

**ecological support, management &  
solutions**



## **Yachthaven Eelgrass Monitoring**

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## **1.0 INTRODUCTION**

### **1.1 Background**

Ecosupport Ltd was originally commissioned in 2011 to carry out an ecological assessment of the Yachthaven site in relation to the proposed redevelopment of the boat yard. Proposals included the erection of six residential dwellings, with associated landscaping and infrastructure, and a 12-berth pontoon.

The production of this Eelgrass Monitoring Strategy is a condition of the Planning Permission for this development. This report provides a basis for survey methodology but should be adaptive to site specific requirements.

### **1.2 Objective**

The objective of the Eelgrass Monitoring is to detect trends and changes over time in the Eelgrass (*Zostera Sp.*) distribution and general health with regard to the new development and the associated factors which have the potential to influence Eelgrass growth and distribution. It is also to allow management intervention to be carried out, if required.

### **1.3 Site Context**

The site is located at Yachthaven on the eastern side of Hayling Island, Hampshire. A parcel of land to the west of the development site lies within Site of Importance for Nature Conservation (SINC) known as 'Fields & Saltmarsh South of Copse Lane'. The site is located directly adjacent to statutory designated sites including Chichester and Langstone Harbour Special Protected Area (SPA); Solent Maritime Special Area of Conservation (SAC); Chichester and Langstone Harbour Ramsar Site and Chichester Harbour Site of Special Scientific Interest (SSSI). The site also falls on the boundary of Chichester Harbour Area of Outstanding Natural Beauty (AONB).

### **1.4 The Importance of Eelgrass**

The Eelgrass (*Zostera*) beds within Chichester Harbour are an important feature of the Solent Maritime SAC and are vital for the bird populations which are features of the Chichester and Langstone Harbours SPA/Ramsar Site/SPA. They are an Annex I habitat under the Habitats Regulations and are a priority within the UKBAP, HBAP and HvBAP. Therefore, the Eelgrass beds within the zone of influence of the development are considered to be of national value.

## 2.0 BASELINE

### 2.1 Previous Survey Work

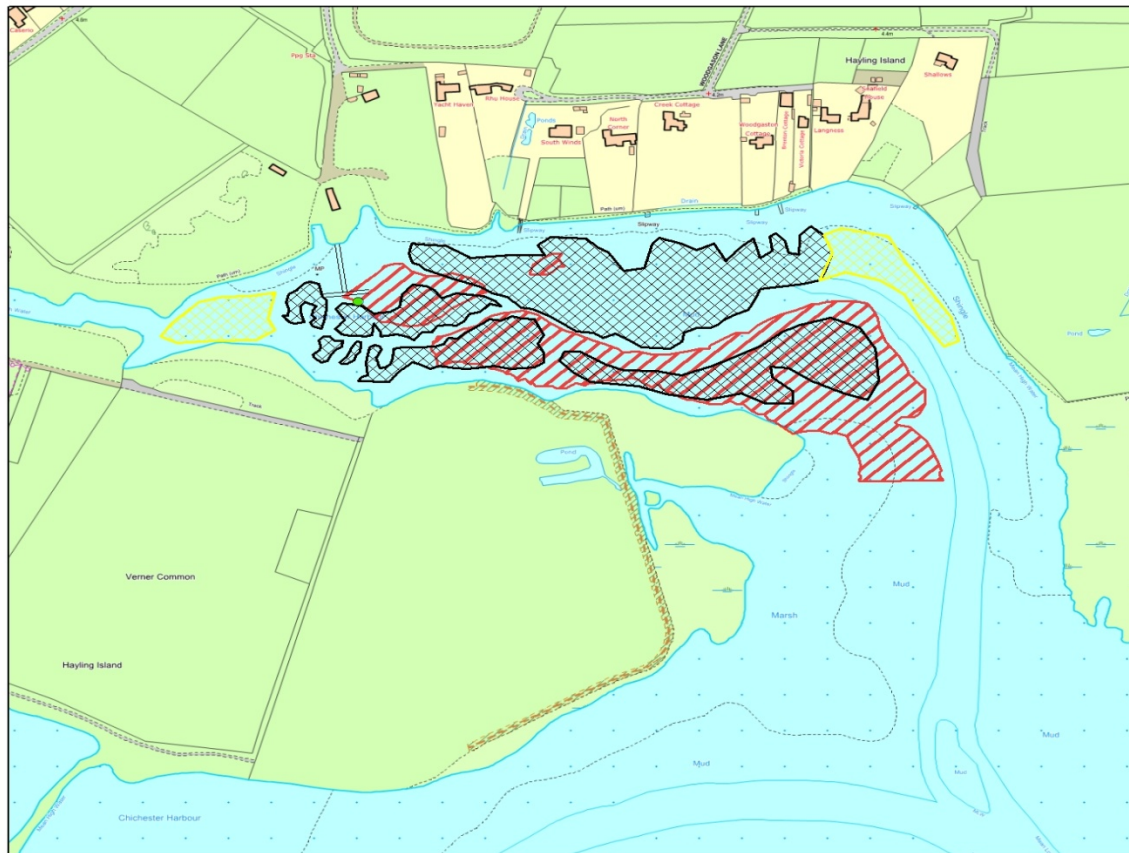
Mapping produced by Hampshire Wildlife Trust from survey work carried out in 2008 prior to the proposals for development showed Eelgrass beds mostly located to the east of the proposed pontoon area (in the lower parts of the creek)<sup>(1)</sup> with further smaller and fragmented beds distributed to the west of the proposed pontoon area.

