Pen Llŷn a'r Sarnau (PLAS) SAC.
Management of the seagrass bed at Porth Dinllaen
Initial investigation into the use of alternative mooring systems

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1 Executive Summary

This report details a review for Gwynedd Council, with support from The National Trust and the Countryside Council for Wales (CCW), upon the mooring and anchoring regime at Porth Dinllaen and the effects of these upon seagrass bed. Boat moorings here have been noted to cause fragmentation of the seagrass bed here affecting the integrity of the Pen Llŷn a'r Sarnau Special Area of Conservation (SAC).

The seagrass bed at Porth Dinllaen is one of the largest seagrass beds in North Wales. It is part of the special biological interest of the Porth Dinllaen to Porth Pistyll Site of Special Scientific Interest and the Pen Llŷn a'r Sarnau marine Special Area of Conservation. This report examines the current situation and past trends in mooring and anchoring activity at Porth Dinllaen and the impact of this activity on the seagrass bed in the bay. The report also examines the current management regime for the harbour and moorings and identifies possible options for alternative moorings and approaches to reduce the impact of mooring and anchoring on the seagrass. The findings of recent biological surveys of the seagrass bed are explained.

The Crown Estate owns the seabed in Porth Dinllaen, as with most of the UK seabed, whilst the National Trust leases the area from The Crown Estate. The National Trust is the Harbour Authority in the area and is therefore responsible for the management of the moorings. However, according to The Crown Estate, the Harbour Authority has no proprietary ownership or rights over moorings, and if new moorings were to be put in place, then The Crown Estate would have to be consulted.

Intertidal and subtidal surveys of the seagrass bed at Porth Dinllaen have been undertaken and provide an estimate of the extent of the seagrass bed on the seashore and underwater. The estimated area of the seagrass bed is 286,350m^2. Underwater surveys in 2008 and 2009 examined the effect of the current moorings on the seagrass bed and found on average a scour area of 10m radius per mooring with an estimated overall impact of 12,560m$^{2.}$ This corresponds to around a 4.5% direct loss of the bed, however the as these individual scars actually have a greater impact than this as in combination they lead to significant fragmentation of the main seagrass bed.

A number of different ecofriendly mooring systems are marketed globally. In the UK the following models are currently in use; Seaflex in Lundy (and previously in Mylor), Eco-mooring Rode in Studland Bay and Hazelett in The Isle of Man. Various other models are used around the World. All of these options for ecofriendly moorings are examined and the different models of mooring are compared in terms of the costs involved with each system and their differing suitability for Porth Dinllaen. From these comparisons it is suggested that the 'Eco-mooring Rode' system in combination with a 'Helix' anchor is likely to be the most suitable. The major difficulty with many of the systems is the large tidal range (~6m) experienced in Porth Dinllaen as they have been designed for areas with smaller tides such as in the USA and Australia.

Best practice for the management of seagrass beds is investigated and case studies are used to show how conflicts, which have arisen in other parts of the UK, can be minimised in Porth Dinllaen. These case studies of past approaches to management of seagrass beds show that the most common conflicts that have arisen in other locations have been due to lake of stakeholder engagement. There are a number of different management approaches that have been taken to establish positive management to safeguard seagrass beds whilst at the same time enabling use of the areas by boat owners and others. The advantages and disadvantages of the different options are discussed. From this analysis it is suggested that;

- A trial of the different suitable systems alongside a voluntary no anchoring zone, in a small area of the bed should be conducted.

- Prior to a trial it is recommended that surveys are undertaken to establish the best locations for any zoning.

- Furthermore it would be vitally important to hold a stakeholder meeting in order to involve the local community and regular visitors/boaters and regard their suggestions on the idea and the placement of any zoning. Such a meeting would also explain the importance of the seagrass bed and why the project is being planned.

The unique management regime in Porth Dinllaen with The National Trust as the Harbour Authority facilitates the opportunity of conducting such trials. Ultimately the trials would not only benefit the seagrass bed at Porth Dinllaen, but potentially all seagrass beds in the UK if the technology is proven to be successful here and permanent ecofriendly moorings implemented.

2 Introduction

Seagrasses are the only truly marine flowering plants in the UK. Three species occur in UK waters: *Zostera marina,* common seagrass or eelgrass; *Z. noltii*, dwarf eelgrass and *Z. angustifolia*, narrow leafed seagrass. It is possible that *Z. angustifolia* is a variety of *Z. marina* rather than a distinct species (Davidson and Hughes, 1998). Seagrass beds are noted as being important marine habitats for a number of reasons. They are known to help stabilise the seabed sediments in addition to providing organic matter, shelter and food for a variety of fish, birds and invertebrates (McKeone, 2005). Seagrass beds are vital nursery grounds for flatfish, and in some areas also for cephalopods (McKeone, 2005). On a global scale they are also known to be significant sinks for carbon dioxide. Due to these reasons it has been estimated that the global value of all ecosystem services provided by seagrass beds is US$3.8 trillion $\cdot yr^{-1}$ (Costanza *et al*., 1997). Further, seagrass beds are strong indicators of anthropogenic disturbance and water quality and for this reason metrics are being developed for monitoring under the Water framework Directive (WFD) (Environment Agency, 2000) (Foden, 2006). Seagrass beds have been designated as a UK Biodiversity Action Plan Habitat (underpinned by the Convention of Biological Diversity, Rio Earth Summit 1992), and as a Habitat of Principal Importance for the Conservation of Biological Diversity in Wales (NERC Act 2006: Section 42). In many areas of the UK seagrass beds (intertidally and subtidally) form part of the special interest of designated conservation areas. The seagrass bed here is part of the special biological interest of the Porth Dinllaen to Porth Pistyll Site of Special Scientific Interest (SSSI) (designated under the Wildlife and Countryside Act 1981 (amended 1985)) and the Pen Llŷn a'r Sarnau marine Special Area of Conservation (SAC) (designated under the EC Habitats Directive). Further, Seagrass is a conservation objective of the intertidal mudflats and sandflats of the SAC.

Seagrass beds only occur in relatively clear and sheltered waters and therefore are only found at a few locations in the UK. The distribution of subtidal seagrass beds in the UK is limited by turbid waters which reduces the penetration of sunlight, a requirement for photosynthesis. Sheltered areas such as Porth Dinllaen that are suitable for the development of seagrass beds are also areas that provide a safe haven for boats and a favourable area for the anchoring and mooring of vessels. This can lead to some conflict between boating activity and conservation of seagrass as research has shown that vessel anchoring and conventional moorings often damages seagrass beds e.g. Collins, *et al.* 2010, Montefalcone *et al*. 2008, Milazzo *et al*, 2004, Francour *et al.* 1999, Walker *et al*. 1989. The problem is due to the design of traditional moorings whereby the chain, which attaches the surface buoy to the seabed, swings on its central pivot abrading the seagrass or

any other habitat within this area(see Figure 1, below). Damage to the seagrass can also occur when the main anchoring blocks and chains are renewed or raised and lowered when inspected.

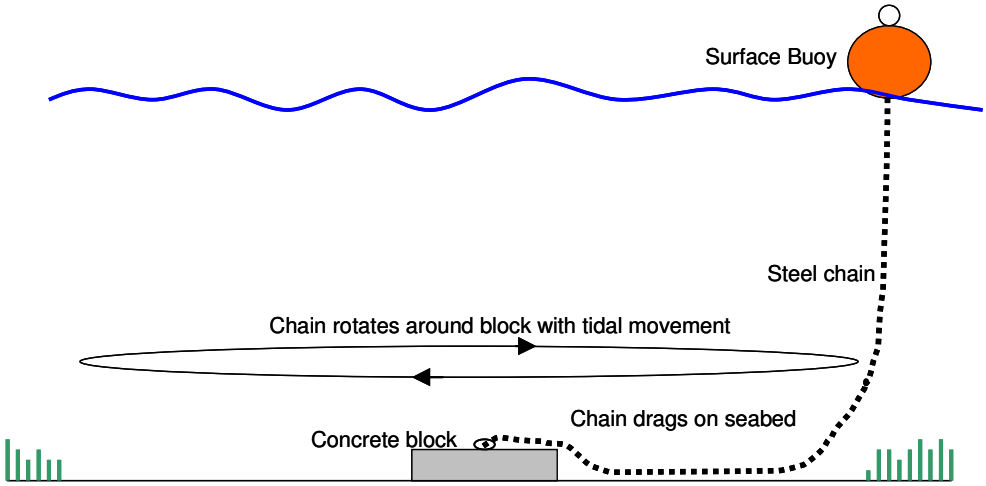

Figure 1. Diagram showing the design of standard mooring systems and how they impact the seabed.

Anchoring of vessels is also known to cause damage to seagrass beds, when the anchor drags through the seagrass bed. Additional damage is caused, as with permanent moorings, when the anchor chain or rope abrades the seabed as the boat swings with the tide (Francour *et al*, 1999). The amount of damage caused to a bed depends on the type of anchor that is used (Milazzo *et al*, 2004). Fixed moorings aim to minimise impact by anchoring to the seabed by limiting habitat damage to a fixed area. Conversely, anchors thrown from individual boats may not have the same length of anchor chain, or duration of scarring, but they will potentially be thrown repeatedly and frequently, damaging multiple small areas of sensitive habitat with lasting effects (Montefalcone *et al*, 2008).

2.1 The Porth Dinllaen Seagrass Bed

The seagrass bed at Porth Dinllaen is one of the largest seagrass beds in North Wales. It is part of the special biological interest of the Porth Dinllaen i Borth Pistyll Site of Special Scientific Interest and the Pen Llŷn a'r Sarnau marine Special Area of Conservation. As part of the Welsh Assembly Government's targets to halt the rate of habitat loss and bring designated conservation sites into favourable management, action to safeguard the seagrass bed at Porth Dinllaen and reduce the likelihood of impact from mooring and anchoring has been identified as one of the key management actions for the SSSI and SAC.

A subtidal survey of seagrass beds around the Welsh coast in 2003, found that although Porth Dinllaen was the densest bed, with greater biomass per square metre than the other sites, it was noted that the seagrass occurred in dense patches, surrounded by bare areas. Such bare patches were identified as likely to be a result of anchoring and the presence of traditional fixed moorings. (Edwards *et al*, 2003). Intertidal surveys in 2004, 2005 (Boyes *et al*. 2008) and 2010 (Mercer, T.S. (In Prep)) and underwater diver surveys in 2008 and 2009 (Morris *et al*, 2008 and 2009) have helped to confirm the extent of the seagrass bed and identify and quantify the likely scale of impact of moorings. The findings of the surveys are detailed in Section 4 of this report. The impact of moorings on the seagrass bed can clearly be seen in the aerial image of Porth Dinllaen shown in Figure 2 below – the areas where moorings have caused scoured areas within the bed can be seen as bare circular scars around boat moorings. The impact of the moorings has been estimated to be 12,560m^2 (1.256 hectares) (Morris and Goudge, 2008). Figure 3 shows an underwater image of the scoured area caused by a mooring.

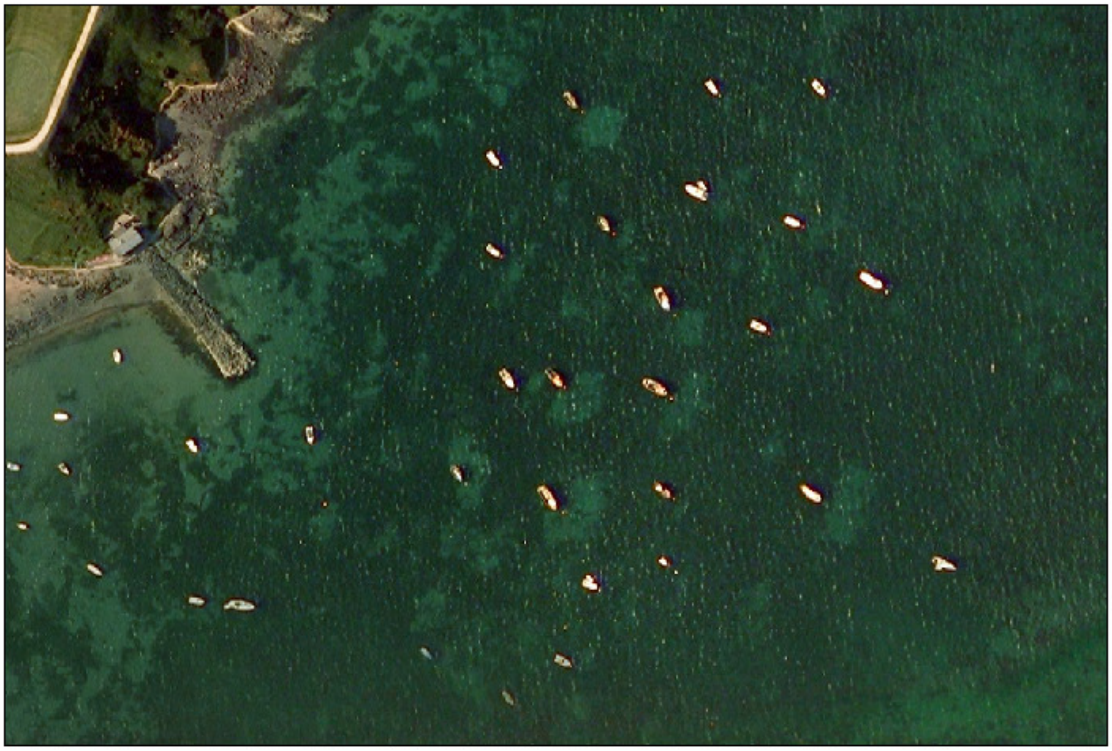

Figure 2. Circular scars visible around traditional fixed moorings in an aerial image of Porth Dinllaen. © This orthophotography has been produced by COWI A/S from digital photography captured by them in 2006. Licensed by the Welsh Assembly Government's Department for Environment.

