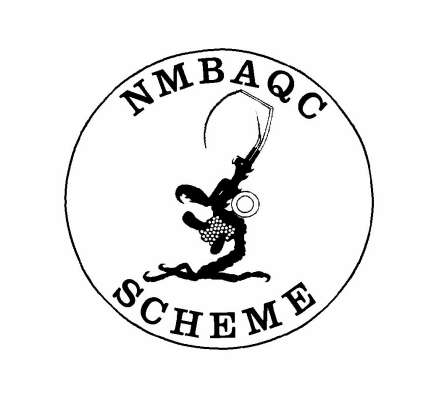

NE ATLANTIC MARINE BIOLOGICAL ANALYTICAL QUALITY CONTROL SCHEME

Annual Report 2018/2019

A report prepared by the NMBAQC Scheme Coordinating Committee
February 2020

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This Annual Report provides synopsis of the scheme year's activities over 2018/2019, the 25th year of the NMBAQC scheme. Detailed information about each of the scheme components is now available as separate reports or bulletins on the scheme's website. The relevant documents are all cited here and the reader is directed via hyperlinks to the NMBAQC website as appropriate.

The NMBAQC Scheme is jointly run by academic, advisory, commercial, conservation and regulatory bodies of the UK and Ireland. As the current scheme treasurers, the Environment Agency wishes to acknowledge the financial assistance of JNCC Support Co. Representatives from these agencies and competent monitoring authorities (CMAs) for the NMBAQC coordinating committee.

The NMBAQC coordinating committee held three meetings during 2018-2019 on 22nd May 2018, 4th of October 2018, and 15th February 2019. The minutes of the meetings are on the NMBAQC web site **http://www.nmbaqcs.org/reports/**.

Committee Membership for 2018/2019 is shown in Appendix 1.

1 Scheme Review

The scope of the NMBAQC scheme continued to develop in 2018/2019 to encompass the requirement to provide quality assurance for assessments under the Water Framework Directive (WFD), for which monitoring commenced in the UK in 2007. The scheme still maintains its role to provide Analytical Quality Control for Invertebrate and Particle Size data collected for the UK CSEMP (Clean Seas Environment Monitoring Programme). Under the UK Marine Monitoring and Assessment Strategy (UKMMAS) the NMBAQC scheme coordinating committee reports to the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG).

All components followed a similar format to the previous year and involved training and testing exercises for the Invertebrate, Particle Size, Fish, Phytoplankton, Zooplankton and Macroalgae components. The Epibiota component supported the first Benthic Imagery workshop and an action plan has been put in place to move forward. The contracts to administer the Invertebrate, Particle Size, and Fish components were due for renewal in April 2018. However, due to staff resource restraints within the procurement section of the Environment Agency around this time, it was agreed that the contracts would each be extended for one year to allow sufficient time for input to the re-tendering process.

The 2018-2019 participation level in the NMBAQC scheme was similar to the previous year (see Appendix 2).

Summaries of all the component activities are provided below.

2 Invertebrate component

Contract Manager: Myles O'Reilly, Scottish Environment Protection Agency.
Component Administrator: David Hall, Apem Ltd.

2.1 Summary of activities

Scheme year 2018 / 2019 (year 25) followed the format of year 2017 / 2018. A series of components, modules and exercises involved the distribution of test materials to participating laboratories and the centralised examination of returned data and samples. The labeling and distribution procedures employed previously have been maintained. Specific details can be found in previous Scheme annual reports.

Forty-two laboratories (with multiple participants from some organizations counted separately) participated in the Benthic Invertebrate Component of the NMBAQC Scheme in 2018 / 2019 (year 25). Seventeen of the participants were UK Competent Monitoring Authorities (CMAs), responsible for the Clean Seas Environment Monitoring Programme (CSEMP) or Water Framework Directive (WFD) sample analysis; eighteen were UK private consultancies. Seven of the participants were non-UK laboratories (including three government organizations and four private consultancies). Laboratory Codes were assigned in a single series for all laboratories participating in the Benthic Invertebrate component. Separate Laboratory Codes were assigned for the other scheme components, such as the particle size component.

As in previous years, some laboratories elected to be involved in limited aspects of the scheme. UK Competent Monitoring Authorities (CMAs) completing benthic biological analyses for monitoring programmes, including the assessment of MPAs (Marine Protected Areas), as evidence under MSFD (Marine Strategy Framework Directive), WFD (Water Framework Directive) and the CSEMP (Clean Seas Environmental Monitoring Programme), must participate in the Benthic Invertebrate component. CSEMP / WFD laboratories are no longer required to participate in all components / modules of the scheme.

This component comprised three modules (each with one or more exercises):

1. Own Sample module (OS) - re-analysis by APEM Ltd. of three samples supplied by participating laboratories.
2. Invertebrate Ring Test module (RT) - identification of two sets of twenty-five invertebrate specimens.
3. Laboratory Reference module (LR) - re-identification by APEM Ltd. of a set of up to twenty-five specimens supplied by participating laboratories.

The analytical procedures of the various modules were the same as for 2017 / 2018 (year 24) of the Scheme.

2.2 Summary of results

Two **Ring Tests (RT)**, each of 25 specimens, were distributed (RT55 and RT56). The second (RT56) was targeted on oligochaetes, originally planned to follow a 2018 Scheme experts workshop, which was to include the development of an updated oligochaete identification guide; however, the workshop was postponed due to lack of subscriptions. The methods and policies used in the module followed the Ring Test Protocol (Worsfold & Hall, 2017a).

For RT55, the average numbers of differences per participating laboratory (for a total of 21 laboratories with 20 submissions) were 2.7 generic differences and 6.2 specific differences.

Four species (two polychaete annelids, one mollusc and one crustacean) were responsible for over half (35%) of the specific differences.

For RT56, the average numbers of differences per participating laboratory (for a total of 23 participants with 18 submissions) were 7.1 generic differences and 9.4 specific differences. Nine specimens (eight oligochaetes and a polychaete added as a potential source of confusion), were responsible for almost two thirds (63%) of the specific differences.

Laboratory Reference (LR): Eight laboratories signed up for the LR23 module and six laboratories submitted specimens for confirmation. Most misidentifications were for Annelida (58%), followed by Mollusca (22%) and minor phyla (11%); some belonged to recently introduced non-native species. The methods and policies used in the module followed the recent Laboratory Reference Protocol (Hall & Worsfold, 2017).

