NE ATLANTIC MARINE BIOLOGICAL ANALYTICAL QUALITY CONTROL SCHEME

Annual Report 2019/2020

A report prepared by the NMBAQC Scheme Coordinating Committee
March 2021

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This Annual Report provides synopsis of the scheme year's activities over 2019/2020, the 26th 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 four meetings during 2019-2020 on 30th May 2019, 8th October 2019, 30th April 2020 and 6th October 2020. The minutes of the meetings are on the NMBAQC web site **http://www.nmbaqcs.org/reports/**

Committee Membership for 2019/2020 is shown in Appendix 1.

1 Scheme Review

The scope of the NMBAQC scheme continued to develop in 2019/2020 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).

Where possible other components followed a similar format to the previous year and involved training and testing exercises for the Invertebrate, Particle Size, Fish, and Macroalgae components. The Zooplankton component is held every two years so the next ring test planned for late 2020 will be documented in the 2020/2021 NMBAQC annual report.

The 2019-2020 participation level in the NMBAQC scheme was similar to the previous year (see Appendix 2).

Summaries of all the component activities are provided in this document.

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 2019 / 2020 (year 26) followed the format of year 2018 / 2019. 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.

Fifty-one laboratories (with multiple participants from some organizations counted separately) participated in the Benthic Invertebrate Component of the NMBAQC Scheme in 2019 / 2020 (year 26). Twenty-three 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; nineteen were UK private consultancies. Nine of the participants were non-UK laboratories (including three government organizations and six 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 2018 / 2019 (year 25) of the Scheme.

2.2 Summary of results

Two **Ring Tests (RT)**, each of 25 specimens, were distributed (RT57 and RT58). The second (RT58) was targeted on non-native species and similar. The methods and policies used in the module followed the Ring Test Protocol (Worsfold & Hall, 2017a).

For RT57, the average numbers of differences per participating laboratory (for a total of 21 laboratories with 23 submissions) were 4 generic differences and 7.2 specific differences.

Three species (one polychaete annelid, one mollusc and one echiuran) were responsible for over a quarter (27%) of the specific differences.

For RT58, the average numbers of differences per participating laboratory (for a total of 19 participants with 19 submissions) were 4.8 generic differences and 7.3 specific differences. Seven specimens (an oligochaete, two crustaceans, two molluscs, a bryozoan and an ascidian), were responsible for almost half (47%) of the specific differences.

Laboratory Reference (LR): Six laboratories signed up for the LR24 module and five laboratories submitted specimens for confirmation. Most misidentifications were for Annelida (62%), followed by Arthropoda (21%) and minor phyla (14%). 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 OS71-73, extraction efficiency (of individuals) was better than 90% in 93% of the comparisons and better than 95% in 89% of all comparisons. 100% of countable taxa were extracted from the sample residues in 52% of samples. The Bray-Curtis similarity index ranged from 49.2% to 100% with an average of 96.5%. The Bray-Curtis similarity index was greater than 95% in 84% of comparisons; in 92% of cases, the value of the index was greater than 90% and, therefore, achieved 'Pass' flags. Twenty-four samples (25%) 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. The **2020/21 timetable will be revised** to reflect the timescales for CMA macrobenthic data availability.

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 coordinated.

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. Scheme participants will be consulted throughout the development of the TDP.

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. 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 encourage 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** is available 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** in 2017 (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, 2019/2020 (Year 26)

Worsfold, T.M., Hall, D.J., and O'Reilly, M. (Ed.), 2021. Benthic Invertebrate Component Annual Report. Scheme Operation 2019/2020 (Year 26). A report from the contractor to the NMBAQC Scheme co-ordinating committee. 29pp, March 2021

Own Sample Module Summary Report OS71, 72 & 73 – March 2021 for 2019/20

Hall, D. 2021. NE Atlantic Marine Biological Analytical Quality Control Scheme. Own Sample Module Summary Report OS71, 72 & 73. Report to the NMBAQC Scheme participants. 18pp, March 2021.

Laboratory Reference Module Summary Report LR24 – April 2020

Worsfold, T., Hall, D. and O'Reilly, M., 2020. NE Atlantic Marine Biological Analytical Quality Control Scheme. Laboratory Reference Module Summary Report LR24. Report to the NMBAQC Scheme participants. 10 pp, April 2020.

RTB58 – March 2020 (Targeted – Non-native species and similar)

Worsfold, T., Hall, D. & Pears, S., 2020. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#58. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#58, 42pp, Mar, 2020.

