Eelgrass: the MarLIN MarESA Sensitivity Review in the Context of Anchoring Pressures

by Michael Simons, May 2017, for the Boat Owners' Response Group

As the Marine Conservation Zone (MCZ) programme for England progresses, it is clear that one of the more contentious issues is the sensitivity of eelgrass, the seagrass *Zostera marina*, to pressures from recreational boating, and especially anchoring. (It is generally accepted that some traditional chain moorings, in which the ground chain sweeps a defined radius of sea bed, can remove the eelgrass within that radius as the often very heavy ground chain sweeps to and fro. However the area affected is finite and limited, and it also depends on the weight and length of the ground chain. This discussion is not concerned with these known effects of chain moorings, but just with pressures from anchoring).

Formal survey data of eelgrass beds in Britain is limited, although there is a considerable amount of photographic evidence of increasing eelgrass bed extent in Studland Bay in particular, through historical aerial photographic data, recently supported by underwater video records. Certain authorities seem reluctant to acknowledge such evidence, and prefer to rely on vulnerability assessment processes. It appears at present that decisions on designation and management of MCZ's will be informed through such assessments.

It is therefore important that the vulnerability assessments are appropriate to the pressure concerned, rather than a generic one-size-fits-all. A garden spade has a very different impact to a JCB digger, and no one in their senses would claim it was otherwise. There is a danger that over-generalisation might occur with the assessment method used for the impact of recreational boating on eelgrass, leading to inappropriate decisions and disproportionate management measures, and that appears to be the case here.

MarLIN MarESA Assessments and Benchmarks

The assessments now being used are the MarLIN MarESA sensitivity assessments, which are a considerable improvement in transparency and evidence compared with previous assessments such as those in MB0102. The assessments for eelgrass are at
http://www.marlin.ac.uk/habitats/detail/257/zostera_marinaangustifolia_beds_on_lower_shore_or_infralittoral_clean_or_muddy_sand *(*URL *A)*
- and the assessments relevant to anchoring pressures are "Abrasion / disturbance at the surface of the substratum or seabed" and "Penetration or disturbance of the substratum subsurface". The former assesses Resistance as Low, Resilience as Medium, and Sensitivity as Medium, while the latter assesses Resistance as None, Resilience as Low, and Sensitivity as High.

The Marine Evidence based Sensitivity Assessment (MarESA) adopted by MarLIN requires descriptors of the pressure (e.g. magnitude, extent, duration and frequency of the effect) termed the ***pressure benchmark*** *(see* http://www.marlin.ac.uk/species/sensitivity_rationale *(URL B)).* In the case of the "Penetration" assessment for *Zostera marina*, the benchmark, revealed on clicking the + sign by the pressure title on the relevant page at URL A, appears to be the use of **heavy fishing gear** *("The deployment of fishing gears on seagrass beds results in physical damage to the above surface part of the plants as well as to the root systems………. Using a model simulation, it has been suggested that with favourable environmental conditions, seagrass beds might recover from dragging disturbance in 6 years but, conversely, recovery under conditions less favourable to seagrass growth could require 20 years or longer (Neckles et al., 2005). Resilience is thus assessed as'Low'. The mechanical harvest ofshellfish damaging the sub-surface of the sediments poses a very severe threat to seagrass habitats, yielding a 'High' sensitivity score.").*

It is here that questions arise. As actually noted in the "Resilience and recovery rates of habitat" section of the MarLIN MarESA assessment:

"The size and shape of impacted areas will also have a considerable effect on resilience rates (Creed et al.,1999). Larger denuded areas are likely to take longer to recover than smaller scars, ***for example seagrass beds are likely to be more resilient to physical damage resulting from narrow furrows left after***

anchoring because of large edge to area ration and related availability of plants for recolonization".

- and recovery time from a pressure is a key determinant of resilience to that pressure, and thus of the sensitivity to that pressure. It follows that the heavy fishing gear benchmark, in which a wide area is heavily impacted at one time, will not be an appropriate benchmark for leisure boat anchoring, in which very small well- separated areas are impacted on a number of separate occasions.

It is instructive to compare images of the benchmark heavy fishing gear and a typical leisure boat anchor of a size suitable for a 30 ft sailing yacht:

Left, close-up of the seabed-penetrating teeth on the cutting bar of a Newhaven pattern scallop dredge.

(Image from http://www.seafish.org/geardb/gear/scallop-dredge/)

Left, a gang or team of 4 scallop dredges being hauled up. The gang is about 4 metres wide and typically dragged along the seabed for hundreds of metres at around 2.5 knots (3 mph, 1.3 m/s). (Image from http://fisheries-conservation.bangor.ac.uk/).