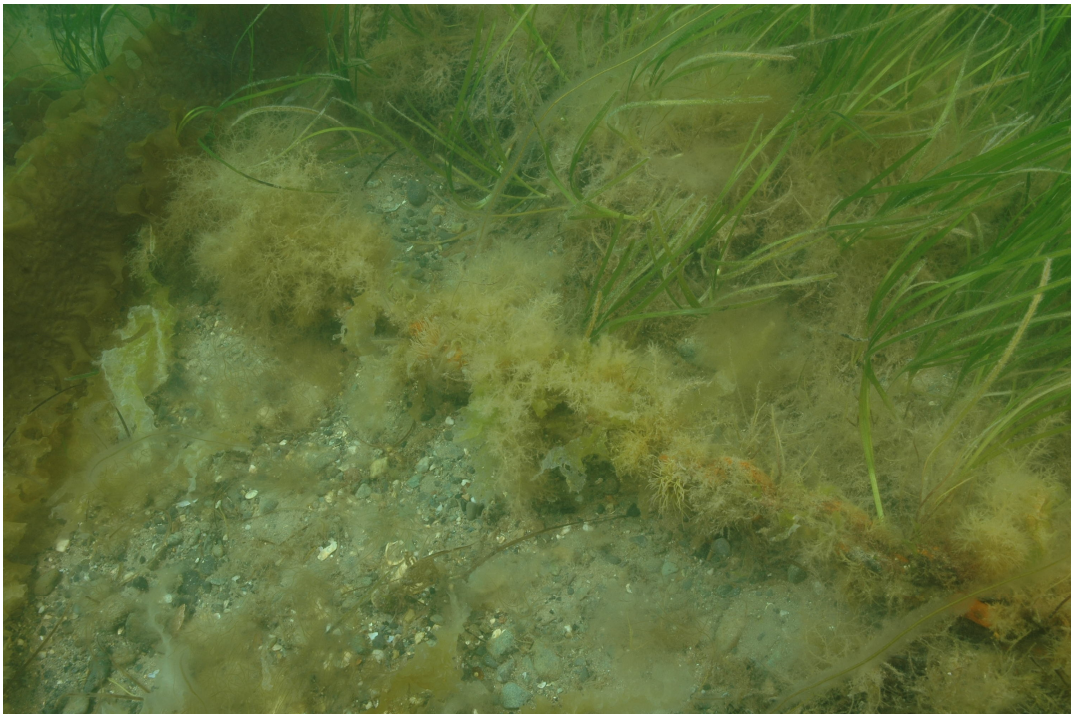

Figure 3. Scour impact to the Porth Dinllaen seagrass bed by a mooring chain. Image: R. Holt CCW.

3 Chapter 1.

3.1 Past and present trends in mooring activity in the inner and outer harbour of Porth Dinllaen.

Historical aerial photographs of Porth Dinllaen were obtained from the Welsh Assembly Government for this project. The images (see Figure 4, below) are from 3rd May 1946, 16 July 1972, 9th August 1977 and 8th May 1991. Minimal vessels can be seen in 1946 (not surprisingly), however in the images from the 1970's many vessels can be seen in the area although it is not possible to tell if they are at anchor or attached to moorings. The 1991 image shows fewer vessels in the area than in the 1970's images, although this may be due to this photograph being taken in May rather than later in the summer. In the images where the vessels are seen there seems to be a similar use of the inner and outer harbour areas as there is currently. The images also give an idea of the extent of the seagrass bed. This suggests that the bed currently is relatively large in its extent; however it is very difficult to be certain about this due to the absence of historic groundtruthing.

Generally, recreational boating is increasing in Wales and this trend is set to continue (University of Brighton, G & L Hughes Ltd. and exeGesIS SDM Ltd. 2008). There is an increase in vessels mooring and visiting all the ports on Llŷn including Porth Dinllaen (P. Lewis pers comm. March 2011). The use of vessels at Porth Dinllaen changes markedly with the seasons and the number peaks with the summer holiday season. The number of visitors to the Porth Dinllaen National Trust car park during the main season from May to the end of August is approximately 22,000, showing the popularity of the area. In the winter months the main use of the area is by the local fishing community. There where 10 licensed fishermen working from this beach approximately 5 years ago, this has reduced to the present figure of 7-8 vessels (P. Lewis, pers comm. 2011).

Modification of the extent and quality of the seagrass bed has been recorded at Porth Dinllaen due to trampling, use of vehicles on the beach and boat moorings. The degree of impact varies seasonally, with greatest use of the beach area where the eelgrass extends into the intertidal in the summer (CCW 2009). There is only limited launching of vessels in the area from The National Trust slipway and this is mainly used by the small local fishing community (Figure 5 below). Access is to the slipway limited through a swipe card system. The launching of vessels and the use of tractors on the beach has however been noted to cause damage to the intertidal seagrass bed (Boyes *et al*, 2008). The usual technique is to drag the boat to the water combining the detrimental effect of the tractor wheels and the vessel hull. Occasionally, especially during summer months, people have been observed dragging small boats up the beach by hand. This too will have an impact on the intertidal seagrass.

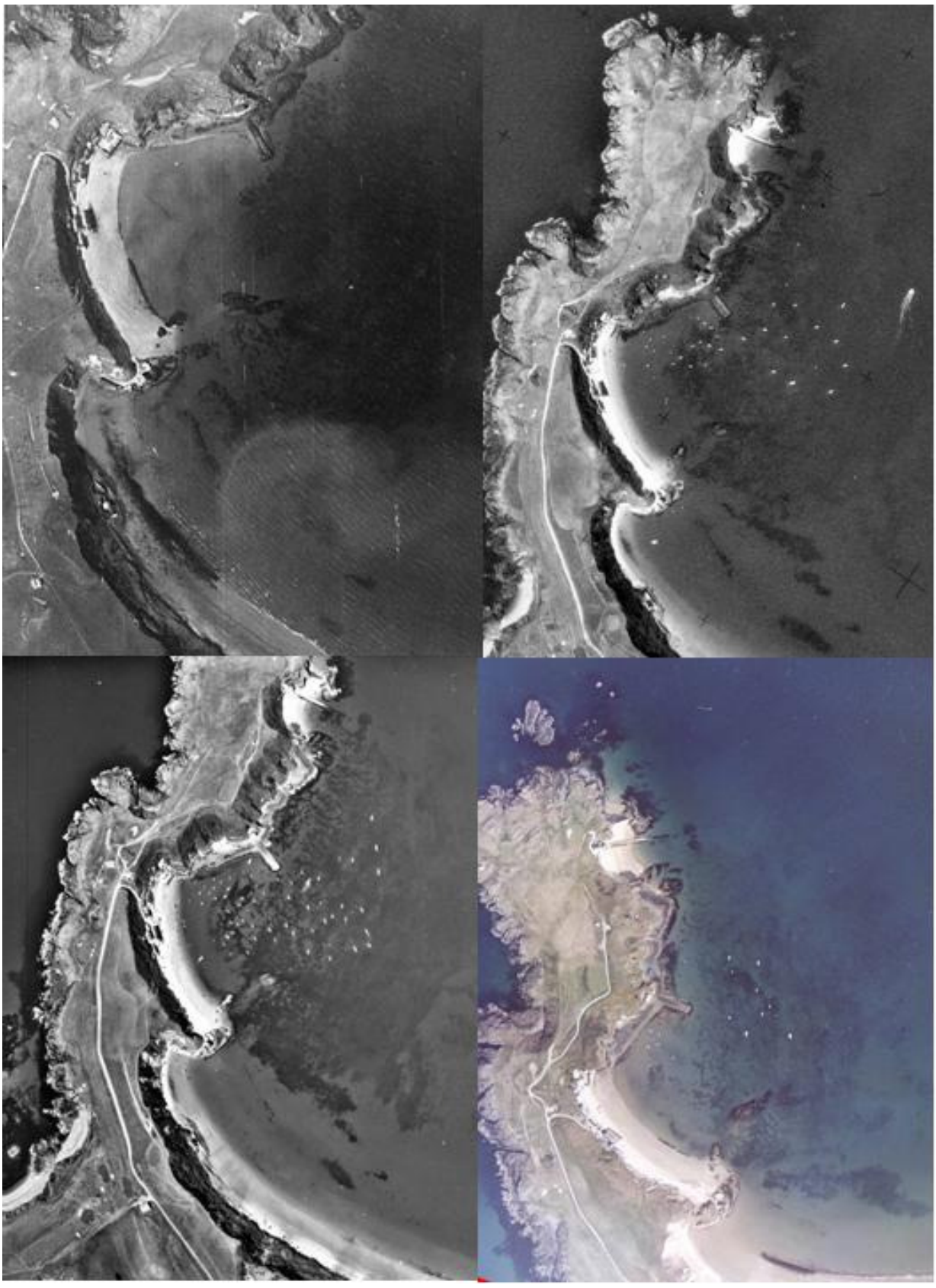

Figure 4. Historic aerial photographs of Porth Dinllaen. Top left 3rd May 1946 RAF, Top right 16th July 1972 ©Ordnance Survey, Bottom left 9th August 1977 ©Fugro-BKS, Bottom right 8th May 1991 ©ADAS. All images supplied by Welsh Assembly Government.

Figure 5. Local fishermen loading the catch of dog whelk on to a tractor on the beach at Porth Dinllaen. Image: J. Egerton

In 2008 there were approximately 40 shallow moorings within the inner harbour area (Morris and Goudge, 2008) (see Figure 6 for location of inner harbour area). There are now currently approximately 50 moorings in the shallow inner harbour area that are under the authority of The National Trust who decided to limit them to this number. There is a good demand for these with around 35 in use in winter to all 50 in use during the summer season. There is a fee for using the moorings which is charged on a weekly, monthly or seasonal basis. The moorings consist of 6 heavy duty chains ranging from 18 to 25 meters in length that are anchored at both ends with 2 further anchors set in the middle, the chains are laid out flat on the sea bed and have ropes and buoys attached. There are also some single moorings that are attached to a large concrete block that is buried in the sand (P. Lewis, pers comm. March 2011). There are around 40 moorings in the outer harbour. These moorings are installed by a contractor at cost of private vessel owners and are unregulated (see Section 3.2, below). The outer moorings typically comprise a surface marker buoy with variable length of rope and a 10m anchor chain, attached to fixed cement blocks on the seabed (dubbed 'dump & chain' or 'swing' moorings) (Morris and Goudge, 2008).

The vessels that are moored on the shallow water moorings are a combination of tender boats for the deep water moorings, including those for fishermen and pleasure craft. The deep water moorings in the outer harbour are used by a combination of local fishing vessels and visiting vessels, normally yachts of 7meters or more in length (P. Lewis, pers comm. March 2011).