A survey of the extent of the Eelgrass within the zone of influence carried out by Ecosupport Ltd of the development was undertaken in September and October 2011. The Eelgrass beds' extent and positions were determined on an aerial image through a combination of on shore observations, using optical aids, and wading out through the channels at low tide. Bed extents were recorded with a hand held GPS device, mapped in the field and later quantified using Geographic Information Systems (GIS). The qualitative on shore visual observations were then drawn as polygons over the aerial image using the GPS points to define bed positions and extents. The survey methodology followed the JNCCs marine monitoring handbook<sup>(2)</sup> as far as was possible.

Using the polygons created by the site visit, the eelgrass beds were estimated to be 3.74ha in area and therefore currently represent approximately 3.74% of the total area of Eelgrass in the harbour<sup>(3)</sup>.

When comparing the approximated areas for the two surveys the 2011 data indicated an increase of 12.6%. During 2011, it was noted that the beds were appearing fragmented in nature (i.e. density falling below 50% coverage, qualitatively assessed on site using a 0.5m<sup>2</sup> quadrat). In these instances (plotted as yellow polygons in the map) the Egg Wrack (*Ascophyllum nodosum*) which dominated the near shore eulittoral zone, was encroaching into the normally dense monospecific Eelgrass stands. It was considered that this was likely to be indicative of some form of disturbance already occurring. For the remaining beds density largely exceeded 85% by coverage. The channels present were also covered by Sea Lettuce (*Ulva lactuca*) by approximately 2m on both sides, thus causing a further degree of fragmentation between beds.

**Figure 1.** Extent of eelgrass beds within the zone of influence (Scale 1:4,000) (Published under Agreement 150326/004 from Hampshire Wildlife Trust).



↑ OS map replicated under licence. Licence number 100048821

-  Extent of the Eelgrass in 2008<sup>(1)</sup>
-  Extent of Eelgrass in 2011 (based on field survey data)
-  Extent of fragmented Eelgrass in 2011 (based on field survey data)

The Eelgrass survey carried out during Autumn 2011 exhibited that, although Eelgrass beds were widespread, they were becoming increasingly fragmented over Yachthaven. There was an apparent reduction in the extent compared to that from 2008<sup>(1)\*</sup>. It was suggested that a potential cause of this was associated with boats moored on swinging moorings within the creek. It was proposed that this may have long term negative influences such as encroachment and colonisation from other less ecologically important species such as Sea Lettuce and Brown Algae (*Fucus Sp.*), erosion of soft sediments with the continuous scaring and scraping of the sediments and likely reducing the likelihood of re-colonisation by Eelgrass.

