NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

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Macroalgae Component - Algal Identification Module Report – RM RT13 2019

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MACROALGAL IDENTIFICATION MODULE REPORT FROM THE CONTRACTOR SCHEME OPERATION –2018-19

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

- The identification of macroalgae species

This is the Thirteenth year in which the identification of intertidal macroalgae has been included as an element of the NMBAQC scheme, with the format following that of previous years. Test material was labelled and distributed to participating laboratories using previously employed procedures, from which species identification forms were completed and returned for analysis.

Six laboratories subscribed to the macroalgae ring test with all six laboratories submitting results with a total of thirteen participants. Three of the subscribing laboratories were government organisations and two were independent consultancies. 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. Individual codes may, however, change slightly due to variations in individual participants. Due to the nature of the exercise there was no limit on the number of participants per lab.

Currently this scheme does not specify a definite qualifying performance level, and NMBAQC ring tests may be treated as training exercises. However, a pass rate of 80% is suggested as an indicator of good performance, which may be used by competent monitoring authorities for internal monitoring of performance. 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.

1.1 Summary of Performance.

This report presents the findings of the macroalgae identification component for the twelfth year of operation within the National Marine Biological Analytical Quality Control (NMBAQC) Scheme. This component consisted of a single macroalgae exercise the analytical procedures of which remained consistent with round twelve of the scheme (RM RT12). The results for the exercise are presented and discussed with comments provided on the overall participant performance.

Images of twenty macroalgae specimens were distributed to the six subscribing laboratories. Round thirteen of the ring test produced a good degree of agreement between identifications made by participating laboratories and initial identification as made by Wells Marine. The ring test tried to incorporate a variety of common and more challenging species including some microscopic and epiphytic species.

The level of performance between laboratories and participants varied, with scores ranging from 29, with 4 incorrect genus names and 7 incorrect species names, to 40, with all species correctly identified. All participants correctly identified six species. Most incorrect species identification were

made at the species level with five species showing considerably difficulty at both genus and species levels. Overall the level of identification was relatively consistent with the previous year with a high level of knowledge of the common species and increased knowledge of the more challenging and unusual species.

2 Summary of Macroalgae Component

2.1 Introduction

There was one module for the macroalgae identification component for scheme year thirteen. This module is described in full below to include details of distribution and logistics, completion of test result forms and full analysis and comparison of final submitted results.

2.2.1 Logistics

The test material was distributed on CD to each laboratory with labelling and distribution procedures following those of previous years. Each disc contained the full identification module including photos and additional habitat, geographical, textural, and size details from which to identify specimens as well as description of methods and data submission forms. Participants were given six weeks to complete the test and return the results. There were no restrictions on the number of participants per laboratory.

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

2.2.2 Analysis and Data Submissions

A prepared results sheet was distributed with the exercise instructions to standardise the format in which the results were submitted as per previous years. All returned data was done so in Excel and has been stored and analysed in this format. In this and previous scheme years slow or missing returns for exercises lead to delays in data processing data, reporting and feedback of results, therefore reminders were distributed two weeks before the exercise deadline.

2.2.3 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 original commenced, the final two digits represent the laboratory. For those laboratories where multiple submissions were provided the four-digit code is followed by a letter allocated to each participant of that laboratory. For example, participant c from laboratory twelve in scheme year twenty-six will be recorded as MA2612c.

2.3 Macroalgae Ring Test (RM RT09) Module

2.3.1 Description

This training module enables the inter-laboratory comparisons of participants' ability to correctly identify macroalgae taxa and whether errors may be attributed to inadequate keys, lack of reference material or incorrect use of satisfactory keys.

One set of photographs for twenty specimens was distributed in January 2019. The specimens included a range of Chlorophyta, Rhodophyta and Phaeophyta and a mix of macroscopic and

microscopic specimens from a variety of habitats including epilithic, epiphytic and endozoic species. There were several photographs per taxon showing different aspects of the alga and its habitat. Some supplementary information on habitat, zonation, geographical location, general size, texture, and any additional information considered vital for correct identification, was included.