RTB57 – Dec 2019 (General/Mixed taxa)

Worsfold, T., Hall, D. & Pears, S., 2019. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#57. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#57, 40pp, Dec, 2019.

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

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 2018/19; 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.

Nineteen laboratories signed up to participate in the 2019/20 PS module exercises (PS72, PS73, PS74 and PS75); eight were government laboratories and eleven were private consultancies. Twelve laboratories signed up to participate in the PS-OS module exercises (PS-OS16, PS-OS17 and PS-OS18); eight were government laboratories and four were private consultancies. One government laboratory had two Lab Codes to submit six PS-OS samples 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

Nineteen laboratories subscribed to the exercises in 2019/20. For the first circulation (PS72 and PS73) seventeen subscribing participants provided results; for the second circulation (PS74 and PS75) all but one participant provided results. Participant PSA_2613 submitted data for PS74 and PS75 after the interim reports were issued with no prior communication, but the data were incorporated into the final reports for these exercises. PSA_2519 did not participate in exercises PS72, PS73, PS74 or PS75 and did not provide email confirmation of their non-participation.

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 (PS72, PS73, PS74 and PS75) have been reported to the participating laboratories.

3.3 Conclusions 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. Participants can choose to opt out of either the sieve or laser aspects if they do not routinely undertake that type of analysis. The participant must let the administrator know at the start of the scheme year if they wish to opt out of any analysis. Results will only be provided for the analysis that was undertaken and a note will be put on the Statement of Performance that the participant has opted out of certain points.

   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. This year’s data will be trialled with the possibility of a report detailing the outcomes available in the next scheme year.

4. **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. Another issue that has occurred is whether muddy samples need only laser analysis or whether sieve analysis should be undertaken too. There were incidents where participants recorded less than 1g of sediment greater than 1mm causing sample descriptions to become “slightly gravelly”. The NMBAQC guidance states in “5.4.2 *Laser diffraction analysis of <1mm sediment fraction*” that “…if no sediment >1mm is left on the 1mm mesh [when preparing a laser sub-sample from the bulk], then no further analysis is required”. With such small amounts of sediment greater than 1mm found in the entire sample it is unlikely that significant amounts of sediment greater than 1mm were present on the mesh when preparing a laser sub-sample and therefore sieve analysis did not have to be undertaken**.** A workshop, either in person or a webinar detailing how to create and homogenise a laser sub-sample, particularly looking at the use of ultrasonics may be useful in forth coming years.

5. **Health and Safety**. Recently **the presence of asbestos in marine samples** has been brought 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. All the natural material used to create PS ring test samples continues to be 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@apem.co.uk

3.4 Reports

PSA Component Annual Report Year 26 (2019/20)
Pears, S., McIntyre-Brown, L., Pye, K. and Hall, D. Particle Size Analysis Component Annual Report Scheme Operation 2019/2020 (Year 26). 37pp, May 2020.

PS72 January 2020
Pears S., McIntyre-Brown, L. & Hall, D., 2019. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS72. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps72, 48pp, January 2020.

PS73 January 2020
Pears, S., McIntyre-Brown, L. & Hall, D., 2019. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS73. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps73, 48pp, January 2020.

PS74 April 2020
Pears, S., McIntyre-Brown, L. & Hall, D., 2018. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS74. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps74, 49pp, April 2020.

PS75 April 2020
Pears, S., McIntyre-Brown, L. & Hall, D., 2018. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS75. Report to the NMBAQC Scheme participants. Apem Report NMBAQCps75, 47pp, April 2020.

4 Fish component

Contract Manager: Jim Ellis, Cefas.
Component Administrator: Stephen Duncombe-Smith, APEM Ltd.

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-sixth year of the NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme (2019/20) followed the format of the twenty-fifth year, with a ring test (RT) and a reverse ring test (RRT) being organised. The Fish Component of the Scheme is currently in its fifteenth 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 (RT), and re-analysis of fish specimens submitted by participants (RRT). Additionally for the RT module, participants were supplied with a suite of images of each taxon and invited to complete an optional 'image based identification' answer sheet in the same format as the normal RT data sheet and submit results before the physical specimens were distributed. The labelling and distribution procedures employed previously have been maintained. Specific details can be found in previous Scheme annual reports.

Nineteen laboratories signed up for Scheme year 2019/2020 (with multiple participants from some organisations counted separately). Thirteen participants were government laboratories, three private consultancies, one University, one chartered laboratory and one research institute. 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. As in previous years, some laboratories elected to be involved in either one or both modules of the scheme.

