NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

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Macroalgae Biomass Component Report – OMB RT09 2018

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MACROALGAE BIOMASS COMPONENT REPORT FROM THE CONTRACTOR SCHEME OPERATION –2017-18

1 Introduction

To enable correct water quality classification and good management decision-making, quality control of biological data is a high priority. This extends through all biological elements including macroalgae and seagrass. Good quality control ensures consistency of data being reported for management purposes, and for macroalgae and marine angiosperms this has been driven, primarily, by the requirements of the Water Framework Directive. This QC scheme aims to facilitate improvements in biological assessment whilst maintaining the standard of marine biological data. The scheme should help to ensure consistency between analysts with improved confidence in ecological quality status.

The Northeast Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme addresses several issues relating to macroalgae and seagrass data collection, this report focuses on just one of these:

- The determination of algal biomass

This is the Ninth year in which biomass of macroalgae has been included as an element of the NMBAQC scheme and was included as a single exercise. The format followed that of previous years of the test (OMB RT01 – RT08 - see NMBAQC website). Test material was distributed to participating laboratories from which data forms were completed with algal biomass results and returned for analysis.

Nine laboratories were issued with test material. All nine laboratories completed the macroalgae biomass component of the NMBAQC scheme. All of the participating laboratories were government; no private consultancy took part in this component of the macroalgae exercises. To ensure consistency between scheme years, each participating laboratory was assigned the same laboratory code as in previous years except where a laboratory was new to the scheme.

Due to the limited number of samples distributed, only a single set of results was permitted per laboratory unless more than one test was requested. It was possible for each sample to be completed by a different participant; however, this was not recorded within the results. Individual laboratories may look at such results internally.

Currently this scheme does not specify a definite qualifying performance level, and NMBAQC ring tests may be treated as training exercises. However, certain targets have been applied to the assessment of the results based on Z-scores allowing “Pass” or “Fail” flags to be assigned accordingly; these may be used by competent monitoring authorities for internal monitoring of performance. These flags have no current bearing on the acceptability of data from such participating laboratories. Ring tests offer a means of assessing personal and laboratory performance from which continued training requirements may be identified, or from which improvements in current field and laboratory procedures may be addressed.

Samples are synthetic, rather than composed of natural algal material. Natural samples would be subject to deterioration, and it is not feasible to ensure that each participant would receive a truly equivalent sample. This is in line with guidance on general requirements for proficiency testing (BS EN ISO/IEC 17043:2010).

1.1 Summary of Performance

A single test consisting of three biomass samples was distributed. This year each sample consisted of a different synthetic material including j-cloths, wool and synthetic stuffing material. These are

currently considered the most representative materials in terms of imitating the overall look and feel of various opportunist macroalgae species. Cloths and wool were cut to different lengths and sizes to represent different foliose and filiform taxa (e.g. Ulva). The synthetic stuffing is considered to be more representative of finer opportunist algae such as Ectocarpus sp. and Chaetomorpha sp. Each sample was contaminated with debris and sediment of a sandy-muddy nature consistent with the substrate type known to support opportunist macroalgal blooms.

Results for wet weight of biomass varied between laboratories with some laboratories producing high measures of biomass compared against the average biomass and actual/expected biomass. The dry weights showed a similar level of variability. Two laboratories failed to remain within the Z-score limit of +/- 2.0 for both the dry weight and wet weight against the mean despite the high standard deviation caused by the high range of results.

Four further laboratories showed significant deviation from the actual sample dry weight with a further three 'Fails' against wet weight. It is worth noting that this means of assessment is not as accommodating towards outliers. There was a total of eleven 'Fails' across all assessments of which seven could be attributed to one laboratory. No one sample resulted in significantly more or fewer 'Fails' with all receiving 3 or 4 'Fails'. Two laboratories had dry weights lower than that of the actual dry weight, suggesting minor losses of material during the rinsing process, however in most cases this loss was very minimal and had limited effect on the overall results.

2 Summary of Macroalgae Biomass Component

2.1 Introduction

There was one exercise for the assessment of biomass of macroalgae which took the form of three representative artificial samples. This exercise is described in full below to include details of distribution and logistics procedures for determination of biomass, completion of test result forms and full analysis, and comparison of final submitted results.

2.2 Description

This exercise examines the participants' ability to process macroalgae samples to extract values of biomass for wet and dry weight. The exercise assesses the differences in sample processing efficiency and comparability of results using Z-scores. Comparison of participating laboratory results can highlight anomalies in processing at various stages of the methodology.