The methods and policies used in the **Own Sample (OS)** module followed the recent Own Sample Exercise Protocol (Worsfold & Hall, 2017b), produced to explain and standardise policies, including details of audit sample selection and determination of 'associated samples' for subsequent remedial actions. Laboratories were asked to submit full completed data matrices from their previous year's CSEMP / WFD, or similar alternative sampling programmes. The OS 'Pass / Fail' flagging system, introduced in Scheme Year 8, was continued (see Hall, 2010: Description of the Scheme Standards for the Benthic Invertebrate Component). In OS68-70, extraction efficiency (of individuals) was better than 90% in 82% of the comparisons and better than 95% in 73% of all comparisons. 100% of countable taxa were extracted from the sample residues in 49% of samples. The Bray-Curtis similarity index ranged from 30.8% to 100% with an average of 91.7%. The Bray-Curtis similarity index was greater than 95% in 64% of comparisons; in 82% of cases, the value of the index was greater than 90% and, therefore, achieved 'Pass' flags. Sixteen samples (18%) achieved 'Pass- Excellent' flags with Bray-Curtis similarity scores of 100%.

2.3 Issues and recommendations

Several observations may be made from the results of the exercises described above. The following is a summary of the major points of importance:

1. The majority of participating laboratories submit data / samples in accordance with the Scheme's timetable. Late submissions, however, are still the major contributing factor for delaying the production of exercise bulletins / reports. Laboratories should endeavour to report their results within the requested time, according to the deadlines circulated at the beginning of each Scheme year.

2. The number of samples in data sets provided for selection of Own Samples varied considerably, with several laboratories offering less than the minimum 20 samples for audit selection (due to low volumes of sample processing) and other laboratories offering a full year's benthic data across multiple projects. Best practice for commercial laboratories should be to use the Scheme as an external auditor for most or all of their samples and no 'cherry picking', pre-analysis selection, or pre-submission re- working of samples should be undertaken. Retention of sample residues will be required to facilitate this and to ensure that any subsequent remedial actions can be adequately completed.

3. Revised data request and sample submission forms were introduced for the 2017 / 2018 OS module to capture data / sample ownership. Where data belong to CMAs, the submitting participant was required to declare this so that audit results could be shared accordingly and CMA data auditing could be tracked and co-ordinated.

4. There were continued problems associated with the measurement of biomass for individual species in the Own Sample module. In this and previous Scheme years, several laboratories, despite using blotted wet weight biomass techniques, rendered some of their specimens too damaged to be re-identified. Additionally, some laboratories had erroneous results where it appeared that biomass had been estimated or mis-transcribed. The initial processing of a sample should in no way compromise the effectiveness of an audit. Biomass procedures should not render the specimens unidentifiable. Biomass must be reported to four decimal places with nominal weights recorded as 0.0001g. A standardised protocol is available in the NMBAQC guidance document (Worsfold, Hall & O'Reilly (Ed.) 2010) and must be followed for CSEMP / WFD analysis.

5. There were some instances (OS & LR modules) of specimens being provided in vials / containers that were not airtight and, as a consequence, specimens were dry and in some case identification was impossible. Participants are reminded that specimens should be stored in

suitable air-tight containers so that viability is maintained for the audit process. Participants should also ensure that OS & LR samples are transported to APEM in accordance with the H&S regulations. Participants should use rigid crates when submitting heavy sample residues to prevent damage in transit.

6. The maintenance of a comprehensive reference collection has numerous benefits for improving identification ability, maintaining consistency of identification between surveys and access to growth series material. The LR exercise can be used as a means of verifying reference specimens. Laboratories are strongly recommended to implement and expand in-house reference collections of biota. The inclusion of growth series material is extremely useful for certain groups, *e.g.* molluscs. All surveys should have an associated reference collection to enable ease of cross-checking or adopting future taxonomic developments.

7. Participants submitting data for laboratory reference exercises should add a note on habitat / location of samples, to aid identification. A similar 'Habitat Notes' section to that distributed with the ring test exercises was distributed for completion in this year's exercise and should continue into the next exercise to support AQC identifications.

8. Laboratories participating in the ring test exercises should attempt to identify all specimens to species and complete the 'confidence level' section of their ring test datasheets to enable additional information to be gathered regarding the difficulty of ring test specimens.

9. The Own Sample module has shown repeated taxonomic errors for some laboratories over several years. Participating laboratories are encouraged to redress or resolve disagreements for taxonomic errors reported in their Own Samples even if their samples achieve an overall 'Pass' flag.

10. There are problems of individuals and taxa missed at the sorting stage of Own Sample analysis. This is an area that is often the major contributing factor in samples with 'Fail' flags or low Bray-Curtis similarity indices. When taxa and individuals are missed during the extraction of biota from the sediment, laboratories should determine why certain taxa have not been extracted. This could be due to the taxon not being recognised as countable, or due to problems with the effect of stains upon the specimens. There may also be a problem within certain taxonomic groups (*e.g.* crustaceans floating within samples or molluscs settled within the coarser sediment fractions). Additional training may be required and a review of existing extraction techniques and internal quality control measures may be beneficial. Remedial action should concentrate on the specific causes of the failure and should be targeted accordingly *e.g*. analyst or method related discrepancies.

11. It is apparent that some laboratories are not utilizing the NMBAQC guidelines for processing macrobenthic samples (Worsfold, Hall &

O'Reilly (Ed.), 2010) issued with MB18 in Scheme Year 17 to improve the consistency of analysis*, i.e.* all analysts extracting and recording all biota. A detailed taxonomic discrimination policy (TDP) needs to be developed and added to the processing requirement protocol (PRP) to ensure that macrobenthic data from multiple analysts are as consistent and inter-comparable as possible. The Own Sample pass / fail criteria will be reviewed to ensure that they are fit for purpose and uphold data consistency between the Scheme participants.