2.3.1.1 Preparation of the Sample

Each specimen was to be identified through several in-situ, macroscopic and microscopic photographs. In total a minimum of five photographs was used for each specimen collected by Wells Marine for this exercise. Specimen photographs were obtained from a range of surveys from around the coast of the UK. Photographs were selected to sufficiently represent each specimen including in-situ (where possible), overall structure, branching patterns, cellular arrangements and cell contents making sure to include key characteristics for accurate identification. Scale bars were included where appropriate. Attempts were also made to ensure a high quality of photographs primarily focusing on clean specimens with sharp photographs.

Using a photographic test is considered a more practical means of testing macroalgal identification skills than preserved samples. These are known to lose colour rapidly and cell contents may become distorted making key characteristics more difficult to distinguish. Equally, fresh samples would not last a sufficient period to enable identification. It may also be difficult to obtain sufficient numbers of more unusual taxa for distribution to all laboratories.

2.3.1.2 Analysis Required

The participating laboratories were required to identify each of the macroalgae specimens from the photographs provided. Additional information should also be submitted including brief notes, information on keys used or possible problems with identification or quality of photograph provided. Expressing the level of confidence of identification should also be detailed, as this can aid in results of any disputes and in the preparation of reports. Participating laboratories were permitted to submit multiple data entries for each exercise to maximise results and allow sufficient comparisons of data entries. The protocol for circulating and completing the module followed that of previous years with six weeks allowed for the identification and submission of results.

2.3.2 Results

2.3.2.1 General Comments

The scheme has taken on the same format as previous years; this includes the format of the test and method of data analysis and scoring. The macroalgae ring test can act as a training aid in the identification of species allowing those difficult taxa to be revealed and further identifying problematic areas.

For this current round of the scheme (RM RT13) specimen photographs were circulated to a total of six laboratories. All six of the laboratories returned data entries with a total of ten individual data sets.

Results were distributed to each of the participating laboratories four weeks after data submission. These results are documented in the preliminary results bulletin (RM RT13) which detailed individual scores and highlighted incorrect identifications, miss-spellings and use of synonyms. The bulletin also outlined reasons for identification discrepancies by comparing incorrect species and genus names with those of the AQC with the aid of photographs to pick out key characteristics.

2.3.2.2 Analysis and Scoring of Data Returns

Laboratories returned lists of their species identifications within the format provided; these were compared against AQC identification as determined by Wells Marine to assess the number of differences. The method of data comparison was achieved by comparing both the genus and species names and identifying where these differed with the AQC names. Such comparison included differences in spelling or use of a valid synonym for example:

- Use of different synonym for a taxon, e.g. *Enteromorpha prolifera* for *Ulva prolifera*
- Mis-spelling of taxa name, e.g. *Halydris siliquosa* for *Halidrys siliquosa*

Such differences are highlighted, but not considered during calculation of the total number of differences in identification.

Data entries were tabulated (as seen in RM RT13 Preliminary Results Bulletin, Table 2) in order of specimen number and laboratory. The individuals' data entries are only given where they differ from the AQC identification. This includes those entries for which species are spelled incorrectly or where an appropriate synonym is provided, as well as those instances in which the specimen has been identified incorrectly. For those entries in which the participant recorded a synonym or mis-spelling, but for which the identification was consistent with that of the AQC, the name was presented in brackets [species name]. Those entries in which the identification was considered different to the AQC the species or genus name that did not correspond to the AQC was provided in the table. If part or the entire species name entered was correct this was indicated by a dash "-" any incorrect name was included in the table e.g. where *Prasiola stipitata* was identified as *Prasiola furfuracea* this would be entered as " – *furfuracea*".

