The effect of raking eelgrass as described by Boese (2002): a commentary

by Michael Simons, August 2014, for the Boat Owners' Response Group

This article is based on the publication

Effects of recreational clam harvesting on eelgrass (*Zostera marina*) and associated infaunal invertebrates: in situ manipulative experiments by Bruce L. Boese

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<u>From the section of the Abstract on raking:</u>

"The effect of recreational clam harvesting on eelgrass (*Zostera marina* L.) was experimentally tested by raking or digging for clams in experimental $1m^2$ plots located in a Yaquina Bay (Newport, OR) eelgrass meadow. After three monthly treatments, eelgrass measures of biomass, primary production (leaf elongation), and percent cover were compared between experimental and control (undisturbed) plots. Benthic macro (retained on 0.5mm mesh sieve) and mega (retained on 3mm sieve) infaunal samples were also taken to compare species number and abundances. **Results indicated that clam raking did not appreciably impact any measured parameter".** (emphasis by author of this article).

<u>Relevance to anchoring disturbance of eelgrass:</u>

Boese used a four- tined hoe having tines about 20 cm in length using a technique "similar to that used by recreational clammers". However he comments that "the intensity (repeated treatments) and spatial area ($1m^2$ units) of the raking disturbance used in the present study was greater than the intensity that I have observed being used by recreational clam harvesters."

The illustrative photographs (not from Boese's paper) in Figure 1, show very significant disturbance of the substrate, and since Boese raked 1m x 1m plots, the area affected was much greater than that affected by an anchoring incident. Note also that the raking was done not once, but three times at monthly intervals.

Boese's experiment would seem close to replicating the disturbance caused by an anchor penetrating the seabed and then being withdrawn, but worse.

Figure 1
From You Tube video of cockle raking in Coos Bay, Oregon
https://www.youtube.com/watch?v=YB0BdMzoS9o

The tines of the hoe appear to be approximately 20 cm long, the horizontal part being about 8 cm and the perpendicular claw 12 cm The width of the hoe is about 12 - 15 cm. Note the cockles here (bottom right) are larger than British cockles.

One difference between Boese's experiment and anchoring is that the eelgrass beds he used were inter-tidal, i.e. were exposed at low water, whereas where anchoring normally occurs any eelgrass would be sub-tidal – although small boats at Studland Bay can anchor, given sufficient rise of tide, over the inshore edge of the beds which is exposed at low water springs. However, compared with the practice of some conservationists of extrapolating the sensitivities of one species of seagrass (*Posidonia oceanica)* onto another *(Zostera marina* – which has entirely different characteristics), this is a relatively minor caveat.