12. Since the beginning of the scheme, continual improvement to the learning structure of the Scheme reports has been maintained. For the LR and OS modules, detailed results have been forwarded as individual exercise reports to each participating laboratory as soon after the exercise deadlines as practicable. The Laboratory Reference Module Summary Reports introduced in 2017 show identification problems found in all LR submissions and should benefit all participants. In the RT module, after each RT exercise a bulletin was circulated, reviewing the literature used, detailing the accepted identification of the taxa circulated, and including images of relevant specimens. Participants are encouraged to review their exercise reports and provide feedback concerning content and format wherever appropriate.

13. The primary aim of the Benthic Invertebrate Component of the Scheme is to improve the quality of biological data via training and audit modules. An informal constructive reporting system exists to assist in the overall improvement of data quality. For example, laboratories struggling with particular taxonomic groups in their Own Samples often receive additional support, as well as receiving their returned OS material separated, according to the AQC identifications, for future reference. Eight of the 16 'failing' Own Samples in Scheme Year 2018 / 2019 (Year 25) have already been rectified via the recommended remedial action. Eight samples remain with pending remedial actions (including one CMA sample). Last year, remedial actions for eight of nine failed samples were completed before the production of the corresponding annual report (all are now completed); however there were fewer failing samples than in this scheme year. This year's increase in failed samples and reduced completion of remedial action does not represent a downturn in processing quality or poor scheme engagement; the differences are within the normal expected range. APEM will continue to proactively chase outstanding remedial actions from previous scheme years to enable these data to be NMBAQC scheme quality assured. Participants are reminded that completion of remedial action is mandatory for CMA labs and labs submitting data to CMAs. Participants are encouraged to provide feedback and request further information for any of the scheme exercises to improve the quality and consistency of their data.

14. Additional guidance for Own Sample 'next steps' following audit results has been created to ensure that all participants and other stakeholders are aware of the route to quality assured data (Hall, 2016; *Own Sample*

Interim Report Review and Remedial Action Processes).

15. There remain some misconceptions about the nature of the Scheme and the services it provides. It is not an accreditation scheme but provides quality assurance for the UK's CSEMP/WFD programme. In addition, the Scheme can provide audits of samples for any marine biological programme or development. It also provides project-level audits by applying the OS and LR protocols to examine project data. These services require more extensive communication (Scheme website, information note etc.) to notify all potential users and maintain consistent quality assurance for European marine data. A best practice guidance protocol for NMBAQC project-level audits needs to be produced and published on the scheme website. Meanwhile, it should be understood that a project level audit includes a review of data and check of reference collection specimens for the whole project, as well as for selected samples. Audits of samples from a project without more extensive reviews of data and other material do not constitute quality control of the whole project through the Scheme.

16. Despite protocol documents being produced for a recent Scheme year (Year 21, 2015- 2016), misconceptions still exist regarding the purpose and methods for some of the Scheme's modules. Protocol documents for all modules were reviewed and re-issued for the previous scheme year (Ring Test Protocol, Laboratory Reference Protocol, Own Sample Exercise Protocol).

17. APEM Ltd. strives to ensure smooth running and transparency of the Scheme at all times. APEM Ltd. log and make available all correspondence to the Benthic Invertebrate Contract Manager (Myles O'Reilly, SEPA). Participants can be assured that their anonymity will be protected if this correspondence is required to be shared with the Committee.

2.4 Reports

Benthic Invertebrate Component Annual Report, 2018/2019 (Year 25)
Worsfold, T.M., Hall, D.J., and O'Reilly, M. (Ed.), 2019. Benthic Invertebrate Component Annual Report. Scheme Operation 2018/2019 (Year 25). A report from the contractor to the NMBAQC Scheme co-ordinating committee. 30pp, August 2019.

Own Sample Module Summary Report OS68, 69 & 70 – July 2019
Hall, D. 2019. NE Atlantic Marine Biological Analytical Quality Control Scheme. Own Sample Module Summary Report OS68, 69 & 70. Report to the NMBAQC Scheme participants. 17pp, July 2019.

Laboratory Reference Module Summary Report LR23 – April 2019

Worsfold, T., Kneebone, N. and Hall, D., 2019. NE Atlantic Marine Biological Analytical Quality Control Scheme. Laboratory Reference Module Summary Report LR23. Report to the NMBAQC Scheme participants. 11pp, April 2019.

RTB56 – April 2019 (Targeted - Oligochaeta)
Worsfold, T., Hall, D. & Pears, S., 2019. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#56. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#56, 37pp, Apr, 2019.

RTB55 – Dec 2018 (General/Mixed taxa)
Worsfold, T., Hall, D. & Pears, S., 2018. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#55. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#55, 36pp, Dec, 2018.

3 Particle Size Analysis component

Contract Manager: Claire Mason, Cefas.
Component Administrator: Lydia McIntyre-Brown and David Hall, Apem Ltd.

3.1 Summary of activities

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The particle size component of the scheme comprises of two modules:

1. The PS Ring Test (PS) - analysis of four sediment samples circulated to participant.
2. The PS – Own Sample (PS-OS) – submission of three analysed sediment samples from participant.

The PS module followed the same format of 2017/18; a series of exercises involved the distribution of test materials to participating laboratories and the centralised examination of returned data and samples.

The PS-OS module, introduced in the 2014/15 Scheme year, followed the same logistical format as the previous year. Selected participant samples are re-analysed by the NMBAQC Scheme PSA contractor and the results are compared. The Particle Size Own Sample module is a training / audit module and the purpose of this module is to examine the accuracy of particle size analysis for participants' in-house samples.

Sixteen laboratories signed up to participate in the 2018/19 PS module exercises (PS68, PS69, PS70 and PS71); six were government laboratories and ten were private consultancies. Ten laboratories signed up to participate in the PS-OS module exercises (PS-OS13, PS-OS14 and PS-OS15); five were government laboratories and five were private consultancies. Two government laboratories had two Lab Codes to submit six PS-OS samples each for AQC analysis.

To reduce potential errors and simplify administration, Lab Codes were assigned with a prefix to determine the Scheme component; all codes for the Particle Size component were prefixed with "PSA_".

As in previous years, some laboratories elected to be involved in limited aspects of the Scheme. Competent monitoring authorities (CMAs) completing PSA in support of biological analysis for monitoring programmes (including in assessment of MPA (Marine Protected Areas), as evidence under MSFD (Marine strategy framework directive) and WFD (Water framework directive), as well as the CSEMP (Clean Seas Environmental Monitoring programme), must participate in this component of the Scheme. The Scheme is aware of other PSA methodologies (*e.g*. those used in the Regional Seabed Monitoring Plan) and encourages those involved in any relevant PSA monitoring programmes to

participate in this Scheme, especially where pass/fail criteria can be used to assess overlapping aspects of different methodologies.