*\* Amy Marsden of Hampshire Wildlife Trust has been consulted to ensure that the most up to date information available is featured within this report. We have been informed that the results above represent the most recent information thus forming the best available baseline for monitoring to take place.*

## 2.2 Potential Impacts

### 2.2.1 Construction Impacts

The proposed pontoon and the new retaining wall on the creek will affect an area of about 267.5m<sup>2</sup> (including boats up to 651.5m<sup>2</sup>) of intertidal habitats will be effected by direct removal or indirect effects such as shading. No dredging is proposed as part of the construction proposals.

The area affected by the pontoon, is dominated by Spiral Wrack (*Fucus spiralis*) with occasional Horned Wrack (*F. ceranoides*) and Knotted Wrack (*Ascophyllum nodosum*), all of which are common in the Solent and around British coasts. However to the east of the pontoon area are some more extensive areas of bare mud, which support beds of Eelgrass in late summer. The pontoon has been positioned away from and north of the Eelgrass beds, as identified by the latest survey, therefore this result in any direct physical damage or non-direct damage such as via shading the habitat.

Although the proposals will result the loss of 267.5m<sup>2</sup> of intertidal habitat, the habitats affected are not considered of high ecological value, and the development avoids direct impacts to any habitats for which the Solent Maritime SAC is designated, in particular the Eelgrass beds and saltmarsh habitats.

The proposals also include the removal of existing sea defences and pontoons which will make additional 650.5m<sup>2</sup> of intertidal habitat suitable for colonization. The potential for the removal of a potential pollution source (the asphalt areas) to improve the quality of the habitat.

### 2.2.2 Operational Damage

The presence of boats moored on the pontoon will provide a further continuous disturbance to estuarine habitats and when moorings are fully utilised will cover an area of approximately 551.5m<sup>2</sup>. Damage to habitats from boat moorings can occur due to swinging anchor chains as the tide rises and falls. However, pontoon moorings offer a significant advantage over the traditional swing-mooring which was previously used within the vicinity, as the pontoon moorings will not move laterally with the tide. Therefore damage will be localised to the pontoon position, unlike with swing-moorings which can cause significant more widespread damage.

Dredging or bottom leveling to maintain access will not be undertaken.

As previously stated the pontoon has been positioned away from and north of the eelgrass beds therefore would not result in any direct physical damage or non-

physical damage by shading the habitat. As all the additional boats using the creek would have a berth at the pontoon there would be no incidental mooring within the creek. The increase in the number of boats using the creek is very small therefore it was considered other potentially damaging impacts, such as the release of pollution and nutrients from boats using the creek, would be negligible.

It was therefore considered there would be no significant impact upon Eelgrass beds or other Annex I habitats within the Solent Maritime SAC, Chichester and Langstone Harbours SPA/Ramsar Site and Chichester Harbour SSSI as a result of operational damage to habitats.

### 2.3 Recommended Protection and Enhancement of Eelgrass Beds

#### 2.3.1 Code of Conduct

Although no significant impacts to the Eelgrass beds were considered likely, in order to raise the awareness of existing and new boat users an '*Eelgrass Code of Conduct*' was recommended (see **Box 1** below). Similar codes are in operation in Studland Bay in Dorset<sup>(4)</sup> and Tor Bay in Devon<sup>(5)</sup>. This contains clauses to prevent anchoring within the creek, speeding through shallows and discharging waste within the creek. As all additional traffic within the creek will be associated with the new dwellings, this code would be much more enforceable than if it applied to general public use and therefore is considered to have a high likelihood of success.

**Box 1.** Code of Conduct.

Proposed Code of Conduct for boat users in Yachthaven Creek to prevent damage to eelgrass. Based on a similar code in Studland Bay, Dorset (see [www.dorsetwildlifetrust.org.uk/support.html](http://www.dorsetwildlifetrust.org.uk/support.html))

1. Do not drop litter within the creek
2. Use fixed moorings to avoid anchoring
3. Do not anchor outside of the navigation channel
4. If you have to anchor, do so on bare mud areas avoiding eelgrass beds
5. Avoid using the boat (sea) toilets within the creek
6. Keep to the speed limit (8 knots) whilst in the creek
7. Avoid grounding on the Eelgrass, but if this happens do not try move the vessel rather allow the tide to lift you.

