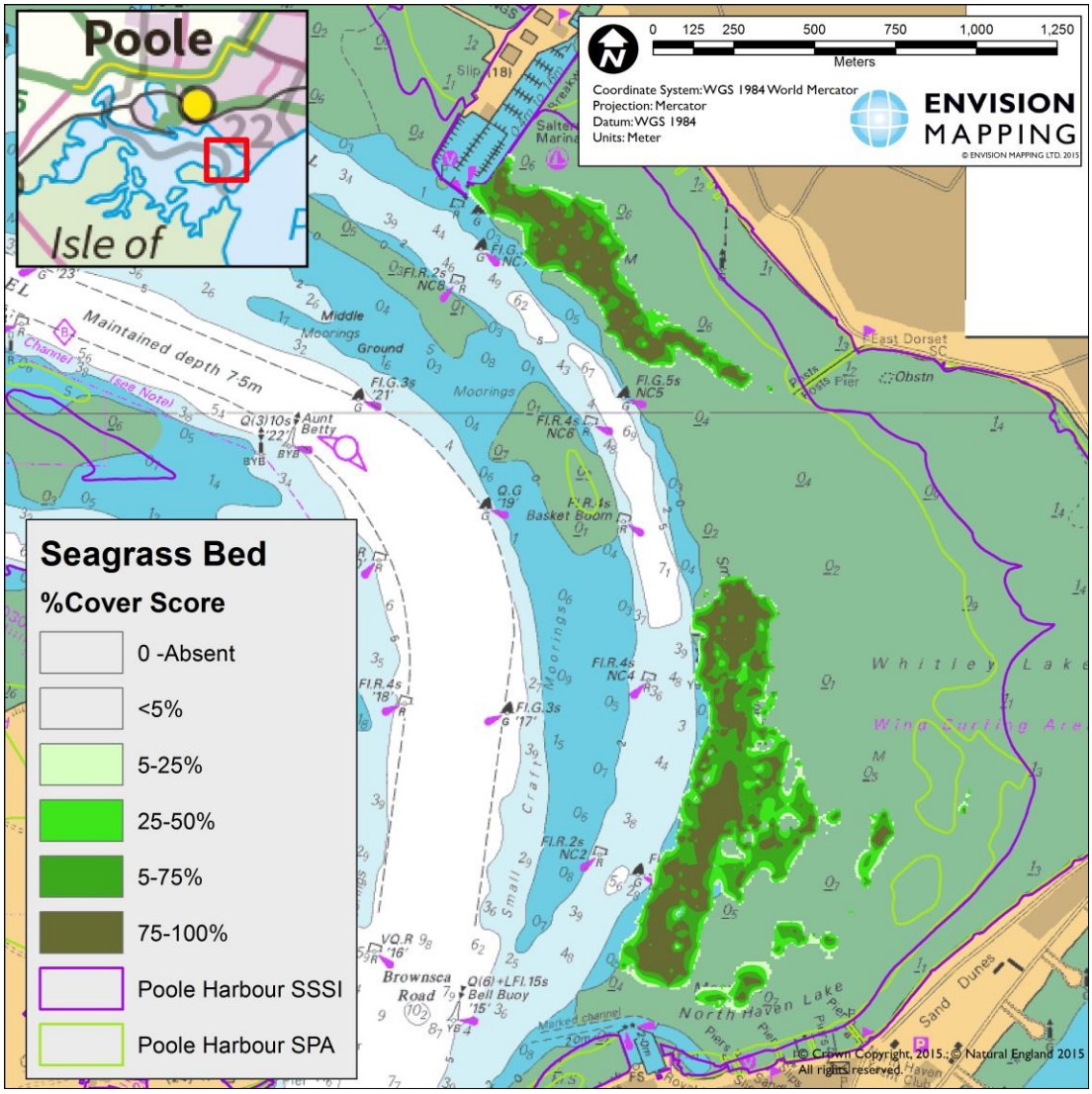

Figure 8 Seagrass beds with varying percentage cover shown spatially.

Seabed Substrate Characteristics, Habitat types and Algae distribution

5.9 The substrate observed from the video was for the majority of images a muddy sand with some shell fragments or empty shells present, and frequent presence of macroalgae and evidence of burrowing infauna (burrows, mounds and casts).

5.10 In many of the images analysed, the substrate was obscured by either the seagrass canopy or presence of macroalgae, but where visible, the substrate consistently appeared to be of the habitat type ‘Infralittoral muddy sand’ (SS.SSa.IMuSa), with some occasional slightly muddier areas, but not of sufficient significance to alter the habitat type recorded. However, as this was the only substrate type visible from the video footage, spatial distribution of substrate therefore shows a homogeneous substrate type throughout all the area surveyed, and would not reflect any variation between areas.

5.11 The predominant habitat present was '*Zostera marina/angustifolia* beds on lower shore or infralittoral clean or muddy sand' (SS.SMp.SSgr.Zmar), with this title taken from JNCC (2015) it should be noted the seagrass present are *Z. marina.* Where seagrass was absent, the substrate was either clear of epifauna, 'Infralittoral muddy sand' (S.SSa.IMuSa), or with algae present in varying abundance, and patches of algal beds (dense algae, close to 100% cover) which would fall under the 'Sublittoral macrophyte-dominated communities on sediments (SS.SMp) habitat. *Crepidula fornicata* was found in abundance in some of the footage at the Whitley Lake site but other associated epifauna could not be clearly identified and therefore these were not attributed to the Crepidula biotope (SS.SMx.SMxVS.CreMed). The presence of Crepidula is shown in Figure 9. No abundance of Crepidula were recorded with the Salterns marina area.

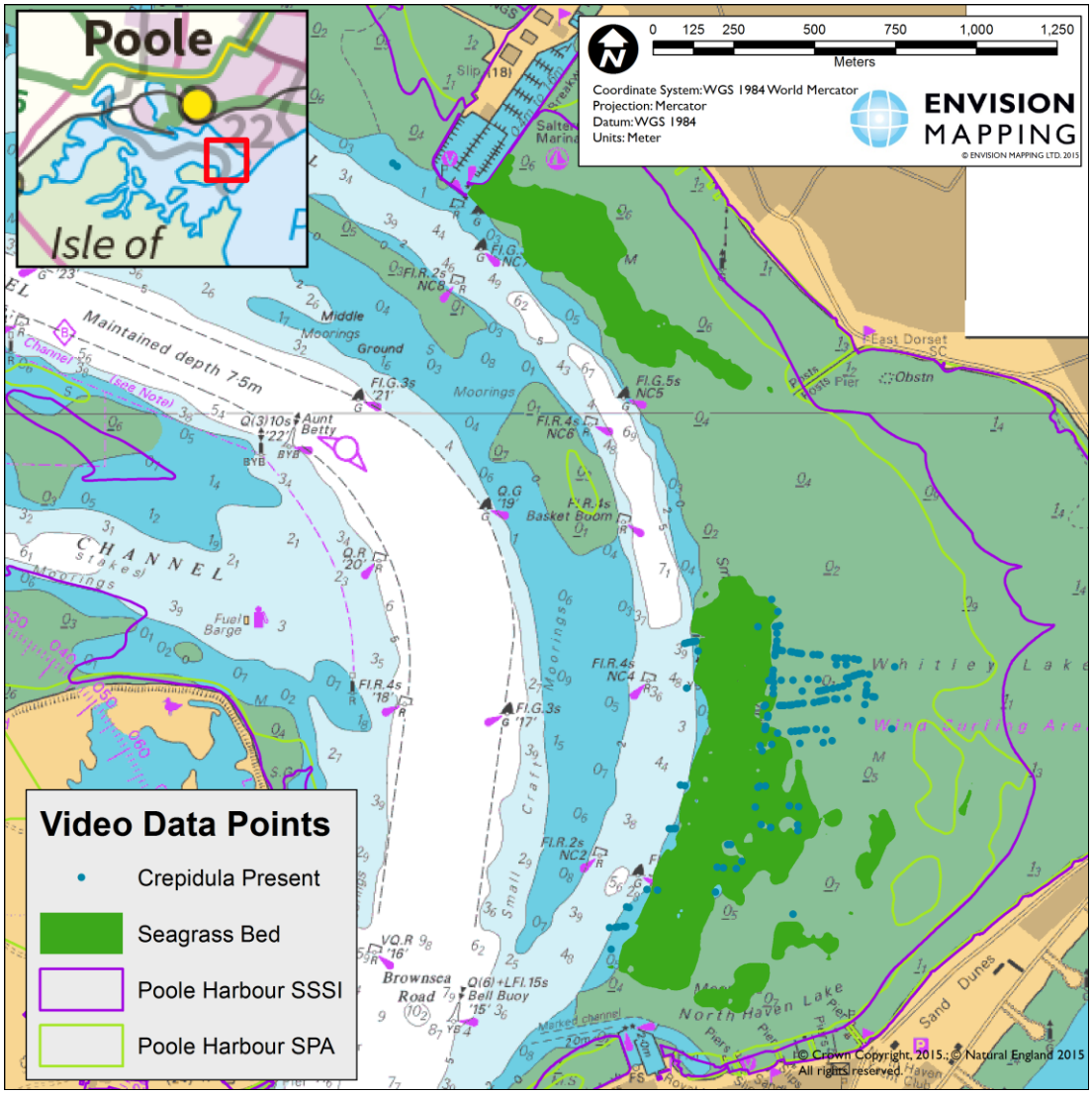

Figure 9 Location of points where video data indicated abundance of *Crepidula fornicata* presence

5.12 The presence of macroalgae and the locations of algal beds (dense algal cover as opposed to macroalgae within a seagrass bed) which may be indicative of seagrass condition are shown in Figure 10.

5.13 Although the presence of macroalgae was recorded at a generic level, species ID was not taken any further within the scope of this study. Although algae could be identified to species or genera from some of the footage, in many instances species identification would not have been possible to a detailed taxonomic level with any confidence, and therefore could not have been recorded on a consistent basis. Similarly, macroalgae were noted with regards to presence/absence from the diver survey, and the video data analysis was carried out using analogous methods.