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 almost all accurate (F_RRT11) (only five taxonomic errors for 190 specimens submitted). The majority of specimens were collected during the 2019 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 – APEM Ltd. Compared to the previous year, the Fish Ring Test (F_RT13) produced a good agreement at generic level; 36 differences (15% of all genus identifications received from participants) were recorded in the 16 data sets received from 11 participating laboratories.

The 2019 Fish Ring Test included three different species, which were responsible for half of the generic differences – *Clupea harengus*, *Merlangius merlangus* and *Crystallogobius linearis.* Three of the specimens circulated were responsible for 43% of the specific differences - these were *Chelon labrosus*, *Pomatoschistus lozanoi* and *C. linearis*.

4.3 Issues and recommendations

A number of 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 latest Fish Reverse Ring Test (FRRT11) and Fish Ring Test (FRT13) were successfully implemented and their format can be continued in the next scheme year. **Participants are encouraged to provide feedback to enable protocols and implementation to be improved where possible.**

2. Most participating laboratories submitted data / specimens in accordance with the Scheme's timetable. There were only two late submissions, although they did not delay initial analysis and distribution of interim reports. **Participants should endeavour to supply data / specimens according to the exercise deadlines to ensure timely summary reporting.**

3. Some identification differences might be the results of inadequate literature. Participants are encouraged to collate fish identification literature for problematic groups or juvenile specimens and follow the most recent taxonomy. **Participants are encouraged to review the bibliography of taxonomic literature available on the NMBAQC website (Section 3 in Worsfold *et al.* 2020) and give details of additions where possible. Reference to online databases for the validity of scientific names (FishBase, WoRMS and Eschmeyer's Catalog of Fishes) is also recommended.**

4. **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 FRRT exercise can be used as a means of verifying reference specimens. Laboratories are strongly recommended to implement and expand in-house reference collections of fish; these should include images alongside physical specimens. The inclusion of juvenile material is useful for certain groups, *e.g.* clupeids. Ideally all surveys should include a photographic reference of all species encountered as a minimum.

5. 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.

6. Since the beginning of the scheme, continual improvement to the learning structure of the Scheme reports has been crucial. For the FRRT and FRT detailed results have been forwarded as **individual exercise reports** to each participating laboratory as soon after the exercise deadlines as practicable. The results and subsequent differences raised in both exercises should **benefit all scheme participants**. A bulletin was circulated after each exercise, reviewing the literature used, detailing the accepted identification of the taxa received or circulated, and including images of relevant specimens. Participants are encouraged to review all exercise reports and **provide feedback concerning content and format** wherever appropriate.

7. Despite being raised as a problematic group in the past gobies and grey mullet continued to be groups with a high number of differences recorded. Future Fish Ring Test exercises are expected to target taxa that were highlighted as potentially problematic in FRT13 and FRRT11. **Participants are encouraged to provide feedback on problem taxa that could be included in future exercise and are invited to submit specimens for use in future exercises** (approximately 20 specimens of similar size and condition).

8. **The distribution and analysis of an 'Image only' FRT provided lots of feedback and helped raise potential difficulties that would need to be overcome** for the use of image only circulations in future exercises. Notably, clear images of all potential diagnostic features (requiring manipulation of the specimen) would need to be supplied; fin ray counts or similar would also need to be supplied. The use of 'image only' specimens also remains a potentially useful option for the inclusion of conservation species or scarce species that would otherwise be impractical to circulate. **Participants are encouraged to provide feedback on the use of 'image only' specimens in future exercises.**

9. The Fish Ring Test (FRT13) included the distribution of some **specimens that were smaller than usually encountered** by some participants, this was probably a factor in more identification differences recorded. Participants are encouraged to provide feedback on the circulation of juvenile specimens in future exercises**.**

10. Two of the eleven laboratories submitted multiple data sets for the Fish Ring Test. **Participants are encouraged to submit multiple data sets** for sub-teams and individual analyst where possible to improve the training aspect of the exercise.

11. Specific protocol documents are yet to be produced for the Fish Component of the Scheme. To avoid possible confusion **protocol documents for the exercises will be produced and made available on the scheme website.**

12. APEM Ltd. always strives to ensure smooth running and **transparency of the Scheme**. APEM Ltd. log and make available all correspondence to the Fish Component Contract Manager (Jim Ellis, CEFAS). Participants can be assured that

their anonymity will be protected if this correspondence is required to be shared with the Committee.

