NE ATLANTIC MARINE BIOLOGICAL ANALYTICAL QUALITY CONTROL SCHEME

Annual Report 2021/2022

A report prepared by the NMBAQC Scheme Coordinating Committee
February 2023

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This Annual Report provides synopsis of the scheme year's activities over 2021/2022, the 28th 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 the 2021-2022 reporting period. This was on the 19th April 2021, 24th August 2021, 24 November 2021 and 3rd March 2022; subsequent meetings will be covered in the next Annual Report. Minutes of this meeting are on the NMBAQC website:
http://www.nmbaqcs.org/reports/

Committee Membership for 2021/2022 is shown in Appendix 1.

1 Scheme Review

The scope of the NMBAQC scheme continued to develop in 2021/2022 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 with the last ring test undertaken during the autumn of 2021, whilst the Phytoplankton component undertakes its International Phytoplankton Comparison (IPI) exercise on a yearly basis.

The 2021-2022 participation level in the NMBAQC scheme showed an increase on the previous period, returning to numbers at pre-Covid levels (See Appendix 2).

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

2 Invertebrate component

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

2.1 Summary of activities

Scheme year 2021/ 2022 (year 28) followed the format of year 2020 / 2021. 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 labelling and distribution procedures employed previously have been maintained. Specific details can be found in previous Scheme annual reports.

Forty-five laboratories (with multiple participants from some organizations counted separately) participated in the Benthic Invertebrate Component of the NMBAQC Scheme in 2021 / 2022 (year 28). Eighteen 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. Eight of the participants were non-UK laboratories (including three government organizations and five 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 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 2020 / 2021 (year 27) of the Scheme.

2.2 Summary of results

Two **Ring Tests (RT)**, each of 25 specimens, were distributed (RT61 and RT62). The second (RT62) was targeted on Gastropoda. The methods and policies used in the module followed the Ring Test Protocol (Worsfold & Hall, 2017a).

For RT61, the average numbers of differences per participating laboratory (for a total of 23 laboratories with 21 submissions) were 2.4 generic differences and 5.1 specific differences. Three species (two polychaetes and an anthozoan) were responsible for just over a third (34%) of the specific differences.

For RT62, the average numbers of differences per participating laboratory (for a total of 23 participants with 21 submissions) were 4.2 generic differences and 5.5 specific differences. Four specimens were responsible for nearly half (45%) of the specific differences.

Laboratory Reference (LR): Six laboratories signed up for the LR26 module and four laboratories submitted specimens for confirmation. Most misidentifications were for Annelida (59%), followed by Arthropoda (35%). The methods and policies used in the module followed the Laboratory Reference Protocol (Hall & Worsfold, 2017).

The methods and policies used in the **Own Sample (OS)** module followed the 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 OS77-79, 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 encourages to redress or resolve disagreements for taxonomic errors 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) is in development to accompany 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 forma**t 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 follow up 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 and other benthic monitoring programmes. 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 biological 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 were reviewed and re-issued for the previous scheme year (Ring Test Protocol, Laboratory Reference Protocol and 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 Component Technical 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, 2021/2022 (Year 28)

Worsfold, T.M., Hall, D.J., and O'Reilly, M. (Ed.), 2023. Benthic Invertebrate Component Annual Report. Scheme Operation 2021/2022 (Year 28). A report from the contractor to the NMBAQC Scheme co-ordinating committee. 29pp, July 2023

Own Sample Module Summary Report OS 77,78,79 – June 2023

Hall, D. 2023. NE Atlantic Marine Biological Analytical Quality Control Scheme. Own Sample Module Summary Report OS77, 78 & 79. Report to the NMBAQC Scheme participants. 15pp, June 2023.

Laboratory Reference Module Summary Report LR26 – December 2022

Worsfold, T., Hall, D. 2022. NE Atlantic Marine Biological Analytical Quality Control Scheme. Laboratory Reference Module Summary Report LR26. Report to the NMBAQC Scheme participants. 9 pp, December 2022.