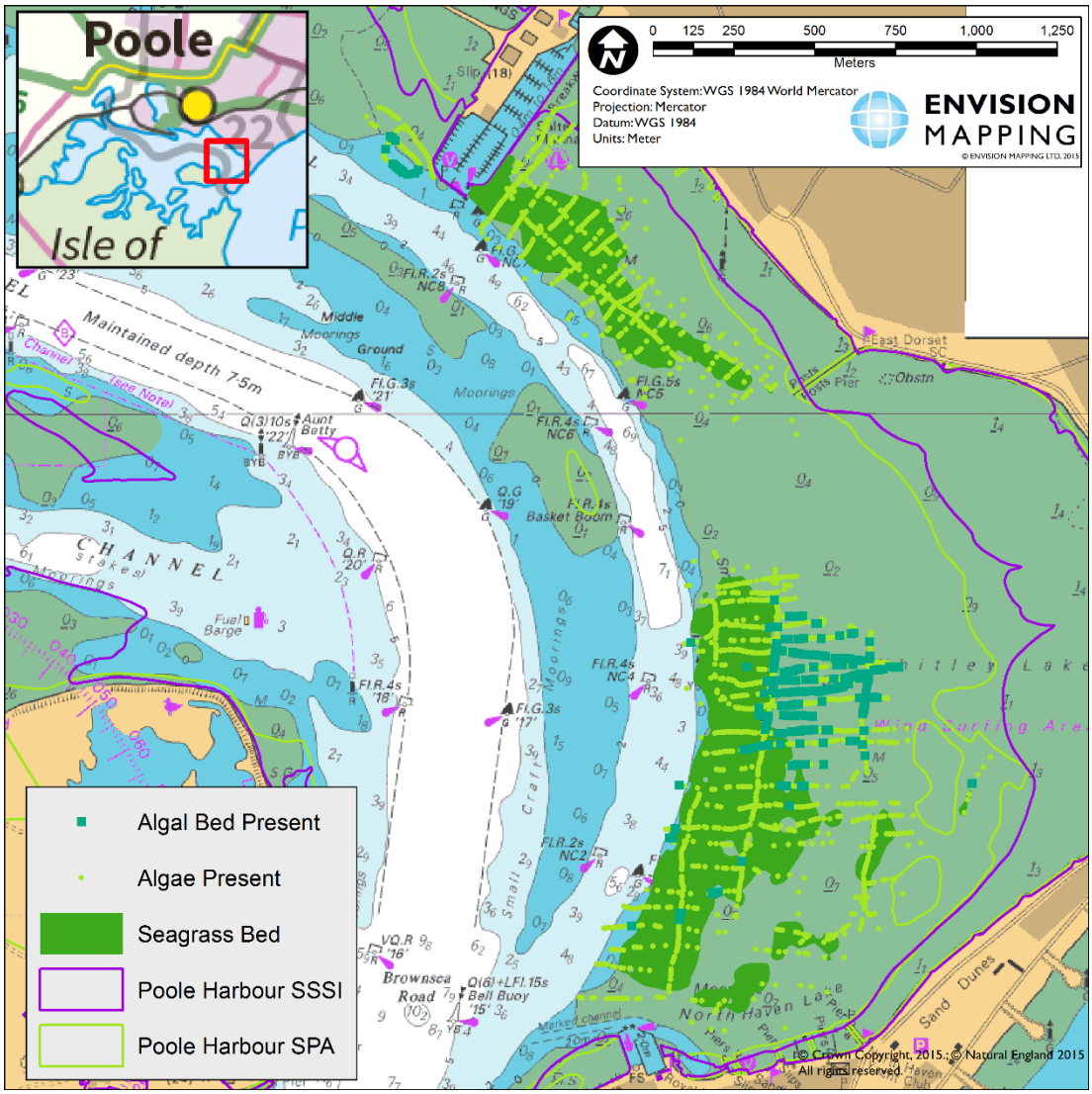

Figure 10 Map showing the location of video records with macoalgae present wkith seagrass beds and also where dense (~100% cover) Algal beds were located

5.14 Two images from the video footage showed evidence of anthropogenic influences in the form of litter (one discarded aluminium can and piece of plastic). These were recorded at the two locations shown in Figure 11.

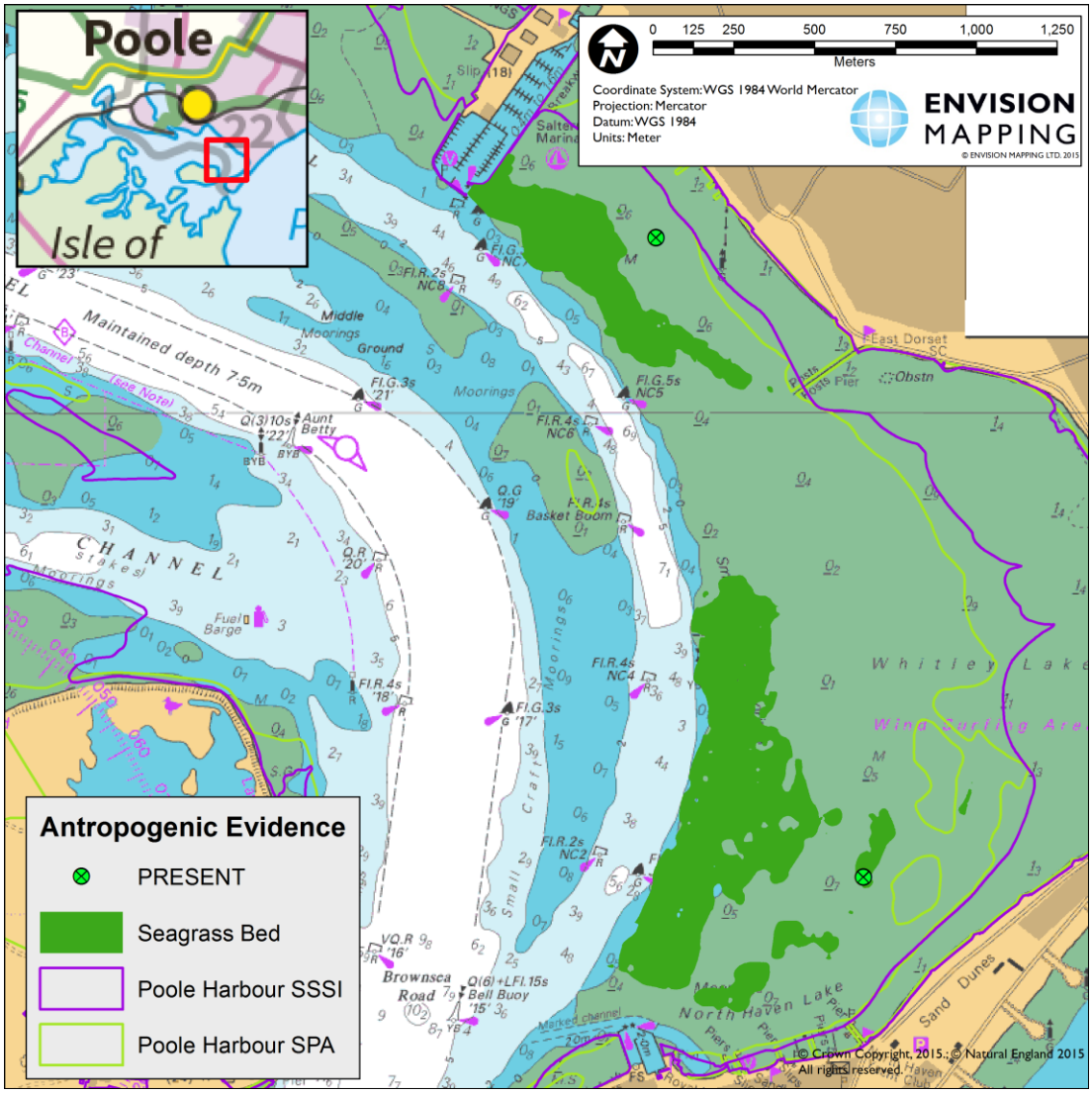

Figure 11 Locations of Anthropogenic Debris identified from video footage

Variability/Patchiness

5.15 Patchiness of the seagrass beds was calculated using a patchiness index, which is calculated for fixed periods of transect with the number of Present/Absent transitions recorded.

5.16 The OSPAR definition of sea grass beds states as that plant canopies should be at least 5% cover to qualify as a Zostera species bed (OSPAR, 2008). This 5% cover is equivalent to a score of 2 within the percent cover score (Table 1) used to assess seagrass coverage in Poole Harbour. Using this score as threshold of when seagrass bed is present or absent the number of transitions between seagrass being present or absent can be recorded as an index of patchiness. This patchiness index highlights only where there are gross changes in seagrass bed and does not highlight where the coverage of seagrass varies within a bed

5.17 Figure 12 shows the patchiness values recorded along the video survey line and in a similar manner to seagrass distribution the patchiness of the seagrass bed was plotted using natural neighbour interpolation to show the areas of patchiness.