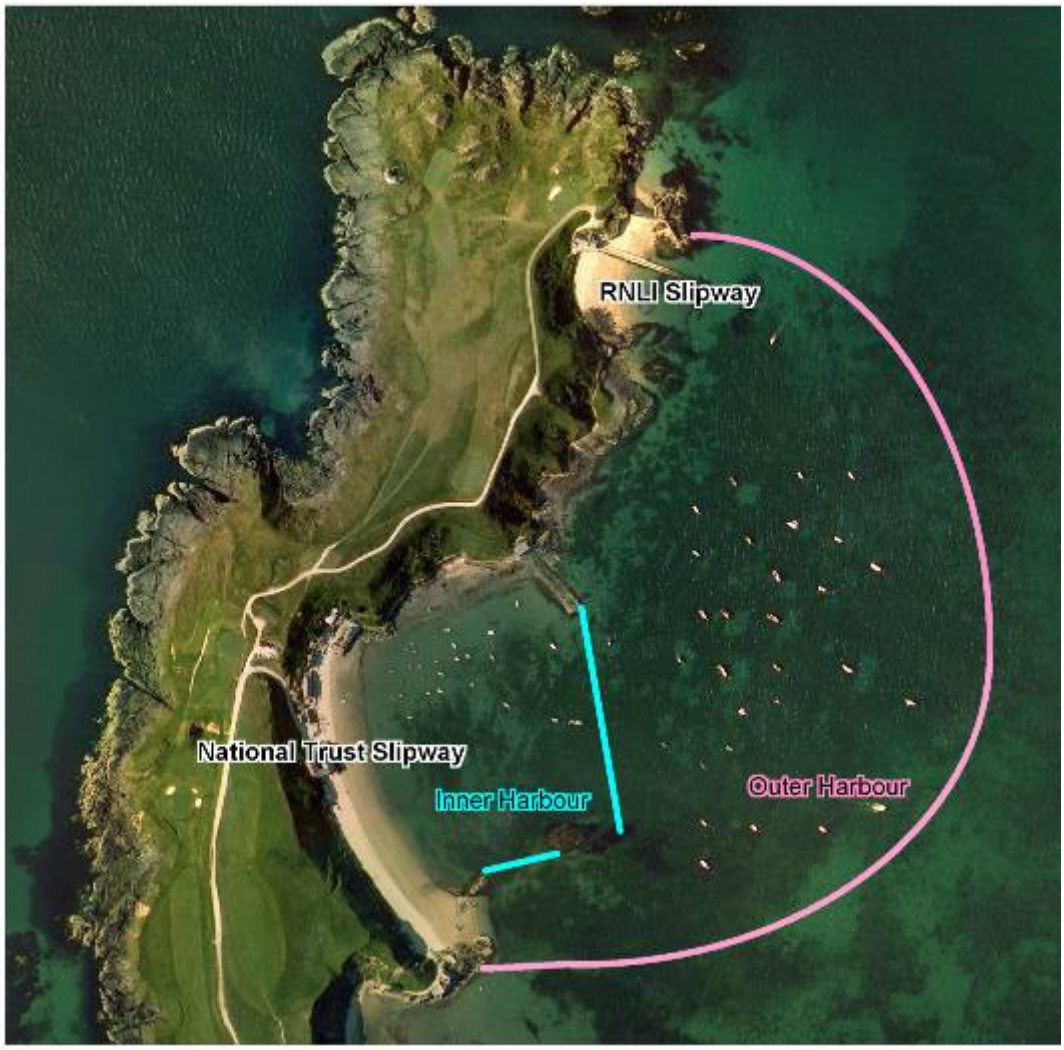

Figure 6. The different harbour areas of Porth Dinllaen (N.B. The boundaries are estimated). ©This orthophotography has been produced by COWI A/S from digital photography captured by them in 2006. Licensed by the Welsh Assembly Government's Department for Environment.

The image shown in Figure 7 below was taken on the 29th January 2011. Due to the season there weren't many vessels in the area and those seen were local fishermen. The photograph only shows a section of the inner and outer harbour and the moorings are circled. In this area there were 56 mooring buoys present which demonstrates the scale of the current mooring activity.

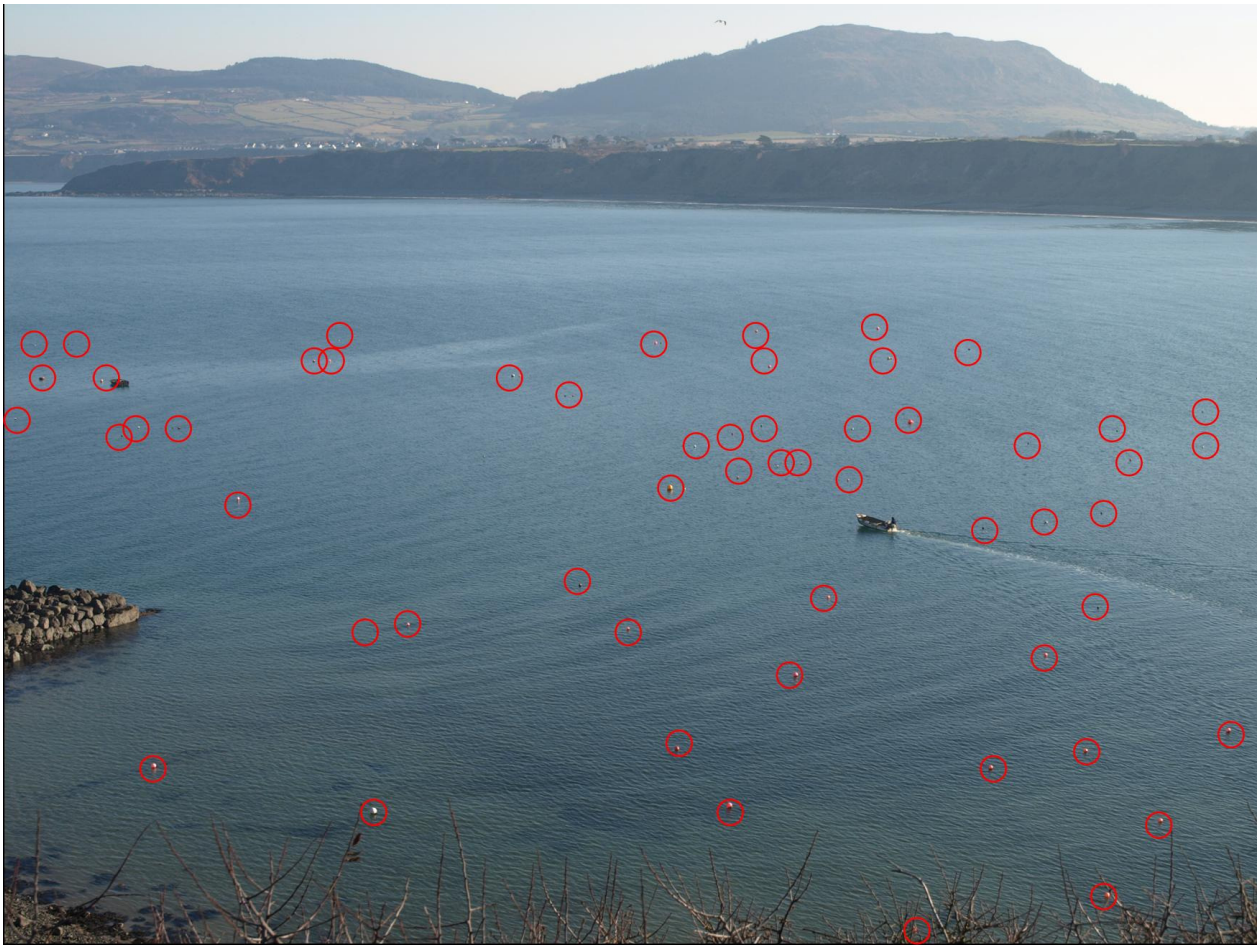

Figure 7. Mooring buoys in an area of the Porth Dinllaen inner and outer harbours. Image: J. Egerton.

There are also three large permanent moorings outside the RNLI life boat station to the north of Porth Dinllaen (Figure 8). The seagrass under one of these was examined in the 2008 volunteer surveys and it was found to have relatively little scarring (Morris and Goudge, 2008). If so, the design of this permanent mooring might want further investigation.

Figure 8. The RNLI slipway and the three associated RNLI buoys. Image: J. Egerton

3.2 The roles of different agencies in managing the moorings.

The Crown Estate owns the seabed in Porth Dinllaen, as with the rest of the UK seabed, whilst Gwynedd Council and the National Trust have rights to the foreshore. Generally, The Crown Estate leases the area of seabed that is within that Harbour Authority' control to the local Harbour Authority, and this includes authority to manage any moorings. The National Trust took on the responsibilities of the Harbour Authority when the area was purchased in 1994 therefore they are responsible for the management of the moorings. However according to The Crown Estate, the Harbour Authority (The National Trust) have no 'proprietary ownership' or rights over the moorings, and if new moorings were to be put in place, then The Crown Estate would have to be consulted (C. Green, pers. comm. February 2011). The moorings therefore are managed by The National Trust, but The Crown Estate retains ultimate ownership and rights over them.

The National Trust have jurisdiction over the moorings of the inner harbour (shown in Figure 6), whereas there is more of a 'free for all' situation in the outer harbour (also shown in Figure 6).
Until recently, a section of the intertidal zone and shallow sublittoral moorings at Porth Dinllaen (in the inner harbour area were managed by the National Trust Harbour Master – Griff Williams. This role is likely to be passed to The National Trust post of Llŷn Coastal Ranger for the area.

The 'free for all' in the outer harbour area is a situation that is complicated to manage. The 'deepwater' moorings are installed by a contractor from Barmouth who receives payment from the boat owners for this service, however there is no official ownership of these moorings as this is retained by the Crown Estate. That said, it is likely that the vessel owners (or other persons) who have paid for moorings to be installed will believe that they do own these moorings. This was the situation recently in Studland bay. There the moorings were officially illegal as no permissions were given by The Crown Estate for their installation and there is no local Harbour Authority. There was recently an amnesty to see who believed that they owned them. Around 50 individuals claimed to own them although there are only around 30 moorings. The Crown Estate *could* take the owners to court about the moorings but have decided that it would be too costly so the moorings remain (K. Collins pers comm., February 2011). This example highlights the difficulties that may surface with the questioning of the ownership of the outer moorings in Porth Dinllaen.

4 Chapter 2. Summary previous surveys of the Porth Dinllaen seagrass bed.

The intertidal part of the seagrass bed was first mapped in 1997 as part of the CCW intertidal Phase 1 survey of the whole of the Welsh coast. In 2004 (Boyes *et al*. 2008) a survey was undertaken that documented the extent of the intertidal area of the seagrass bed and recorded observed impacts on the seagrass. Further survey of the intertidal seagrass was undertaken in 2010, the report is currently being prepared (Mercer, T.S. (In Prep)). In 2008 and 2009, CCW trialled the use of volunteer divers to survey the seagrass bed at Porth Dinllaen (Morris and Goudge, 2008 and Morris *et al* 2009). These surveys also examined the effect of the current moorings on the seagrass bed.

4.1 Intertidal Surveys.

A Survey of the intertidal seagrass took place in 2004 (Boyes *et al.*, 2008) and was re-surveyed more recently in 2010 (Mercer, T.S. (In Prep)); however both these surveys were restricted to the intertidal area and excluded the subtidal seagrass. Nevertheless, the surveys provide useful information that is also relevant to the mooring strategy in Porth Dinllaen. Although only mapping the intertidal, the 2004 survey recorded a total seagrass bed area of 29,611m^2 and of this a dense area made up 12,840m^2. CCW Phase 1 mapping of the seagrass bed at Porth Dinllaen in 1997 found a total area of the IMS.Zmar (seagrass) biotope of 70,810m^2 (again this area is only of the intertidal area). The differences in the areas between these two surveys are likely to be due to a lower tide experienced during the 1997 survey.

In Boyes *et al*, 2008, physical damage to the bed was noted at sites within the inner harbour; scoured areas of the seagrass caused by the mooring of boats (especially to the northern extent of the beds), impact from the movement of mooring chains and buoys (occurring particularly towards low water), and impact to the beds by vehicles driving across the intertidal area. These impacts were mapped showing that the damage is concentrated to the North West of the inner harbour from a line on the same latitude as the Ty Coch Inn. The map of the damage as given in Boyes *et al*, 2008 has been re-represented below in Figure 9.