Existing swing-moorings were causing damage to Eelgrass beds within the creek, potentially leading to increased fragmentation of the beds (see **2.1**). It was proposed that no new licences for swing-moorings were granted by the Chichester Harbour

### **2.3.2 Licence Renewal**

Conservancy and existing licence should be reviewed. This would reduce the overall level of damage from moored boats within the creek and therefore reduce the negative impacts of the development upon Eelgrass beds.

It is recommended that when a leaseholder applies to renew their mooring licence, this is used as an opportunity to encourage adherence with the code of conduct. For example a public awareness advisory leaflet will be issued with the new licence. Within this leaflet the code of conduct should be emphasized along with clear imagery showing the location of the Eelgrass.

### **2.3.3 Marking the Channel**

The pontoon will be located away from Eelgrass beds and therefore no direct impact will occur either from moored yachts or the pontoon itself. There is however considered to be a potential risk from watercraft en route exiting and/or accessing the pontoon and navigating the Yachthaven creek. The possible risk from moving craft may impact sediments and therefore possibly incurring scouring of actual eelgrass beds.

Previous survey work identified that the main navigational central channel within Yachthaven, is void of vegetation. *Fucus Sp.* covers areas 3 meters either side of this channel with the Eelgrass beds located beyond this range within the much shallower areas of the Yachthaven channel. The areas where Eelgrass is located pose a greater risk to yachtsmen running aground and would therefore they are inclined to automatically avoid these areas. In close proximity to the pontoon itself there is less risk of groundage and therefore no natural deterrent. It is therefore recommended that where the boats will gain access to the pontoons, Eelgrass beds will be marked out by marker posts, which will protrude from the water. These will be coloured so that they are clearly visible from onboard the boats. This will prevent boats venturing over the Eelgrass beds.

### 3.0 MONITORING

#### 3.1 The Purpose of Monitoring

Monitoring specific meadows, using scientific sampling methods, can provide the data required to detect and assess environmental changes or impacts to Eelgrass beds and lead to the implementation of mitigation programs to prevent further loss.

#### 3.2 Monitoring Parameters

Eelgrass meadows possess many attributes that can be mapped and monitored to assess changes over time and track ecosystem health. There are many variables that are commonly measured to detect changes in Eelgrass populations. The following are taken from a document produced by Precision Identification Biological Consultants<sup>(6)</sup> and guidelines produced for monitoring Seagrass within the EU<sup>(8)</sup>:

##### 3.2.1 Delineation

The delineation (the exact position of a border or boundary) of Eelgrass beds enables the detection of increases or decreases in area or range over time<sup>(6)</sup>.

##### 3.2.2 Cover

Eelgrass cover describes the fraction of floor covered by Eelgrass and thereby provides a measure of abundance<sup>(8)</sup>.

##### 3.2.3 Depth Distribution

This is the maximum water depth at which the Eelgrass can grow. Depth limits can either be defined as the maximum depth of well-defined meadows or as the depth of the deepest-growing shoots<sup>(8)</sup>.

##### 3.2.4 Shoot Density

This is the number of *Zostera Sp.* plants within an area. It is usually determined as part of the density estimate since it may reflect environmental change or stress<sup>(6)</sup>.

##### 3.2.5 Leaf Area Index (LAI)

Leaf area indices are used to estimate the productivity of Eelgrass and the amount of habitat available for colonization by epifauna<sup>(6)</sup>.