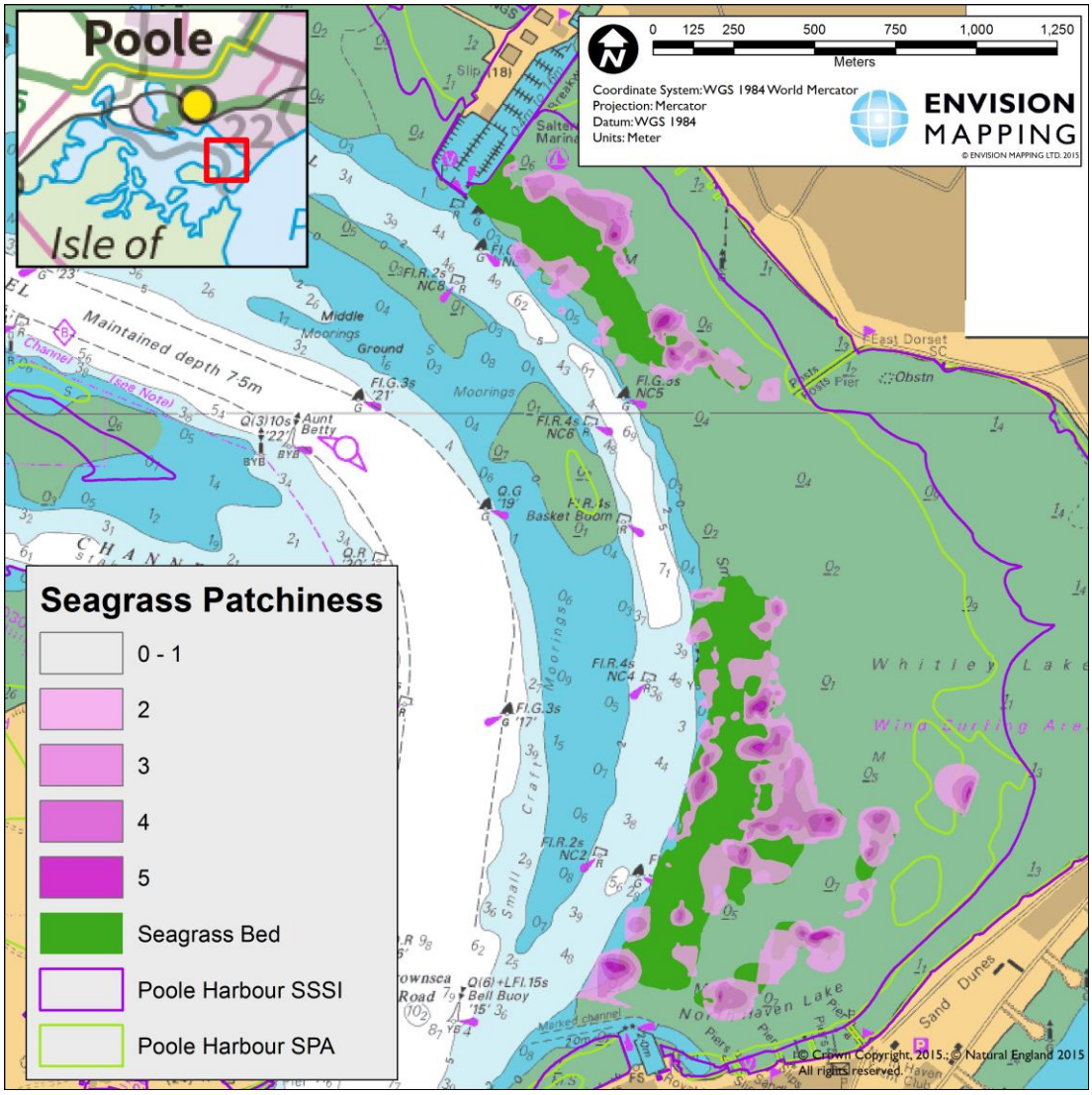

Figure 12 Patchiness index plotted with seagrass boundaries for reference.

5.18 The mean length of patches was calculated from the distance between each transition which showed an average patch size of 3.80m (s=1.98m) for all areas of seagrass with the Salterns Marina having an average patch size of 4.37m (s=2.05m) and Whitley Lake area smaller average patch size of 3.51m (s=1.87m). This shows a slight difference between the areas but within the realms of expected variation.

Diver Survey

5.19 Data was gathered during the diving survey from 9 transects in Whitley Lake (WL01-09) and 6 transects near Salterns Marina (SM01-06), the locations of which are represented in Figure 4. Data from a seventh transect at Salterns Marina could not be collected due to extreme shallowness of water during the survey period which meant that the collection of data whilst diving was not possible. Shallow water also meant that one of Whitley Lake transects had to be completed whilst snorkelling and prevented the collection of density data at this stage (i.e. collection of plant shoots) and another transect had to be aborted due to poor visibility

5.20 A summary of the data collected for each transect in Table 2 is shown below, with values for all the plants and leaves recorded at each 5 metre interval averaged for the entire transect. For the percent cover, the information recorded at 1m intervals along each transect is also averaged (over 5m sections, with the 5m intervals as central points) for the purposes of summarising and presenting the data briefly. This data is also shown in more detail in maps below, which may be of more relevance for reflecting the spatial variation of the attributes measured for seagrass condition at each of the diver survey transects.

Table 2 Diver data summarised using average values per transect

Transect	Percentage Cover Score	Density (plants per m^2)	Mean maximum leaf length (cm)	Number of leaves per plant	%age of leaves with 0 infection	No of infected leaves per plant	%age of leaves infected	mean infection score	mean epiphyte score
SM01	3.8	688.0	34.84	3.5	31.0%	2.46	68.96%	1.0	1.2
SM02	2.8	370.9	23.43	2.9	42.9%	1.45	38.91%	0.8	2.0
SM03	3.0	645.8	22.38	3.2	47.8%	1.76	52.20%	0.9	2.6
SM04	3.5	743.3	24.55	3.1	47.9%	1.53	43.06%	0.8	2.1
SM05	3.0	781.1	37.64	3.3	48.7%	1.62	42.23%	0.8	1.9
SM06	2.7	449.5	25.27	2.6	39.9%	1.19	32.82%	0.4	1.7
WL01	3.8	689.5	29.26	3.4	44.2%	1.83	46.75%	0.7	0.9
WL02	3.5	491.6	31.56	3.4	31.8%	2.33	68.24%	1.2	1.6
WL03	3.1	258.9	27.68	2.4	29.4%	1.45	43.28%	0.7	1.3
WL04	2.0	0.0	33.71	3.2	43.3%	1.24	29.39%	0.4	0.8
WL05	2.0	470.4	28.10	3.0	35.0%	1.72	45.03%	0.6	1.6
WL06	3.9	656.0	35.52	3.8	46.9%	2.01	53.05%	1.0	2.4
WL07	2.1	409.1	34.64	2.5	25.0%	1.71	46.40%	1.0	0.9
WL08	3.4	480.0	20.75	2.0	13.9%	1.40	31.54%	0.7	0.7
WL09	3.3	542.5	37.68	3.7	43.0%	2.18	57.02%	0.8	2.0

5.21 Data were examined for the following seagrass bed attributes, and are represented spatially in the maps below:

- percentage cover score, 0-5
- density (plants per m^2)
- maximum leaf length (cm)
- leaf infection score (0-5)
- epiphyte score (0-5).

5.22 As part of the divers survey, occurrences of flower plants or egg present on leaves are to be recorded, however, none were recorded within the quadrats.

5.23 The average diver recorded percentage cover score of seagrass per transect is shown for Salterns Marina in Figure 13 and for the Whitley Lake area in Figure 14 and Figure 15, overlain on the seagrass percentage cover score maps from the video analysis. These values represent the percentage cover of seagrass recorded at 1m intervals (using the 1-5 score), but averaged over 5m sections, around the 5m interval central point, for representation at the same spatial scale as the rest of the data.

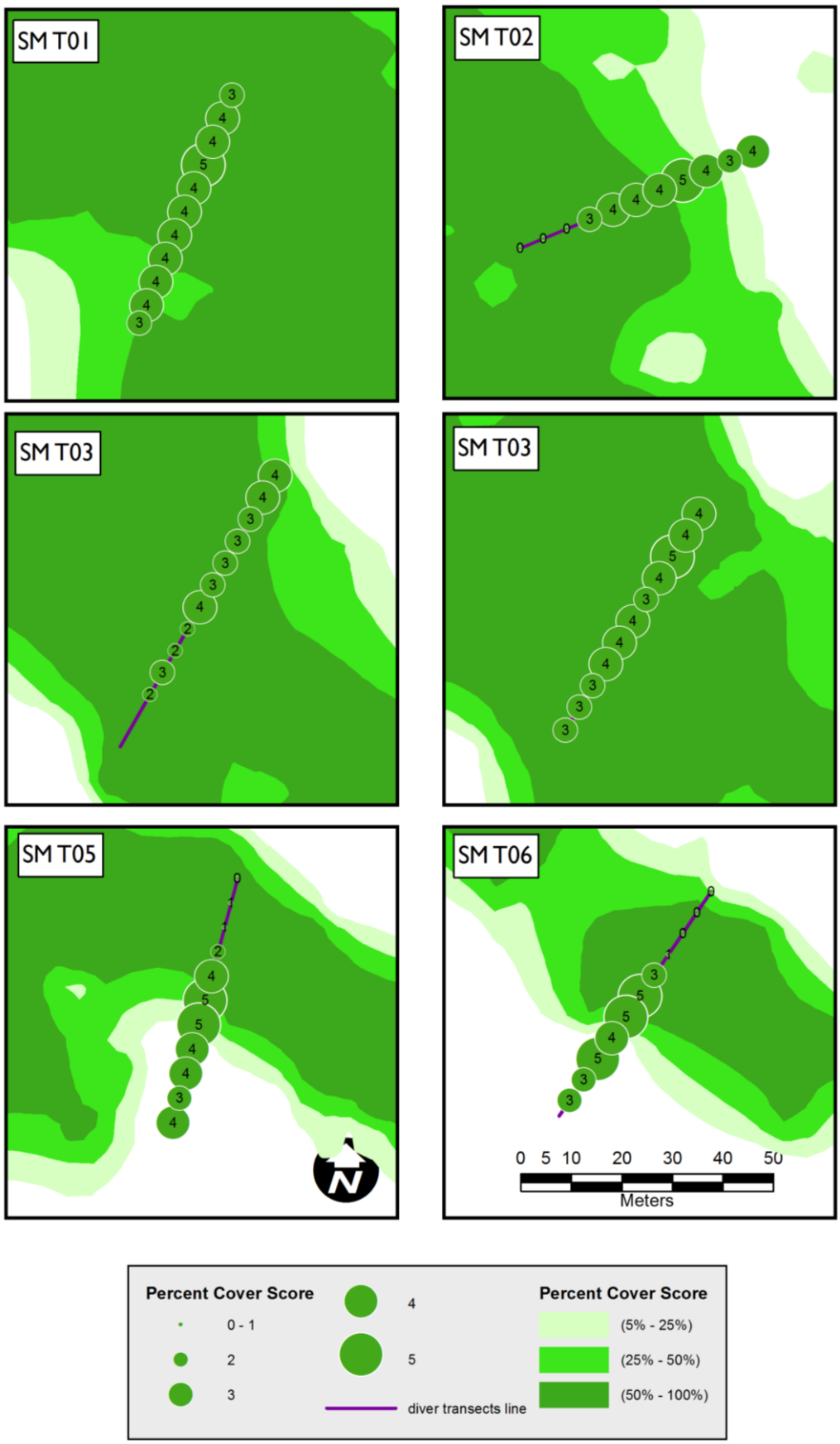

Figure 13 Seagrass percent cover scores for Salterns Marina diver transects overlain on seagrass percent cover score from video