4.4 Reports

Fish Component Annual Report, Year 2019/2020

Duncombe-Smith, S., and Hall, D., 2020. Fish component - Report from the contractor. Scheme Operation - 2019/2020. A report to the NMBAQC Scheme co-ordinating committee. 17pp, May 2020.

FRT_13 - April 2020

Duncombe-Smith, S., Hall, D., and Pears, D. 2020. NE Atlantic Marine Biological Analytical Quality Control Scheme. Fish Ring Test Bulletin: FRT#13. Report to the NMBAQC Scheme participants. APEM Report NMBAQCfrtb#13, 43pp, April 2020.

FRRT11 – January 2020

Duncombe-Smith, S., and Hall, D., 2020. National Marine Biological Analytical Quality Control Scheme. Fish Reverse Ring Test: FRRT11. Final report to the NMBAQC Scheme participants. APEM Report NMBAQC FRRT11, 29pp, January 2020.

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

IPI Phytoplankton Report

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.iphyi.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, whether there would be interest in this new measurement. 53 analysts or 54% of the total for 2019 responded that they would be interested in participating in bio-volume measurements. This compares with 58% (57 analysts) in 2018 and 32% (29 analysts) when asked the same question in 2017. This is an area that we are interesting in and something that we would like to develop further as Bio-volume measurements could be easily integrated into the IPI programme.

Also, since 2018 we have changed how we produce our materials. The main variation introduced during the production process was the preservation of materials using 10 ml brown glass ampoules under nitrogen gas and the automation of the homogeneity of the materials using the 'inversina', a bio-engineered mixer that uses the Paul-Schatz inversion method. Materials produced in this way are very stable for long periods of time.

The number of IPI participants has increased significantly since 2011 and the influence of the test has been widened to many regions across the globe. This year we reached the highest number of analysts (98) and the largest number of laboratories (52). Many laboratories participate regularly and since 2005, approximately 100 laboratories have partaken of this exercise since 2005 and several analysts have more than 10 contributions. In 2019, we had for the first time participants from Central America; Cuba and Nicaragua.

The IPI workshop took place in Hillerød, Denmark from the 23-27 February 2020 and had 16 attendees.

5.2 Summary of results

a) Identification and Enumeration Exercise

Ten species were used in the IPI2019 test. There were five dinoflagellates and five diatoms in the samples. These were the dinoflagellates *Akashiwo sanguinea* (K.Hirasaka) Gert Hansen & Moestrup, 2000, *Prorocentrum micans* Ehrenberg, 1834, *Gonyaulax spinifera* (Claparède & Lachmann) Diesing, 1866, *Azadinium spinosum* Elbrächter & Tillmann, 2009*, Heterosigma akashiwo* (Y.Hada) Y.Hada ex Y.Hara & M.Chihara, 1987 and the diatoms *Pseudo-nitzschia seriata* complex (Cleve) H.Peragallo, 1899, *Chaetoceros danicus* Cleve, 1889, *Corethron hystrix* Hensen, 1887, *Chaetoceros curvisetus* Cleve, 1889 and *Thalassiosira tenera* Proschkina-Lavrenko, 1961.

The robust average and confidence limits 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 measurands. 18 Red flags (1.8%), 23 (2.3%) yellow flags and 12 (1.2%) non-identification flags from 980 scores is evidence of good performance overall. Six analysts failed the test (see annex XI). One analyst (70%) is just below the requirement with three failed test items and 4 analysts (60%) failed 4 items need some improvement. One analyst (20%) score failed 8 out 10 items requires substantial training and improvement in the next round. There were no significant issues with the qualitative aspects of this exercise and the number of non-detections 2.04% (2.1% in 2018) and mis-identifications 1.73% (5.9% in 2018) in the samples were relatively lower in comparison with previous years.

The performance of analysts on the correct identification of species was generally very good. *Prorocentrum micans* was recognized by all 98 analysts to species level correctly and the easiest to identify dinoflagellate. *Pseudo-nitzschia* was also detected by all analysts to genus level. There were a small number of mis-identifications and non-identifications across the measurands. The most non-detected organisms were *Akashiwo sanguinea* related probably to its low cell density and *Heterosigma akashiwo*, a difficult raphidophyte. The most mis-identified species were *Gonyaulax spinifera*, which was confused with *Lingulodinium polyedrum* by 6 analysts followed by *Scrippsiella* spp. (4 analysts).

b) Ocean Teacher 2019 online HAB Quiz

The online HAB assessment was set up in the OTGA website (https://classroom.oceanteacher.org/) and consisted of 12 questions. 97 analysts completed and submitted the quiz. There were two type of questions in this assessment; matching (Q2, 3, 4, 9, 10, 11 & 12) and multiple choice (Q 1, 5, 6, 7 & 8). Multiple choice type questions carried penalties for choosing the wrong answer and this penalty was proportional to the number of possible erroneous answers.