3.2 Summary of Results

Sixteen laboratories subscribed to the exercises in 2018/19. For the first circulation (PS68 and PS69) all subscribing participants eventually provided results; PSA_2515 were given an extension due to a laser malfunction needing an engineer to fix. For the second circulation (PS70 and PS71) all but one participant provided results. PSA_2506 did not participate in exercises PS70 or PS71 and did not provide email confirmation of their non-participation. Participant PSA_2513 was given an extension due to delays with their sub-contractor.

Most participating laboratories now provide data in the requested format, although some variations remain. As reported previously, it should be remembered that the results presented may be from a more limited number of analytical laboratories than is immediately apparent since this component of the Scheme is often sub-contracted by participants to one of a limited number of specialist laboratories. Detailed results for each exercise (PS68, PS69, PS70 and PS71) have been reported to the participating laboratories.

3.3 Issues and recommendations

A number of observations may be made based on the results of the exercises described above. The following is a summary of the major points of importance.

1. Laboratories should ensure that they follow the NMBAQC methodology when participating in the Particle Size (PS) Ring Test. The PS Ring Test is designed to test that all participants are getting comparable results when they follow the same methodology. It is therefore important that only the NMBAQC methodology (Mason, 2016) is used where possible and that results for 3 x 3 laser analyses are provided Participants who do not have access to a laser analyser will be permitted to use alternate methods for samples that contain sediment less than 1mm as long as the method used is detailed in the summary section of the workbook. Samples for the PS-OS module can be analysed following alternative in-house methods however these must be thoroughly described and the participant should be aware that re- analysis will be undertaken following the NMBAQC methodology. Samples provided for PS-OS which have been routinely analysed do not necessarily have to provide 3 x 3 laser analysis data but should show that appropriate QC checks have been carried out, including on the final data set.

2. Participants should review their data prior to submission. Errors in datasets can often be spotted in the summary statistics, e.g. percentage gravel, sand and silt/clay, before the data are submitted. All parts of the workbook should be double checked before submission to ensure that they are all filled in correctly. This will help eradicate typing and transcription errors.

3. The current NMBAQC Scheme Pass/Fail criteria for the PS modules are under review. Currently results are broken down for review, including methodology, sieve processing, laser processing, data merging and summary statistics. Laboratories then received a “Good” or “Review” flag based on their results; “Review” flags came with accompanying comments as to where mistakes have been made and how to correct them. This approach was thought to be more informative and would help participants to identify errors and correct any issues for future exercises. Lydia McIntyre-Brown (APEM), Scheme contract manager Claire Mason (Cefas) and Jon Barry (Cefas) are currently researching a statistical method to compare participant results with the Benchmark data, providing the initial work has been completed this method will be trialled alongside the current “Good” or “Review” format.

4. The PS and PS-OS module results both highlighted differences between the sensitivity of laser instruments. Comparison of laser data in the PS-OS and PS results showed that the Beckman-Coulter LS13320 instrument used by the AQC lab, which includes a Polarization Intensity Differential Scattering (PIDS) and gives enhanced measurement capability in the clay-size range (<2 um) compared to other lasers models used by many of the NMBAQC scheme participants. The NMBAQC PSA workshop in December 2017 looked at possible ways to minimise the differences created by the use of different laser instruments and optical models, and the possibility of standardising so that all labs following the same procedures. It was agreed that the recommended optical model is Mie Theory with Particle Refractive index of 1.55 and a Particle Absorption Index of 0.1. Experimental results have demonstrated that use of the Fraunhoffer optical model reduces the differences between laser instruments, albeit by loss of ‘detail’ within the very fine silt and clay size fractions. However, the potential suitability of using the Fraunhofer model to achieve greater inter-laboratory comparability will need to be explored in more detail when enough data have been collected. Obscuration will vary depending on sample type; only a small amount of mud is needed to reach an obscuration of 10%, and the presence of relatively small but potentially significant amounts sand may be missed; it may therefore be better to run at a higher obscuration where the presence of sand is observed during sample preparation. A gap can appear between the sieve and laser data in the final merged distribution if not enough sample is added to the laser to detect the sand. It is essential that participants complete the relevant metadata sections.

5. Possible workshop looking at sample preparation and presentation to laser. Most participants now use the recommended laser parameters of an optical model of Mie Theory with Particle Refractive index of 1.55 and a Particle Absorption Index of 0.1; however the results can still differ from the Benchmark data and other participants. One possible reason for this could be due to sample preparation and homogenisation as well as presentation of the sample to the laser. A workshop, either in person or a webinar detailing how to create and homogenise a laser sub-sample, particularly looking at the use of ultra0sonics may be useful in forth coming years.
6. Health and Safety. Recently the presence of asbestos in marine samples has been bought to light. Although safe when the sample is wet, asbestos particles could become air-borne when analysing a particle size sample particularly during the dry sieving process. At the PSA workshop in December 2017, laboratories were informed how to mitigate the hazards associated with analysing samples that may contain asbestos. In light of this, all the natural material used to create PS ring test samples PS68 – 71 was sent for presence/ absence of asbestos before being distributed to participating laboratories. This will continue for subsequent years and participants can request to see the results of the tests by emailing nmbaqc@apemltd.co.uk

3.4 Reports

PSA Component Annual Report Year 25 (2018/19)
McIntyre-Brown, L., Pye, K. and Hall, D. Particle Size Analysis Component Annual Report Scheme Operation 2018/2019 (Year 25). 33pp, June 2019.

PS71 February 2019
McIntyre-Brown, L. & Hall, D., 2019. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS71. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps71, 46pp, February 2019.

PS70 February 2019
McIntyre-Brown, L. & Hall, D., 2019. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS70. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps70, 46pp, February 2019.

PS69 December 2018
McIntyre-Brown, L. & Hall, D., 2018. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS69. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps69, 47pp, December 2018.

PS68 December 2018

McIntyre-Brown, L. & Hall, D., 2018. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS68. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps68, 47pp, December 2018.