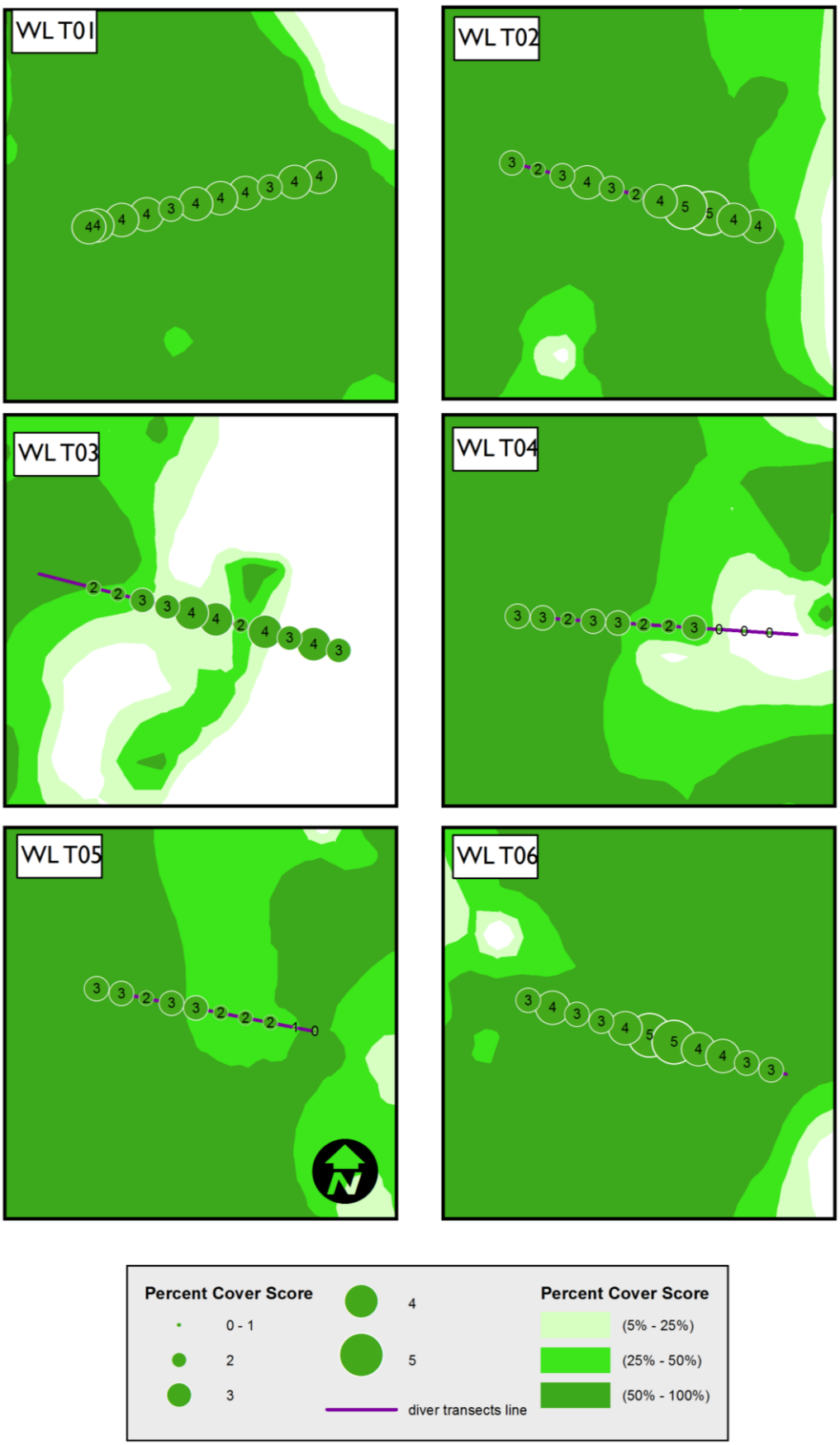

Figure 14 Seagrass percent cover scores for Whitley Lake diver transects overlaind on seagrass percent cover scores from video

Figure 15 Seagrass percent cover scores for Whitley Lake diver transects overlain on seagrass percent cover scores from video

5.24 Seagrass density measurements are represented in Figure 16 for the Salterns Marina area and Figure 17 and Figure 18 for the Whitley Lake area, overlain on the seagrass percent cover maps from the video analysis. This shows the number of plants per m^2 recorded at 5m intervals along each transect.

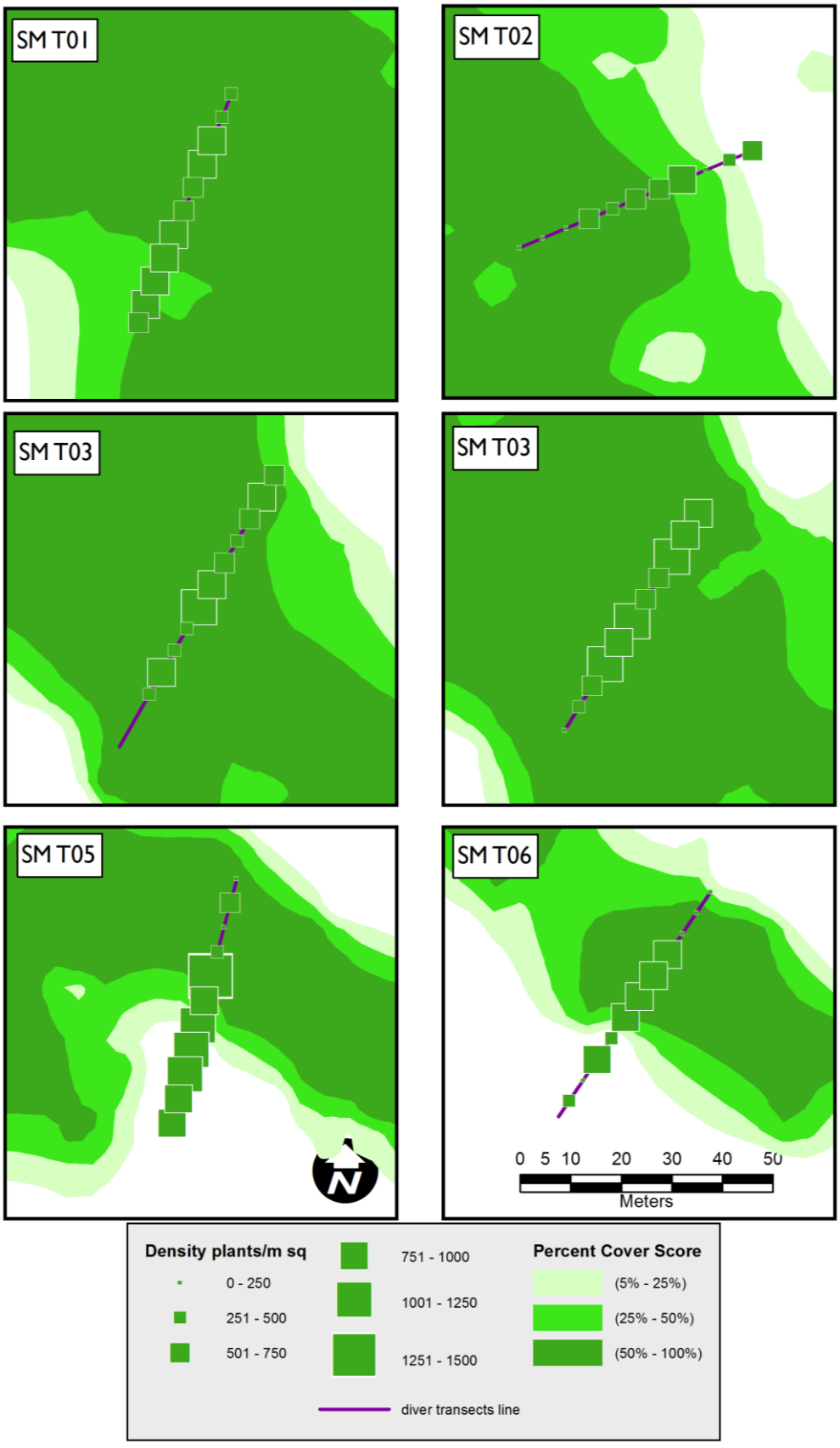

Figure 16 Seagrass density for Salterns Marina diver transects overlain with seagrass percent cover score from video

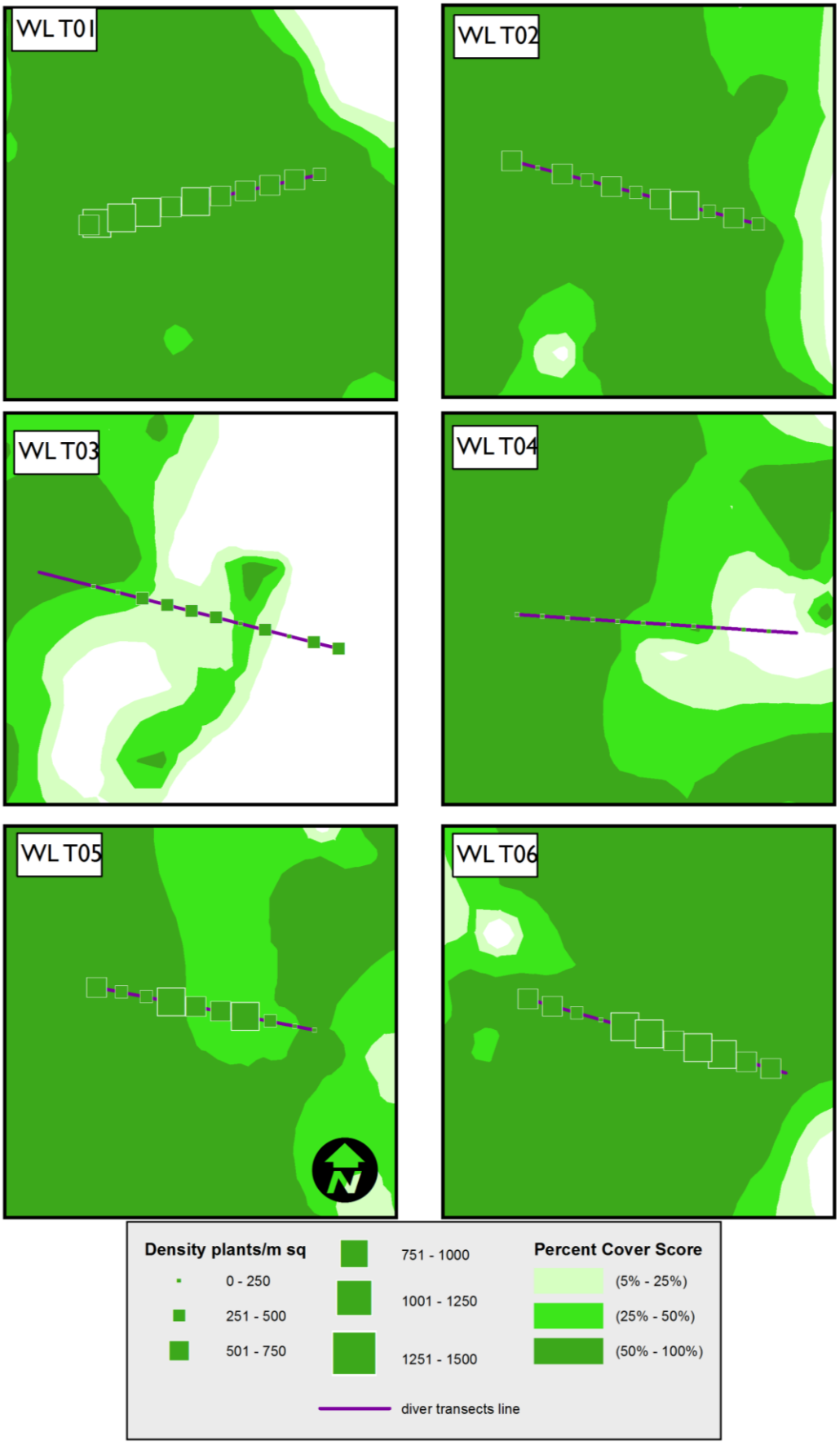

Figure 17 Seagrass density for Whitley Lake diver transects (1-6) overlaid on seagrass percent cover score from video