##### 3.2.6 Water Quality

Many Eelgrass monitoring programs incorporate environmental parameters into their study to provide a 'snapshot' of conditions that provide evidence to significant water quality differences<sup>(6)</sup>. Increased activity at Yachthaven has the potential to lead to increased disturbance and/or erosion within the channel. This may result in the increased suspended solids in the water and therefore turbidity of the water. The suspended solids absorb heat from the sunlight, thus raising water temperature, which in turn lowers dissolved oxygen levels. They also prevent sunlight from reaching plants below the surface. This decreases the rate of photosynthesis. The turbidity of water is based on the amount of light scattered by particles in the water

column. The more particles that are present, the more light that will be scattered. As such, turbidity and total suspended solids are related. However, turbidity is not a direct measurement of the total suspended materials in water rather an optical determination of water clarity <sup>(8)</sup>. As the depth limit of Eelgrass is primarily determined by water clarity this is an important factor to monitor.

### **3.3 Monitoring Techniques**

The following methodologies have been taken from the above referenced documents. These are general recommendations on how data can be collected. These will later be adapted to fit the site-specific requirements.

#### **3.3.1 Bed Delineation**

Aerial photography is the most common remote sensing method for mapping studies and for monitoring over time, while satellite data is valued for large-scale investigations. Cost and accuracy varies between satellite and airborne sensors, satellites being the least accurate and least costly. Aerial photos are a low-cost remote sensing technique with reasonable resolution and precision<sup>(9)</sup>.

Alternatively a GPS can be used to georeference the boundaries of the Eelgrass bed. These coordinates can later be used to create a polygon outlining the boundary of the Eelgrass. The boundaries of the bed may be determined using<sup>(6)</sup>:

- an aquaviewer,
- a diver or snorkler with weighted floats,
- a towed underwater camera,
- walking around patches (if possible)<sup>(9)</sup>.

GPS readings should be recorded at roughly 15 metre intervals around the perimeter of the bed<sup>(6)</sup>.

#### **3.3.2 Depth Distribution**

The maximum and minimum depths should be determined when the bed is submerged. One of the preferred methods is to have a weight attached to the end of a metre tape, which is lowered to a diver at the deepest and most shallow edge of the Eelgrass bed. The diver should place the weight on the bottom and then tug three times to notify the assistant on the boat that the line is in place. The assistant checks to make sure that the line is taught and vertical then records the measurement<sup>(6)</sup>.

Another method, again with the aid of a diver, involves swimming along the lower limit of the meadow perpendicularly to the depth gradient and record depth limits at several points. The diver records the depth limit using a high-precision depth recorder<sup>(9)</sup>.

The water depth at the time of observation is subsequently corrected to average water levels, for example using a locally calibrated tidal table <sup>(6,8)</sup>. These methods should be carried out in the growth season and preferably at the same time of the year in multi-year comparisons <sup>(9)</sup>.

Depth limits can be estimated with relatively high precision if good depth sensors are used and if water depth is corrected depending on the tidal level at the sampling time. An advantage of these methods is that they are non-destructive and allow repeated measurements at the same location <sup>(9)</sup>.

### **3.3.3 Shoot Density, Cover and LAI**

As shoot density and cover are depth dependent, any measure of must be related to water depth <sup>(8)</sup>. As Seagrass abundance changes markedly on an annual basis, it is important for all indicators of abundance that comparisons between years are based on samplings performed at the same time of year for example in August where biomass usually attains its annual maximum.

#### **3.3.3.1 Shoot Density**

A temporary transect using a metre tape or marked line should be established in each zone, roughly parallel to the shore, along a depth continuum. The length of each transect should be roughly 60% of the bed width. The transects should be centred in the bed to avoid edge effects <sup>(6)</sup>.

Predetermined random numbers should be established along either side of the transect where quadrats should be placed <sup>(6)</sup>. A fixed number of 0.25m<sup>2</sup> (50cm x 50cm) quadrats should be used. It will be necessary to determine the number of replicates (quadrats) that are required to estimate the mean density of shoots on a site specific basis due to the natural variability within Eelgrass communities. The accepted method by which to accomplish this is to plot the running mean. Sample size is adequate once the variation between samples, which decreases as the number of samples increases, is reduced to 5%. It is likely that the number of replicates required will be less, however this number of samples should be sufficient to determine the running mean <sup>(6)</sup>.