4 Fish component

Contract Manager: Jim Ellis, CEFAS.
Component Administrator: Ruth Barnich, Thomson Unicomarine.

4.1 Summary of activities

This component consisted of two modules, each with a single exercise:

1. Fish Reverse Ring Test (F_RRT) - Re-identification of a set of fifteen fish specimens supplied by each of the participating laboratories.
2. Fish Ring Test (F_RT) - Identification of one set of fifteen fish specimens circulated by the scheme contractor.

The twenty-fifth year of the NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme (2018/19) followed the format of the twenty-fourth year, with a ring test (RT) and a reverse ring test (RRT) being organised. The Fish Component of the Scheme is currently in its fourteenth year (start 2005/06). It involved the distribution of test specimens to participating laboratories and the centralised examination of returned data for the first module, and re-analysis of fish specimens submitted by participants for the latter. The component was managed by the contractor Thomson Unicomarine Ltd., while the results of both ring tests were analysed by PISCES Conservation Ltd.

Twenty-five laboratories originally signed up for Scheme year 2018/2019. But due to lack of fish for re- analysis in the RRT module, three laboratories had to withdraw, leaving the number of participants at twenty-two. Seventeen participants were government laboratories, three private consultancies, one a University and one a chartered laboratory. Although some fish are sampled under the Clean Seas Environment Monitoring Programme (CSEMP), the number of target species is relatively few. However, the requirement to monitor fish assemblages in transitional waters for the Water Framework Directive (WFD) provides a major impetus for the Fish Component modules.

4.2 Summary of results

Fish Reverse Ring Test (F_RRT): The identification of fifteen fish specimens selected and supplied by the participating laboratories was relatively accurate (F_RRT10) (thirteen taxonomic errors for 244 specimens submitted). The majority of specimens were collected during the 2018 autumn monitoring surveys. As observed in previous years, there were differences in the approach to the reverse ring test by the participating laboratories; some used this as a test

for confirming voucher specimens, whilst others submitted problematic specimens, hence comparison of results is not applicable.

Fish Ring Test (F_RT): Fifteen fish specimens were distributed to the participants by the contractor. Compared to the previous year, the Fish Ring Test (F_RT12) produced a higher number of taxonomic differences between the participating laboratories and the analysing laboratory, PISCES Conservation Ltd. On average 0.75 generic and 1.83 specific differences were recorded per participating laboratory (compared to 0.23 generic and 0.85 specific differences in the previous year). The 2018 Fish Ring Test included three different species from the genus *Pomatoschistus*, which largely accounted for the increased number of specific differences.

4.3 Issues and recommendations

A number of observations may be made from the results of the modules described above. The following is a summary of the major points:

1. The latest Fish Reverse Ring Test (F_RRT10) and Fish Ring Test (F_RT12) were successfully implemented and their format can be continued in the next Scheme year. Participants are encouraged to provide feedback to enable protocols and bulletins to be improved where necessary.

2. The majority of participating laboratories submitted their data / specimens before the deadline, or were only slightly late. This allowed for a fast analysis and delivery of results.

3. Laboratories are encouraged to collate fish identification literature to improve their identification skills and follow the most recent results in taxonomy. The Scheme has produced a UK Standard Taxonomic Literature database. Participants are encouraged to review the content and give details of additions wherever possible. Referring to databases such as Catalog of Fishes, FishBase or WoRMS is recommended to check the validity of scientific names. Discrepancies between those databases were highlighted in the F_RRT10 bulletin.

4. The maintenance of a comprehensive reference collection has numerous benefits, such as improving identification ability, training new staff and maintaining consistency of identification between surveys. The inclusion of growth series is extremely useful for certain taxa. Ideally all surveys should have an associated reference collection to facilitate cross-checking or keep track of changes in taxonomy. It is strongly recommended that laboratories implement and expand in-house reference collections of fish; these collections could include images and physical specimens.

5. Future Fish Ring Test circulations will target taxa identified in the Fish Reverse Ring Tests as potentially problematic. Participants are encouraged to inform the contractor of difficult taxa that should be included in ring tests. Participants are also invited to submit specimens for use in such exercises (approximately 20 specimens of equal size and condition would be required for inclusion).

6. The Ring Test and Reverse Ring Test modules offer training and baseline data for fish; a quality control module could be devised to provide quantifiable data assurance.

7. This year's Fish Ring Test (F_RT12) produced twelve sets of results from twelve participating laboratories. No participant submitted multiple data sets. The option of multiple data submissions per participant laboratory will be continued into future ring tests. Participants should not submit multiple sets of data if these data represent a replicated consensus; multiple data submissions are to allow sub-teams and individual analysts to receive specific results and feedback.

4.4 Reports

Fish Component Annual Report, Year 2018/2019

Barnich, R., 2019. Fish component - Report from the contractor. Scheme Operation - 2018/2019. A report to the NMBAQC Scheme co-ordinating committee. 13pp, June 2019.

FRT 12 May 2019

Seaby, R., Barnich, R., 2019. NE Atlantic Marine Biological Analytical Quality Control Scheme. Fish Ring Test Bulletin: FRT#12. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCfrtb#12, 26pp, May 2019.

RRT 10 - March 2019

Seaby, R., and Barnich, R., 2019. National Marine Biological Analytical Quality Control Scheme. Fish Reverse Ring Test: FRRT10. Final report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQC FRRT10, 9pp, March 2019.

5 Phytoplankton component

Scheme Administrator: Joe Silke, Marine Institute, Republic of Ireland.
Scheme Coordinator: Rafael Salas, Marine Institute, Republic of Ireland.

5.1 Summary of activities

The phytoplankton component is undertaken by the Marine Institute (Ireland) in collaboration with the IOC Science and Communication Centre on Harmful Algae, Denmark (and in association with the NMBAQC, UK). Previously this component undertook intercomparison exercises under the BEQUALM banner. However, as the BEQUALM programme closed in 2014, these exercises were renamed in 2016 as IPI (International Phytoplankton Intercomparison).

Participants undertake Identification and Enumeration exercises on three preserved 50ml marine water samples which have been spiked with cultured material. They also take part in an online Harmful Algal Bloom (HAB) quiz where they are required to identify planktonic algae from photos or diagrams. Each year the exercises are followed by workshop with discussion of the exercise results and additional presentations on phytoplankton issues.