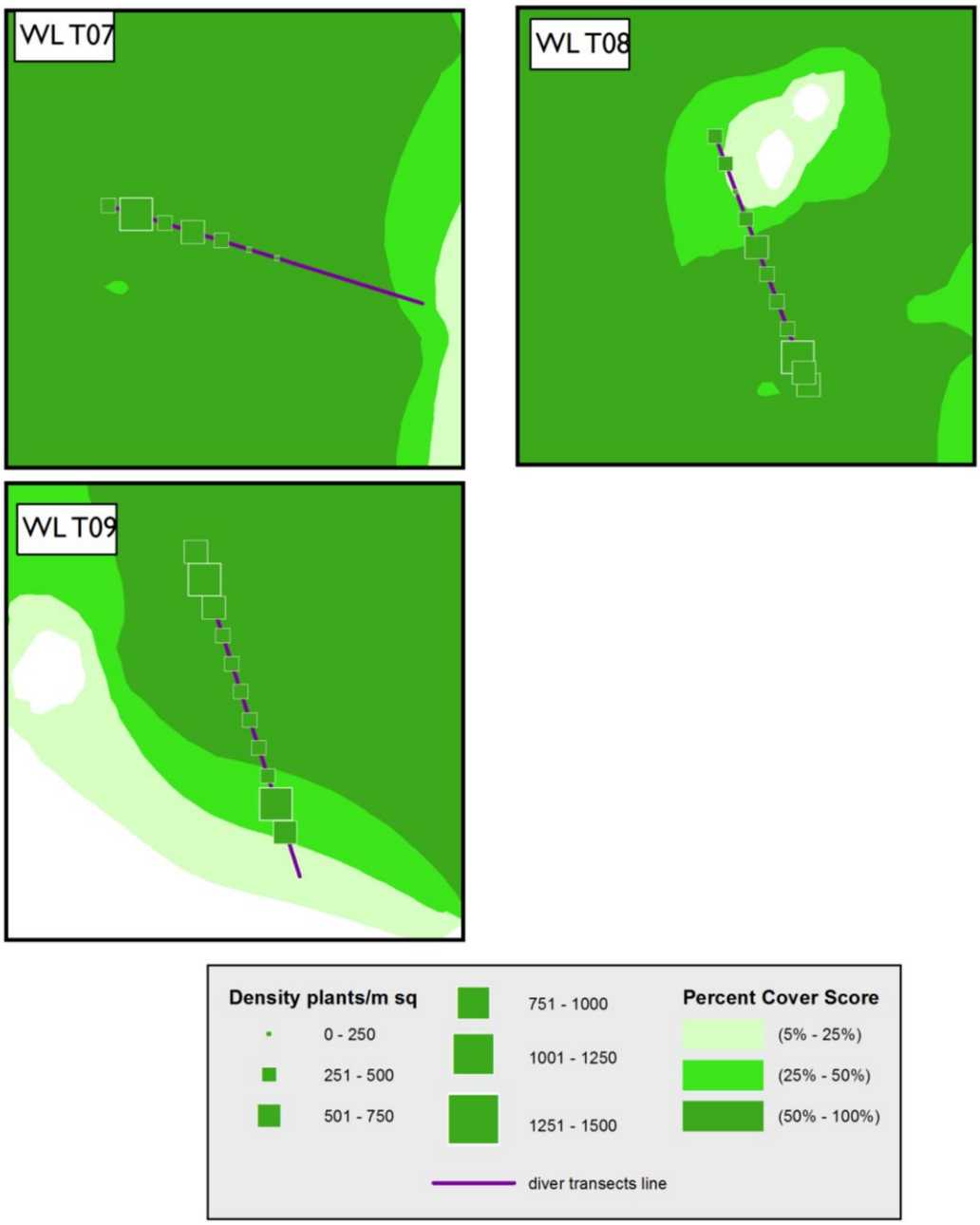

Figure 18 Seagrass density for Whitley Lake diver transects (7-9) overlain on seagrass percent cover from video

5.25 The maximum leaf length distribution was examined on a site basis (Poole Harbour) and per bed (Salterns Marina and Whitley Lake) and has been plotted in a size frequency histogram to reflect population structure at the various scales. When looking at the site level data (Poole Harbour), or the data from Salterns Marina, it appears that the majority of leaves are of shorter length with a peak at around 20-25cm, with a distribution that tails off with a maximum of around 90cm in the longest leaves. Looking solely at the Whitley Lake data, whilst there is a similar maximum leaf length of around 90cm, it appears that the population has a more even spread of leaf lengths of between 20-55cm.

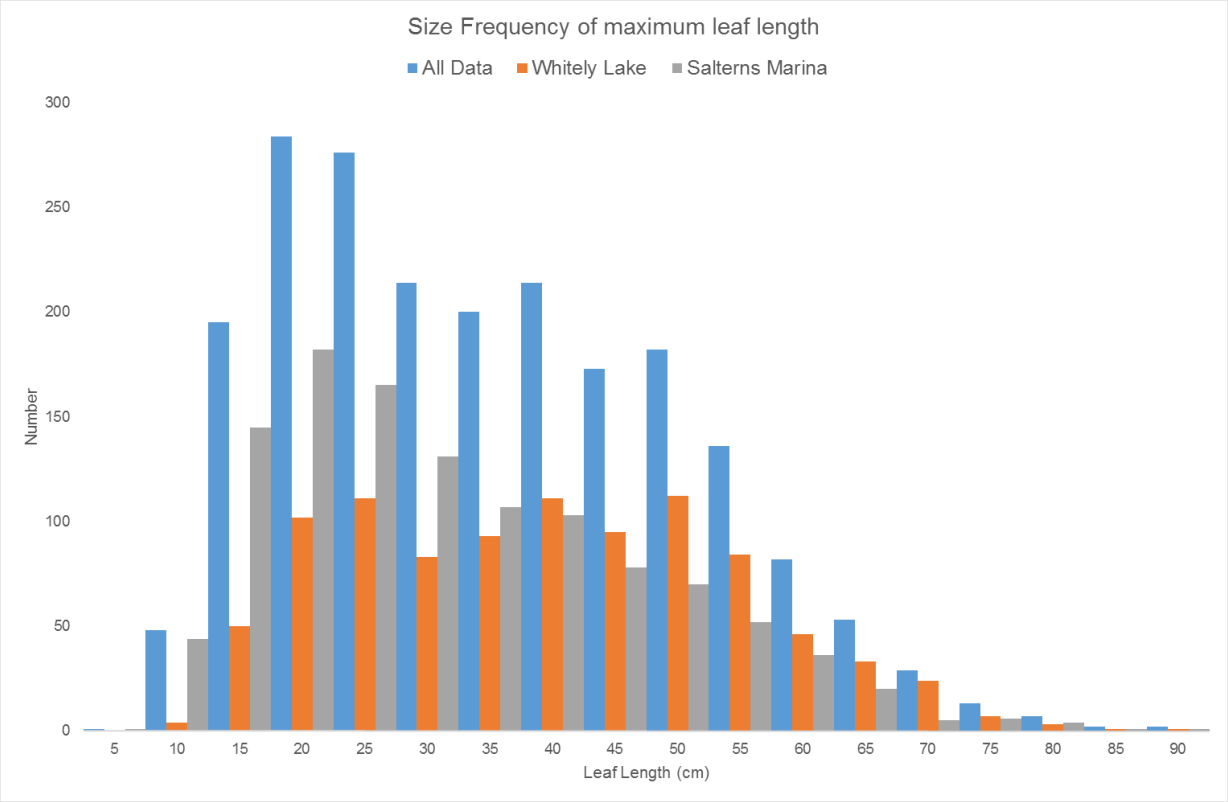

Figure 19 Size frequency of maximum leaf length within Poole Harbour seagrass beds.

5.26 Leaf infection was recorded using the 0-5 scale to reflect percentage cover of blackening of leaves as a proxy for incidence of the wasting disease *Labyrinthula* and measured for each leaf of each plant collected at 5m intervals. The percentage of infected leaves per plant was averaged for all plants measured at each 5m interval, and represented spatially for each transect at the Salterns Marina site in Figure 20, and for the Whitley Lake area in Figure 21.