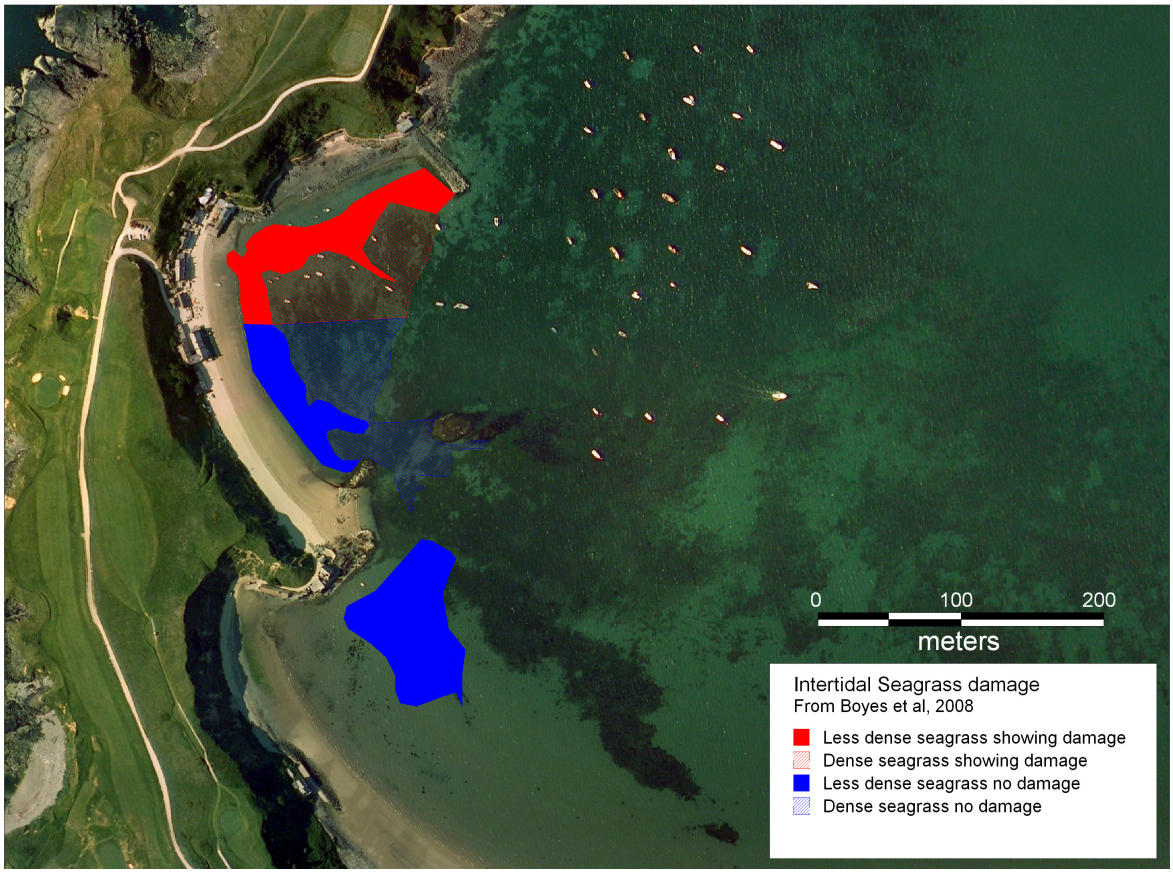

Figure 9. Intertidal areas of seagrass and associated damage in Porth Dinllaen. Data taken from Boyes *et al*, 2008). ©This orthophotography has been produced by COWI A/S from digital photography captured by them in 2006. Licensed by the Welsh Assembly Government's Department for Environment.

4.2 2008 Volunteer Diver Surveys.

The 2008 surveys at Porth Dinllaen examined the effect fixed moorings were having on the seagrass density below and surrounding the moorings. Five of the fixed moorings were examined. The aim was to estimate the 'footprint' (or 'scar') each mooring has on the seagrass bed. Divers were instructed to swim transects from a central point (the mooring) in N, E, S & W directions for 30m, undertaking quadrat counts every 5m. Seagrass was absent in 83% and 86% of the quadrats at the base and 5m from the moorings respectively; absent in 39% of quadrats 10m from the base; and absent in 20-25% of quadrats at distances greater than 10m from the base of the moorings. The impact on the seagrass was also evident when the mean shoots per m^2 were examined with distance from the centre of the mooring. There were marked reductions in seagrass density up to 20m from the centre of the moorings as shown graphically in Figure 10 below and also in the bar chart of Figure 11. The volunteers established that the area of 'scarring' (decline in number of seagrass shoots) was most apparent approximately 10m from the base of the mooring in 4 out of 5 regularly used fixed 'dump and chain' moorings. The report stated that "assuming that there is a minimum of a 10m radial scar in seagrass around each of the 40 fixed moorings and assuming there is seagrass under all moorings, the combined impact of moorings on seagrass beds at Porth Dinllaen is approximately 12,560m^2 (1.256 hectares)" (Morris and Goudge, 2008).

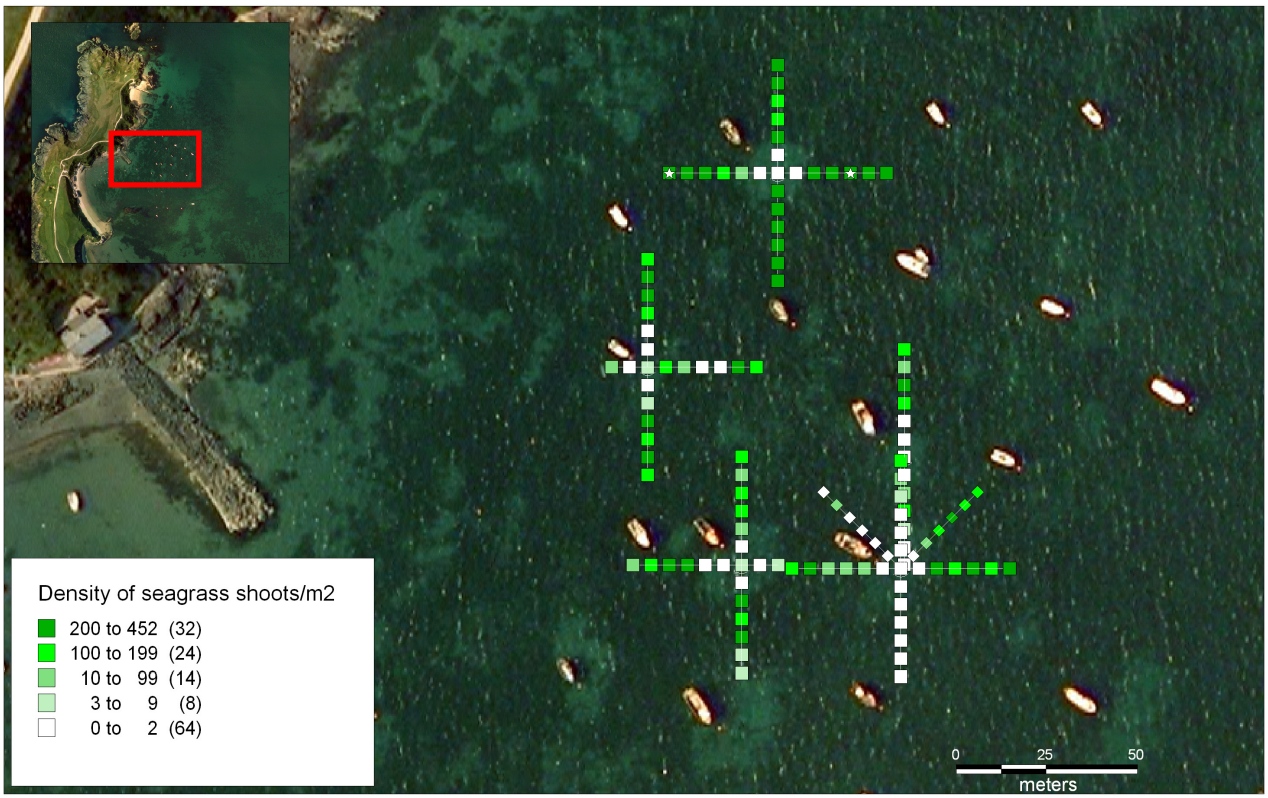

Figure 10.The reduction of seagrass density around boat moorings in Porth Dinllaen (Morris and Goudge, 2008). ©This orthophotography has been produced by COWI A/S from digital photography captured by them in 2006. Licensed by the Welsh Assembly Government's Department for Environment.

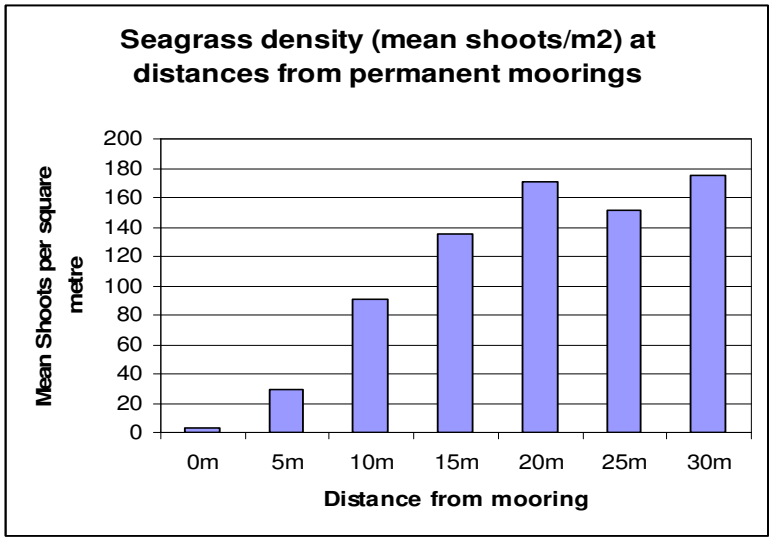

Figure 11. The average reductions of seagrass density around the boat moorings investigated in Porth Dinllaen (Morris and Goudge, 2008).

Outside the areas impacted by the moorings, the average density of seagrass was found to be 184 shoots per m^2 with a maximum density of 452 shoots per m^2 recorded. The 2008 surveys also investigated the extent of the seagrass bed. Primarily this was done by groundtruthing aerial images to determine areas where seagrass was present and which areas were comprised of other habitats giving a similar dark signature in the image. Transects were also run over the main areas of the seagrass bed. On the western side of the bay, seagrass dominated the sublittoral seabed transect for 480m parallel to the shore. In this survey the deepest live seagrass recorded was at 5.6m below chart datum.

4.3 2009 Volunteer Diver Surveys.

The 2009 survey found the maximum extent of the bed at this site to be over 1150m wide (west to east) at the southern area, and 790m in length (south to north). Unfortunately, due to the differing transect positions of the 2008 and 2009 surveys; the results from the two years of volunteer diver surveys are not directly comparable. There were two methods used to measure extent on this survey. The first method was to use divers who swam towards a fixed underwater acoustic marker (transponder) with a homing device, noting the distance and bearing to the transponder to note the key features of the bed. The second method was for the divers to follow a fixed bearing across the bed and to record where the bed starts and stops in conjunction with a surface tracking GPS buoy. This second method was found to be more effective. The bed had large dense distinct patches, but was broken into smaller patches amongst the moorings as was seen in the previous surveys. Several divers anecdotally reported that the seagrass blades were both denser and longer in 2009 than in previous years. Detailed density measurements were taken, with a mean of 115 live shoots per m^2 and a maximum of 503 shoots per m^2. However density measurements can not be directly compared to the 2008 survey as they were taken in different parts of the bed due to differing aims of the surveys in 2008 and 2009. The deepest live seagrass recorded was at 6.25m below chart datum on the 2009 surveys. This figure is not directly comparable to the shallower maximum depth of live seagrass found on the 2008 survey, due to differing dive locations. However examining the maximum depth of seagrass has been used in other studies as an indicator of water quality and bed health (e.g. Krause-Jensen *et al* 2003) and this parameter could be used in future surveys for these purposes using repeatable locations for the measurements.

4.4 Combining all the recent Surveys.

Combining the results from both the 2008, 2009 subtidal surveys, the intertidal surveys and the underlying aerial image an estimation of extent and density of the seagrass bed is possible. The estimated extent is shown below in Figure 12 (286,350 m^2) but should be thought of as indicative of the bed due to limitations of the data and variability of the boundary of the bed. No seagrass was recorded on the volunteer surveys to the North of the RNLI slipway.