The data entries for an individual scored one point where the entry was consistent with that of the AQC. For instance, where text other than a dash "-" or a bracketed name [name] is provided no score was given. This includes differences at both genus and species level, although species can be considered a largely independent value (where the generic identification was incorrect then the species identification would also be incorrect). Therefore, where the full genus and species name was correct a score of two would be given; where either genus or species name was incorrect a score of one would be given. The method of scoring applied to those species in which a correct identification was provided and included those instances where synonyms were used, or species/genus names spelled incorrectly.

2.3.2.3 Ring Test Results

RM RT13 contained twenty specimens for identification for which there was a good, albeit varied, level of agreement through all thirteen participants. At the generic level, there were a total of twenty-seven differences (from a potential 260) across the thirteen sets of data received from the six participating laboratories (10.38%). At the specific level, there were a total of fifty-three differences (20.38%). Although the overall % of incorrect species identification was consistent with the previous year the total number of differences was much higher due to the increased number of participants.

The differences in species identifications could be attributed primarily to several taxa which showed the highest number of incorrect identifications at both the genus and species level. The most significant number of differences was recorded for species Callithamnion tetricum (RT1315) with 5 generic and 11 specific differences recorded. Species RT1312 (Colaconema davesii) resulted in 4 generic and 4 species differences and species RT1320 (Ulva pseudocurvata) resulted in 4 generic and 5 species differences. However, these three species only accounted for 41% of differences. Unlike in

previous years there were a number of species which had a few generic and specific differences which made up the greater portion of those differences recorded. Vertebrata thuyoides, Ralfsia verrucosa, Chondracanthus acicularis, Sphacelaria cirrosa, Elachista scutulata, Scytosiphon lomentaria, Halochloroccocum moorei and Pterocladia capillacea all had at least one generic difference and up to 7 specific differences. These results indicate that the incorrect identifications were distributed across almost ¾ of the species and could also not be attributed to one specific phylum with Chlorophyta, Rhodophyta and Phaeophyta species proving equally problematic. In total six specimens were identified correctly across all participants which is significantly lower than recorded last year.

There were a few alternative synonyms used, mainly attributed to very recent changes in nomenclature, these included *Boergeseniella thuyoides*, currently known as a synonym of *Vertebrata thuyoides, Audouinella* and *Acrochaetium* were also accepted as synonyms for *Colaconema, Chlorochytrium* was accepted as a synonym of *Halochlorococcum* and Pterocladia was accepted as a synonym for *Pterocladiella.* All synonyms are accepted for the ring test and receive no scoring penalty. *Chondracanthus* and *P. Cartilagineum* had incorrect spellings but this did not affect the scoring.

The difference between participants' entries and AQC identifications was well distributed across the participants with one participant identifying all species correctly. The overall scores and number of incorrect identifications ranged from zero to eleven which is much lower than in the previous year. A pass rate of 80% (which equates to a total score no lower than 32) is suggested as an indicator of good performance, but above 70% is still considered acceptable. These levels may be used by competent monitoring authorities for internal monitoring of performance. All participants managed to identify the species to a level considered acceptable (Table 1).

Table 1: Participants final scores and overall pass mark.

Lab Code	Total Score	Pass Mark
MA2510	40	100
MA2503c	39	97.5
MA 2635b	37	92.5
MA2635a	36	90
MA2614b	35	87.5
MA2614a	34	85
MA2507	34	85
MA2503a	33	82.5
MA2512b	32	80
MA2503b	32	80
MA2614c	30	75
MA2512a	29	72.5
MA2512c	29	72.5