One set of three representative samples was distributed to each participating laboratory in January 2018. Participating laboratories were required to submit biomass results for both wet and dry weight. The sample material was consistent with that of OMB RT08 including cloths, wool and synthetic stuffing. Non-biological and non-algal biological material was added to simulate contaminating materials encountered in the field.

2.3 Logistics

Each sample was distributed within an airtight plastic container. Each sample within the container was separately sealed within a zip lock plastic bag to retain moisture. The samples were distributed either via first class mail or recorded delivery, depending upon the recipient's requirements. All instructions and additional test material was distributed on CD, within the parcel, to each laboratory. Each disc contained a description of methods and data submission forms. Participants were given six weeks to

complete the test and return the results. Only one set of results could be submitted per set of samples although it was possible to have up to three participants complete the sample analysis.

Email has been the primary means of communication for all participating laboratories subsequent to the initial postal distribution of test material.

2.4 *Preparation of the Samples*

To assess the accuracy of determining biomass of opportunistic macroalgae, samples were distributed consisting of j-cloth, wool and synthetic stuffing material that had been cut and finely shredded in order to mimic species of *Ulva*. These alternative materials were deemed to be the most representative of actual opportunist species and were based on suggestions from previous ring test feedback forms. Three representative samples were supplied for subsequent processing. Sediment and debris commonly found within areas of opportunist algal growth were mixed into the samples with small amounts of water. For each sample, wet weight and dry weight had to be ascertained.

The sample were labelled from A to C. Samples of identical original dry weight were provided for all participants.

Sample A – 73g

Sample B – 47g

Sample C – 15.5g

Due to the nature of the samples they could be kept for several days retaining most of the moisture. However, much of the water was removed prior to distribution to reduce weight during transportation therefore it was necessary for participants to add additional water to each of the samples prior to commencement of the tests to enable rehydration of the material and aid with rinsing.

2.4.1 Method for Wet Weight

The laboratory instructions stipulated that each of the samples required rinsing free of all sediment. The samples should be fully washed in a bucket or sieve to ensure no loss of sample material until the water runs clear and all debris is removed. Once the samples are adequately washed they are squeezed of excess water. This is achieved by hand, using samples no larger than the size of a tennis ball, to ensure it fits in the palm of the hand, and can still be squeezed properly. Where the sample was large, it should be divided into smaller clumps for squeezing. The samples are squeezed until no additional running water can be removed by hand, but the sample should not run green, as this indicates damage to cell membranes (over-enthusiastic squeezing of actual algal samples can damage cell membranes and lose 'genuine' weight). At this stage the whole sample is weighed on a calibrated balance to two decimal places. The exact method used for rinsing and squeezing should be consistent with that used in the field; this may vary between laboratories.

2.4.2 Method for Dry Weight

Once each of the samples has been wet weighed they are spread out on a sorting tray or similar container. By spreading the samples this aids with the drying process. The samples are left to air dry for at least 24 hours, but this may be longer depending on the size of the sample and the temperature of room. The samples should be checked regularly, and the drying/weighing process is continued until constant mass is achieved, recording weight to 2 decimal places. The unchanged dry weight is the final weight to be submitted.

The same process is required for all 3 samples.

2.5 Analysis and Data Submissions

A pre-prepared spread sheet was distributed with the exercise instructions to standardise the format in which the results were submitted. These results will be retained and stored appropriately. Each Laboratory was required to submit a dry weight and a wet weight for each of the 3 samples provided. Laboratories were permitted six weeks to complete the sample analysis and submit results.

2.6 Confidentiality

To preserve the confidentiality of participating laboratories, each participant is allocated a four-digit laboratory code from which they can identify their results. These codes are randomly assigned. The initial letters (MA) refer to the scheme, this is followed by the scheme year which refers to the year in which the NMBAQC scheme originally commenced, and the final two digits represent the laboratory. For example, laboratory twelve in scheme year twenty-five will be recorded as MA2512.

2.7 Results

2.7.1 General Comments

In total nine laboratories signed up for the biomass component of the macroalgae element for OMB RT09 and nine laboratories returned both wet and dry weight data. The results have been collated and presented in various formats to enable full comparisons both between laboratories and against actual sample weights.