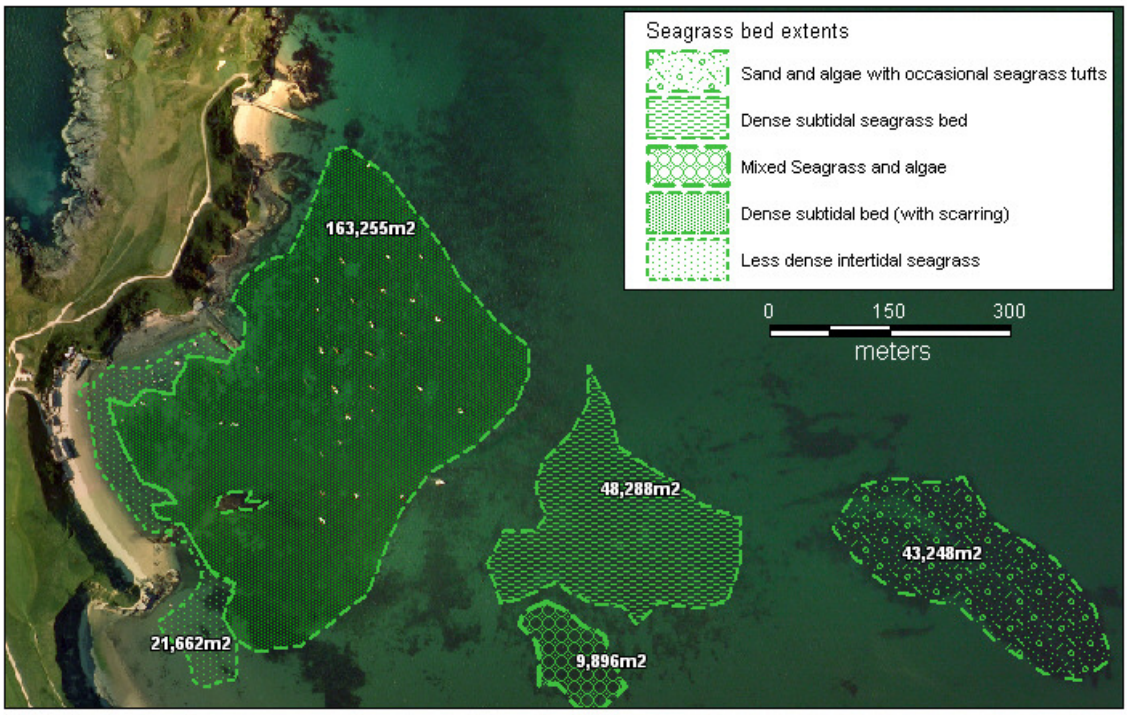

Figure 12. Estimated seagrass bed extents and density in Porth Dinllaen extrapolated from the CCW 2008 and 2009 volunteer surveys. ©This orthophotography has been produced by COWI A/S from digital photography captured by them in 2006. Licensed by the Welsh Assembly Government's Department for Environment.

5 Chapter 3. A summary of seagrass friendly mooring options.

5.1 Literature on the benefit of using Seagrass friendly moorings.

The damage that is caused to seagrass beds by traditional moorings systems is now well established and has been shown by many authors (e.g. Collins, *et al*., 2010, Montefalcone *et al.,* 2008, Milazzo *et al.*, 2004, Francour *et al.,* 1999, Walker et al. 1989). Most of the work examining the effect of new seagrass friendly moorings replacing conventional ones has shown that the recovery is not straightforward and may take many years (Collins *et al.,* 2010).

Although the technology of Seagrass friendly mooring systems has been around for decades, very few systematic trials have been conducted in order to compare the benefits to seagrass beds from the use of the different systems available. Trials are underway on the effect of using environmental friendly mooring in Moreton Bay in Queensland, Australia and preliminary results have shown a significant recovery of seagrass surrounding these moorings. In other places such as Vineyard Haven in Massachusetts, USA, and Komodo National Park, Indonesia, trials are also underway on the effect of new mooring systems on seagrass beds. However the results of these studies have not yet been published.

The effect of the 'Harmony' mooring system has been tested on seagrass during a two year long project in the Mediterranean. The study by the 'Laboratoire Environnement Marin Littoral' measured the impact of anchorages using this mooring system on *Posidonia Oceanica* seagrass beds. Fine scale mapping of the seabed was undertaken in a 3m radius around the anchor and the vitality of seagrass was studied in a 15 m radius around anchor. The study investigated factors such as: extent of rhizome baring, the density of rhizomes, epiphyte growth on seagrass leaves, degree of meadow fragmentation and regrowth. The conclusion after two years was that there was no impact on the surrounding seagrass bed from the 'Harmony' mooring system.

Apart from the benefits to Seagrass beds and other benthic habitats, another reported advantage of Seagrass friendly moorings is that they reduce the amount of swing of a vessel on a mooring, so in theory it is possible to have more moorings within the same area. This however may not be the case in areas where there is a relatively large tidal range such as that experienced in Porth Dinllaen.

As with traditional mooring systems the seagrass friendly ones should be periodically checked to ensure that no corrosion or damage has occurred. These inspections would follow the manufacturers' recommendations.

5.2 Comparison of the different types of ecofriendly mooring systems available

There are various systems of Seagrass friendly moorings available on the market; however few of these have been used in the UK. A major issue with the many of the systems is that they have been designed for areas with a smaller tidal range (of up to 3m) than that which is experienced in the UK and specifically in Porth Dinllaen which has a range of ~6m. The difficulties of the large tidal range are further increased due to the shallow depths experienced in the area. In shallow waters where the seabed is exposed at low water problems can occur such as entanglement and UV degradation. The different systems and their potential suitability for use in the area is summarised in the matrix below (Table 2). Before the comparative matrix is a brief introduction to each of the systems so they can be visualised. Much of the information has kindly been provided by Clare Davies from CCW (Davies, C. 2011).

It is best to think of the mooring systems in two parts. The first part would be the rope/chain, rode and buoy system. The second part to consider is the way that the system is attached to the seabed. This can either be through the use of (i) a concrete anchor block (or similar) as are used in traditional moorings, which in themselves have their own impact or footprint, or (ii) to attach the system by anchoring it into the sediment. If anchor blocks are to be used it is worth noting that dead weights weigh less when underwater than on land. Cement blocks lose 45%, while granite loses 36%, iron loses 14%, and steel 13% when submerged. Steel objects therefore have the greatest weight per area of impact (PADI Project Aware, 2005). Anchoring the mooring system directly into the sediment would however be preferred from an ecological perspective to minimise impact. The main direct anchoring systems available for the substrate type at Porth Dinllaen (mud/sand) are either Helix or Manta Ray anchors (shown in Figure 13). These direct anchoring types are compared with others in
Table 3.

Type of mooring anchor	Material Cost per anchor	Estimated anchor cost including installation	Strength (tonnes)	Suitable substrate	Depth of substrate required	Used in UK
Manta ray	£160	£800	11.34	Any	5ft	Unknown
Helix	£350	£540	9.43	Soft Clay/Mud/Sand	5ft	Yes - Studland Bay
Concrete Block 2720kg	£100	£1,500	1.45	Any	n/a	Yes
Train wheel 500kg	£325	£1000 with rope + buoys	1.4 at least	Any	n/a	Yes
Mushroom 225kg	£300	£625	0.77	Mud/Silt	n/a	Yes

In order to suggest a certain type of anchoring system, however, detailed substrate data is required. This is because a certain depth of sediment is needed in order to provide the required strength for the system and the strength requirements vary with the size of vessel using the mooring. The British Geological Society (BGS) and also The Crown Estate do have some data on marine sediments, but is likely that a more detailed survey would be required. This however may be as simple as hammering a thin steel rod into the sediment at desired locations to check it is deep enough.

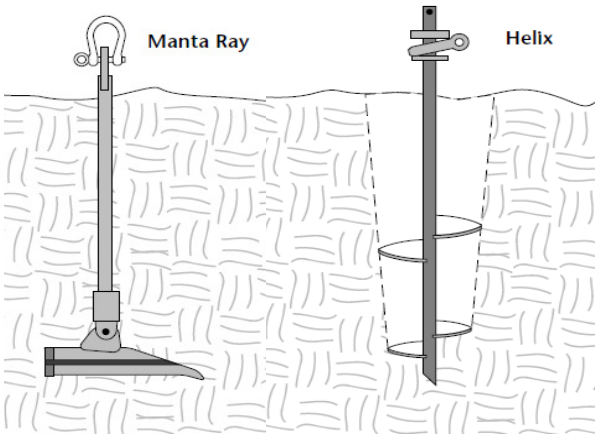

Figure 13. Direct anchoring types suitable for the sediment types of Porth Dinllaen. Adapted from PADI Project Aware 2005.

5.3 The different models of ecofriendly moorings available.

5.3.1 Halas System

The Halas System consists of a single pin or anchor unit embedded into the seabed. Used on solid substratum (e.g. granite or limestone) the stainless steel eye bolt anchor is placed into a drilled hole in the sea floor and cemented in place using marine cement or epoxy cement.

The Halas system uses a commercial 18-inch diameter buoy. Within the buoy lies a PVC pipe through which a ¾-inch through line may pass. The Halas System uses a three part rope system instead of one continuous rope. The first line runs from the anchor pin to the surface buoy. The second line runs through the surface buoy and is attached with a loop to the anchor line which is attached to the third pick up line with a loop at the other end. Sections of the rope system can be replaced as and when needed reducing maintenance time and cost removing the need for heavy shackles. A weight is placed 3ft down from the surface on the anchor line to avoid slack rope floating.

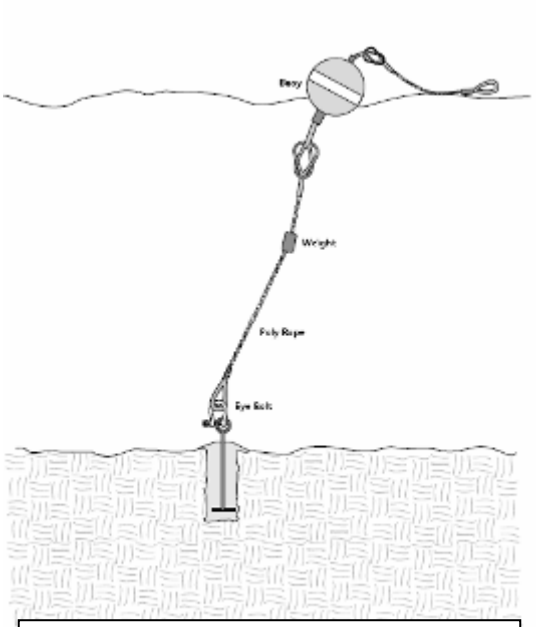

Figure 14. Halas System

5.3.2 Ezyrider

The Ezyrider mooring system has been trialled throughout Australia and more than 450 units have been deployed in varying conditions and substratum.

The Ezyrider displacement buoy moves freely up and down a stainless steel shaft attached to a down-line chain at one end and a surface line at the other. When a vessel is attached it pulls the buoy away from the vertical position and forces the buoy to move up the shaft continually surfacing. If the force is sufficient the buoy will eventually submerge. As the force decreases the strong rubber connections at the base of the buoy contract causing the buoy to slide up the shaft and return to its neutral vertical position. Ezyrider claims this self centring technique reduces the swing area of a vessel by up to 50%. It is usually fitted with an offset anchor system may also be fitted to existing clump weights for smaller vessels (<10ms).

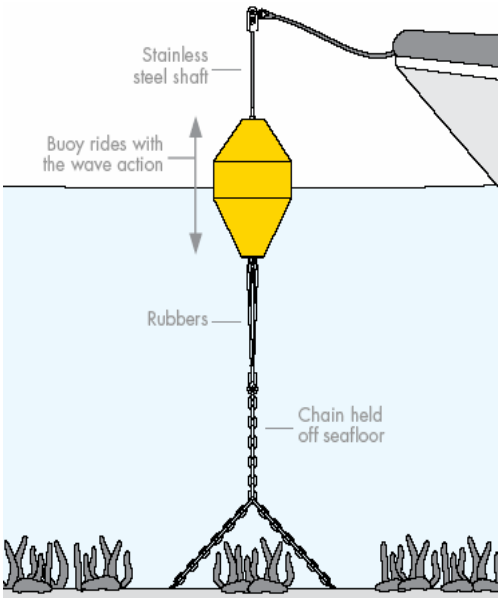

Figure 15. Ezyrider System

5.3.3 Seaflex

Seaflex is an elastic mooring system that can be used with pontoons and mooring buoys. Here a mooring is attached to the buoy through a stainless shackle. A marine grade rope is attached to the buoy through an integrated nylon thimble and a float ensures the rope doesn't chafe against the anchor. The Seaflex mooring buoy can be used with any anchor type.

The crucial part of a Seaflex mooring system is the reinforced homogenous rubber hawser. The hawser is built around a homogenous rubber core. A specially braided cord is wrapped around the core, and the outer layer consists of a durable rubber cover which forms the outer shell of the hawser. A unique construction that gives a progressive resistance that will dampen all movements within the water column. Seaflex acts as a safe shock absorber, even at surge as the material never faces load peaks. Seaflex claims less swinging space is required and thus more boats can be moored.

Figure 16. Seaflex System

5.3.4 Seagrass Friendly Mooring

Currently being tested in the several locations in New South Wales the Seagrass Friendly Mooring is tipped with a helix screw that has minimal environmental damage when being installed, removed or during use. The Seagrass Friendly Mooring System is screwed into the seabed using a hydraulic auger drive attached to a surface vessel.