2.4 Discussion

This is the thirteenth macroalgae identification ring test as circulated through the NMBAQC scheme, with early exercises being essentially trials of the methodology. Although the results were broadly comparable with those of previous years (RT10 and RT11) there was a noticeable decrease in the level of agreement between participating laboratories and the AQC when compared with RT12. As per previous years the test included several cryptic and taxonomically challenging species as well as those considered more common. Such genera included *Callithamnion sp*., *Colaconema sp*. and *Ulva sp*., which are notoriously difficult to identify to species level. Other species proved troublesome due to morphological similarities to other species such as *Scytosiphon lomentaria* which bears some resemblance to *Dumontia contorta. Elachista scutulata* can also been easily misidentified due to confusions with other morphologically similar species such as *Herponema velutinum,* which also shares the same host, therefore it can be very difficult to tell these species apart from each other. These genera require an increased depth of knowledge on the cellular attributes, which can be remarkably similar between species, as well as other characteristics, such as overall texture, which can be used to separate such species.

Table 2: Summary of differences in identification.

			Total differences for 13 returns	
Specimen	Genera	Species	Genus	Species
RT1301	*Ahnfeltia*	*plicata*	0	0
RT1302	*Fucus*	*spiralis*	0	2
RT1303	*Himanthalia*	*elongata*	0	0
RT1304	*Codium*	*fragile subsp. Fragile*	0	3
RT1305	*Vertebrata*	*thuyoides*	1	7
RT1306	*Ralfsia*	*verrucosa*	1	1
RT1307	*Chondracanthus*	*acicularis*	2	2
RT1308	*Sphacelaria*	*cirrosa*	2	5
RT1309	*Bryopsis*	*hypnoides*	0	5
RT1310	*Dilsea*	*carnosa*	0	0
RT1311	*Elachista*	*scutulata*	1	1
RT1312	*Colaconema*	*davesii*	4	4
RT1313	*Plocamium*	*cartilagineum*	0	0
RT1314	*Ulothrix*	*flacca*	0	0
RT1315	*Callithamnion*	*tetricum*	5	11
RT1316	*Scytosiphon*	*lomentaria*	2	2
RT1317	*Halochlorococcum*	*moorei*	3	3
RT1318	*Griffithsia*	*corallinoides*	0	0
RT1319	*Pterocladiella*	*capillacea*	2	2
RT1320	*Ulva*	*pseudocurvata*	4	5
		Total differences	27	53
		Average differences per Genus/ species	1.350	2.650

Other challenging species included *Chondracanthus acicularis* and Pterocladiella capillacea these two species are less commonly found and can also be easily confused with other morphologically similar and more commonly found species such as *Polyides rotundas* and *Gelidium pulchellum.* respectively. Some participants may be less familiar with those less common and despite having their own unique characteristics such species can be easily confused with other similar species. As intended by the scheme these tests aim to challenge participants and assist with training by stimulating the use of various keys and increasing familiarity with taxonomic terminology. Further, it allows problem taxa to be identified stimulating areas for inclusion in workshops and targeting such taxa within future exercises. Photographs used within the ring tests may be retained within the participating laboratories for future reference, with some descriptions allowing the comparison of taxonomically similar species.

The most problematic species was Callithamnion tetricum which may be considered relatively difficult to identify due to the occurrence of morphologically similar species and genera and its microscopic nature. This species was misidentified at both the Genus level and Species level with most misidentifying as C. tetragonum, which has branches overtopping the apices, or *Aglaothamnion hookeri,* a very closely relative genera but with only one nucleus per cell. However, two participants only managed to identify to the level of order or division and one lab failed to submit an identification, suggesting this to be a particularly difficult species. Only Two participants correctly identified this species.

Certain issues arose with a few species. Ulva pseudocurvata proved problematic for some participants with misidentifications including *Ulvaria obscura, Umbraulva olivascens* and *Gayralia oxysperma*, all of which are morphologically similar but lack the key characteristic of *U. pseudocurvata* which is the presence normal vegetative cells and rhizoidal cells, of similar form and size differing only by their darker contents, within the basal portion of the blade. *Halochlorococcum moorei* had a high number of correct identifications given that it is rarely found due to its size and unicellular nature. Misidentifications included *Acrochaete sp.*, a multicellular filament and identification of division only, one lab did submit a result for this species.