RTB62 - August 2022 (Targeted Gastropoda)

Worsfold, T., Hall, D., & Pears, S., 2022. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#62. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#62, 34pp, Aug, 2022.

RTB61 – January 2022 (General/Mixed taxa)

Worsfold, T., Hall, D., & Pears, S., 2022. NE Atlantic Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#61. Report to the NMBAQC Scheme participants. APEM Report NMBAQC RTB#61, 36pp, Jan, 2022.

3 Particle Size Analysis component

Technical 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 2021/22; 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.

Eighteen laboratories signed up to participate in the 2021/22 PS module exercises (PS80, PS81, PS82 and PS83) seven were government laboratories and eleven were private consultancies. Twelve laboratories signed up to participate in the PS-OS module exercises (PS-OS22, PS-OS23 and PS-OS24); six were government laboratories and six were private consultancies. One government laboratory had eleven Lab Codes to submit thirty-three 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

Eighteen laboratories subscribed to the exercises in 2021/22. For the first circulation (PS80 and PS81) fourteen subscribing participants provided results; for the second circulation (PS82 and PS83) sixteen participants provided results. PSA_2805 and PS_2810 did not submit data and did not provide any further communication indicating 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 (PS80, PS81, PS82 and PS83) 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, 2022) 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 have been completed correctly. This will help eradicate typing and transcription errors. The workbook was updated for the current Scheme Year (Year 28) to help enable the continuity of data through the

workbook. Conditional formatting will flag up red cells where there are possible data entry errors.

3. **The current NMBAQC Scheme Pass/Fail criteria for the PS modules are under review**. Currently results are broken down for review, including, sieve processing, laser and final data. 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. Following the publication of 'Statistical comparisons of sediment particle size distributions' (Barry *et al*., 2021) in Continental Shelf Research, data from previous and future reports will trial this new statistical method of comparing the benchmark and participant data to understand if we can achieve a pass/fail criteria for the particle size component, with the possibility of a report detailing the outcomes available in the next couple of scheme years.

4. **Possible workshop looking at sample preparation and presentation to laser.** Covid-19 restrictions put an end to any possible face-to-face workshops in Years 27 and 28, as restrictions ease this may become an option in the next couple of Scheme years.

   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 2021/2022 (Year 28)

Pears, S. & McIntyre-Brown, L. Particle Size Analysis Component Annual Report Scheme Operation 2021/2022 (Year 28). 39pp, September 2022.

PS80

Pears, S., McIntyre-Brown, L. & Hall, D., 2022. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS80 Report to the NMBAQC Scheme participants. Apem Report NMBAQCps70, January 2022.

PS81

Pears, S., McIntyre-Brown, L. & Hall, D., 2022. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS81 Report to the NMBAQC Scheme participants. Apem Report NMBAQCps73, January 2022.

PS82

Pears, S., McIntyre-Brown, L. & Hall, D., 2022. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS82 Report to the NMBAQC Scheme participants. Apem Report NMBAQCps79, February 2022.

PS83

Pears, S., McIntyre-Brown, L. & Hall, D., 2022. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS83 Report to the NMBAQC Scheme participants. Apem Report NMBAQCps74, February 2022.

4 Fish component

Technical Manager: Jim Ellis, Cefas.
Component Administrator: Debbie Walsh and David Hall, 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 up to fifteen fish specimens supplied by each of the participating laboratories.
2. Fish Ring Test (F_RT) - Identification of fifteen fish specimens supplied with images.

Scheme year 2021/2022 (Year 28) followed the format of year 2020, with a ring test (RT) and a reverse ring test (RRT) being organised. The Fish Component of the Scheme is currently in its seventeenth 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 for the second module (RRT). The labelling and distribution procedures employed previously have been maintained. Specific details can be found in the fish reverse ring test protocol and fish ring test protocol (FRRT Protocol and FRT Protocol).