The Seagrass Friendly Mooring system uses a pivoting raised arm attached to a fixed anchor. A 360° rotating head is fixed to the anchor to allow movement of an 1100mm seawater-driven spring-loaded shock absorber. When fixed to marine grade rope and surface buoy the combined buoyancy keeps the shock absorber elevated from the seabed even under extremely low tidal conditions.

Figure 17. Seagrass friendly mooring

5.3.5 Eco-mooring Rode

The Eco-Rode is an elasticised rope that can be attached to numerous anchor types. Under strain the Eco-Rode stretches evenly, the standard 12ft will stretch to 19ft under load and buoys may be added help float longer systems. The website suggests fitting the Eco-Rode to a Helix anchor but other anchoring systems can be used. This is the system that has been used to mark out the voluntary no anchoring zone in Studland Bay.

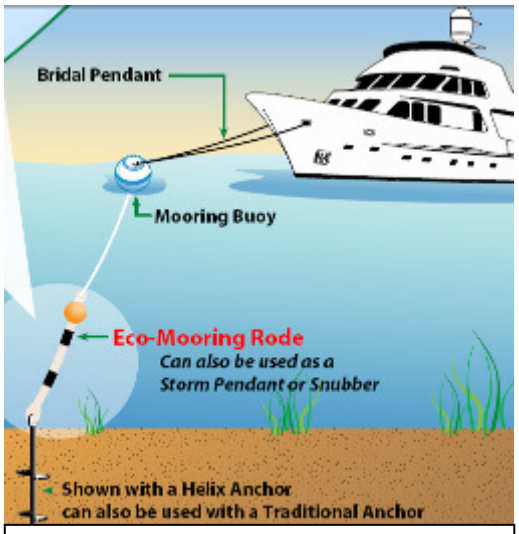

Figure 18. Eco-mooring Rode

5.3.6 Hazelett Elastic Mooring Rode

Similarly to the Eco-Rode the Hazelett Elastic Mooring Rode is another alternative to the conventional mooring chain. Because of its engineered elasticity, it stretches out smoothly under load, eliminating peak forces of a rigid chain road. This elastic high-stretch material connecting the buoy to the anchor can stretch up to four times it's unloaded strength and can tolerate twisting and uses rigid polyurethane thimbles to eliminate metal-metal contact. The smooth extension of the Hazelett rode acts to keep the boat pointed into the wind as opposed to yawing. The Hazelett mooring system uses a spar buoy instead of the conventional rounded buoy as seen in the image below. According to the website the Hazelett mooring system claims to reduce loads on deck hardware by 50%, eliminate chain replacement and increase mooring density in a harbour by 40% with minimal impact to the seabed.

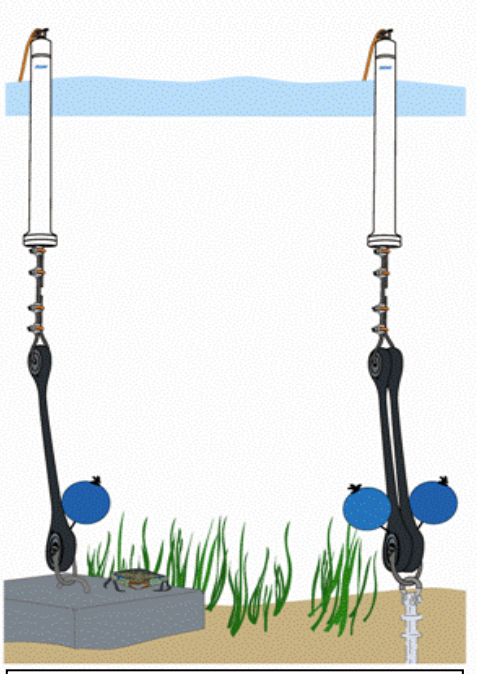

Figure 19. Hazelett mooring rode

5.3.7 Harmony System

With this system from France The anchor line is exclusively made of inspected polyamide rigging. By virtue of an intermediate floater, the line is kept permanently taut in open water. Even while not in use, the anchor line does not have contact with the seabed. At the surface, the line is attached to a mooring buoy. At the head of the anchor, lying flush with the seabed, the line is fastened to a highly resistant shackle. The length of the anchor line is calculated to obtain a 45° angle of traction. At the surface, the swinging area of the boat is equal to one time the depth of the water. (Using the traditional dead weight mooring system, the length of the anchor line must be equal to three times the depth of the water). A variety of anchors can be used with the system in *Posidonia* beds a spring shaped anchor is used (shown) otherwise a Helix anchor is suggested in soft sediments. The system has been used widely in the Mediterranean.

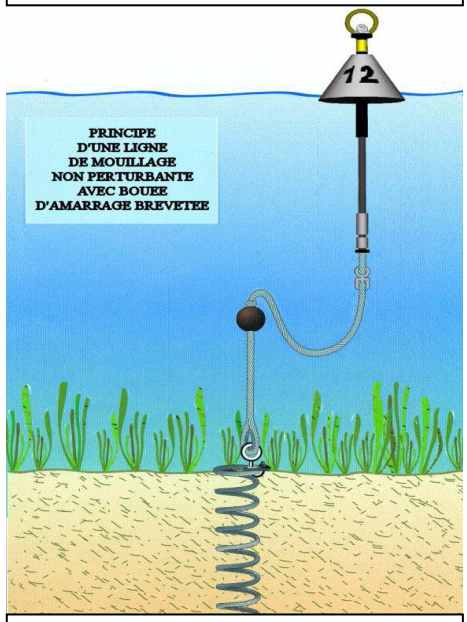

Figure 20. Harmony System

5.3.8 Traditional Style with subsurface buoy and high tensile rope.

Another option that is available would be to use high tensile rope rather than steel chain attached to a weight – such as a train wheel. The rope would have a subsurface buoy ensuring that it doesn't drag on the seabed. This system was suggested by Dr Ken Collins from the National Oceanography Centre in Southampton. He has much experience on seagrass beds and the mooring system employed therein and has extensively studied the situation at Studland Bay. This system could be put in place for around £1000 and may be a solution to the high costs and insurance issues with the other systems.

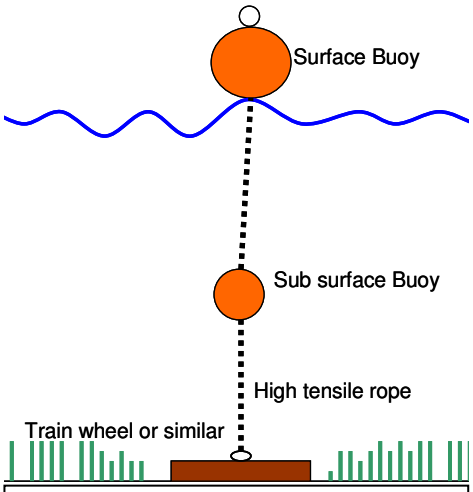

Figure 21. Traditional style mooring with subsurface buoy and rope.

5.4 Comparison of the systems available.

Before comparing the different systems available it is useful to examine the different loads or strengths that are required for the safe mooring of vessels. Table 1 provides a summary of load (in tonnes) on vessels at variable wind speeds.

Table 1. The load in tonnes on vessels at wind speeds of 64knots and 100knots. Adapted from Project Aware 2005.

Length of vessel (ft)	Beam width of vessel (ft)	Tonnes of Load in 64knot wind	Tonnes of Load in 100knot wind
10	4	0.33	0.68
15	5	0.51	1.13
20	7	0.74	1.63
25	8	1.01	2.27
30	9	1.44	3.18
35	10	1.85	4.08
40	11	2.47	5.44
50	13	3.29	7.26
60	15	4.11	9.07
70	17	4.54	10.89

Table 2 below provides a summary comparison of the attributes of the different ecofriendly mooring systems that are currently available. Firstly, it is important to note that the costs are only estimations (they have been converted from prices that are usually in Australian or US dollars. Secondly, the cost per mooring will vary greatly depending on the number of moorings required; the installation equipment costs are generally the most expensive part of installing the moorings and if more are required then individual costs will be less. As an anchoring system would be needed the costs will be of the anchor (Table 3) plus the mooring (Table 2).

The other caveat required with the information in the matrices is the number of ‘depends’. The strength of the mooring systems depends of the individual model used. If more strength for larger vessels is required then the moorings can be doubled. The costs, suitability, strengths and suitable vessel sizes of the systems depend on the depth of water in which the moorings are to be placed. With the anchoring system, the major consideration is the type of sediment in which the moorings are to be installed (unless seabed weights such as concrete blocks or train wheels are used). In Porth Dinllaen the sediment is likely to be sandy with areas of gravel however the depth of the sediment is also important to provide suitable holding strength.

Table 2. Matrix showing the attributes of the different ecofriendly mooring systems available.

Type of Mooring system	Cost^	Copes with 6m tides?	Used in the UK?	Strength (tonnes)	Suitable vessel size	Independently tested?
Eco-mooring rode	£220 (+ 50% import tax) not installed	Yes	Yes Studland (4)	12.70	Up to 50ft	Yes
Ezrider	tbc	No	No	12.70	up to 30ft power boat	Yes
Halas	£1220 if 10 were installed with manta ray anchor	Possibly according to manufacturer	No	9.07	Unknown	No
Hazelett	£800	No. Manufacturer is doubtful in shallow water	Yes Isle of Man (1)	10.89 to 28.12*	Up to 50ft	Yes
Seaflex	£850 minimum	Yes, if in deep enough water	Yes Lundy & Mylor	1.00	varies	Yes
Seagrass friendly mooring	£1500 installed (in Australia)	Yes	No	1 to 2.5*	Up to 40ft	Yes
Harmony System	tbc	Unknown awaiting answer	tbc though widely used in France	3.36 in sand 2.45 in *Posidonia* bed	Up to 60ft	Yes
Traditional + rope and subsurface buoy	£1000 installed	Yes	Unknown	Equivalent to standard mooring	Equivalent to standard	No –but rope would have equivalent strength

*different models are available with varying strength. = unsuitable. 'tbc' = to be confirmed.
^ cost per installed mooring unless otherwise stated.

Table 3. The different options available for anchoring the mooring systems.

Type of mooring anchor	Material Cost per anchor	Estimated anchor cost including installation	Strength (tonnes)	Suitable substrate	Depth of substrate required	Used in UK
Manta ray	£160	£800	11.34	Any	5ft	Unknown
Helix	£350	£540	9.43	Soft Clay/Mud/Sand	5ft	Yes - Studland Bay
Concrete Block 2720kg	£100	£1,500	1.45	Any	n/a	Yes
Train wheel 500kg	£325	£1000 with rope + buoys	1.4 at least	Any	n/a	Yes
Mushroom 225kg	£300	£625	0.77	Mud/Silt	n/a	Yes

5.5 UK use and experience of Seagrass friendly moorings.

The main places in the UK Seagrass friendly moorings have been used in Lundy to protect the seabed habitat and also in Studland Bay in order to establish a voluntary no anchoring zone. Case studies of the different places where they have been used are given below.

Lundy Island
Nicola Saunders the Lundy Island warden has confirmed that four Seaflex moorings are in operation around the island and their effectiveness as moorings relies on wave exposure and depth of water. However they were deemed to be very effective in reducing drag on the seabed. She has been quoted as saying: "A Seaflex mooring has been in use at Lundy Island Nature Reserve for 3 years now and has been a huge success with divers and other users of the Marine Nature Reserve. The non-scouring nature of Seaflex means that there is no damage to the marine ecosystem" (Marina World Magazine, February 2009) The buoys are situated in around 10m of water at low tide and there is a 9m tidal range. However, she also noted that there were initially problems with the buoys used; the buoys have a large metal pole going through the buoy eye which some vessel owners' claim clatters into the bow of the vessel. This problem has now been rectified (N. Saunders, pers comm. 2011).

Studland Bay
In Studland Bay (See Chapter 4), the voluntary no anchoring zone has now been marked out with Helix anchors and the Eco-mooring rode mooring systems. Fiona McNie (Natural England) who leads on the Studland case work chose the Helix system because of its demonstrated effectiveness in soft sediment and relatively low installation cost. A Helix anchor has a very small footprint and no scouring at all was observed thereafter. Prior to installation it is imperative to know the sediment type, depth and size of boats using the mooring in order to ensure the correct number and size of Helixes used (F. McNie. pers. comm. 2011).