In 2018 a new way to register laboratories to the International Phytoplankton Inter-comparison (IPI) exercise was introduced. The website www.iphy.org was developed to provide a structured and user-friendly single point source of information relating to the IPI. Here, laboratories can find information about the IPI exercise, find the schedule for the year and register their analysts. As part of the registration process, we asked laboratories if bio-volume measurements were to be introduced as part of the test, whether they would be interested in taking part in this new section. 57 analysts responded that they would, that is 58% of all participants for 2018. This compares to only 32% when asked the same question the previous year.

The number of IPI participants has increased appreciably since 2005 and the influence of the test has also been widened to many regions across the globe. The highest number of analysts (99) was reached in 2018 with the majority of laboratories come from European countries (77%), while an increasing number of laboratories 23 % (up 8% from last year) are from further afield - made up from South America (10%), Africa (7%), Australia & New Zealand (5%) and Middle East (1%).

There is now an automated process for production of materials for the exercise and have invested in new equipment to advance this area. An ‘Inversina’ instrument was bought to homogenise the materials and a new technique developed for the preservation and long term storage of the samples. The stability of the samples is quite good now and the focusing for 2019 will be on the homogeneity side of things. The main aim is to introduce an assessment of

Uncertainty of Measurements to the materials and strive towards a laboratory reference material.

The IPI workshop took place in Hillerød, Denmark in December 2018 and had 18 attendees.

5.2 Summary of results

a) Identification and Enumeration Exercise

Ten species were used in this test. These were the dinoflagellates *Heterocapsa triquetra* (Ehrenberg) Stein, 1883, *Amphidinium carterae* Hulburt, 1957, *Prorocentrum micans* Ehrenberg, 1834, *Levanderina fissa* (Levander) Ø.Moestrup, P.Hakanen, G.Hansen, N.Daugbjerg & M.Ellegaard, 2014, *Karenia mikimotoi* (Miyake & Kominami ex Oda) Gert Hansen & Ø.Moestrup, 2000 and the diatoms *Pseudo-nitzschia delicatissima* complex (Cleve) Heiden, 1928, *Dactyliosolen fragilissimus* (Bergon) Hasle, 1996, *Thalassiosira rotula*/ gravida Meunier, 1910/ Cleve, 1896, *Chaetoceros lorenzianus* Grunow, 1863 and *Melosira nummuloides* C.Agardh, 1824.

The average and confidence limit for each test item was calculated using the robust algorithm in annex C of ISO13528:2015 which takes into account the heterogeneity of the samples and the between samples standard deviation from the homogeneity and stability test. ISO 13528:2015 is only valid for quantitative data. We have used the consensus values from the participants.

All measurands passed the expanded criterion for homogeneity according to ISO13528:2015 and the stability test according to ISO13528:2015. There were a very small number of warning and action signals across the measurands. 13 Red flags (1.36%), 31 (3.26%) yellow flags and 22 (2.3%) non-id flags from 950 scores is evidence of good performance overall. Seven analysts did not pass the test with a score below 80%. There were no major problems identifying the composition of samples in this exercise and the number of non-identifications (2.1%) and mis-identifications (5.9%) were relatively small. An array of commonly found diatoms and dinoflagellates were used. Overall, from 960 possible correct identifications, there were a total of 883 correct answers at genus level that is 91.9% correct, 20 (2.1%) non identifications and 57 (5.9%) incorrect answers mainly on one species. This indicates a high level of taxonomic proficiency amongst participants.

b) Harmful Algal Bloom (HAB) quiz

Q1 on diatom taxonomic terminology was found to be the most difficult question in this test. The average grade was 70% and there was confusion with some of the terminology used. However, there were no problems with Q2 (93.5%), Q11 (96%) and Q12 (92%), also on diatoms. The numerical questions Q3-Q5 did not cause major problems for analysts. However, the percentage of correct answers

was different for Q3 (88%) to Q4 (97%) and Q5 (98%), which were mostly perfect. Q3 showed a chain of the diatom *Melosira nummuloides* showing cells in the chain at different stages of division which could have caused difficulty in interpreting the cell count. The 2018 Ocean teacher online HAB taxonomic assessment results show a high rate of proficiency. 76% of analysts achieved a score over 90% (Proficient). 21% of analysts above 80%, 3 % need improvement.

5.3 Reports

Phytoplankton Enumeration and Identification Ring Test, 2018

Salas, R.G., Walsh, D., Larsen, J., 2018. International Phytoplankton Intercomparison proficiency test in the abundance and composition of marine microalgae 2018 report. PHY-ICN-18_MI1 VR 1.0. 155pp.

6 Macroalgae component

Contract Manager: Claire Young, DAERA-NI.
Component Administrator: Emma Wells, Wells Marine.

6.1 Summary of activities

The format for 2018 -19 followed that of the previous year.

The component consisted of three modules:

1. **Opportunistic Macroalgae Biomass Ring Test (OMB - RT):** - synthetic samples of different weights for washing and drying to both wet and dry weights.

2. **Opportunistic Macroalgae/Seagrass Cover Ring Test (OMC - RT)**:- estimation of percentage cover of opportunistic macroalgae and seagrass based on photographs of field quadrats.

3. **Rocky Shore Macroalgae Ring Test (RM - RT):** - Identification of twenty macroalgae species based on a series of images.

The analytical procedures of all modules were the same as for the previous year of the Scheme.

6.2 Summary of results

Biomass of macroalgae (OMB-RT10)

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, particularly for the larger sample. The dry weights showed a lesser degree of variability between laboratories. All laboratories remained within the Z-score limit of +/- 2.0 for both the dry weight and wet weight against the mean, which may have been due to the high standard deviation caused by the high range of results.

Four laboratories showed significant deviation from the actual sample dry weight with a further seven ‘Fails’ against wet weight. It is worth noting that this means of assessment is not as accommodating towards outliers, hence the higher number of ‘Fails’. There was a total of eleven ‘Fails’ across all assessments of which six could be attributed to the wet weight results of sample C and a further four attributed to the dry weight of sample A. All laboratories had dry weights lower than that of the actual dry weight for at least one of the three samples, suggesting minor losses of material during the rinsing process. This was most evident for samples B and C. Two laboratories did not submit dry weight results.