The total number of shoots rooted in each quadrat should be recorded, along with the total number of reproductive shoots in each quadrat. The number of vegetative shoots is calculated by subtracting the number of reproductive shoots from the total number of shoots.

#### **3.3.3.2 Cover**

The percentage cover can be either coarsely defined as a corridor through which a diver swims and estimates visually the fraction of the bottom area covered by Seagrass or be more precisely by the use of quadrats of a given size.

Visual estimates of percent cover provide a simple, although rather coarse, non-destructive way of quantifying Seagrass abundance. Cover estimates can be sensitive to observer bias as they are based on visual observation. If the surveyor has no previous experience, it is important to ensure they are properly trained. Quadrats reduce subjectivity as they provide a quantitative approach to calculating the percentage as each square represents a fixed percentage.

#### **3.3.3.3 LAI**

The mean leaf length and width can be determined from a random sample of shoots. This will correspond with the number of quadrats used. The data may be collected at the same time as the density is assessed. In order to avoid sampling only the largest shoots, the shoot located nearest to the upper right corner and the lower left corner of the quadrat should be measured. The leaf length from sheath to tip of the second oldest leaf and the width near the middle of the leaf should be measured<sup>(6)</sup>.

Calculate the LAI according to the following formula:

$$\text{mean shoot length} \times \text{mean shoot width} \times \text{mean density of shoot /m}$$

#### **3.3.4 Water Quality**

##### **3.3.4.1 Turbidity**

A secchi depth reading is recommended to assess turbidity.

##### **3.3.4.2 Salinity**

A salinometer should be used to determine salinity, in parts per thousand (ppt).

##### **3.3.4.3 Total Suspended Solids**

Water samples should be collected and taken to a local laboratory for analysis. The laboratory will provide a specific protocol for collecting and storing the samples.

#### **3.4 Widely Used Techniques**

The most widely used parameters to ascertain Seagrass abundance and detect changes are the Cover and Shoot Density of Seagrass meadows. Similarly direct observations of the distribution of the meadows along transects are used in many monitoring programmes and have proven to be effective in detecting declines<sup>(6)</sup>.

The health of Eelgrass meadows is linked to the health of the wider marine environment. For this reason programmes combine monitoring with the monitoring of water quality. This environmental quality information can help ascertain the causes of trends detected on Seagrass meadows, thereby facilitating action. Among the environmental properties monitored, water transparency, measured with the secchi disc, provides the most integrative, robust and yet simple indication of water quality.

### 3.5 Key Points to Consider

- The selection between different monitoring options is dependent on the structure and resources available for example cumbersome methods are not practical for volunteer-based monitoring networks<sup>(7)</sup>.
- Methodologies involving the use of a motorised boat are not feasible due to the shallow nature of the creek and will therefore result in additional negative impacts. This does however provide the opportunity to access areas via foot. In order to measure water depth, un-motorised transport will be used, for example an inflatable or kayak.
- The variable of 'Biomass', although considered to be a precise measure of Seagrass abundance, has not been considered within this document due to its destructive and costly nature. It was also considered that it was not possible to adapt the techniques involved in biomass sampling.
- Although the methodology in '**3.3.3 Shoot Density, Cover and LAI**' states the transects should be centred in the bed to avoid edge effects this strategy wants to look at the edges in order to identified impacts. Therefore this methodology will be adapted to incorporate all areas of Eelgrass.

## **4.0 RECOMMENDED MONITORING**

### **4.1 Bed Delineation**

Finer scale mapping using GPS is very accurate<sup>(8)</sup>. Surveyors will walk around the edge of the Eelgrass patches, at regular intervals their position will be noted with the use of a handheld GPS device.

### **4.2 Depth Distribution**

The two methods described for Depth Distribution (**Section 3.3.2**) are highly costly and due to the shallow nature of the site are not feasible. As the depth limit of Eelgrass is primarily determined by water clarity<sup>(9)</sup> a more cost effective way to measure this variable would be to use a secchi disk. A visual assessment will take place at low tide in order to establish where the most shallow and deepest points are located. Again, these will be marked using GPS so that once high tide occurs the boat can be used to access the points and the secchi disc can be utilised.