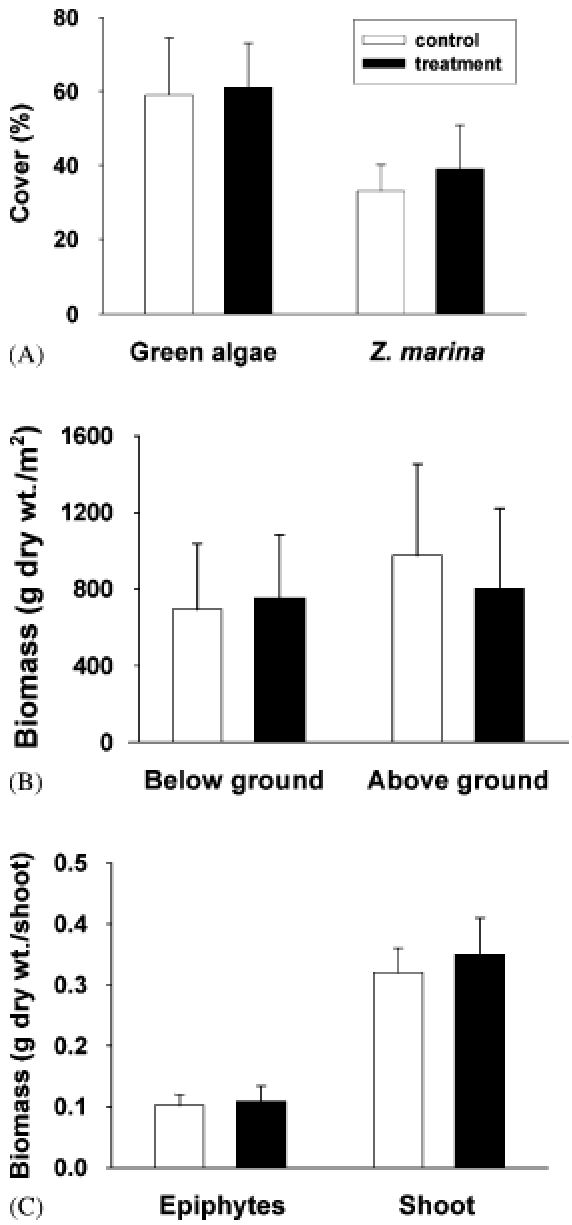
<u>What he did</u>

100 1x1 m plots in the eelgrass bed were identified for the study and 50 of each assigned on a randomised basis as either controls or experimental plots. The experimental plots were each raked as described in June, July and August 1998, giving three successive raking treatments each one month apart. Boese explains that "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."

Two weeks after the last treatment, measurements were made to determine percent cover of *Z. marina* and of algae, *Z. marina* above- and below-ground biomass, *Z. marina* new leaf production and associated epiphytic growth (Fig. 3C). (Full details are given in Boese's paper). Percent cover was estimated over the whole square metre by the point/intercept method, the other measurements by extracting carefully controlled samples from the plot, for each of the 50 replicates of treated and untreated control plots.

<u>What he found</u>

"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)."



Boese's Fig 3 (right)

Fig. 3. Comparison of plant metrics in clam raking treatment and control (undisturbed) plots measured 2 weeks following final raking treatment: (A) percent cover of *Z. marina* and green algae by point/intercept method; (B) *Z. marina* above- and below-ground biomass; (C) *Z. marina* new leaf biomass produced in 2 weeks and associated new leaf epiphytes. Values are mean + 2 S.E.M. (error bars).

Boese's Conclusions

In respect of clam raking, he states "Thus it appears unlikely that the recreational harvest of cockles by raking significantly damages eelgrass beds."

In the same paper he reports clam digging experiments in which 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 this test he reports "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." (Note the 10-month sampling was done before the start of the growth season following the experiment). Nevertheless, substantial regrowth had occurred.

Taking the two sets of results together he comments "Overall the results of this study indicate that recreational clamming is not a great threat to existing eelgrass beds in Yaquina Bay", then gives certain caveats but concludes "However, eelgrass is still present in areas of Yaquina Bay which have been intensively clammed by recreational clam harvesters for decades, suggesting that long-term effects are minor."

Implications for Eelgrass Response to Anchoring Pressures

A. Sensitivity of eelgrass

The fact that, just two weeks after three successive monthly treatments, treated and untreated plots were indistinguishable in terms of the measured parameters suggests that the eelgrass was **not sensitive** to the pressure applied. The depth of disturbance was similar to that expected of a medium size leisure boat anchor, and the area affected (1 sq m) substantially greater. (See http://boatownersresponse.org.uk/anchoring-density.pdf). This suggests that eelgrass may have negligible or low sensitivity to leisure boat anchoring pressures.

B. The "fragile rhizome mat" speculation

It has sometimes been suggested that eelgrass forms a "rhizome mat", and that physical disruption of this mat has dire consequences for the stability of the eelgrass bed in the vicinity. This appears to be conjecture rather than an observed phenomenon, and clearly was not the case in Boese's study. The seabed was thoroughly raked, rhizomes dislodged, but two weeks later it was indistinguishable from control areas.

C. The "repeated stress" argument

It has been argued that even if eelgrass is not badly affected by exposure to a pressure, it could be vulnerable to repeated exposure. While examination of the geometry of anchoring shows that impact on the same spot is unlikely within a boating season (See http://boatownersresponse.org.uk/anchoring-density.pdf), Boese's results showed rapid recovery after three successive treatments.

D. The MB0102 "assessment"

Boese's 2002 report bears directly on an assessment, in the report Tillin, Hull and Tyler-Walters (2010), also referred to here as the MB0102 document, of the sensitivity of eelgrass to mechanical pressures. These are defined in that report as "Shallow abrasion/penetration: damage to seabed surface and penetration < 25mm", also "Penetration and/or disturbance of the substrate below the surface of the seabed > 25mm", and the assessment in that report is of Very Low resilience and No resistance.