A 1 km dredging run would impact 4000 sq m in a swathe 4 m wide.

Left, to the same scale as immediately above, a 10 kg leisure boat anchor. Note it is the triangular blade, which is 31 cm wide at its widest point, which penetrates the seabed. We estimate that when it starts to dig in, the process is complete within a few tens of centimetres, and the area of seabed affected is about 0.15 sq m.

A useful description of scallop dredging gear is given by Shephard at al (2009), and anchor dimensions may be found on the manufacturers' (eg Lewmar) websites.

Resilience Issues

In the case of leisure boat anchoring, an average anchor would measure about 30 cm wide, and this would be the approximate width of an area impacted or damaged by an anchor. In fact, anchor action is unlikely to remove all the eelgrass from the area: much of it will fall back into place when the anchor is removed, leaving viable rhizome pieces for vegetative regeneration. This is supported by the findings of Boese (2003) who subjected plots of 1m x 1m to either raking or digging treatments. The raking treatment used a four-tined hoe with tines 20 cm long. In the case of raking, the plots were raked three times, each treatment being a month apart, and the raking was not just a trivial scratching of the surface. The author reports:

"Each of the monthly clam raking treatments visibly removed large numbers of eelgrass leaves, some below-ground rhizomes and almost all green algae from each of the treatment plots. However, ***2 weeks after the last of these monthly treatments****, there were* ***no statistically significant differences*** *(t-tests,P > 0.05) between treatment and control plots in percent cover (Fig. 3A), Z. marina above- and below-ground biomass (Fig. 3B), Z. marina new leaf production and associated epiphytic growth (Fig. 3C)."*

These results point to a very high **Resilience** of the eelgrass to this treatment, which is probably not dissimilar to the action of an anchor but over a 1m x 1m area as opposed to the smaller 0.3 x 0.5 m area which an anchor might disturb. They also point to a high **Resistance** to the raking pressure, as two weeks is not enough for significant lateral growth from the undisturbed areas. Note that the MarLIN assessment for the heavy fishing gear benchmark is NO resistance, at the other end of the scale. Clearly the heavy fishing gear benchmark is not applicable to all forms of "abrasion and disturbance" or "penetration and disturbance". Further examples follow.

In the digging treatments reported by Boese, cylindrical cores of sediment (plus its eelgrass) 25 cm in diameter and 30 cm deep were removed from the seabed and deposited in a pile 0.8 m away. For these experiments he reports that the "mimicked recreational clam digging appeared to affect Z. marina above- and below-ground biomass measures determined 1 month after the final treatment. Although not statistically significant, these trends were evident 10 months after the final treatment."

So recovery was in statistical terms complete after 10 months. According to the MarESA criteria listed at URL B, recovery within two years denotes high resilience. Note that in this experiment, the whole core of sediment and eelgrass was physically removed, a much more extreme pressure than the digging in and pulling out of an anchor.

Two studies, Boese et al (2009), and Ruesink et al (2012), reported the experimental removal of the above and below ground eelgrass biomass from multiple 2x2 m plots: squares with 2 metre sides, far larger than any recreational anchor damage. Recovery, full eelgrass growth to the centres of the squares, took 2 years, although complete recovery in the former case took 30 months. Again, this suggests high resilience.

In these studies, the growth of new eelgrass inwards from the edges of the denuded squares was about 25 cm a year.

As shown by Boese et al (2009), and as is widely recognised in the literature, recovery of eelgrass from damage is generally driven by lateral rhizome growth from adjacent undisturbed areas. If we consider the case of disturbance by leisure boat anchors, the disturbed area is likely to be around 30 cm across, corresponding to the width of a typical anchor blade. Thus a lateral growth rate of 15 cm per year should allow repair or regrowth within twelve months, as lateral rhizome growth will occur from each side. A growth rate of 10 cm / yr should repair a 40 cm wide feature within two years. Thus a lateral growth rate of

10 cm or more a year should indicate High Resilience.

There are many measurements of lateral rhizome growth rates of eelgrass in the literature, we will cite a further four in addition to the 25 cm per year from Boese (2009) and from Ruesink et al (2012) mentioned above:

Olesen and Sand-Jensen (1994a), 16 cm /yr (range 0 – 31 cm /yr) in Denmark

Orth & Moore (1982) 15 cm over a 7-month growing season in Chesapeake Bay

Davis and Short (1997) 8 – 25 cm /yr in Great Bay, NH

and Neckles et al (2005) 12.5 cm /yr in Maquoit Bay, Maine

All these papers would suggest a **High Resilience** level for physically damaged eelgrass using a recreational anchor scale benchmark, and would suggest the Assessment of Low or Very Low resilience is not applicable to anchor damage pressures. A High level of resilience would be more appropriate.