Eleven laboratories signed up for Scheme year 2021/2022, with a total of 25 participants. Of the nine organisations, four were government laboratories, two private consultancies, two University linked laboratories and one chartered laboratory. This was the first year a laboratory from outside the UK has taken part in the fish component of the NMBAQC scheme.

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 exercise. 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): Eight out of eleven registered participants, from six laboratories, submitted specimens to the Fish Reverse Ring Test (FRRT13). In almost all cases, the identifications made by APEM Ltd. agreed with those made by the participants, with just five taxonomic errors from 117 specimens being recorded (4.3%). Fourteen taxonomic discrepancies were recorded, which were mostly either spelling errors or the use of junior synonyms (old scientific names). One unidentified specimen was submitted, which was identified as *Helicolenus dactylopterus*.

Fish Ring Test (F_RT): Samples of 15 specimens were distributed (FRT 15). The FRT was not a targeted ring test and most species included were those that are caught commonly in routine monitoring surveys. Some specimens were relatively small but could still be expected to be caught using standard monitoring methods (e.g. by seine netting). There were relatively few taxonomic errors for the specimens circulated. Seven out of seventeen specimens were identified by all participants correctly, four specimens had one incorrect identification each, and four specimens had two incorrect identifications. Flatfish (*Pleuronectiformes*) and gadoids (*Gadidae*) accounted for most of the errors. For FRT15, the average numbers of differences per participating laboratory (for a total of eight laboratories with 14 submissions) were 0.9 generic differences (4.3%) and 1.2 specific differences (5.7%).

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 (FRRT13) and Fish Ring test (FRT 15) 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 and extensions were granted to accommodate some laboratories due to delays in their survey schedule. **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 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 datasheet** to enable additional information to be gathered regarding the difficulty of ring test specimens.

6. Despite being raised as a problematic group in the past, clupeids continued to be a group with a high number of differences recorded. Three species of flatfish (*Pleuronectiformes*) accounted for six of the taxonomic differences in the FRT. Future Fish Ring test modules are expected to target taxa that were highlighted as potentially problematic in previous modules. Participants are encouraged to provide feedback on problem taxa that could be included in future modules and are invited to submit specimens for use in future modules (approximately 20 specimens of similar size and condition).

7. The distribution of fresh frozen specimens was for the most part successful. Following feedback from previous exercises, fish were placed in individual bags and packed so the larger fish do not damage specimens in transit.

8. One of the 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.**

9. 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 2021/2022 (Year 28)

Walsh, D., and Hall, D., 2022. Fish component - Report from the contractor. Scheme Operation - 2021/2022 (Year 28). A report to the NMBAQC Scheme coordinating committee. 9pp, July 2022.

FRT 15 – March 2022

Walsh, D., and Hall, D., 2022. NE Atlantic Marine Biological Analytical Quality Control Scheme. Fish Ring Test Bulletin: FRT#15. Report to the NMBAQC Scheme participants. APEM Report NMBAQC FRTB#15, 18pp, March, 2022.

FRRT13- March 2022

Walsh D., and Hall, D., 2022. NE Atlantic Marine Biological Analytical Quality Control Scheme. Fish Reverse Ring Test Bulletin: FRRT13. Report to the NMBAQC Scheme participants. APEM Report NMBAQC FRRT13, 23pp, Jan, 2022.

5 Phytoplankton component

Technical Manager: Rafael Salas, Observatorio Canario de Algas Nocivas (OCHABs)

5.1 Summary of activities

The phytoplankton component is administered from the Canary Islands Harmful Algal Bloom Observatory (OCHAB), University of Las Palmas de Gran Canaria, Spain 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).

In 2021, 124 analysts across 59 laboratories around the world participated in the IPI exercise. European countries accounted for 78% of the total participation, 7% came from South America, 7% from African countries, 4% from Oceania and 4% from Asia.