The MB0102 document explains that No resistance implies ***the loss of 75% of the extent, density or abundance of the selected species or habitat***, and Very Low resilience means ***Negligible or prolonged recovery possible; at least 25 years to recover structure and function.***

Boese's experiment undoubtedly subjected the eelgrass to "Penetration and/or disturbance of the substrate below the surface of the seabed > 25mm". However **full recovery** was measured just **two weeks** after the final treatment, and that could not have been possible had 75% of the eelgrass been lost.

In the light of this, the accuracy of the MB0102 Assessment, which was based on anonymous "expert opinion", and cited no evidence whatsoever, appears highly questionable. Boese's paper was published several years before the anonymous "experts" delivered their opinion, which raises the question were the "experts" not aware of the existence of the paper, or did they deliberately choose to ignore it? Either way, it does not reflect well on their expertise.

Are the findings of Boese (2002) supported by other studies?

While the recovery time reported in Boese (2002) is the fastest of which the present author is aware, a recovery time of up to 2 years is accepted as showing High Resilience or Recoverability. There are many examples in the literature showing recovery in 2 years or less.

Boese cites Peterson et al.(1987) (Peterson, C.H., Summerson, H.C., Fegley, S.R., 1987. Ecological consequences of mechanical harvesting of clams. Fish. Bull. 85, 281–298. http://fishbull.noaa.gov/852/peterson.pdf)

Their study was in North Carolina on (just) subtidal beds having a mixture of *Zostera marina* and the shoalgrass *Hallodule wrightii* having 0.1 - 0.3 m depth at low water. They carried out eelgrass raking experiments using rakes with 6 - 10 prongs of 14 cm length and also studied the effects of "clam kicking", a hydraulic harvesting method in which a powerful downwash from a boat's propellor is directed at the seabed. A light "clam kicking" treatment had similar effects to raking.

Immediately after a raking treatment in Spring 1981, dry seagrass biomass was reduced by some 30%. By Fall 1981, some 9 months later, it had recovered to 100% of the expected level, as had the light clam kicking area. On the other hand, areas which had intensive clam kicking hydraulic treatment, which removed much more material from the seabed, had not recovered 4 years later, showing that the extent and intensity of the disruption is a decisive factor.

Tallis et al (2009) simulated mechanical oyster harvesting with a toothed metal dredge and found recovery time varied with substrate: while recovery of eelgrass on a muddy site took 4 years, on a sandy site the initial decline was 15% and recovery occurred within one year. (Tallis HM,Ruesink JL ,Dumbauld B , Hacker S and Wisehart LM, *Oysters and Aquaculture Practices Affect Eelgrass Density and Productivity in a Pacific Northwest Estuary* , Journal of Shellfish Research 28(2):251-261. 2009 http://www.bioone.org/doi/abs/10.2983/035.028.0207

In addition to the above, the present author cites 12 further studies indicating recovery from small-area physical disruption of eelgrass in one or two years or less in *The Resilience and Resistance of Eelgrass to Short Term Mechanical Pressures: a Review* by M.J.Simons, July 2014, published at http://boatownersresponse.org.uk/Eelgrass-Resilience-and-Resistance.pdf

Possible Recovery Mechanisms

The studies discussed here, and others discussed in the reference immediately above, suggests two vegetative recovery mechanisms:

(A) where viable eelgrass fragments remain within the site of disruption, they can quickly produce new shoots and growth, as in Boese (2002), and

(B) rhizome growth from adjacent healthy areas can fill in gaps

In addition, recovery from the seedbank or from new seeds is possible.

Hence the wide variation in recovery times seen after damage to eelgrass beds. If the cause is over a wide area, and the damage extensive, recovery can take years, especially if the cause persists over more than two seasons, (as with continuing pollution for example), by which time the seedbank becomes non-viable. On the other hand, small-scale localised damage can repair rapidly, as discussed here. This should come as no surprise, as eelgrass beds on open coasts, as with Studland Bay, open to the east, will be subject to wave and storm damage from time to time, so robust recovery mechanisms will have evolved to ensure the survival of the species.