Details of each participating laboratory's performance were distributed in the OMB RT09 Preliminary Bulletin Report, which represents a summary of the results for RT09. The Bulletin provides 'Pass' and 'Fail' flags to each data set to highlight deviation from sample mean and actual results. Values of Z-scores were used to apply the 'Pass' & 'Fail' assessment.

Z-scores, calculated to indicate how much each participant's weight results deviated from the mean, used the following formula:

$$Z = \frac{X - \mu}{\delta}$$ where μ is population mean and δ is the standard deviation

A Z-score of greater than +/- 2.0 was considered to be outside an acceptable limit of deviation from the mean. This value was assigned a 'Fail' or 'Pass' flag on the data. However, it should be noted that 9 sets of data are not considered a large sample size for deriving Z-scores.

2.7.2 Returns from Participating Laboratories

The raw data (Table 1) indicates a wide range of both wet and dry weights. Sample A, which had the greatest algal mass showed a wide range of results for both dry and wet weights however Sample B had the overall greatest range of 85.1g. This was not consistent with all previous OMB tests. However, sample C (15.5g) showed, proportionally, the smallest degree of variation in both wet and dry weights between participants. For wet weight the range of results was 248.32 – 318.3g (Sample A), 113.4 – 198.5g (Sample B) and 63.77 – 93g (Sample C). There was one slight outlier in the wet weight results from lab MA2511 with a wet weight of 248.32g for sample A. Although this was lower than the expected wet weight of 293.2g the mean wet weight for this sample remained consistent with the expected at 290.64g. Sample B showed consistently significant deviation from the expected biomass with an average deviation of 30.71g which lowered the mean biomass considerably to 158.66. Sample

C, which was the smallest of the biomass samples also showed a larger average deviation than would be expected which could, in part, be attributed to one larger outlier from lab MA2517. The large degree of variation in wet weight results are primarily a result of the non-specific method of squeezing and rinsing as this is an element of the exercise that cannot be measured successfully and can vary significantly between participants. This is particularly evident with the larger sample sizes where there is a greater chance of error. There is clearly still a lack of consistency between laboratories during the rinsing and squeezing of the samples particularly within the larger sample size (Samples A and B).

Table 1. Raw Data results from each laboratory including both dry and wet weights.

	Sample A		Sample B		Sample C	
Lab Code	Wet weight 293.2g	Dry Weight 73g	Wet weight 189.38g	Dry Weight 47g	Wet weight 63.60g	Dry Weight 15.5g
MA2510	294.42	78.654	137.68	48.354	76.52	16.082
MA2503	297.3	73.3	154.4	46.6	66.4	15.2
MA2502	305.15	140.28	153.5	49.86	68.41	15.6
MA2509	274	74.6	198.5	48.3	80.1	15.7
MA2534	303.1	73.4	113.4	47.1	64.8	17.6
MA2519	277.2	133.91	164.93	49.67	77.11	16.05
MA2517	298	151	169	63	93	46
MA2511	248.32	76.6	166.36	49.77	63.77	15.99
MA2537	318.3	73.1	170.2	47.3	75.7	15.4
Max	318.3	151	198.5	63	93	46
Min	248.32	73.1	113.4	46.6	63.77	15.2
Range	69.98	77.9	85.1	16.4	29.23	30.8
Average	290.64	97.20	158.66	49.99	73.98	19.29

The level of variation in dry weight was also consistent with previous years with sample A Showing the greatest range of results and the average dry wet of 97.2g being substantially higher than the actual dry weight of 73g. This large deviation from the actual dry weight was not evident within the other two samples (Samples B and C). The dry weight results also displayed a few large outliers. Laboratories MA2502, MA2519 and MA2517 submitted results considerably higher than the actual dry weight of sample A. These results were between 60.91g and 78g higher than the actual dry weight. This causes a skew in the overall results and a significantly higher mean and standard deviation than would be considered acceptable further masking the degree of variation in the results and the extent of the outliers. Consequently, these outliers were not highlighted as 'Fails' during the z-score calculations. The results from these laboratories indicate some problems during the processing of the samples. This may be due to procedures used, inadequate rinsing or incomplete drying. Given that the wet weight values from these labs for sample A were relatively consistent with the average the data suggests that possibly the samples were not dried fully prior to weighing or some of the debris was retained within the sample. This could be attributed to the material used for this sample causing it to take longer to dry. However, lab 2517 showed consistently higher dry weights than the actual weights for all three samples, suggesting a laboratory error.