Cover of macroalgae & seagrass (OMC-RT10)

Two sets of fifteen quadrat photographs showing various % covers of opportunist macroalgae and seagrass were used for the exercise. These sets of photographs were duplicated to produce the three separate exercises incorporating the different assessment methods utilised by the various participating laboratories. The set of quadrat photos differed by the use of grid squares of varying quantities; open quadrat, 5 x 5 square grid and 10 x 10 square grid. Each photo represented natural levels of opportunist macroalgae and seagrass cover.

Results for % cover of both opportunist macroalgae and seagrass varied between participants and between the different methods used. Several results deviated from the sample mean and from the % cover as calculated by image analysis. Deviation from the latter was more noticeable and this has also been reported in previous years. There was a considerable lack of consistency between the three methods in terms of the degree of continuity between participants as well as how the data compared with the image analysis % cover. There was greater preference for methods A and C for both macroalgae and seagrass and as seen in previous years method B had far fewer participants.

The number of ‘Fails’ between test methods and comparison against mean or image analysis varied considerably with no apparent trend. The overall number of ‘Fails’ was far higher for macroalgae than seagrass. The seagrass tests resulted in a much broader range of results thereby increasing the standard deviation, so it is likely that the Z-scores were unable to pick up slight deviations from mean or ImageJ analysis % cover, therefore resulting in fewer ‘Fails’.

Rocky shore Macroalgae (RM-RT13)

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.

6.3 Reports

OMB RT10 Final report 2019
Wells, E., 2019. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report -OMB RT10 2019. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

OMC RT10 Final report 2019
Wells, E., 2019. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report -OMC RT10 2019. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

RM RT13 Final report 2019
Wells, E., 2019. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report -RM RT13 2019. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

7 Epibiota component

Component Administrator: Hayley Hinchen, JNCC.

7.1 Summary of activities

The JNCC have created procedural guidance for the use of ROVs and AUVs for benthic marine monitoring. These guidelines link to the existing NMBAQC operational and interpretation guidance for imagery data and support practitioners in using these more novel techniques, particularly in relation to epifaunal data collection. The guideline documents are available from the JNCC website:

JNCC, 2018. Remotely Operated Vehicles for use in marine benthic monitoring. _ Marine Monitoring Platform Guidelines No.1. JNCC, Peterborough. ISSN 2517-7605J

JNCC, 2018. Autonomous Underwater Vehicles for use in marine benthic monitoring. _ Marine Monitoring Platform Guidelines No.2. JNCC, Peterborough. ISSN 2517-7605J

The JNCC also hosted a benthic imagery analysis workshop: "THE BIG PICTURE" in Birmingham in March 2019. The main aim of the workshop was to create a work plan to organise, prioritise and coordinate future benthic imagery standards and quality assurance work in the UK. Around 50 participants attended from public bodies, research institutes, universities and consultancies across the UK. Workshop sessions focused on the issues of standardising image acquisition across platforms, sample sizes, taxa identification and enumeration issues and what standards and quality control measures are needed for the future. The workshop report was issued in April 2019 and is available here:

The 'Big Picture' Benthic Imagery Analysis Workshop Report – APRIL 2019

Workshop participants agreed to appoint a task and finish group, the Plan Development Group (PDG), to develop a *Benthic Imagery Analysis Action Plan* for the UK, based on the recommendations from the workshop which would report in 2020. This action plan is being presented to the UK's Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) in February 2020 and will be owned by the NMBAQC scheme.

The development of the epibiota taxonomic discrimination protocol (Epibiota TDP) has continued and drafts were circulated through NMBAQC to the wider community for expert input. Taxonomic identification formed one of the themes at the Big Picture Workshop with discussions on how to further develop the protocol, under the amended name of 'Epifaunal Identification Protocol'. This work is heavily dependent on the identification of a suitable epibenthic

classification system for imagery data, and will be tackled as part of implementing the Action Plan.

The JNCC have also been investigating the differences, strengths and weaknesses of different data extraction (annotation) methods on a set of high quality reef images. This data extraction method comparison study aimed to identify those approaches that are most efficient, precise and consistent between observers. The work was contracted out to Aquatic Survey and Monitoring Limited and Envision. Preliminary results of this work fed into the benthic imagery "Big Picture" workshop in March 2019. The final report on the optimisation of benthic image analysis is now available on the JNCC website:

Moore,J., van Rein, H., Benson, A., Sotheran,I. Mercer,T., & Ferguson, M. (2019). *Optimisation of Benthic Image Analysis Approaches*. JNCC Report No.641, JNCC, Peterborough. ISSN 0963-8091

8 Zooplankton component

Component Administrator: David Johns & Marianne Wootton, the Marine Biological Association.

8.1 Summary of activities

This component comprises a single module – the Zooplankton Ring Test

A trial ring test was held in 2015 and following this the first official ring test took place in 2016/17. This comprised a circulation of ten zooplankton taxa specimens for identification, a quiz with ten questions based mostly around zooplankton images and a bead enumeration exercise with 12 varieties of coloured beads.

The second zooplankton ring test took place in 2018/19 and followed a similar format except that the bead enumeration part was replaced with a real sample from a zooplankton monoculture.

For the 2018/2019 ring test, 13 participants from 12 different laboratories took part. Most participants were from the UK, as in the previous year's ring-tests; in addition, four new laboratories from Denmark, Finland, Germany and Canada, were also welcomed in to the Scheme. In June 2019, we hosted a two-day results and training workshop for the NMBAQC zooplankton component. Training sessions delivered include: planktonic mollusc identification (Katja Peijnenburg) and an introduction to automated plankton counting technology and image analysis (George Graham/Rob Camp and James Scott).

8.2 Summary of results

As in previous years the 2018/2019 ring test included a specimen identification (ID) element and written quiz: the average result for the specimen ID was 77.7% with results ranging between 40% and 100%; the average score for the written exercise was 86.8%, with marks ranging from 75% to 98%.

This year the enumeration section was coupled with basic copepod identification and an assessment of ability to separate different copepods life stages.
Levels of accuracy varied between 0% and 100% for the various life stages, but the number of total copepods displayed a more encouraging range of 82%-100%.