5.2 Summary of results

Fourteen species were used in total but only 10 species were inoculated per sample. There were four dinoflagellates and ten diatoms in the samples distributed in a batch system. The robust average and standard deviation for each measurands was calculated using the Q/Huber method in ProLab Plus statistical software. The expanded standard deviation was input manually into the programme to take into consideration the heterogeneity of the samples.

Twenty-one analysts were unsuccessful at the overall test: nine analysts failed the quantitation, with four analysts just below the requirement with three failed test items (70%) and four analysts with four failed items (60%). One analyst failed six out of the ten items (40%) which highlights a requirement for training and improvement for the next round. The other twelve analysts failed the qualitative test with ten failing three identifications and two analysts failing four identifications. Three analysts failed the test quantitatively and qualitatively.

There were 113 attempts at the OTGA (OceanTeacher) HAB assessment with the overall median grade 91.3%. 57.5% of analysts performed above the proficiency threshold of 90% and 27.4% of all analysts between 80-90%. 7.9% were above 70% and another 7.9% below 70%, requiring improvement.

For further information please find the full IPI 2021 report here. Details of the 2022 IPI exercise will be provided under the 2022/2023 NMBAQC Annual Report.

6 Macroalgae component

Technical Manager: Claire Young, DAERA-NI.
Component Administrator: Georgina Brackenreed-Johnston, APEM Ltd.

This is the sixteenth year of the Macroalgae Component.

6.1 Summary of activities

The format for 2021 - 22 followed that of the previous year.

The component consisted of two 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.

The analytical procedures of all modules were the same as for the previous year of the Scheme. There were seven laboratories participating in the OMB-RT and nine laboratories in the OMC-RT.

6.2 Summary of results

Biomass of macroalgae (OMB-RT13)

This is the thirteenth year in which biomass of macroalgae has been included as a module of the NMBAQC scheme and was included as a single exercise. The format followed that established by Wells Marine during the previous years of the module (OMB RT01 – RT12 - see NMBAQC website). Test material was distributed to participating laboratories along with data forms, which were completed with algal biomass results and returned for analysis.

Nine laboratories were issued with test material, of which seven laboratories completed the macroalgae biomass module of the NMBAQC scheme. Six returned both wet and dry weight data and the seventh returned wet weight data only. All of the participating laboratories were government; no other organisations took part in this component of the macroalgae exercises.

Results for wet weight of biomass varied between laboratories with some laboratories producing very different measures of biomass when compared against the average biomass and actual/expected biomass, particularly for the wool material sample (sample B). The dry weights also showed a high degree of variability between laboratories. Most laboratories remained within the Z-score limit of +/- 2.0 for both the dry weight and wet weight against the mean, with only one 'fail' flagged the wet weight of sample B.

Comparing wet and dry weights using z-scores calculated from the expected wet weight and actual dry weight is less accommodating and more sensitive to slight deviations in results than comparisons against the mean. Consequently, six of the laboratories 'failed' at least

one of the samples and the seventh laboratory only submitted data for wet weights. There was a total of eleven 'Fails' across all assessments of which seven were for sample C, which was the largest sample.

Cover of macroalgae & seagrass (OMC-RT13)

This is the thirteenth year in which percentage cover estimations of macroalgae have been included as an element of the NMBAQC scheme and the eleventh year for which seagrass has been assessed as a separate exercise. This module included one exercise for macroalgae and one for seagrass, both of which were split into three additional tests based on methodology. The format followed that established by Wells Marine during the previous years of the module (RT03 – RT12).

Eleven laboratories were issued test material. Nine laboratories completed the percentage cover macroalgae/seagrass module with a total of eighteen participants. Of those laboratories submitting results, all nine were government organisations.

Results for percentage 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 method C for both macroalgae and seagrass and contrary to previous years, method A had the fewest 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 similar for macroalgae and seagrass particularly when compared against ImageJ. The tests continue to produce a broad range of results thereby increasing the standard deviation, this results in the Z-scores being unable to pick up slight deviations from mean or ImageJ analysis percentage cover.