The range of results for both the dry and wet weights (as seen in Bulletin OMB RT09) when compared against the mean could overall be considered acceptable with only four 'Fails' suggesting a good

degree of consistency in practiced methods, albeit higher than in the previous year. However, the mean weight value for both wet and dry weight was higher than expected for some samples and, consequently, produced a much higher standard deviation, which does not allow the Z-scores to successfully reveal the outliers. Unlike in previous years the level of error could not be related to the actual sample size with all three samples producing at least one 'Fail'.

In total three results were flagged as 'Fail', when using Z-scores based on the actual dry weight of samples. All three 'Fails' could be attributed to one laboratory. The level of error from this lab was also consistent with the wet weight results as seen below.

The expected wet weight was calculated using all historical NMBAQC data including the current years data. The expected wet weight is based upon the known dry wet from which a scatter plot of dry and wet weight results can be plotted producing a best fit trendline and corresponding linear equation. This linear equation can be applied to the known dry weight to allow an 'expected' wet weight to be calculated from which all wet weights may be compared. The linear equation applied to this years data was $y = 3.993x + 1.706$. The 'expected' wet weight for samples A, B and C were 293.2g, 189.4g and 63.6g respectively.

The comparison of results against expected wet weight produced 4 'Fails' which were distributed across all three samples. The range of wet weight results for Sample B were all lower than the expected wet weight which can also be seen in Figure 3 in the results bulletin. For sample C the range of wet weight results were more consistently higher than expected and Sample A showed a broader ranger of results neither consistently higher or lower than the expected. It is unclear as to the reason for this variation between samples. The exceptionally high standard deviation prevented further samples from being flagged as significantly deviating from the expected wet weight despite the broad range of wet weight results. Unlike with the dry weight results these 'Fails' were distributed across four laboratories; MA2510, MA2534, MA2517 and MA2511.

With the exception of two laboratories (MA2503 and MA2537) all dry weight results were higher than the original sample weight. This is to be expected during the exercise. The two lower dry weights for sample A were insignificant and do not detract from their level of accuracy but could indicate a slight loss of material during the rinsing process particularly due to the fine nature of the synthetic stuffing. Across all test comparisons for both wet and dry weight there were a total of eleven 'Fails' of which seven could be attributed to one laboratory (MA2517).

2.8 Discussion

Of the nine samples distributed, all nine laboratories submitted results. Although many of these laboratories do not routinely measure dry mass for macroalgae, this is still a necessary part of this exercise as it enables the procedure to be reviewed for inter-laboratory differences. If samples are dried to a level where the mass remains unchanged then a result that lies well above the actual dry weight is a clear indication that the sample has been insufficiently rinsed and it is the additional particles that are adding to this increased weight. This will contribute to both an overestimation of wet and dry weights. Seaweed is much harder to rinse especially in the field so may contribute to an overestimation of the levels of biomass present. Equally some laboratories do not measure wet weight only recording the final dry weight. Dry weight could be considered a much more accurate measure of biomass since this measure has fewer variables, i.e. it is only dependent upon the removal of debris and not the degree of pressure during squeezing. However, both measurements need to be incorporated into the test to cover all the different measurements and procedures utilised.

The level of accuracy remains greater for comparisons of dry weight than for wet weight, for reasons given above. However, this tends to be significantly less for smaller or mid range sample weights e.g. weight from 10g to 40g. This suggests the techniques used between laboratories to rinse and squeeze vary considerably and may also do so between participants within the same laboratory. The lack of consistency in wet weight indicates a high level of variation in pressure applied during squeezing of samples. However, this is highly difficult to regulate between field workers. It is the wet weight that is most commonly used during routine opportunist monitoring, therefore this lack of consistency in methodology should be fully addressed within the standard operating procedures especially in association with areas of high biomass. Each lab should have its own in-house training and competence assessment measures. It is recommended within the test methods that '*Where the sample is large it should be divided into smaller clumps for squeezing*' and *'This should be achieved by hand using samples no larger than the size of a tennis ball to ensure it fits in the palm of the hand and can be properly squeezed*'.

Most laboratories produced a dry weight greater than that of the actual biomass of the sample; this would be due to insufficient drying or rinsing of the sample a level of which can be expected during such a test. However, two laboratories produced dry weights less than that of the actual biomass which is likely due to a slight loss of material during rinsing. Furthermore, the significant deviation in results from laboratories MA2502, MA2519 and MA2517 for Sample A dry weight, compared with the and actual weights, produced an exceptionally high standard deviation (33.72) making it impossible for the analysis to pick up any smaller deviations from actual biomass without removing the outliers. The standard deviation across all three samples was considered quite high.