Colaconema davesii is also a microscopic species often not identified but commonly located on the fronds of *Palmaria palmata*. One participant identified as *Acrochaetium secundatum* this species has shorter and smaller cells with abundant second branching in the upper portions, two participants identified as *Grania efflorescens* this species has much longer cells up to 90um in length and one participant identified as *Rhodothamniella sp.* which has several chloroplasts per cell each with its own pyrenoid unlike *C. davesii*. However, all these species are synonyms of *Audouinella* as is *Colaconema* which is a good indication that the identification process or use of keys is relatively effective with misidentifications occurring at the highest level.

It is apparent that many participants are consulting with photos and descriptions from Algaebase. This is a highly valuable source of information particularly with regards to the current taxonomic status of algae. However, species descriptions are not always as detailed as those within the natural History Museum series or other identification guides and include species of ‘uncertain’ or ‘preliminary’ taxonomic status. Although it is hugely important to stay aware of current changes it is also important to stay cautious of such changes particularly where a new species remains somewhat synonymous with old species or where conflicting descriptions are provided. This was the case for Species RT1203, *Fucus Spiralis*, which was identified by two participants as *F. guiryi*. The description of the latter species broadly overlaps that of both *F. spiralis* and *F. vesiculosus*. Appearing morphologically similar to *F. vesiculosus* it differs by the presence of a sterile receptacle rim. *F. spiralis* is also still described as

possessing a thick rim around its receptacles but is thought to differ superficially by its spiralled frond. Both of these characteristics were present within the photos provided. *F. guiryi* is also currently considered to be of 'Uncertain taxonomic status' therefore it was considered an incorrect answer for the purpose of the test. However, it is worth paying attention to possibility that many specimens of *F. guiryi* may in fact be misidentified as either *F. spiralis* or *F. vesiculosus* based on their superficial morphological characteristics, which are also known to vary according to the levels of exposure and other environmental variables. Species RT1306, *Ralfsia verrucosa,* was also misidentified by one participant as *Stragularia clavata* this alternative was also not accepted due to its current 'uncertain' taxonomic status.

In some instances, it was unclear which keys or guides were used by participants to identify the species. This information can be vital to determining if the guide descriptions were insufficient to correctly identify the species or if the photographs provided were insufficient. Additionally, it is recognised that some keys require revision, but this is not within the scope of NMBAQC. However, current developments and taxonomic changes to species should be considered during future field surveys using the correct and most recent identification descriptions, where possible, for verification.

Although the range of results was consistent with last years results the total number of misidentifications were much higher. It is likely that this is attributed to the degree of difficulty of the test species compared with the previous year and does not necessarily reflect the current levels of competency of participants or suggest a decreased level of competency. The current test included a higher number of taxonomically challenging and microscopic species which are notoriously difficult to identify. However, given that many of the misidentifications occurred at the species level, which is often reliant upon the smallest of variations in characteristics to separate species, suggest that there is an increased level of competency at the genus level for which the greatest number of misidentifications was 5, one less than recorded last year.