6.3 Reports

OMB RT13 Final Report 2022

Pears, S., Brackenreed-Johnston, G. & Hall, D. 2022. National Marine Biological Analytical Quality Control Scheme. Macroalgae Biomass Component Report Ring Test OMB RT13 2022. Report to the NMBAQC Scheme participants. Apem Report NMBAQCmaomb13, 10pp, April 2022.

OMC RT13 Final Report 2022

Pears, S., Brackenreed-Johnston, G. & Hall, D. 2022. National Marine Biological Analytical Quality Control Scheme. Macroalgae/Angiosperm Percentage Cover Component Report Ring Test OMC RT13 2022. Report to the NMBAQC Scheme participants. Apem Report NMBAQCmaomc13, 15pp, April 2022.

7 Epibiota component

Technical Manager: James Albrecht, JNCC.

7.1 Summary of activities

External quality assurance processes

JNCC, Cefas and Marine Scotland Science continued to include 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 with a summary of the protocol followed and results/remedial action undertaken captured in each project report.

The Big Picture Project

The Big Picture III workshop was run this financial year. Unlike the previous Big Picture workshops, Big Picture III was a combination of seven online mini-workshops (each addressing one of the Benthic Imagery Action Plan themes) held between 29 November and 7 December 2022 and a one and a half day in-person workshop, 18 and 19 January 2023.

The objectives of the workshops were to identify high priority tasks from the Benthic Imagery Action Plan and identify clear and straightforward ways of working for the Big Picture Group. A workshop report is scheduled to be published later this financial year.

Ongoing work discussed at the workshop included plans for future development of standardised methods to identify epibiota observable in marine imagery. The SMarTaR-ID application was published by the SMarTaR-ID V1 Consortium (2022), and is aligned with the CATAMI morphological classification. Work underway this financial year aims to develop the CATAMI classification to better describe epibiota morphotypes in UK waters. A questionnaire was circulated in October 2022, and a workshop was held 12 December 2022 for the project working group to identify the sections of the CATAMI classification system that require updating for the UK. Further workshops to work on updating the high priority sections are planned for March 2022.

Other work currently underway and scheduled for completion this financial year includes a literature review of enumeration approaches available to analysts of seabed photographs. The literature review aims to identify the variety of enumeration approaches available and provide analysts and survey planners with advice to help chose the most appropriate enumeration approach for their circumstances.

8 Zooplankton component

Technical Manager: Marianne Wootton, CPR Survey, Marine Biological Association.

Zooplankton are included in the Marine Strategy Framework Directive (MSFD) as an indicator group; however, at present there are no current standards for their sampling and identification. As such, a quality control mechanism for the correct identification of zooplankton was identified by the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG). Thus, in 2014-2015 a zooplankton 'ring-test' component for the NE Atlantic Marine Biological Analytical Quality Control (NMBAQC) scheme was developed, by the Sir Alister Hardy Foundation for Ocean Science (SAHFOS), which was successfully adopted by the zooplankton research and monitoring community. The aim of the NMBAQC scheme, and therefore the ring-test, is to encourage consistency amongst zooplankton analysts, within and between different laboratories.

This is the third official NMBAQC scheme zooplankton component ring-test, with the test occurring biennially. In October 2020, the Continuous Plankton Recorder (CPR) Survey, with the Marine Biological Association (MBA)*[1], on behalf of the NMBAQC scheme, sent out a call of interest for the third official zooplankton ring-test, to organisations and individuals known to be involved in zooplankton research and monitoring.

8.1 Summary of activities

A ring test comprising of: 10, single taxon, tubed zooplankton specimens for identification (from the North Atlantic); 8 written questions and a copepod (*Calanus*) enumeration test, were sent out in December 2020. Twenty-one participants from 15 different laboratories took part in the ring test. As in previous years, almost all participants were from Europe with approximately half of participants from UK organisations. This year we welcomed four new laboratories to the Scheme from Germany, Italy, Norway and the United Arab Emirates.