There was, as in previous years, a slight trend whereby the level of deviation from actual biomass increased as the sample biomass increased although the smallest biomass (sample A – 15.5g) did show more sample deviation than the mid-range Sample B (47g). There is no apparent reason for this, the larger biomass may be more difficult to rinse free of debris or possibly it is more difficult to squeeze or dry thoroughly. Equally the very small sample size may just as difficult to squeeze. This is equally something that should be addressed within individual laboratories as well as across standard operating procedures to reduce this level of error. Laboratories may wish to check internal samples for this pattern.

It may be considered, in this years test, that the range of wet and dry weight results between samples could again be attributed to the different materials used. This is the second year in which the materials have been used separately, as opposed to mixed material samples as in previous years, thus it is possible that some materials are much easy to rinse and squeeze than others leading to more accurate and consistent results between participants. Given the results from this years test it is also possible to speculate that it is much more difficult to obtain an accurate dry weight for the wool material which had the highest degree of variation and considerably higher dry weight results. If the same format is adopted for following years, it will be possible to gather sufficient data to compare the attributes of the different materials used and how they respond to the squeezing and drying. It is hoped that any visible trends can be applied to both the test and to field procedures.

In general, the results were comparable with those from previous years. The ring test can provide evidence of problems in the measuring of biomass samples, such issues require addressing through workshops and specifically aimed training. Hopefully on receipt of the results bulletin those laboratories with outliers will also be able to review the procedures adopted during the processing of their samples.

It should be further highlighted that the 'Fails' do not necessarily signify poor quality data they merely flag those results which show significant deviation from either the actual sample weights or from the

average and should be investigated. These flags have no current bearing on the acceptability of data from such participating laboratories.

3 Conclusions and Recommendations

A number of observations may be made from the results of the exercise and from participants' feedback which have been summarised below:

1. Despite the artificial nature of the sample material, the test has been generally well accepted by all laboratories with constructive comments on points of possible improvements. All laboratories found the test useful despite the differences between the use of artificial material compared with actual macroalgae samples.

2. All samples arrived in good condition and in time for the commencement of the test.

3. It seems there is now a general agreement that the use of artificial material to mimic algae is an acceptable surrogate for the test. This is the third year in which synthetic stuffing has been used to mimic much finer opportunist algae such as *Pilayella* and *Chaetomorpha* and has been well received and considered at this time the most representative of the three materials. It is appreciated that the use of synthetic materials do not fully represent the conditions experienced within the field. It may be possible in the future to utilise alternative materials that may be more representative of the texture and general nature of opportunist algae but at this stage alternative materials have not been tested with the same success rate. Throughout the nine years of the OMB ring test there has so far been no consensus on the preferred material of use and can depend on the current opportunist blooms being experienced in the field. In contrast to previous years the wool was considered more challenging this year retaining more sediment and water which could account for the higher dry weights.

4. This has been the second year in which each sample has consisted of a different artificial material which has enabled a better comparison against actual macroalgae samples. Due to the mixed opinions on which material is the most representative all three materials will continue to be used for future tests or until a more realistic alternative is sourced. However, it was suggested at least one of the samples be a combination of all three materials to represent mixed algal stands in the field and more realistic sampling conditions.

5. During this ninth cycle of the macroalgae biomass exercise all participating laboratories submitted results within the designated timescale. All laboratories should continue to submit results within the requested deadlines as detailed at the beginning of the exercise. Reminders will continue to be distributed two weeks prior to the completion of the exercise to aid with this process.

6. This year all laboratories submitting results managed to complete both wet and dry weights for all samples, however some participants still question the necessity to incorporate both dry and weights within the ring test. Although many in-house field procedures do not incorporate dry weight of algal samples these values are included within the NMBAQC scheme to enable comparison of laboratory procedures. The values provide evidence of insufficient rinsing of samples, whereby the dry weight would be considerably higher than the actual dry weight. Also, there is no definite wet weight from which to compare the individual laboratories submissions, so it is difficult to conclude which results are the most representative. The dry weight however can be compared directly with the original weight of the samples which was measured very accurately prior to addition of debris. Most laboratories submitted dry weight values that were considered well within an acceptable limit of the actual biomass; however wet weight remains

highly variable. Therefore, the level of squeezing remains an issue within the overall procedure and should be addressed. In addition, some laboratories only measure the dry weight therefore, for such an exercise to be appropriate for such laboratories; this measure of biomass needs to remain within the test. It is in all laboratories' own interest to complete all aspects of the test. Submission of partial results may hinder any explanation of outliers and skew statistics due to the relatively small data sets. During subsequent ring tests, all laboratories should continue to complete the full exercise even if it is not part of their routine monitoring to maximise the usefulness of the ring tests.