For each question a plate of images were shown and analysts asked to pick the right answers from the list. 74.2% analysts performed above the proficiency threshold of 90% and 20.6% of all analysts between 80-90%. 4.1% above 70% and only 1.1% requiring improvement. The consensus is largely rather good among participants and the scores suggest a high degree of proficiency.

5.3 Reports

Phytoplankton Enumeration and Identification Ring test, 2019
Salas, R.G., Clarke, D., Larsen, J., 2019. International Phytoplankton Intercomparison Proficiency test in the abundance and composition of marine microalgae 2019 report. PHY-ICN-19_MI1 VR 1.0. 132 pp.

6 Macroalgae component

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

6.1 Summary of activities

The format for 2019 -20 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. There were 7 laboratories participating in the OMB-RT, 10 laboratories in the OMC-RT and 6 laboratories in the RM-RT.

6.2 Summary of results

Biomass of macroalgae (OMB-RT11)

A single test consisting of three biomass samples was distributed. As with previous years, each sample consisted of a different synthetic material including j-cloths, wool and synthetic stuffing material contaminated with debris and sediment of a sandy-muddy nature.

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.

Three laboratories showed significant deviation from the actual sample dry weight with a further one 'Fail' 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 six 'Fails' across all assessments of which five could be attributed to dry weight comparisons, albeit these were distributed across all three samples. Two laboratories had dry weights lower than that of the actual dry weight for sample A, suggesting minor losses of material during the rinsing process.

Cover of macroalgae & seagrass (OMC-RT11)

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 modules 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 year's method B had far fewer participants.

The overall number of 'Fails' was higher for macroalgae than seagrass particularly when compared against Image J. 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 Image J analysis % cover, therefore resulting in fewer 'Fails'.

Rocky shore Macroalgae (RM-RT14)

Images of twenty macroalgae specimens were distributed to the six subscribing laboratories. Round fourteen 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 5 incorrect genus names and 6 incorrect species names, to 40, with all species correctly identified. All participants correctly identified nine species. Most incorrect species identification were made at the species level with three 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 RT11 Final report 2020
Wells, E., 2020. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report - OMB RT11 2020. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

OMC RT11 Final report 2020
Wells, E., 2020. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report -OMC RT11 2020. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

RM RT14 Final report 2020
Wells, E., 2020. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Module Report -RM RT14 2020. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

7 Epibiota component

Component Administrator: Joey O'Connor, JNCC.

7.1 Summary of activities

External quality assurance processes

Since 2018, JNCC, Cefas and Marine Scotland Science have introduced external quality assurance processes for further quality assuring results of imagery analyses undertaken in-house and sub-contracted for offshore Marine Protected Area monitoring. These include a full reanalysis of a subset of 10% of the imagery data by an independent analyst, a subsequent comparison of the two analyses to check for differences and remediation where necessary before the imagery analysis is deemed complete. The processes run alongside internal quality assurance checks undertaken by the primary analysts. The protocols are set out in each project specification and a summary of the protocol followed with results captured in each project report. The protocols have been refined on a project by project basis with JNCC, Cefas, Marine Scotland Science, Envision Ltd, Seastar Survey Ltd, MarineSpace Ltd, Ocean Ecology Ltd, Galathea Ltd and the Zoological Society of London all having participated to date. Costs relating to these new external quality assurance processes have been absorbed into the imagery analysis costs of each project on a per project basis.

Cost and readiness evaluation of remote and autonomous technology in the context of MPA monitoring report

In 2019, Defra published a report written by JNCC, NE and Cefas (lead author Hayley Hinchen, JNCC) entitled "Cost and readiness evaluation of remote and autonomous technology in the context of MPA monitoring". The report explored the use of Marine Autonomous Systems (MAS) and remote sensing in the context of delivering benthic Marine Protected Area (MPA) monitoring objectives in the inshore and offshore environment. Technologies including Satellites, Autonomous Underwater Vehicles (AUVs), Remotely Operated Vehicles (ROVs), Unmanned Aerial Vehicles (UAVs) and Unmanned Surface Vehicles (USVs) were considered alongside more traditional data acquisition methods.

http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=20216

Big Picture: UK Benthic Imagery Action Plan

In early 2020, the NMBAQC committed to further developing the Epibiota component through the implementation of the UK Benthic Imagery Action Plan.