Participants were given 10 weeks to complete their test, and results were assessed by the senior plankton analysts at the CPR Survey, Plymouth.

8.2 Materials and methods

Specimen identification test: the CPR Survey acquired various mixed zooplankton net caught samples from different areas of the North Atlantic. From these samples, single species were picked and verified by an analyst, and subsequently confirmed by the Senior Analyst. Single taxa were then transferred to centrifuge tubes and the success of the transfer was checked. Where possible more than specimen of the same taxon was placed in each tube.

Written quiz: this quiz was prepared by the CPR Survey Senior Analyst.

[1] In April 2018, the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) merged with the Marine Biological Association of the UK (MBA) and is now referred to as the 'CPR Survey' (within the MBA).

Enumeration component: counting and basic identification of copepods. For the copepod enumeration component*, Calanus finmarchicus* stage/sex-sorted specimens were supplied from culture by Biotrix, Norway; *Metridia* specimens from samples collected in the Norwegian Sea, by the Institute of Marine Research, Norway and *Gaetanus* specimens collected in the Fram Strait (East of Greenland) by the British Antarctic Survey. Specimens were sorted, counted and tubed according to sex and stage; prior to posting out to participants, contents were checked by the Senior Analyst with another experienced analyst as witness.

8.3 Summary of results

Following on from participant feedback from the two previous NMBAQC zooplankton ring tests, the ring test should be community driven and 'self-policed'. To help accomplish this, a results workshop (hosted by the CPR Survey with the MBA) was organised and took place online in Plymouth on 29th Sept 2021. Twenty participants, from fifteen different laboratories took part in the workshop, where results were discussed and consensus for marking of results was reached.

The average result for the specimen identification section was 74.3%, with individual results ranging between 45% and 100%; the worst identified specimens was a juvenile copepodite from the genus *Paraeuchaeta* with only 38% of participants identifying it correctly. Several answers assigned the specimen to a similar family member *Euchaeta,* with some participants assigning the specimen to species (e.g. *E acuta*/*E.marina*). Identification to species level is only possible with adults in the group. In contrast, the pelagic harpacticoid copepod *Euterpina acutifrons* was correctly identified by 85.7% of participants. Most participants (again 85.7%) were able to correctly identify a brachyuran decapod belonging to the genus *Ebalia*.

For the written exercise, the average score was a proficient 81.6%, with individual marks ranging from 58.3% to 100%. The most poorly answered question concerned the identification of shelled molluscs. The overall score for this question was 62.7%: all participants recognised the specimens as belonging to *Gastropoda*, but there was clear confusion on how to correctly separate *Limacina* (a common holopelagic pteropod) from other meroplanktonic gastropod larvae.

Two questions scored the highest marks amongst participants (both 91.7%): the subject of one question being the correct identification (with explanation) of a *Branchiostoma lanceolatum*; with the other question testing participant's ability to measure copepods correctly.

This year, the enumeration section combined counting expertise together with basic copepod identification skills and an assessment of the ability to separate different copepods life stages. The enumeration sample contained a mix of three calanoid copepod genera (*Calanus*, *Metridia* and *Gaetanus*), participants were informed that their sample could contain a mix of taxa and were asked to only count the genus *Calanus. Calanus* is an important component of North East Atlantic Zooplankton, so it is reasonable to expect that participants are able to separate it from other co-occurring similar sized taxa.

8.4 Conclusions and Recommendations

Overall, the zooplankton ring test was deemed a success. It showed that the level of zooplankton identification amongst participants overall is very good, and that it was a useful training exercise.

For the specimen identification test, the most difficult to identify proved to be the Oncaeid copepod and the non-native copepod *Acartia tonsa*. However, most participants correctly identified the genus for both of these specimens. For the written test, the most difficult question concerned the recording of Siphonophore taxa and their correct enumeration.