<u>Resistance Issues</u>

Using the heavy fishing gear benchmark, the resistance of eelgrass to "penetration and disturbance" is given as None. This may be true of heavy dredging gear, but is clearly inapplicable to lesser degrees of pressure such as leisure boat anchoring.

In fact the very logic of the Resistance assessment is open to question: under the heading "Sensitivity Assessment" in the MarESA document it is stated "Seagrasses do not have an avoidance mechanism; resistance to this pressure is therefore assessed as 'None'." If the pressure involved total removal or death of all the eelgrass biomass then this would be true. However if the pressure resulted in displacement of plant fragments which remained viable and available for rapid regrowth, then this would constitute an avoidance mechanism by displacement, and the above statement would be untrue.

In fact Boese (2003), discussed above, found that just two weeks after intensive repeated raking treatments the eelgrass there was no significant difference in four measures of eelgrass health between treated and untreated plots. The implication is that the disturbed biomass, only part of which was removed, very rapidly recovered, which would suggest at least a moderate, and possibly high, resistance to the pressure via rapid regrowth of roots and shoots from the surviving rhizomes.

A systematic study of the effects of physical damage to the rhizomes of the seagrass *Zostera nolti,* a close relative to *Z. marina,* was carried out by Cabacao et al (2005). Their findings relating to physical damage are summarised*: "An experimental manipulation of rhizome fragmentation revealed that plant survival is reduced only when fragmented rhizomes are left with 1 intact internode. Shoot production and rhizome elongation and production of fragmented rhizomes having 2 to 5 internodes were not significantly affected, even though growth and production were lower when only 2 internodes were left. Experimental shoot damage at different positions along the rhizome had a significant effect on plant survival, rhizome elongation, and production only when the apical shoot was removed."*

So rhizomes of Zostera nolti are shown in that study to be capable of surviving a range of degrees of physical damage or loss and still remain viable.

It appears highly likely that eelgrass **does** have an avoidance mechanism (by displacement) in the case of physical disturbance by relatively small objects as in raking and leisure boat anchoring, and that at least some of the displaced biomass will be capable of rapidly re-establishing itself. Such a capability might be expected to have evolved anyway, as eelgrass is from time to time naturally subject to physical disturbance from wave action in rough weather, so a survival mechanism from such damage would be expected to have evolved.

We conclude that the assessment of **No** resistance to “penetration and disturbance” is not supported by evidence, logic, or common sense in the case of small-scale pressures such as leisure boat anchoring.

<u>The Importance of the Actual Area Impacted</u>

It is not possible to make a sensible assessment of the impact of leisure boat anchoring on a broadscale habitat feature without having at least some idea of the actual area of seabed impacted. In the absence of any other published data on this subject, the present author has published some quantitative estimates of the area of seabed affected by anchoring in a year, both for a real life anchorage (Studland Bay) based on observation and extrapolations, and for a theoretical closest-packed anchorage in which boats are assumed to fill a given area as closely as safe swinging radii will allow (Simons, 2014 A). In the case of the actual anchorage, the estimate is less than 1% of the seabed is impacted even in the most densely anchored areas, and in the theoretical closest-packed case substantially less than 2%. (These numbers apply to the area impacted by the anchors themselves, as there is little or no evidence that the anchor chains damage the eelgrass. Anchor chains are much lighter than the heavy ground chains used in traditional moorings, and in any case are not in the one area for more than a few hours).

So, even if the Resistance to anchoring pressures were assumed to be None, less than 2% of the eelgrass habitat would be impacted in a year, and because of the Resilience discussed above, growth would be fully re-established in a year or two anyway. No cumulative effect would be expected.

In a sense, the Resistance of eelgrass to leisure boat anchoring pressure could be assessed as High, because at least 98% of the eelgrass habitat would be unaffected by the pressure in any given year.

<u>Direct Evidence</u>

The above discussion considers the MarLIN MarESA assessment for sensitivity of *Zostera marina* beds to “penetration or disturbance of the substratum subsurface” based on a heavy fishing gear benchmark. The discussion draws attention to serious discrepancies between that assessment and a range of studies in the literature examining the effects of smaller scale disturbances relevant to leisure boat anchoring. Both the MarESA assessment and the critique offered here are desk top or literature-based studies. What of the real world?

It is a fundamental tenet of science that hypotheses (and these assessments are nothing more than hypotheses) – that hypotheses must stand up to the test of experiment or observation. If an hypothesis does not stand up to experimental or observational test, it must be considered invalid.