South Devon AONB
The Estuaries Officer at South Devon AONB Unit (Nigel Mortimer) has been investigating alternative mooring systems for some time. Initially the Seaflex system was favoured here, but the Harbour Authority was sceptical about the technology as it hadn't been fully tested in the UK. Subsequent failure of Seaflex units on a pontoon at Mylor Harbour (see below) lead to a further loss of trust in the system. The system failed where the 'elastic' is crimped to the anchor block. Nigel Mortimer now favours the Hazelett system which doesn't use the crimps that failed (N. Mortimer pers.. comm. 2011). The Hazelett system is being used in the Isle of Man by Bryan Gullan. He states that "the mooring here on the Isle of Man is pretty exposed but is performing exceptionally well (B. Gullan pers. comm. 2011)

Falmouth (Mylor Harbour)
A trial has taken place in Falmouth by Plymouth Marine Laboratory (PML) under the Cycleau project, which has been investigating the reduction of damage to the benthic environment by Seaflex mooring systems. These trials have not shown any significant difference in damage to the habitat between under the Seaflex moorings and that under the traditional chain moorings. However there are some important aspects to note in this study; firstly the areas on which both types of moorings were located were already impoverished and species poor (due to fresh water runoff and macroalgal debris). Further, during the study the Seaflex moorings were moved around for 'commercial reasons' meaning that the study was compromised (M. Kendal, pers. comm. 2011). The views reported of Matthew Oaks from Mylor Yacht Harbour on this trial at are very important to note and are quoted below (email from M. Kendal, 2011):

1. “A chain mooring system is designed such that heavy chain under the water acts as a shock absorber gently taking up the pull of a boat on its mooring as the boat is battered by wind or rides the waves. A Seaflex mooring consists of a short length of Seaflex (large bungee cord) and strong rope. This Seaflex is not elastic enough for small boats and too elastic for heavy boats. It needs to be graded depending on the weight to be placed on the mooring”.
2. “As the tide falls on a chain mooring, the chain gathers in one position and keeps the boat in one place. As the tide falls on a Seaflex mooring the swinging room just increases and increases until at low tide you have a boat that requires a radius of 80ft swinging room as apposed to 40ft. For us this led to boats banging in to each other at low tide”.
3. “The moorings at Mylor are all tightly packed in and moored to trotts [horizontal chains on the seabed] as apposed to single blocks. This meant that in attempting to trial a Seaflex mooring amongst the chain trott moorings was a disaster! We have found that it is not possible to mix the Seaflex system with chain moorings as they both behave very differently and you end up with damaged boats!”
4. “When there is no boat moored to the mooring there are problems with the marker buoy sitting along way away from the mooring block. This meant that in our shallow mooring area at low tide we had trouble with boats fouling their propellers on the rope that leads down to the Seaflex. This does not happen with a chain mooring as the chain is much heavier”.
5. “Servicing the mooring requires a diver as you cannot lift a 2 ton block with the Seaflex system. Currently chain moorings can be lifted out the water for inspection and servicing but this cannot be done with a Seaflex mooring without the aid of a diver attaching a lifting chain to the mooring block adding a lot more time and expense”.

He summarises that “We could see little or no benefit to using this system even if it were to be developed further. Perhaps it is great for use in small tide areas perhaps on a coral reef etc. but at present it is not viable for commercial use here”. It was also presumably under this study that some Seaflex units failed on the pontoon as stated by Nigel Mortimer.

5.5.1 Summary of the most suitable seagrass friendly mooring options.

Based on the attributes of the various seagrass friendly mooring systems that are available and current experience with these systems in the UK and elsewhere, it appears that the ‘best’ (most cost efficient/fit for purpose) mooring system would be to use the Eco-Mooring Rode in combination with a Helix anchor system. The Eco-mooring Rode is less expensive than similar systems such as Seaflex, and UK experiences of it have been good. If the impact of the existing concrete anchor blocks is tolerable then the system could be attached to these avoiding the need for Helix anchors. Otherwise a low cost and simple (although relatively novel) system could be tested being that suggested by Dr Ken Collins (Using a train wheel, subsurface buoy and high tensile rope). This is a similar design to the Harmony system, but unfortunately we are waiting to hear back about more details on their system.

6 Chapter 4.

6.1 Review of best practice for seagrass beds.

Studland Bay

The main study in the UK examining the impact of anchoring and moorings on seagrass beds is being done at Studland Bay in Dorset. This study is being conducted by Seastar Survey Ltd on behalf of Natural England and the Crown Estate.

The Crown Estate and Natural England agreed to fund an independent scientific study aimed at quantifying the impacts of anchoring and mooring on seagrass health. A key element of this study was to establish a voluntary no-anchoring zone (100m x 100m) in order to monitor the health of the seagrass and populations of key associated flora and fauna, to determine the potential rate of recovery in this area. Boaters are asked to avoid anchoring in the area which will be marked by four yellow marker buoys on each corner as well as two in the centre of the zone. Monitoring is also taking place in unmarked areas to assess the potential rate of decline in areas where management remains unchanged. The study commenced in May 2009 and monitoring will take place for a full two years. The study could be extended to three years depending on whether the results warrant further investigation. Part of the study will be to also consider the practicality of installing ecofriendly moorings and the long term status of moorings generally in Studland Bay.

This project is ongoing, but there are already lessons that can be learnt from it. Although the project consulted an extensive list of stakeholders, individuals from the local boating community have been highly vocal in their objection to the project on online internet forums such as www.ybw.com (see http://www.ybw.com/forums/showthread.php?t=255947&page=3 for a good example of this). There is even also a social networking website 'Facebook' page 'Save Studland Bay' which campaigns *against* the creation of a marine conservation zone there. There have been reports of survey divers being verbally abused and marker buoy eco-moorings cut. The situation is becoming very contentious and every effort must be made at Porth Dinllaen to avoid similar conflict.

The main problems seem to be firstly that the Voluntary no anchor zone moved around as its mooring buoys were not fit for purpose (although it has also been suggested that they have been moved) and secondly there seems to be the attitude of the boating community that they are being 'ganged up' on by the conservationists and divers and that their views are not being adequately considered. Local yacht clubs and the RYA were both stakeholders on the project, but it is likely that those who have voiced concern on the internet forums are not members of these organisations, or if they are, their views differ from those of the representatives. Another issue is at present the vessel owners do not need to pay for use of the moorings as strictly speaking, they are illegal (as discussed in Section 3.2). It is likely that vessel owners are worried that if new ecofriendly moorings are put in place, the management will have to change and they will end up being charged for them. It has also been stated that the text on voluntary no anchoring mooring buoys was also too small to read (see Figure 22, below) so vessels had to get very close to the buoys in order to read the information.

Seastar Survey Ltd was contacted about the Studland bay project and they were very helpful. The director Magnus Axelsson said that there are strong feelings on both sides (the boating community and the conservationists) and it is important to maintain a neutral scientific position. He agreed that communication is a major issue in the success of such a project and that local stakeholders should be made aware of the short term and long term plans of the project as soon as possible. On the issue of seagrass friendly moorings, there is no definite plan for these at Studland Bay, although there is much interest in trying to use them. The idea of using these was

initially met with reluctance from The Crown Estate due to the technology being unproven in the UK. Apparently The Crown Estate is softening their position on the potential use of these systems for boat moorings but the major problem is getting insurance to cover the systems. The voluntary no anchoring zone is however now marked out with buoys using the Eco-mooring Rode system; these elastic moorings are attached to a Helix anchoring system which screws into the substrate attaching them to the seabed; which should solve the issue of the zone moving around. There is now also clearer text used on the buoys (M. Axelsson. pers comm. February 2011).

The main lesson that can be learnt from this study is the necessity to consult as many local boat owners as possible, as stakeholders, and listen to their views. Stakeholders should also be involved in identifying suitable areas for mooring and no anchoring zones. Further the aims of seagrass friendly moorings and any potential zoning plan should be fully described so that people clearly understand the rationale and the 'rules'. The word 'rules' should also probably be avoided.

Figure 22. The buoys used to mark out the voluntary no anchor in Studland Bay. Image: Fiona McNie

Helford Estuary

There are examples where seagrass beds have been protected by the creation of a voluntary no anchoring zones. One example is the Helford Estuary on the south coast of Cornwall which is popular with visiting yachts and local boat owners because of its naturally sheltered waters. The shallow waters also provide perfect conditions for the growth of seagrass which flourishes in the estuary. In the late 1990s concerns were raised after surveys suggested that the seagrass beds were being damaged by anchoring. A voluntary no-anchoring zone was set up with the support of the local sailing club and the manager of the moorings. The voluntary no-anchoring zone is marked by buoys and a postcard (Figure 23) showing the zone and the local area helps ensure

boaters are aware. The voluntary approach has been very successful in reducing the number of boats anchoring on the seagrass and recent surveys indicate that the bed is in excellent health and may even be expanding (www.greenblue.org).

It should be noted that in reality all no anchoring zones are 'voluntary' as there is a public right of navigation for vessels in tidal navigable waters. It is also well established that anchoring in the course of navigation is part of this public right (Harris 2004). In theory a Nature Conservation Order could over rule this public right, however this would have to go through the Welsh Assembly Government, would be a lengthy and difficult process and single objection would most likely stop the application. In any case voluntary zones are more likely to work due to self regulation by vessel owners and are further recommended as they are beneficial in keeping stakeholders 'on board'.

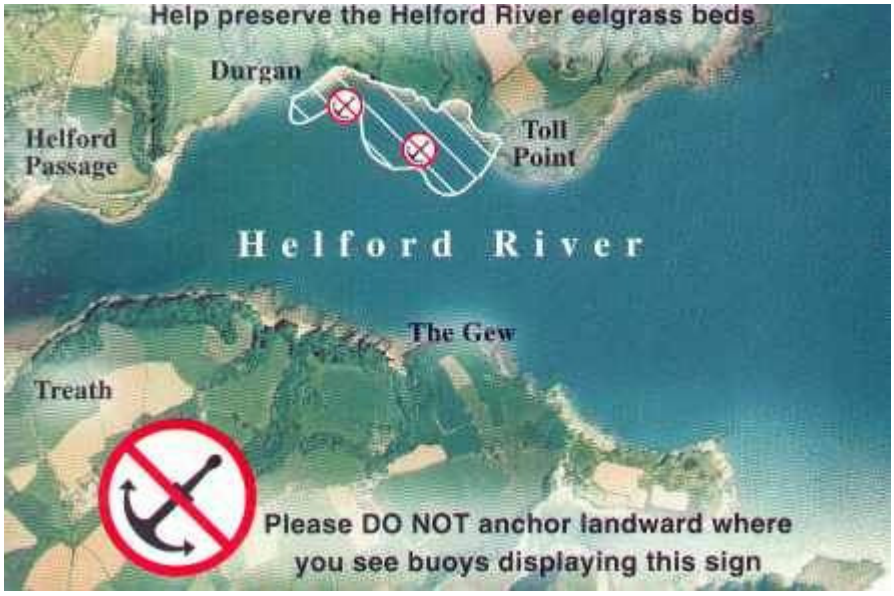

Figure 23. Postcard showing the no anchor zone in the Helford river, Cornwall. Source: http://www.helfordmarineconservation.co.uk/eelgrass.htm

Torbay Coast and Countryside Trust

A similar project is run by the Torbay Coast and Countryside Trust. Here, seagrass beds are marked out by buoys as voluntary no-anchoring zones and there are also 5 knot speed limits in inshore areas to protect the seagrass. Various posters (see Figure 24, below) and postcards highlight the voluntary no-anchoring areas and give information on the reasons for the protection of seagrass.

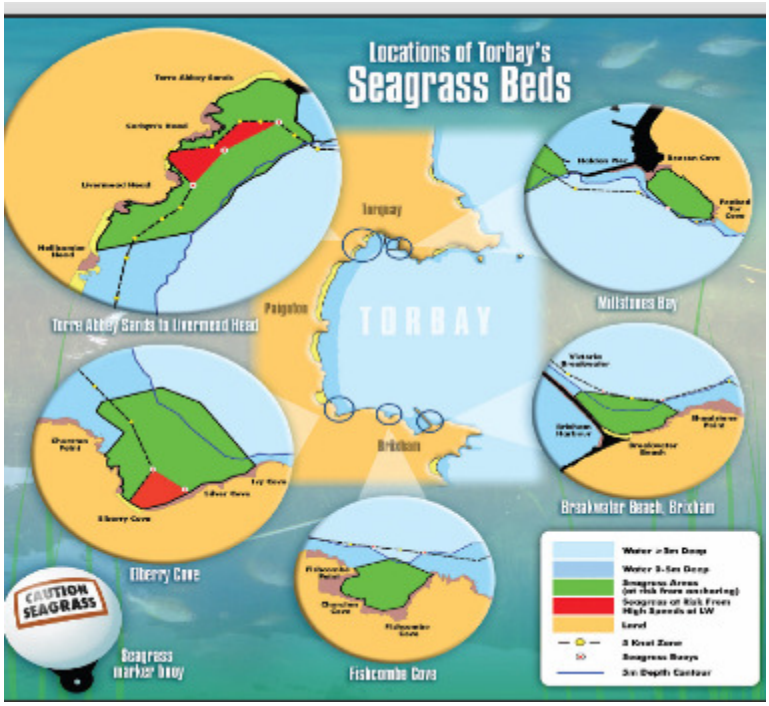

Figure 24. Poster advertising the no anchoring zones in Torbay. Source: http://www.countryside-trust.org.uk

Alex Schofield the Biodiversity Officer at Torbay Coast and Countryside Trust was contacted and provided very useful advice on the implementation of such a scheme. In the seagrass areas she noted that Scallop dredgers had stopped their activity within the area, but stopping the anchoring of recreational vessels was more difficult. She stated that the Harbour Authority of the area found it hard to 'police' these areas due to limited resources. Locals who will have seen the campaign literature were likely to avoid the no-anchoring zones but it was by nature harder to get the message to visiting vessel owners. Further, the buoys just state 'Caution Seagrass' (Figure 24) and she acknowledged that more information may be required on the buoys to strengthen the message of i.e. to avoid anchoring in these areas.