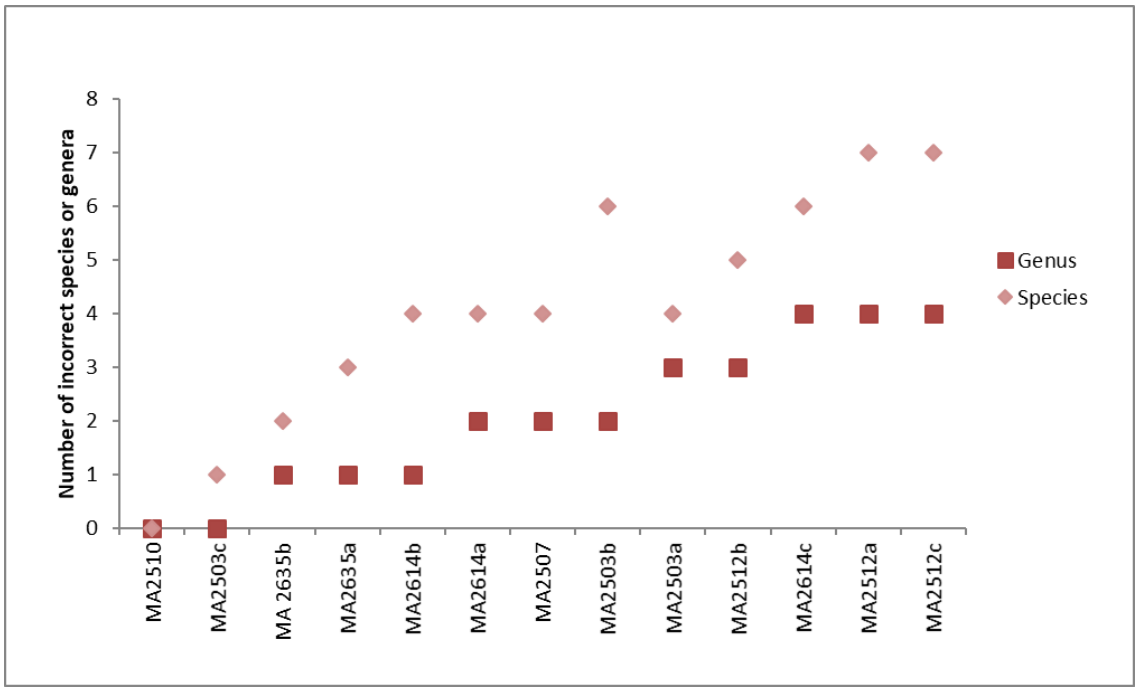

Figure 1: The number of differences from the AQC identification of intertidal macroalgae specimens, for each of the participating laboratories for RT12, arranged in order of increasing number of differences.

At this time the use of a photographic test is considered the most effective means of testing macroalgal identification skills. Preserved samples are known to rapidly to lose colour with cells becoming distorted making key characteristics more difficult to distinguish. Equally, fresh samples would not last a sufficient period to enable identification. However, it is possible that some photographs were not considered to be of sufficient quality or contain sufficient characteristics to correctly identify the specimens despite all efforts. This may have attributed to some misidentifications with some of the more cryptic species.

It is accepted that using fresh samples can be much easier to identify than photographs, however it must also be appreciated that even when using fresh specimens, it is not always possible to see certain characteristics, such as unique branching patterns and cell contents or perhaps it was not possible to retain the holdfast. Some features may be masked by excessive debris or diatoms or the specimen may be too small or partly deteriorated. Other issues arise where species show high degrees of morphological variation. All these factors would have to be considered in the field as well as within such ring tests as this and while all attempts are made to ensure perfect specimen material this is not always possible. It is equally difficult to find microscopic epiphytes and endophytes, much less be able to clearly see the cell contents and branching patterns and capture a still of such fundamental characteristics. However, it is considered important for the personal development of participants to be challenged with such species.

3 Conclusions and Recommendations

1. The thirteenth macroalgae ring test exercise was implemented successfully and completed by all participating laboratories with a general agreement of the format. All feedback has been reviewed and will be considered for subsequent exercises; such feedback is encouraged to enable the protocols to be refined.

2. The tests are distributed with a spreadsheet of additional species information such as geographic location of species, height found on the shore and habitat preferences. This year there was better uniformity in terms of habitat, morphological or textural information being provided. A more detailed spreadsheet was provided during the current ring test to include such information for all species in a clear and concise manner and included the following characteristics:

    i. Specimen number
    ii. Geographic location from where species was collected
    iii. Zonation/height at which the species was located
    iv. Habitat preferences
    v. Overall texture e.g. gelatinous, cartilaginous, hairy
    vi. General size of species
    vii. Host species where relevant
    viii. Number of photos provided and magnification levels
    ix. Any relevant additional information

    It has been evident this year that this additional information provided significant assistance with the identification, aiding with eliminating possible confusions between potential species identifications so will continue to be included in the future. There has been a request for seasonal

details to also be included, this will be considered, where appropriate, to be included in subsequent tests.