In the case of leisure vessel anchoring and eelgrass beds, there is an excellent test bed in Studland Bay, Dorset. Leisure vessels have been anchoring there in substantial numbers during the last sixty years and more, and eelgrass beds are present. A series of historic aerial images (Simons 2014 B) between the years 1972 – 2011 shows steady growth and consolidation of the eelgrass beds in the Bay, with a shoreward advance of the inshore edge of about 2 m per year.

Underwater video footage of the inshore eelgrass beds in the moorings area over about 300 linear metres shows dense, healthy eelgrass to be present, which provides some ground-truthing for the aerial images (Simons 2016). On the basis of this aerial and underwater evidence, there are grounds for believing that the eelgrass is in Favourable Condition as defined in MCZ designation orders, as its area is increasing and its condition appears to be healthy.

There is a tendency in some quarters to discount this evidence as it is not peer reviewed and does not conform to the conventional process of divers counting and measuring shoots within quadrats. We assert that the underwater video evidence is clear visual evidence of the existence and health of the eelgrass, and the aerial images are strong supporting evidence of the advance of the eelgrass beds.

However, for those who will only accept dived surveys and quadrats, we draw attention to the study carried out by Seastar Survey Ltd (Axelson et al 2012) (http://www.thecrownestate.co.uk/media/5290/Seastar%20survey%20Studland%20Bay%20second%20seagrass%20monitoring%20report.pdf) which conducted methodical dived surveys in the central anchoring area, and in October 2011, that area was found to have dense eelgrass at 55% coverage with an average shoot density of 208 shoots per sq metre, which the report said was "typical for the wider Weymouth and Portland area". Full details of the observations are given in the Dive Logs in the Appendix of that report.

There is then abundant evidence of extensive, healthy and expanding eelgrass beds in the Bay, in which leisure vessels regularly anchor in significant numbers. This is Best Available Evidence, and must be considered alongside the theoretical assessments.

How do these observed facts measure up against the MarESA assessment (whose only benchmark pressure is that of heavy fishing gear)? The assessment at that benchmark is Resistance, None; Resilience, Low; and Sensitivity (a combination of the two), High.

In the introductory notes to MarESA assessments (http://www.marlin.ac.uk/species/sensitivity_rationale (URL *B*)) it is stated that a Resistance level of None (the assessed level) is typified by

"Key functional, structural, characterizing species severely decline and/or physico-chemical parameters are also affected e.g. removal of habitats causing change in habitats type. A severe decline/reduction relates to the loss of 75% of the extent, density or abundance of the selected species or habitat component ….."

A Resilience level of Low (the assessed level) is typified by

"Full recovery within 10-25 years "

So if the MarESA assessment (hypothesis) were correct, taken at face value we would expect the eelgrass to be all dead. But it is not. It is thriving and it is increasing in extent.

Clearly the application of the MarESA assessment (No Resistance, Low Resilience) to leisure boat anchoring directly and without modification and interpretation would be inconsistent with the observed facts as well as inconsistent with a considerable number of reports in the published literature, as pointed out in earlier sections. To make any sense, account would have to be taken both of the actual area impacted by anchors, and of the dependency of resilience on the physical dimensions of any damage caused, as discussed above.

<u>The Case for Monitoring vs Theoretical Assessments</u>

The above discussion highlights the unknowns and uncertainties in attempting a theoretical assessment of sensitivity to a specific pressure, in this case anchor-sized penetration and disturbance of the sediment. And that is without considering local environment variables such as wave exposure, depth, turbidity and nature of the sediment, all of which could be relevant to the health and resilience of seagrasses.

It would make sense to embrace the enhanced capabilities of up-to-date technology, and actually observe and monitor the health and status of conservation features such as seagrass bed habitats, to look and measure rather than speculate and pontificate about things which may or may not be true. That, looking at actual evidence, is the way of proper science. The tools and operations need not be costly. Small photographic aerial drones allow aerial imaging when the sea state and clarity are suitable, and modern submersible cameras allow direct imaging underwater at low cost – the author used photographic equipment costing less than £200 to obtain high quality underwater videos and stills of the eelgrass beds in Studland Bay. The latest echo sounding technology used in fish finders such as the Raymarine Dragonfly equipment is claimed to give good acoustic imaging of seabed vegetation, which could probably include a measure of canopy height (or leaf length) in the case of seagrasses. These devices are currently priced at between about £200 and £500 in the UK, but substantially less if sourced from the USA. The use of such equipment should at least be explored.

In the case of static inshore conservation features, transparent and verifiable monitoring of feature health would help develop public trust in, support for, and compliance with conservation measures in a way which contentious proclamations by "experts" never could.

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