Recommendations from the previous ring-test were taken on board by the organisers and, where possible, were tried to be employed in this current test (e.g. include: juvenile copepods, non-calanoid copepods, Echinodermata; higher numbers in the enumeration test; results sent out to participants prior to workshop; host a two day workshop).

At the end of the results workshop, participants were again given an opportunity to give feedback on the ring test and training, both verbally and anonymously via a feedback form. The overall feeling was that participants found the test useful and enjoyable, saying that it challenged them at the right level; also, the length of time it took to complete the test was about right.

Appendix 1 - NMBAQC Co-ordinating Committee – 2021/2022

Name	**Organisation**	**Position /Role**
David Johns	The Marine Biological Association (MBA)	Chair
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 Technical Manager and CMA representative
Rafael Salas	Observatorio Canario de algas nocivas	Phytoplankton Technical Manager

Claire Young	Department of Agriculture, Environment and Rural Affairs, Northern Ireland (DAERA)	Macroalgae Technical Manager
Ross Griffin	Ocean Ecology Ltd	Contractors' Representative
James Albrecht	Joint Nature Conservation Committee (JNCC)	Epibiota Component Administrators
Jim Ellis	Centre for Environment, Fisheries & Aquaculture Science (Cefas)	Fish Technical Manager
Claire Mason	Cefas	PSA Technical Manager
Marianne Wootton	The Marine Biological Association (MBA)	Zooplankton Technical Manager
Paul McIlwaine	Cefas	CMA Representative
David Hall	APEM Ltd	Component Administrator for Benthic, Fish and PSA
Lydia McIntyre Brown	APEM Ltd	Component Administrator for PSA
Debbie Walsh	APEM Ltd	Component Administrator for Fish
Matthew Green	Natural Resources Wales (NRW)	CMA Representative
Adele Boyd/Alex Callaway	Agri-Food Biosciences Institute, Northern Ireland (AFBI)	CMA Representatives
Claire Taylor	The Marine Biological Association (MBA)	Technical Secretary

Appendix 2 - NMBAQC Scheme – Component Participation for 2021/2022

(Participants from UK unless otherwise stated)

Invertebrates 2021-2022 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, Tenerife	✓	-	-
Benthic Solutions Limited	-	-	✓
Biofar, Faroes	✓	✓	-
Biotikos Limited	-	-	✓
Cefas Lowestoft Benthic Laboratory	✓	-	-
Cyfoeth Naturiol Cymru / Natural Resources Wales	-	-	✓(x6)
DAERA Environment, Fisheries and Marine Group Laboratory	✓	✓	✓
Eco Marine Consultants Ltd	-	-	✓
Ecospan Environmental Ltd	✓	✓	✓
Environment Agency, Kingfisher House	-	-	✓(x8)
Eurofins Omegam BV	✓	✓	-
Fishlab, Viby, c/o Orbicon, Denmark	✓	-	-
Fugro GB Marine Limited (Edinburgh)	✓	-	✓
Fugro GB Marine Limited (Gt. Yarmouth)	✓	-	-
Fugro GB Marine Limited (Portsmouth)	✓	-	✓
HEBOG Environmental Limited	✓	-	✓
Hull Marine Laboratory	✓	-	✓
ILVO (Institute for Agricultural and Fisheries Research) -	✓	✓	✓
Magnus Axelsson	✓	-	-
Marine Invertebrate Ecological Services	-	-	✓
Marinescope Taxonomy Ltd	✓	-	-
MBM Benthic Identification Services (The Lab Shed)	✓	-	-
Myriad Taxonomy	-	-	✓

Natural England	-	-	✓
Ocean Ecology	✓	-	✓
Pelagia Nature & Environment AB, Sweden	✓	-	-
Pharmaq Analytic Limited (formerly Fish Vet Group)	-	-	✓
Precision Marine Survey Ltd	✓	-	-
Rijkswaterstaat CIV	✓	-	-
Scottish Environment Protection Agency	✓	-	✓
Shalla Benthic Indentification Services	✓	-	-
Thomson Ecology Ltd	-	-	✓
WMR (Wageningen Marine Research)	✓	✓	-