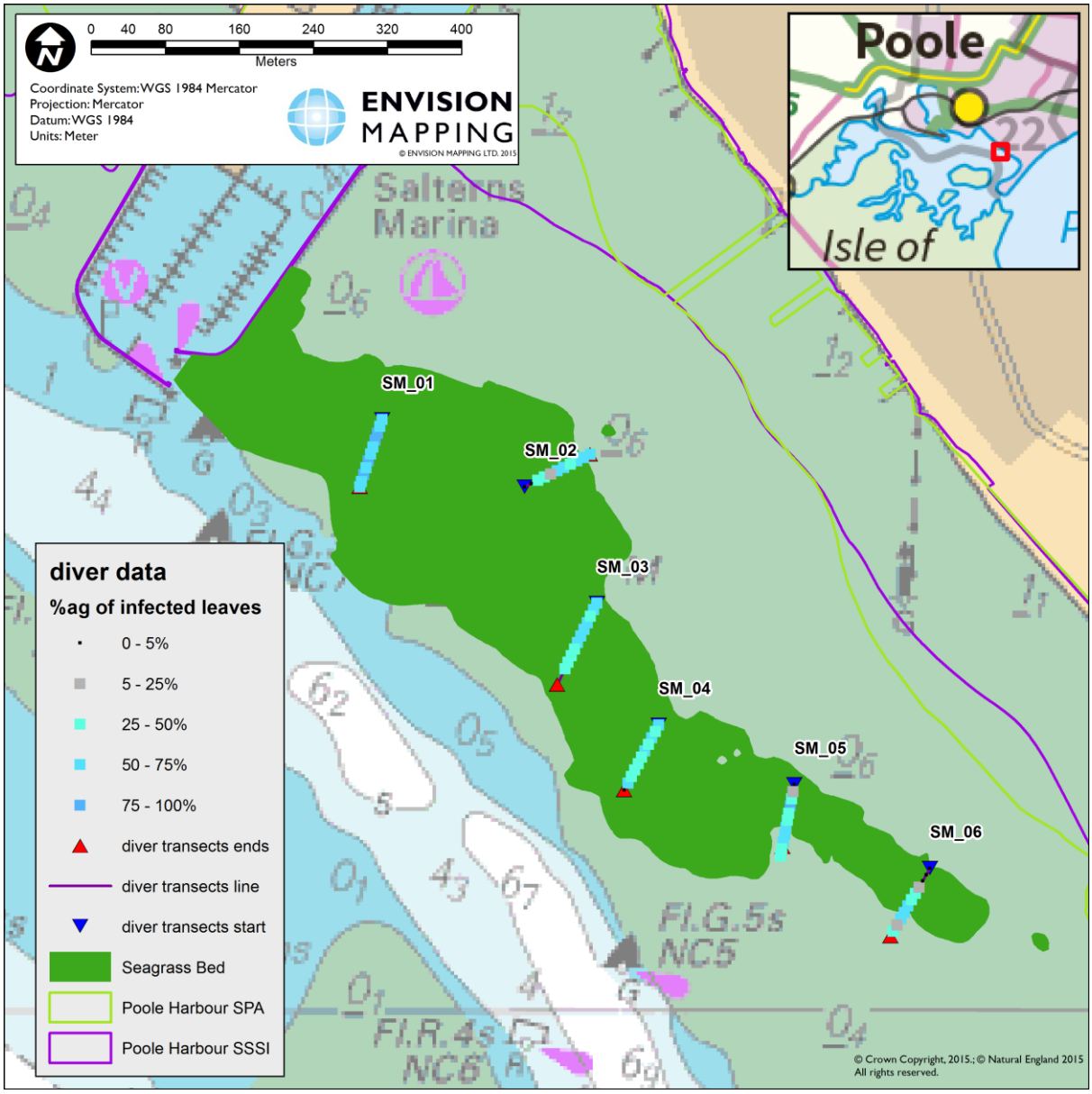

Figure 20 Percentage of infected leaves shown on each diver transect for Salterns Marina

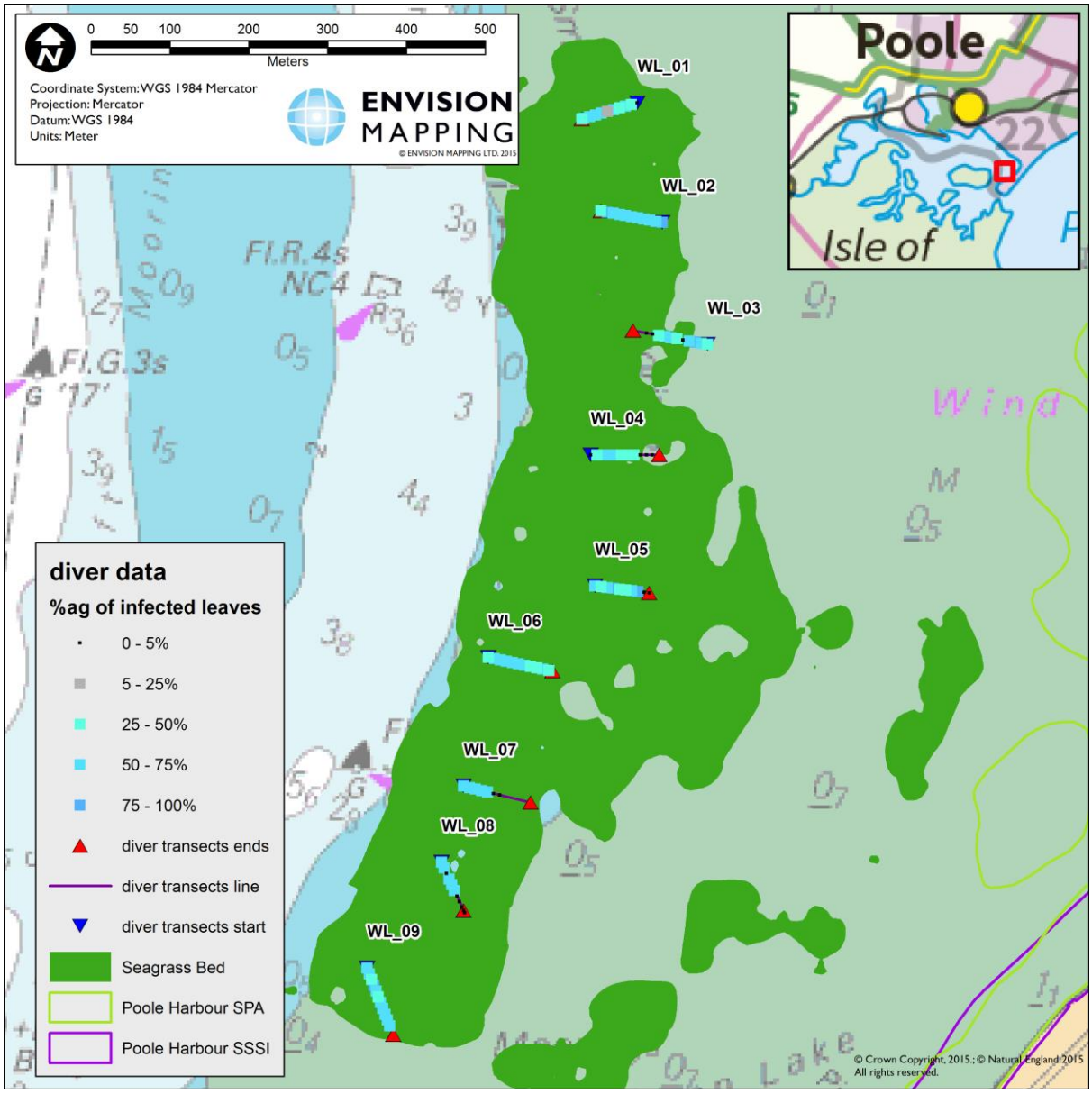

Figure 21 Percentage of infected leaves shown on each diver transect for Whitley Lake

5.27 Epiphyte scores were also recorded for each leaf of each plant on a 0-5 scale. These values have been averaged for all the plants at each 5m interval in every transect and are represented spatially for the transects at Salterns Marina in Figure 22 and at Whitley Lake in Figure 23.