8.3 Reports

Zooplankton Ring Test 2018/2019

M. Wootton and D. Johns, Zooplankton component - Zooplankton Ring Test. Report to the NMBAQC Scheme committee and participants. 31pp, Feb 20

Appendix 1 - NMBAQC Co-ordinating Committee – 2018/2019

Name	Organisation	Position /Role
David Johns	The Marine Biological Association (MBA)	Chair and Zooplankton Component Administrator
Tim Mackie	Department of Agriculture, Environment and Rural Affairs, Northern Ireland (DAERA)	CMA Representative
Graham Phillips	Environment Agency (EA)	Finance Manager and CMA representative
Myles O'Reilly	Scottish Environment Protection Agency (SEPA)	Invertebrate Contract Manager and CMA representative
Joe Silke/ Rafael Salas	Marine Institute, Ireland (MI)	Phytoplankton Component Administrators
Claire Young	Department of Agriculture, Environment and Rural Affairs, Northern Ireland (DAERA)	Macroalgae Contract Manager
Ross Griffin	Ocean Ecology Ltd	Contractors' Representative
Hayley Hinchen Henk van Rein	Joint Nature Conservation Committee (JNCC)	Epibiota Component Administrators
Jim Ellis	Centre for Environment, Fisheries & Aquaculture Science (Cefas)	Fish Contract Manager
Claire Mason	Cefas	PSA Contract Manager
Pail McIlwaine	Cefas	CMA Representative
Matt Green	Natural Resources Wales (NRW)	CMA Representative
Annika Clements	Agri-Food Biosciences Institute, Northern Ireland (AFBI)	CMA Representative
Clare Ostle	The Marine Biological Association (MBA)	Technical Secretary

Appendix 2 - NMBAQC Scheme – Component Participation for 2018/2019 (Participants from UK unless otherwise stated)

Invertebrates 2018-2019 Participants:

	Ring Test (RT) Module (intercalibration / training)	Laboratory Reference (LR) Module (intercalibration / training)	Own Sample (OS) Module (audit)
Agri Food Biosciences Institute (AFBI) NI	-	-	✓
APEM	Administrator	Administrator	Administrator
Benthic Solutions Limited	-	-	✓
Biofar	✓	-	-
Biotikos Limited	-	-	✓
Cefas Lowestoft Benthic Laboratory	✓	-	-
Cyfoeth Naturiol Cymru / Natural Resources Wales	-	-	✓(x2)
DAERA Environment, Fisheries and Marine Group Laboratory	✓	✓	✓
eCoast	✓	-	-
Ecospan Environmental Ltd	✓	✓	✓
Environment Agency, Kingfisher House	-	-	✓(x9)
Eurofins Omegam BV	✓	✓	-
Fish Vet Group	✓	-	✓
Fugro GB Marine Limited (Edinburgh)	✓	-	-
Fugro GB Marine Limited (Gt. Yarmouth)	✓	-	-
Fugro GB Marine Limited (Portsmouth)	✓	-	✓
HEBOG Environmental Limited	✓	-	✓
Jacobs	✓	-	-
ILVO (Institute for Agricultural and Fisheries Research) - ANIMALAB	✓	✓	✓
IMARES Wageningen UR benthos team	✓	✓	-
Institute of Estuarine & Coastal Studies	✓	✓	✓
Marine Invertebrate Ecological Services	-	-	✓
Marinescope Taxonomy Ltd	✓	-	-
Myriad Taxonomy	-	-	✓
Natural England	-	-	✓(x2)
Ocean Ecology	✓	-	✓
Precision Marine Survey Ltd	✓	-	-
Rijkswaterstaat	✓	-	-
Seastar Survey Ltd	-	-	✓
Scottish Environment Protection Agency	✓	✓	✓
Shalla Benthic Indentification Services	✓	✓	✓
TAXON Estudios Ambientales, S.L	-	-	✓
Thomson Ecology Ltd	-	-	✓

PSA 2018-2019 Participants:

	Particle Size (PS) Module (intercalibration / training)	Particle Size Own Sample (PS-OS) Module (audit)
ABPmer	-	✓
Agri Food Biosciences Institute (AFBI) NI	✓	✓
APEM	Administrator	Administrator
Benthic Solutions Limited	✓	-
Biotikos Limited	-	✓
Cefas Lowestoft Benthic Laboratory	✓	✓
Cyfoeth Naturiol Cymru / Natural Resources Wales	✓	✓(x2)
DAERA Environment, Fisheries and Marine Group Laboratory	✓	✓
Fish Vet Group	✓	-
Fugro GB Marine Limited	✓	-
Institute of Estuarine & Coastal Studies	✓	✓
Kenneth Pye Associates Ltd	✓	✓
Marine Scotland Laboratory	✓	-
National Laboratory Services (EA)	✓	✓
Natural England	-	✓(x2)
Ocean Ecology	✓	✓
Precision Marine Survey Ltd	✓	-
RPS	✓	-
Scottish Environment Protection Agency	✓	✓
Thomson Ecology Ltd	✓	-

Fish 2018-2019 Participants:

	Fish - Reverse Ring Test (FRRT10)	Fish - Ring Test (FRT12)
AFBI	✓	✓
APEM Limited	-	✓
Department of Agriculture, Environment and Rural Affairs (DAERA)	✓	✓
Environment Agency (CLA Preston)	✓	-
Environment Agency (DCS Bodmin)	✓	✓
Environment Agency (ECMAS)	✓	✓
Environment Agency (ECMAS)	✓	-
Environment Agency (ECMAS)	✓	-
Environment Agency (ECMAS)	✓	-
Environment Agency (ECMAS)	✓	-
Environment Agency (ECMAS)	✓	-
Environment Agency (KSL West Malling)	✓	-
Environment Agency (SSD Romsey)	✓	-
Environment Agency (WMD Tewkesbury)	✓	✓
Environment Agency (WSX Blandford)	✓	-
Fugro GB Marine Limited	-	✓

IECS	-	✓
Natural Resources Wales	✓	✓
Natural Resources Wales	✓	✓
Ocean Ecology ltd.	-	✓
Scottish Environment Protection Agency	✓	✓
The Marine Biological Association of the United Kingdom	✓	-
Thomson Ecology Ltd.	Administrator	Administrator