### **4.3 Shoot Density, Cover and Leaf Area Index**

Temporary transects will be established in each zone, roughly parallel to the shore, along the depth continuum. The length of each transect will be roughly 60% of the bed width<sup>(6)</sup>. Predetermined random numbers should be established along either side of the transect where quadrats should be placed<sup>(6)</sup>. Ten 0.25m<sup>2</sup> (50cm x 50cm) quadrats will be placed within each zone. The location of each quadrat will be recorded via GPS.

These quadrats will be accessed via foot during low tide. As shoot density and cover are depth dependent, at each point the depth of the water will be recorded. This will be taken separately at high tide.

### **4.4 Bed Fracturing**

The extent of the bed may not change but the bed may break up internally leading to increased patchiness. This will be monitored via the use of an aerial drone. This will fly over the extent of the Eelgrass taking photos that can then be used to compare annually. A grid will be overlaid on the imagery so that the percentage of fracturing can be calculated resulting in a comparable numeric value.

### **4.5 Water Quality**

Turbidity measurements will be taken during Depth Distribution monitoring. If it becomes apparent that Eelgrass is being impacted/declining around Yachthaven further assessment of the water quality will have to take place to try and determine the cause. For example a sample can be taken and sent to a local laboratory for analysis. These techniques will be used in conjunction with the Environment Agencies monitoring with regard to the Water Framework Directive.

#### **4.6 Timing**

Cover and density estimates are highly seasonal for Eelgrass. Therefore monitoring should take place at the same time each year. To avoid any natural deterioration in the condition of the *Zostera* biomass, monitoring in August (2015 – 2020) is recommended.

#### **4.7 Personnel**

It is yet to be confirmed whom will be carrying out the required monitoring work. Therefore the techniques recommended have been presented with the knowledge that volunteers could potentially be carrying out tasks. Therefore they do not require a certain skill set and are not too technically challenging. It is however important that if this is the case, all personnel carrying out works are appropriately trained by someone with prior experience.

The information attained from the on going surveys will be passed on to the Local Planning Authority, Natural England, Hampshire Wildlife Trust and Chichester Harbour Conservancy. It will also inform the Yachthaven Management Company. There will be liaison between the surveyors and the management company so that any detrimental effects are identified quickly with subsequent mitigation measures put in place.

#### **5.0 THRESHOLDS**

A decrease in the extent of Eelgrass cover of >20% would trigger management intervention. Similarly if the Eelgrass cover within the quadrats decreases, on average by >25%, management will be implemented. This will be in line with the monitoring of bed fracturing. If, using the grid method outlined above, bed fracturing increases above 25% then management will be implemented.

## 6.0 SCHEDULE OF MONITORING

**Table 1** below depicts when the monitoring will take place. August/September is when Eelgrass biomass usually attains its annual maximum but to allow for natural deterioration monitoring will be focused within August.

**Table 1.** Timing of Monitoring.

|                    | 2015   | 2016   | 2017   | 2018   | 2019   | 2020   |
|--------------------|--------|--------|--------|--------|--------|--------|
|                    | August | August | August | August | August | August |
| Bed Delineation    |        |        |        |        |        |        |
| Bed Fracturing     |        |        |        |        |        |        |
| Depth Distribution |        |        |        |        |        |        |
| Shoot Density      |        |        |        |        |        |        |
| Cover              |        |        |        |        |        |        |
| Leaf Area Index    |        |        |        |        |        |        |
| Water Quality      |        |        |        |        |        |        |

## 7.0 RESTORATION OF EELGRASS BEDS

Within the Inventory of eelgrass beds in Hampshire and the Isle of Wight Marsden and Chesworth (2014)<sup>(10)</sup> give four broad options for restoration:

### 7.1 Seeding

Seeds can be collected by taking reproductive shoots from natural beds. This method has the advantage that seeds can be sown relatively quickly and cheaply over large areas. The disadvantages are that it can take a long time to gather the seeds and currents and bioturbation can transport the seeds outside of favourable germination areas. Seeds should be put into fine mesh bags which are fixed to the seabed, preventing seeds from being removed.