PSA 2021-2022 Participants:

	Particle Size (PS) Module (intercalibration / training)	Particle Size Own Sample (PS-OS) Module (audit)
ABPmer	-	✓
Agri Food Biosciences Institute (AFBI) NI	✓	✓
APEM Ltd	Administrator	Administrator
Benthic Solutions Limited	✓	-
Biotikos Limited	-	✓
Cefas Lowestoft Benthic Laboratory	✓	✓
Ecospan Environmental Ltd.	✓	-
Fugro GB Marine Limited	✓	-
Hull Marine Laboratory(University of Hull)	✓	✓
ILVO	✓	-
Kenneth Pye Associates Ltd	✓	✓
Marine Scotland Science	✓	-
National Laboratory Services (NLS -EA)	✓	✓
Northern Ireland Environment Agency (NIEA)	✓	✓
Ocean Ecology Ltd	✓	✓
Precision Marine Survey Ltd	✓	-

Rijkswaterstaat	✓	-
RPS Environmental Management Ltd	✓	-
Scottish Environment Protection Agency	✓	✓
Thomson Environmental Consultants	✓	-

Macroalgae 2021-2022 Participants:

	Subscribing Labs
RM RT15 2021 - Algal Identification	4
OMC RT12 2021- Macroalgae/Angiosperms % Cover	7
OMB RT12 2021- Macroalgae Biomass Component	4

Phytoplankton 2021-2022 Participants:

Company/Agency	Country
Dalcon Environmental	Australia
Microalgal Services	Australia
PIRSA	Australia
Sydney Water	Australia
Instituto de Fomento Pesquero (IFOP)	Chile
Plancton Andino	Chile
Universidad Católica del Norte	Chile
Lamar Asociados Ltda	Chile
Institute of Oceanography and Fisheries	Croatia
Centro de Estudios Ambientales de Cienfuegos (CEAC)	Cuba
IFREMER	France

AquaEcology GmbH & Co. KG	Germany
Laboratory Unit for Harmful Marine Microalgae, Aristotle University of Thessaloniki	Greece
Marine Institute	Ireland
Agenzia Regionale per la Prevenzione Protezione dell'Ambiente	Italy
Fondazione Centro Ricerche Marine	Italy
Istituto Zooprofilattico Sperimentale delle Venezie	Italy
IZSS	Italy
Ministry of Ocean Economy, Marine Resources, Fisheries and Shipping	Mauritius
Institute of Marine Biology-University of Montenegro	Montenegro
nstitut National de Recherche Halieutique	Morocco
Bureau Waardenburg bv	Netherlands
Rijkswaterstaat	Netherlands
Wageningen Marine Research	Netherlands
Universidad Nacional Autónoma de Nicaragua, Managua	Nicaragua
Medical Laboratory	Nigeria

science Council of Nigeria	
Institute of marine research, Flødevigen	Norway
R-Lab Sac	Peru
Sanipes	Peru
Instituto del Mar del Perú (IMDP)	Perú
IPMA	Portugal
AGAPA (Agencia de Gestión Agraria y Pesquera de Andalucía)	Spain
Banco Español de Algas, Universidad de Las Palmas de Gran Canaria	Spain
IRTA	Spain
Swedish Meteorological and Hydrological Institute	Sweden
National Institute of Science and Technology of Sea Sfax – Tunisia	Tunisia
APEM	United Kingdom
Cefas	United Kingdom
CPR Survey, MBA	United Kingdom
Marine Scotland Science	United Kingdom
AFBINI	United Kingdom
Northern Ireland Environment Agency	United Kingdom
SAMS	United Kingdom
National Direction of Aquatic Resources	Uruguay