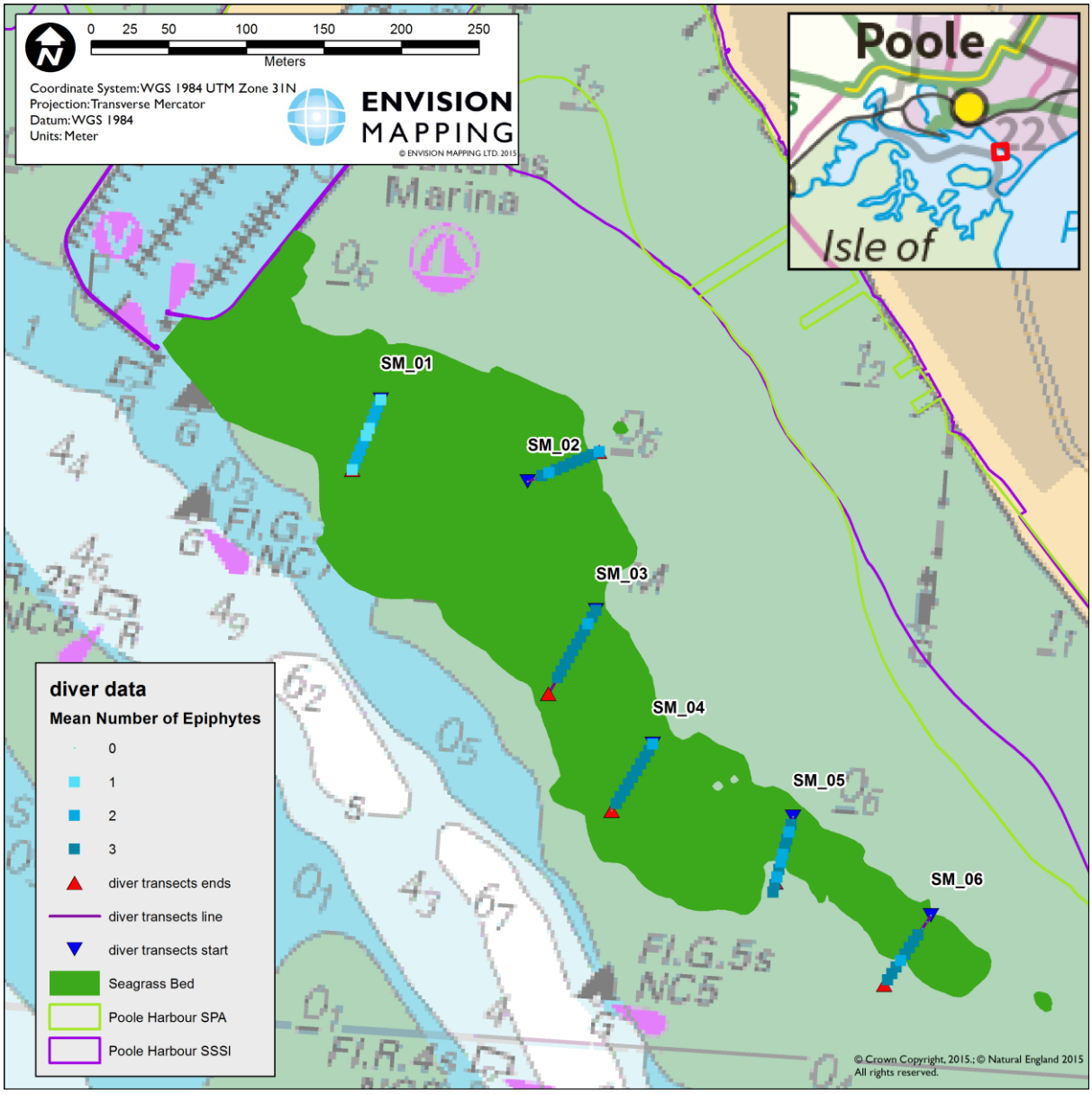

Figure 22 Average epiphyte score for each diver transect for Salterns Marina

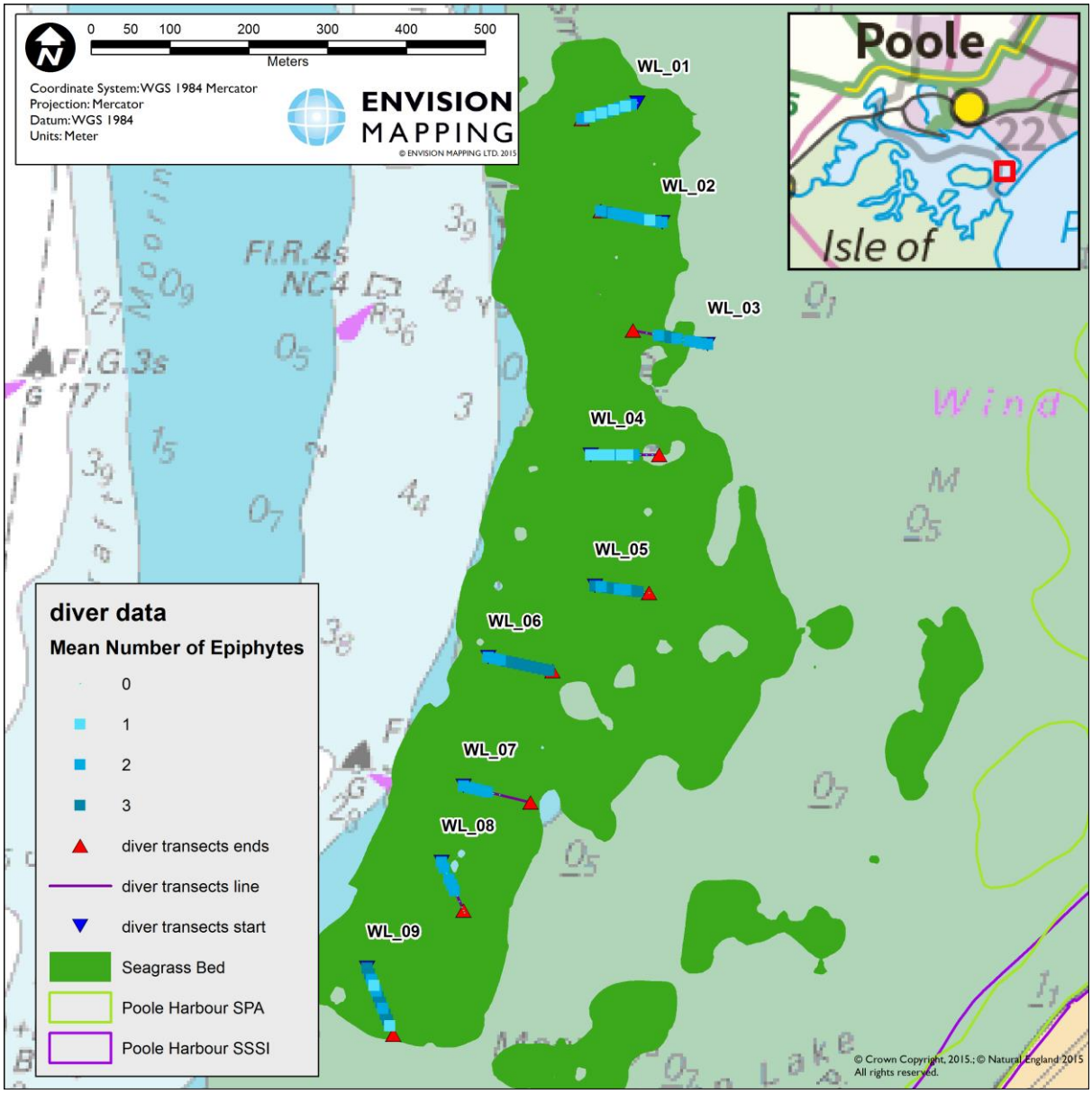

Figure 23 Average epiphyte score for each diver transect for Whitley Lake

Comparison of Diver and Video Survey data

5.28 When examining the diver data and video data together, it is noted some transects appear contradictory to the video data and it may be that start and end locations of transects may have been transposed, or that positional accuracy of recorded positions may have resulted in these discrepancies i.e. Figure 13 SM T02, SM T05 and SM T06 show seagrass to be abundant in deeper/shallower water yet no seagrass was observed in video footage.

5.29 Percentage cover scores data from diver transects in the Whitley Lake area support the percentage cover score data obtained from video data and the extent limits derived from the video are supported by the diver data i.e. Figure 14 WL T04 and WL T05 show decreases in percentage cover as the extent boundary is crossed.

5.30 Relationships between percentage cover and density data have been investigated but no strong correlations have been found. This is also shown when diver transect density data is plotted over the video percentage cover score maps i.e. Figure 16 to Figure 18 show varying densities with a range of percentage cover score.

6 Discussion

Assessment of Condition (Extent) of Seagrass Beds

6.1 Using towed video and image analysis has enabled the extent of the seagrass bed within Poole Harbour to be mapped, and the extent is supported by the diver transects and also agrees in principle with the historical records.

6.2 The data from the video survey does show some patchiness within the seagrass beds (Figure 12) with the majority of these areas found in shallow regions and at the periphery of the seagrass beds. The centre sections of the seagrass bed are shown to have little patchiness and this could be indicative of the stability and condition of the seagrass beds.

6.3 Diver data for epiphytic growth upon the seagrass appears to show occasional patches of seagrass with increased epiphytes (Transect WL 06, SL03 & SL04) and other areas having variable growth of epiphytes.

6.4 Diver data which examined the disease levels within seagrass samples shows a low to medium level of disease (5 to 50% infected leaves) throughout the seagrass beds for both Salterns Marina and Whitley Lake with occasional transects showing elevated level >50% of infected leaves WL09 and WL02 have respectively on average 68% and 57% of leaves infected with levels of infection high throughout the transect. SL02 also show elevated levels of disease with an average of 68% infection within leaves with the majority of samples along the transect showing high levels (>50%).

Anthropogenic influences

6.5 Little was observed in the video footage in terms of anthropogenic influence, with only one instance of a tin can covered in faunal turf, and another possible piece of plastic debris.

6.6 This level of litter would appear to be very low level and is likely to be of little concern to the health or condition of the seagrass within the area.

6.7 There are numerous small craft mooring located within the Whitley Lake site with seagrass found under moored vessels and close to mooring lines. Mooring footings could not be surveyed by towed video therefore no assessment of conditions close to the footings can be made.

Assessment of Direction of Ecological Change/Comparison with Previous Data

6.8 Diver collected data, which are spatially restricted but are recorded in situ, have been spatially correlated with the broad-scale data obtained from video survey to investigate where the two data sets support or contradict each other.

6.9 Previous data for the site was available as geographic shapefiles for extent of the seabed calculated from digitised aerial photographs from 2008 (Pearce, 2009). The survey data from video surveys in 2008 and 2012 was not available. In addition, the extent of the seagrass beds were digitised from 2013 aerial images (obtained from Channel coastal observatory) to assist in survey planning.

6.10 No previous data from in-situ recording were available for comparison with diver data.

6.11 The extents from the current survey and previous data are shown in Figure 24. In general, there is good concordance with previous data sets with the main 'core' of the beds being consisted throughout. The Salterns Marina site does show some extension shoreward from the 2008 data and the current survey agrees with inshore boundaries digitised from 2013 aerial imagery. The Whitley Lake area shows some slight modification to the extent in small shallow areas and there is some discrepancy between the northern inshore boundary from 2013 to now, which is likely due to the digitised extents delineating algal beds rather than seagrass bed.

6.12 In terms of hectare coverage, the current extent is given as 21.7 Ha with 22 Ha measured by the Poole Harbour Commissioners using acoustic transect surveys in autumn 2008 (Pearce, 2009).

Table 3 Summary of Seagrass Bed areas from three studies

Survey	Seagrass Area
2015 – Current Results	21.7 Ha
2013 Digitised Results	23.28 Ha
2009 – Pearce (2009)	22 Ha