### 7.2 Transplanting seagrass shoots with sediment intact

Transplanting cores or plugs involves taking cores using PVC pipes, metal cans and spades. It has the advantage that well developed roots and rhizomes can be transplanted along with the natural sediment nutrient pool. However, it creates holes in the donor bed that can lead to erosion and significant damage

### 7.3 Transplant shoots with bare roots

The bare root method involves removing seagrass shoots along with a small length of rhizome from a donor site and planting it at the transplantation site.

Transplantation can be achieved relatively easily at low tide, and laboratory experiments suggest germination can occur at a high rate but subsequent survival is poor.

#### 7.4 Improve habitat conditions

In conjunction with transplantation, efforts should be put into protecting the *Zostera* beds and improving the habitat to make it more suitable for natural recolonisation. This may mean improving water quality and preventing physical disturbance. A viable, yet time consuming method to determine the cause behind degradation in water quality and increased physical disturbance would be for personnel to monitor yacht activity in and around Yachthaven. This way they can check if it is certain individuals that are resulting in the negative changes, if so these individuals can be approached.

#### 8.0 CONCLUSION

This monitoring survey strategy has identified the techniques normally implemented to monitor Eelgrass. It has suggested ways they can be adapted to this site. It is considered that if these techniques are implemented over the long time, at the stated time of year and follow the guidance provided assessment of changes of Eelgrass distribution and occurrence of damage within Yachthaven will be able to be assessed. Continual monitoring will be to inform and enable mitigation measures if indeed detrimental affects are recorded associated with the Yachthaven development.

#### 9.0 REFERENCES

1. Dale, A.L., Chesworth, J.C. and Leggett, V.L. (2010) '*Inventory of Eelgrass beds in Hampshire and the Isle of Wight, Section Two: Data*' Hampshire and Isle of Wight Wildlife Trust, Curdridge.
2. Davies, J., Baxter, J., Bradley, M., Connor, D., Khan, J., Murray, E., Sanderson, W., Turnbull, C. and Vincent, M. (2001) '*Marine monitoring handbook, mudflats. JNCC UK marine SACs project*'. JNCC, Peterborough.
3. Roswell, E. (2011) '*Chichester harbor wildlife and ecology report 2010 – 2011*'. Chichester Harbour Conservancy, Chichester.
4. Dorset Wildlife Trust (2014) Available online:  
[www.dorsetwildlifetrust.org.uk/support.html](http://www.dorsetwildlifetrust.org.uk/support.html)
5. Torbay Coast and Countryside Trust (undated) '*Torbay's Seagrass Beds – A Hidden World*'. Torbay Coast and Countryside Trust, Goodrington.

6. Precision Identification Biological Consultants (2002) 'Field Methods for Mapping and Monitoring Eelgrass Habitat in British Columbia ' Available online at: <http://www.cmNBC.ca/sites/default/files/Methods%20for%20Mapping%20and%20Monitoring%20Eelgrass%20Habitat%20in%20British%20Columbia,%202002.pdf>
7. Duarte, C.M., Alvarez, E., Grau, A. and Krause-Jensen, D. (2004) Chapter 7 'European seagrasses: an introduction to monitoring and management' Eds J Borum, J., Duarte C.M., Krause-Jensen D. and Greve T.M.
8. Kemker, Christine (2014) "Turbidity, Total Suspended Solids and Water Clarity." Fundamentals of Environmental Measurements. Fondriest Environmental, Available online at: <http://www.fondriest.com/environmental-measurements/parameters/water-quality/turbidity-total-suspended-solids-water-clarity/>
9. Duarte, C.M. (2004) Chapter 7 'European seagrasses: an introduction to monitoring and management' Eds J Borum, J., Duarte C.M., Krause-Jensen D. and Greve T.M.
10. Marsden, A. L. and Chesworth, J. C. (2014) 'Inventory of eelgrass beds in Hampshire and the Isle of Wight', Section One: Report. Hampshire and Isle of Wight Wildlife Trust, Hampshire.