Ms Schofield also recommended early and clear communication with the boating community about the scheme and highlighted the importance of educating people about the importance of the habitat. With regard to Seagrass friendly moorings such as the Seaflex system the Torbay Coast and Countryside Trust would ultimately like to have these installed but noted reluctance of the Harbour Authority as the technology is largely untested in the UK and also due to difficulties with getting insurance policies with these systems (A. Schofield pers. comm. February 2011).

USA

In the USA there have been a number of voluntary no-anchoring zones established in order to protect seagrass beds. One of these was set up in Port Townsend Bay, Washington where the zone has been marked out with buoys in addition to a public outreach campaign including the use of strategically placed signs (Figure 25), and stalls at local events. The views of the boating community have been supportive and the marker buoys have dramatically changed the behaviour of the boaters anchoring along the downtown Port Townsend shoreline. The Voluntary No-Anchor Zone has nearly eliminated negative impacts to the sensitive eelgrass habitat from anchoring.

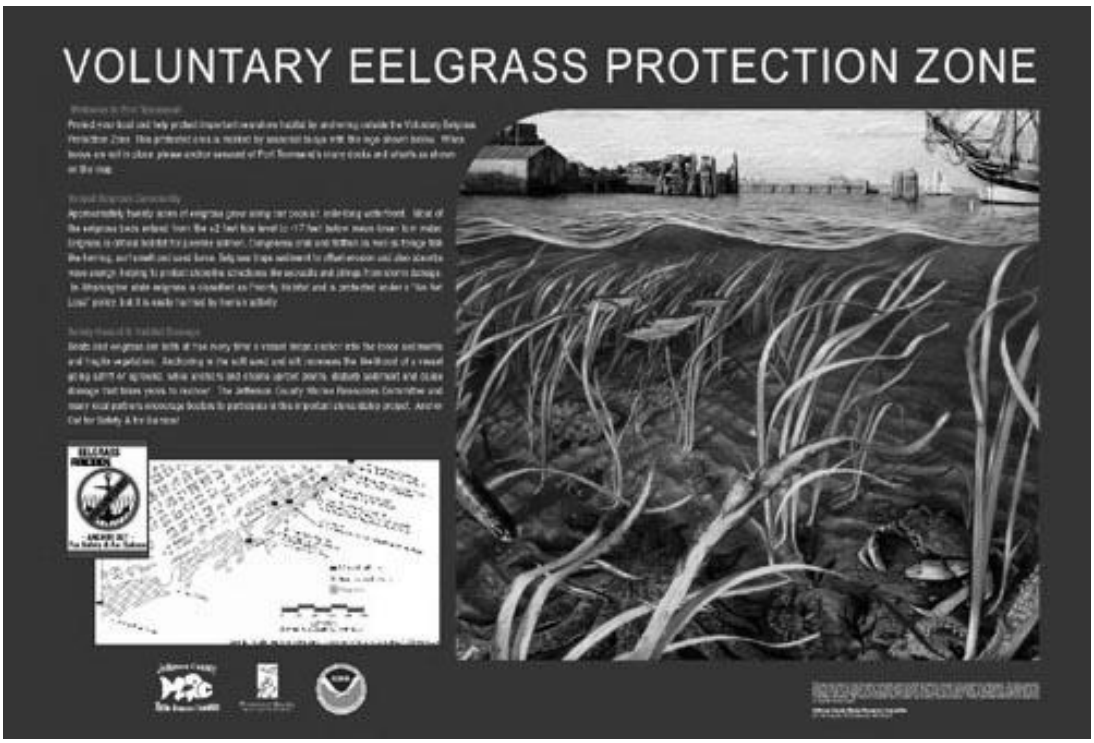

Figure 25. Sign showing information on the voluntary no anchoring zone in Port Townsend Bay, US. Source: http://www.nwstraits.org

6.1.1 Summary of lessons learnt from similar projects.

- Consult as many stakeholders as possible, especially locals and involve them in any zoning plan.
- Let everyone know what is going on and why at the earliest opportunity.
- Be open about what is going on throughout any project.
- Explain clearly the importance of seagrass and why it is protected and the benefits a healthy bed could bring to the local economy. Produce flyers and posters explaining this.
- If a no anchoring zone is to be established a voluntary system would be recommended.
- If a voluntary no anchoring zone is established this should be clearly marked out with buoys that will not move. Further the buoys should have large lettering and a clear message so that they can be read from a distance.
- Voluntary no anchoring sites should be shown on maps (on the above mentioned posters) and possibly advertised online and with groups such as the RYA.
- If seagrass friendly moorings are used it must be ensured that the right one for the situation is used with regard to vessel size, water depth and tidal range. At high tide the elastic should be taught but not stretched.

6.2 Options for management in Porth Dinllaen.

This chapter should be viewed as an initial investigation into the options available. Before any management changes are made, further investigations/work is recommended. This should include the following:

1. Further survey of the seagrass bed in order to establish its accurate extent and identify the most suitable areas for any spatial zoning.
2. Information about sediment type and depth: In order to establish the most suitable type of mooring anchor the sediments and their depths would also have to be investigated in the locations where the mooring systems might bed used.

3. Establish early engagement with stakeholders such as vessel owners, fishermen and local businesses so that their ideas and any potential objections are known as early in the process as is possible. This could take place in the form of a meeting in Porth Dinllaen and would also ensure that stakeholders know what is going on and the reasons for any possible management changes from the start.

Another important factor that needs to be taken into account before any definitive plans are made is how much budget is available. This will have substantial implications on the scale of what is possible and the type of moorings available.

Table 4. The different options available for the management of the seagrass bed with the advantages and disadvantages of each.

Option	Pros	Cons
Option 1. Keep the mooring arrangement as it is currently	• Minimal financial implications • Existing level of communication and liaison between National Trust and current users and vessel owners.	• The seagrass bed will continue to be impacted and fragmented by the traditional mooring systems • The seagrass bed will continue to be damaged by anchoring • The damage to the seagrass bed is likely to increase if number of vessels increases as predicted. • The above will lead to a reduction of the ecological potential of the area.
Option 2. Create a voluntary no anchoring zone, preferably marked out with seagrass friendly moorings (as in Studland Bay) and keep the traditional moorings in place.	• Reduction in the damage caused to the seagrass bed by anchoring in no-anchoring area. • Low potential to create conflicts with current users and vessel owners if can agree location of no-anchoring area.	• The seagrass bed will continue to be impacted and fragmented by the traditional mooring systems • The damage to the seagrass bed may be increased in areas adjacent to the voluntary no anchoring zone. • The combination of the above may lead to further reductions in the ecological status of the area.

Option 3. Replace the traditional moorings throughout the bed with seagrass friendly mooring systems and create a voluntary no anchoring zone	• Likely reduction in the fragmentation of the seagrass bed due to reduction in scaring effects around the moorings. • If done correctly would demonstrate to other agencies and areas that it is possible to use non damaging moorings whilst not creating conflict. This could have knock on effects to leading to the improvement of the seagrass beds in other areas too. • Would be a good advert for The National Trust, Gwynedd Council, CCW and Wales. • Helps to meet Welsh Biodiversity actions under the NERC Act 2006 and to achieving favourable condition for the seagrass bed (as part of the intertidal mudflats and sandflats of the Pen Llŷn a'r Sarnau SAC.	• The seagrass friendly moorings and their installation may be costly if done throughout the bed. • There may be difficulties with gaining insurance for the new or untested moorings. • The seagrass friendly moorings may increase the swing of vessels. • Some friendly moorings could lead to problems with boats fouling propellers on the lighter weight ropes when they are slack at low tide. • Anchoring levels may increase in areas adjacent to the no anchoring zone.
Option 4. Conduct a trial of the recommended suitable systems in a small area of the bed and also a trial of a voluntary no anchoring zone.	• Lower initial financial implications. • Lower potential to create conflicts with current users and vessel owners. • Gives the opportunity to establish the most suitable and cost effective option before any large decisions or changes are made. • Will determine if the positive impacts are significant enough to warrant a bay wide change in management.	• In the short term the seagrass bed will continue to be fragmented by the majority of traditional mooring systems. • The seagrass bed will continue to be damaged by anchoring in the short term outside the trial area.

	• Allows the management to change gradually rather than one big initial change that causes much disruption. • If the trials are successful then there would be good 'evidence' to back up the case for a change in management, further reducing the potential for conflict. • The trials may also remove any potential issues with insuring the moorings if their effectiveness is proven during this stage. • With the National Trust as the Harbour Authority there is a unique opportunity to conduct any trails and the results of these could lead to seagrass friendly mooring systems being used in other places in the UK.	

6.3 The most suitable Option.

Examining the different options given above, Option 4 is recommended. The trials could be conducted in a variety of ways but the main aim would be to see if the use of seagrass friendly moorings is practical and safe at Porth Dinllaen, and whether it has a beneficial effect on the seagrass bed here.

One method would be simply to replace a few of the current traditional moorings with new systems. The only problem with this approach is that the recovery of seagrass in mooring scars can take some time (more than a year) and is far from straightforward (Collins *et al*., 2010). Also, it may be difficult to find volunteers to trial the new mooring system. To scientifically test the reduction of scarring caused by the new systems therefore, seagrass friendly moorings and traditional ones could be put in unscarred areas of seagrass and then the differences in the subsequent amount of scarring could be tested.

The effects of a voluntary no anchoring zone could be tested by surveying the area before it is put in place and then after a certain amount of time and then comparing this to a 'control' area of similar seagrass but where anchoring is not restricted and then compare the densities of seagrass between the two areas after a period of time. To complement this option in the intertidal area, a zone could be created on the beach for the launching of vessels, whist strongly discouraging the activity in other area on a voluntary basis. It is likely that the best place for this would be directly below The National Trust slipway so as not to hamper the activities of the fishing community. This area could therefore be seen as a sacrificial area in order to benefit the other areas of the intertidal zone.

7 Summary

- At Porth Dinllaen the seagrass bed covers an estimated area of 286,350 m^2 and has approximately 90 moorings. The impact of the 40 moorings in the outer harbour is causing fragmentation of the bed has been noted by previous surveys estimated to be 12,560m^2 (Morris and Goudge, 2008).
- In Wales generally there is a increasing number of recreational vessel users and this is also likely to be the case in Porth Dinllaen in the future.
- The best options of seagrass friendly mooring would be to use the Eco-mooring rode system in combination with a Helix anchor (or attaching to existing concrete blocks) or to use a train wheel in combination with high tensile rope and a subsurface buoy.
- The best option for management would be to conduct a trial of the recommended suitable systems in a small area of the bed and also to trial a voluntary no anchoring zone.

7.1 Conclusion

The situation at Porth Dinllaen provides a potentially valuable opportunity to trial the use of seagrass friendly systems. This option is suggested as being the most beneficial and least risky out of the options considered in Section 6 above. The trials would benefit not only the Porth Dinllaen seagrass bed, but if the technology is proven to be successful here and permanent ecofriendly moorings implemented, potentially to other seagrass beds in Wales and the rest of the UK. In order to progress any project in the right direction, it is recommended that surveys are undertaken to establish the best locations for any zoning. Further it would be vitally important to establish early communication with all stakeholders in order to involve the local community in the project and have regard to their views and suggestions. Such a meeting would also explain the importance of the seagrass bed and why the project is being planned. Hopefully such openness will help avoid the conflicts experienced by similar projects in the UK.

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