7. There are further requests that more *Hydrobia* could be added to the sample or material to mimic Hydrobia. This is something that has been considered and all attempts will be made to incorporate it into future tests.

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8. It is evident that the larger samples create a greater margin of error with far less consistency between laboratories. However, it has been suggested that these samples are more appropriate in terms of representing natural conditions. This will be taken on board when compiling future tests whereby they will be aimed at including a good range of weights but focusing on some much larger biomass weights.

9. There may be future requirements to include biomass analysis within a workshop to further discuss processing procedures and levels of intensity for manual removal of debris and water. This has been suggested by some participating laboratories and may be considered a more realistic measure of quality assurance. This is something that requires further discussion as to the nature of the approach.

10. Several laboratories submitted results of less accuracy than others. It is stipulated that both wet and dry weights be provided to 2 decimal places where possible. This will highlight smaller variations in weight as the samples are relatively small compared with some field samples. However, if this is not feasible for some laboratories then measurements to the nearest gram are also acceptable but it needs to be recognised by participating laboratories that such measurements will be less accurate particularly with smaller sample sizes. In the instance where the dry weight recorded is less than the actual weight this may be an indication of loss of material but may also be linked to the accuracy of the scales. It is recommended that all laboratories use calibrated scales to reduce such minor discrepancies.

11. It is requested that all laboratories fill out the result spreadsheets provided and include *all* the required information. Data presented in Word files or within emails is very inconvenient when collating and storing the results and will not be accepted in subsequent years. If this does occur a request will be sent for the data to be completed in the correct format. Not complying with instructions can create significant extra work and may result in data discrepancies particularly where there are underlying formulas. It is also requested that only the final dry and wet weight results be submitted and not the interim results, this is to eliminate error in the transferring of data and these additional results are not required as a part of the test.

12. There is some question as to whether the methodology for both wet weight and dry weight is being read and followed consistently across all laboratories. This applies to the appropriate squeezing of samples and the removal of debris. It is clear in the methods that when working with a large biomass this should be split into smaller sizes such as the size of a tennis ball, to ensure they can be squeezed properly. Any attempts to squeeze the sample as a whole will result in too much residual water being retained within the sample and increase the wet weight. This can affect the whole sample and increase the average. It is also clearly stated that the material used

to mimic the algae is J-cloth, wool and synthetic stuffing, any other material within the sample may be considered debris and should be removed during the washing phase. Failure to remove the debris will result in much higher wet and dry weights. The length of time required to dry the samples may also vary from sample to sample and from lab to lab and if the samples are not completely dried or thoroughly checked prior to weighing this can result in a dry weight significantly greater than the actual dry weight. These points will be made clearer in future methodologies. In future tests extreme outliers may also be removed from the analysis to highlight minor discrepancies between labs.

13. The differences in sample processes have become evident through the degree of variation in the results submitted. There needs to be a greater level of consistency in the methodology utilised for both rinsing and squeezing of samples and documented in guidance procedures to be distributed to all laboratories involved in such practices. There are often several outliers which significantly skew the results and affect the average weight which is used to compare all other results. If this average is abnormally high or low, it will affect the outcome of some laboratories results which might otherwise be considered acceptable.

14. It has also been questioned whether the procedures of the test should be followed or those of the individual laboratory. The two methods may vary in terms of the amount of squeezing pressure applied to the sample. It is important that an individual laboratory has consistent results that are comparable from year to year. However, if they are consistently higher of lower than other labs they may be under or overestimating the actual biomass, particularly with regards to wet weight, which may then be reflected in the overall classification of a water body when applying the WFD blooming tool or any other quality status assessment.

If anyone has further thoughts on this, or disagrees with any of the interpretation, please pass forward your comments to Dr Emma Wells (emma@wellsmarine.org). This ring test is now in its seventh year and although proving successful it is still open to continual refinement.