3. The high range of performance levels within this ring test provided evidence of a high range of proficiency but with the number of cryptic and microscopic species included within the test this does not necessarily indicate a reduced level of competence within and between laboratories. There are, naturally, several problematic areas but this is to be expected, as some taxa are inherently more difficult than others. The errors occurring were at both the generic and specific level and within all three divisions, Rhodophyta, Phaeophyta and Chlorophyta. Many of these errors occurred due to confusions with taxonomically and morphologically similar species which share similar characteristics and are therefore hard to separate. Such species will be noted for possible future workshops and will be targeted in future exercises.

4. There were still some incorrect spellings; therefore, participants are urged to take more care prior to submitting results to ensure all names are spelled correctly. It is also important that the species names, including subsp. be appropriately entered in to the spreadsheet to avoid confusion. Where there is limited confidence in the final identification it should be remembered that this scheme does not specify a definite qualifying performance level, and NMBAQC ring tests should be treated as training exercises. Ring tests offer a means of assessing personal and laboratory performance from which continued training requirements may be identified. In practice, it is likely that additional expertise would be consulted where the level of confidence in species identification is questionable.

5. Several data spreadsheets were also not fully completed, often missing out the keys or guides that were used. This may seem trivial information but can help identify where the participant has been misled with the keys or help explain how or why an alternative identification was reached. For future ring tests it is requested that the data spreadsheets be completed in full, including level of confidence in the identification. Participants should include the authority alongside taxon names, as this also aids in the analysis of returns.

6. All laboratories are encouraged to keep all test photographs within a reference collection. This has several benefits particularly with regards to improving identification ability, training new staff and maintaining consistency of identification between surveys and staff. This reference collection should also be extended through to literature to ensure current keys are used with up to date nomenclature. A list of identification works will be given on the NMBAQC website. However, this is not exhaustive, and does not necessarily include unpublished keys provided at workshops unless specifically authorised by the key's author.

7. During this thirteenth cycle of the macroalgae identification exercise all participants submitted results within the designated timescale. Within future ring tests 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 and in the case of very late submissions at the deadline. Emails will also be distributed to inform laboratories that the ring test material has been posted and expected date of arrival although this may be difficult with some laboratories outside of the UK. However, all attempts will be made to ensure all laboratories receive the material by the test commencement date.

8. There is now good consensus over the time of year for the test with the slightly earlier distribution of this years' test allowing the results bulletin and final report to be distributed

before the sampling season. There has also been no further comment on the amount of time provided for the test, so this has been taken as acceptable.

9. Several species have been requested for inclusion in subsequent tests such as filamentous Phaeophyta, foliose Rhodophyta, Gelidium species and invasive species. All attempts will be made to include such species and cover the requirements of the participants.

10. There was a general agreement from participants that this years test was considered more difficult than previous tests with a higher number of challenging species. However, there was a general agreement that the overall quality, detail and use of photographs was considered acceptable with most participants. All attempts will be made to ensure more clarity, particularly of key characteristics and inclusion of transverse sections, where appropriate, in subsequent tests to aid with correct identification and use of guides and keys. It is hoped that recommendations from previous tests have been taken on board and that for most species enough photos and key characteristics were provided for correct and confident identification. However, it must be recognised that even when looking at fresh specimens not all such characteristics may be present, e.g. reproductive structures. No staining is currently used, and this shall remain for the following test. All attempts will be made in the future to ensure that sufficient material is provided, allowing correct identification to species level.

If anyone has further comments 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 continually being refined to ensure it provides the best opportunity to test macroalgae identification skills, so all suggestions and comments are welcomed.

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