The Action Plan provides a strategic framework to carry out necessary improvements for a wide range of imagery analysis standards in a collaborative and coherent way, so that national resources are used more efficiently. The Action Plan was developed by the Big Picture Plan Development Group (PDG), who formed following the March 2019 Big Picture workshop to develop a plan based on the recommendations from the workshop.

8 Zooplankton component

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

8.1 Summary of activities

Whilst no Ring test was planned for the 2019/2020 NMBAQC year, work continued on the design of the next test (autumn 2020), with an enumeration component, a quiz and species identification test all in the pipeline. The results of this will be discussed at the next annual report.

Appendix 1 - NMBAQC Co-ordinating Committee – 2019/2020

Name	Organisation	Position /Role
David Johns	The Marine Biological Association (MBA)	Chair and Zooplankton Component Manager
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/Joey O'Connor 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
Paul McIlwaine	Cefas	CMA Representative
Matthew Green	Natural Resources Wales (NRW)	CMA Representative
Adele Boyd/Alex Callaway	Agri-Food Biosciences Institute, Northern Ireland (AFBI)	CMA Representative
Clare Ostle/Claire Taylor	The Marine Biological Association (MBA)	Technical Secretary

Appendix 2 - NMBAQC Scheme – Component Participation for 2019/2020

(Participants from UK unless otherwise stated)

Invertebrates 2019-2020 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
APPLUS NORCONTROL S.L.U	✓	-	-
Benthic Solutions Limited	-	-	✓
Biofar	✓	-	-
Biotikos Limited	-	-	✓
Cefas Lowestoft Benthic Laboratory	✓	-	-
Cyfoeth Naturiol Cymru / Natural Resources Wales	-	-	✓(x7)
DAERA Environment, Fisheries and Marine Group Laboratory	✓	✓	✓
Eco marine Consultants Ltd	-	-	✓
Ecospan Environmental Ltd	✓	✓	✓
Environment Agency, Kingfisher House	-	-	✓(x11)
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	✓	-	✓
Hull Marine Laboratory (formerly IECS)	✓	-	✓
ILVO (Institute for Agricultural and Fisheries Research) -	✓	✓	✓
Jacobs	✓	-	-
Marine Invertebrate Ecological Services	-	-	✓
Marinescope Taxonomy Ltd	✓	-	-
Myriad Taxonomy	-	-	✓
Natural England	-	-	✓
Ocean Ecology	✓	-	✓
OCEANSNELL S.L	-	-	✓
Pelagia Nature & Environment AB	✓	-	-
Precision Marine Survey Ltd	✓	-	-
Rijkswaterstaat	✓	-	-
Seastar Survey Ltd	-	-	✓
Scottish Environment Protection Agency	✓	✓	✓
Shalla Benthic Indentification Services	✓	-	✓
Thomson Ecology Ltd	-	-	✓
WMR (Wageningen Marine Research)	✓	✓	-

PSA 2019-2020 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	✓	✓
Ecospan Environmental Ltd.	✓	-
Fish Vet Group	✓	-
Fugro GB Marine Limited (Portsmouth)	✓	-
Hull Marine Laboratory(formerly IECS)	✓	✓
Kenneth Pye Associates Ltd	✓	✓
Marine Scotland Laboratory	✓	-
National Laboratory Services (EA)	✓	✓
Natural England	-	✓
Ocean Ecology	✓	-
Precision Marine Survey Ltd	✓	-
Rijkswaterstaat CIV	✓	-
RPS	✓	-
Scottish Environment Protection Agency	✓	✓
Thomson Ecology Ltd	✓	-

Fish 2019-2020 Participants:

	Fish - Reverse Ring Test (FRRT10)	Fish - Ring Test (FRT12)
AFBI	✓	✓
APEM Limited	Administrator	Administrator
Department of Agriculture, Environment and Rural Affairs (DAERA)	✓	✓
Environment Agency (ECMAS)	✓	✓(x6)
Fugro GB Marine Limited	✓	-
Hull Marine Laboratory (formerly IECS)	✓	-
Natural Resources Wales	✓ (x2)	-
Ocean Ecology ltd.	-	✓
The Marine Biological Association of the United Kingdom	-	✓