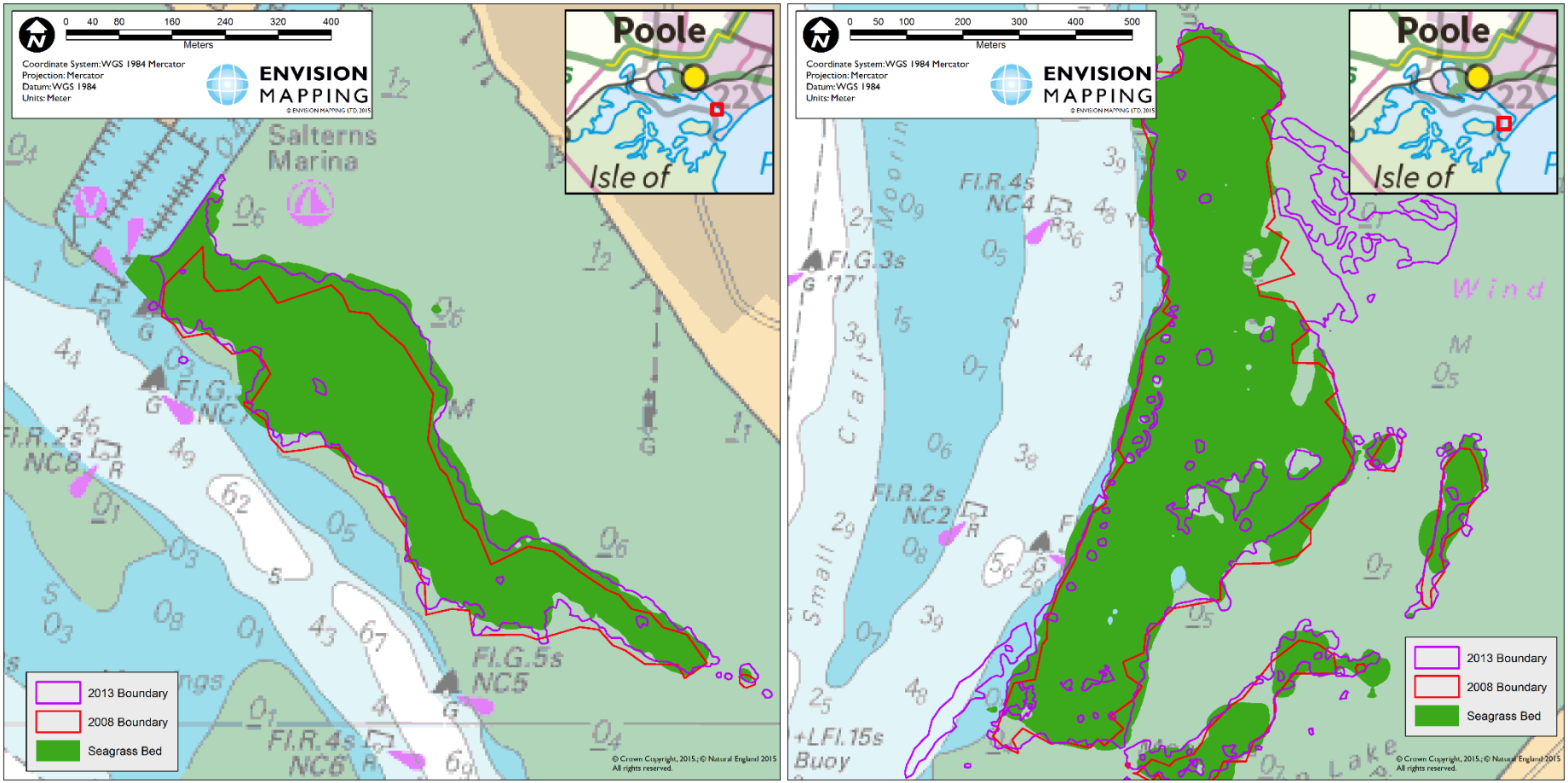

Figure 24 Seagrass bed extents with previous extents shown for Salterns Marina and Whitley Lake areas

Repeatability of survey design

6.13 The towed video survey was undertaken using uncomplex methods and the design aimed to determine spatial extents of the seagrass with some indication of percentage cover within the seagrass beds. The survey method does not require repeatability of exact towed video transect positions, only that a similar number of transects be collected using a similar spatial distribution and spacing.

6.14 The camera system shown in Plate 1 is bespoke but uses a simple design and to this end another similar system could be deployed to produce similar results. Specifications of the camera used are provided in the field report for this survey should the system need to be replicated.

6.15 The diver survey transects are located using GPS which will enable them to be resurveyed with reasonable accuracy.

6.16 The methods used for diver data field collection are established and documented within peer reviewed scientific literature, the collection of percentage cover data following the Braun-Blanquet (BB) scale described in Jupp *et al*. 1996 and the estimates of wasting disease and epiphyte cover following methods in Burdick *et al.* 1993. Employing well documented established methodology increase the likely success of any repeat surveys.

6.17 The technique of using drop down video data to assess extent and variation in percentage cover combined with the diver collected data should mean that the technique is easily repeatable as all methods are well documented.

Issues & Assumptions

6.18 Some of the diver transect positions recorded (SM T02, SM T05, SM T06 and WL T03) do not concur with the video data, or previous/current boundaries of seagrass beds. There is a possibility that start and end locations of transects may have been transposed, or that positional accuracy of recorded positions may have resulted in these discrepancies. There is also some duplication within records and contradiction between null or zero data records and other data. These data have been checked but no further clarification is currently available.

6.19 When analysing images taken from video, the seabed was occasionally obscured by algae or seagrass and this can affect the quality of the data. Obscured images are likely to be an unavoidable aspect of collecting data within seagrass beds and whilst it has been recorded where this occurred, it is recommended any future survey methodology should stipulate that images which are obscured should be noted and only analysed if more than 50% of the image is visible.

6.20 An important difference between video and diver collected data is utilising video footage to assess seagrass beds is useful in determining the extent and percentage cover of seagrass over a large area rapidly but identification of epiphytic growth and any disease present is virtually impossible from video footage due to the speed of survey and the distance from the seagrass. If quantitative assessment of epiphytic growth and disease are a requirement of any monitoring or assessment, then in-situ measurement by diver survey is required. It is therefore recommended that any future assessment employs both video and diver collected data with specific variables recorded by each survey technique.

6.21 Video analysis and diver survey both used the substrate categories detailed in Table 1 and these categories include sediment, modifying features and biological features. This can introduce ambiguity and confusion and it is recommended the substrate categories be better defined and the modifying features such as shell and algae be recorded separately.

6.22 In order to summarise and pool data over distance or within quadrats, an average value of seagrass percentage cover scores has been employed within the diver data and within interpolation parameters. The seagrass percentage cover scores are non-linear and semi categorical with a skew to lower values with 1 representing 0-5%, category 2, 5-25% and the remainder increasing in 25% increments. When averaging these the lower values can skew the result towards lower percentage cover scores and care should be taken if using these for monitoring. Within interpolation the algorithm used is critical and within this project natural neighbour was chosen as this treats data as categorical rather than continuous whereas inverse distance models may over-exaggerate boundaries and care should be taken within monitoring projects that interpolation of boundaries calculations are consistent.

6.23 It has been assumed consistently through the data analysis that the OSPAR definition of a seagrass bed in accurate and appropriate and that a 5% coverage of seagrass qualifies as a seagrass bed. Should this definition alter or be deemed unsuitable then the results in this report will require appropriate reinterpretation.

Confidence

6.24 In order to assess the suitability of the seagrass distribution map for its intended purpose, a confidence assessment using the MESH Confidence Assessment method (MESH, 2008) has been undertaken. This approach assesses the quality and suitability of the geophysical acoustic data, the point sample data, and the interpretative techniques using a scoring system (Table 4).

6.25 The maps are solely for the distribution of seagrass and for this purpose no remote sensing data were used and therefore this Remote Sensing Score is not applied this case

6.26 Interpretation of the data was restricted to seagrass metrics and whereas this is appropriate for the maps in question the MESH confidence tool is more applicable for habitat category maps. Nevertheless, the interpretation methods were considered appropriate and given such scores.

Table 4 MESH confidence assessment output for each map produced

	Remote Sensing (Geophysical data)					**Ground Truthing (sampling)**						**Interpretation**				**Results**			
	Remote Technique	Remote Coverage	Remote Positioning	Remote Stds Applied	Remote Vintage	BGT Technique	PGT Technique	GT Positioning	GT Density	GT Stds Applied	GT Vintage	GT Interpretation	Remote Interpretation	Detail Level	Map Accuracy	Remote score	GT score	Interpretation score	**Overall score**
Biotope & Substrate Maps AOI	NA	NA	NA	NA	NA	3	1	3	3	2	3	3	NA	2	1	NA	85%	50	**73**

6.27 The site map score 73 with good cover of ground truth samples and good interpretative methods employed.

7 QA

7.1 Of the 4716 frame captures from the video, 635 were re-analysed for quality assessment by an independent in-house analyst, which represents approximately 13.5% of the work.

7.2 Of the frame captures that were re-analysed, 78.5% were an exact match for the percent cover score for seagrass. As this is slightly low, the results were examined in further detail to ascertain the reason for the differences. The results for each category of seagrass percent cover were collated and compared using a pivot table, and the following results were found (exact matches are shown in bold):

		Analyst % Cover Score							**Total**	**% match per score**
		0	1	2	3	4	5	NULL		
QA % cover score	0	**229**							229	100%
	1		**3**	9					12	25%
	2			**11**	14	2			27	41%
	3			2	**24**	31	4		61	39%
	4				7	**42**	41		90	47%

	5				6	20	**174**		200	87%
	NULL							**16**	16	100%
	Total	229	3	22	51	95	219	16	635	

7.3 From this analysis, it can be seen that there was a 100% match between the 0% seagrass cover records and the NULL records (where it was concluded that the image could not be analysed). There was also a relatively high agreement (87%) for records given a score of 5 (75-100% seagrass cover). However, it is apparent that the highest mismatches were in categories 1 (0-5% cover), 2 (5-25% cover), 3 (25-50% cover) and 4 (50-75% cover) and that the majority of mismatches were only 1 category out.

7.4 On this basis, it can then be calculated that level of agreement for scores that matched within 1 category was almost 98%. Of the frame captures that were re-analysed, the mis-matches were then reviewed to explore why different scores had been given. For the majority of examples, it was found that the images that were given different scores by the main analyst and the QA analyst were borderline between the categories and this was thought to be a justifiable margin of error.

7.5 Certain issues which arose during the analysis and made scoring ambiguous, were the position of seagrass fronds in relation to the camera system and the presence of algae (Plate 2). In some instances, the presence of macroalgae within a seagrass bed made the observation of percent cover of seagrass more complex. In other instances, when seagrass fronds were very close to the camera lens, although the field of view of the camera could be taken up with seagrass canopy, it was also obvious that these were solely in the foreground and a considerable part of the substrate was not in fact covered by seagrass. Allocating scores in these instances were more complicated, and the error between categories has been in the large part attributed to these conditions.

Plate 2 Example of obscure images

7.6 However, on reflection, it was decided that the most significant issue for mapping the extent and distribution of seagrass beds was the difference between presence and absence (this achieved 100% agreement within the QA process) and the difference between less than or greater than 5%, which is the percentage cover stated in the OSPAR definition above which qualifies as a Zostera species bed (OSPAR, 2008). For this reason, every frame capture with a score of 1 or 2 was then revisited by both analysts together, and scores confirmed for the presence or absence of seagrass bed (over or under 5%).

8 GIS & Map Data

- An ArcGIS project for final interpretative maps is provided with associated MESH/Medin format metadata and MESH confidence assessments, and clean of any topology errors.
- Shape files for samples and polygon maps for seagrass coverages, are provided in MESH DEF format with associated ArcGIS layer files.
- Habitat data supplied in Marine Recorder Exchange format (.mdb) (created using the Marine Merge tool)
- All report maps are provided as image files at 300 dpi or higher.
- Copies of original data spreadsheets / databases are also provided in appropriate Microsoft Office format or ArcGIS format, and on CD or DVD.
- A spreadsheet which summarises the data is provided in MS Excel 2010 format and the meta data is provided in Appendix 1

9 Bibliography

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Further information

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