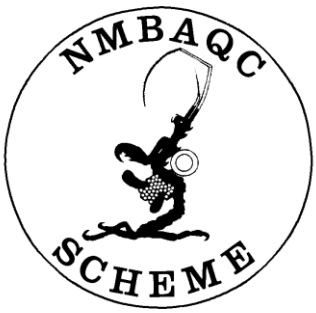

BEQUALM
NATIONAL MARINE BIOLOGICAL ANALYTICAL QUALITY CONTROL SCHEME
Annual Report - Year 19 - 2012/2013

A report prepared by the NMBAQC Coordinating Committee – July 2014

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This Year 19 Annual Report provides synopsis of the scheme year's activities over 2012/2013. 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 coordinating committee held 4 meetings during the scheme Year 19 on 7th June 2012, 4th October 2012, 24th January 2013 and 18th April 2013.

Committee Membership for Year 19 is shown in Appendix 1.

1 Scheme Review

The scope of the NMBAQC scheme continued to develop in Year 19 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 UK CSEMP (Clean Seas Environment Monitoring Programme). Under the UK Marine Monitoring and Assessment Strategy (UKMMAS) the NMBAQC scheme coordinating committee now reports to the Healthy and Biologically Diverse Seas Evidence Group (HBDSEG).

Year 19 of the scheme followed a similar format to the previous year and involved training and testing exercises for the Invertebrate, Particle Size, Fish, Phytoplankton and Macroalgae components. There was no progress with the development of the Epibiota component. Preliminary scoping of a new component for Zooplankton was undertaken. Zooplankton assessment is not included within CSEMP or WFD but is a key indicator within the forthcoming EU MSFD (Marine Strategy Framework Directive).

David Hall the Invertebrate, Particle Size, and Fish component administrator stepped down from his role when he resigned from Thomson Unicomarine at the end of 2012. David has administered these NMBAQC scheme components since the scheme's inception in 1994 and has been instrumental in developing many of the scheme's protocols, procedures and guidance. Richard Arnold acted as interim administrator for Thomson Unicomarine for the remainder of Year 19 pending their appointment of a new principal scientist.

The Year 19 participation level in the NMBAQC was similar to the previous year (see Appendix 2).

Summaries of all the component activities are provided below:

2 Invertebrate component

Contract Manager: Myles O'Reilly, Scottish Environment Protection Agency.
Component Administrator: David Hall, Richard Arnold, Thomson Unicomarine.

2.1 Summary of activities

Thirty-nine laboratories participated in the benthic invertebrate component of the NMBAQC Scheme in Year 19. Fifteen participants were Competent Monitoring

Authorities (CMAs) and twenty-four were private consultancies. One of the participants was a consortium of sole traders. Five of the CMA participants were responsible for the Clean Seas Environment Monitoring Programme (CSEMP) sample analysis. Additionally other statutory drivers for which the scheme provides external QA are the Water Framework Directive and Habitats Directive. This scheme year monitoring for Marine Conservation Zone baselines began and the scheme has also provided an avenue for external QA for this. To reduce potential errors and simplify administration, LabCodes were assigned in a single series for all laboratories participating in the benthic invertebrates, fish and particle size components of the NMBAQC Scheme (due to Thomson Unicomarine administering these three components).

This component consisted of four modules (each with one or more exercises):

- Analysis of a single natural estuarine macrobenthic sample (MB, Macrobenthic Sample module);
- Re-analysis by Thomson Unicomarine of three own samples supplied by each of the participating laboratories (OS, Own Sample module);
- Identification of two sets of twenty-five invertebrate specimens (RT, Invertebrate Ring Test module); and
- Re-identification of a set of twenty-five specimens supplied by each of the participating laboratories (LR, Laboratory Reference module).

The analytical procedures of the various modules were the same as for Year 18 of the Scheme, which includes the specification that the Macrobenthic Sample module and CSEMP samples or any statutory driver within the Own Sample Module should be conducted using the NMBAQC guidance for macrobenthic invertebrate sample analysis (Worsfold, Hall & O'Reilly (Ed.) 2010).

A taxonomic workshop for experts was held at the Dove Marine Laboratory (Cullercoats) in November 2012. The workshop focused on Syllidae (Polychaetes) which were presented by Guillermo San Martin (Madrid University) and also looked at Caprellidea (Amphipods) led by Jose Guerra Garcia (Seville University). The workshop was oversubscribed and was attended by 32 participants. The workshop programme is shown in Appendix 3.

2.2 Summary of exercise results

Two **Ring Tests (RT)** of 25 specimens were distributed (RT43 and RT44). Both sets contained 25 invertebrate specimens, the second (RT44) including several taxonomically challenging species. In general, there was fairly good agreement between the identifications made by the participating laboratories and those made by Thomson Unicomarine.

For RT43 each participating laboratory recorded on average 2.3 generic differences and 4.7 specific differences. Nine taxa (two polychaetes, three molluscs, and four crustaceans) were responsible for more than two thirds of the specific differences.

For RT44 each participating laboratory recorded on average 2.5 generic differences and 5.4 specific differences. Again nine taxa (one mollusc, one crustacean, one oligochaete, one ctenophore, and five polychaetes) were responsible for more than two thirds of the specific differences.

Laboratory Reference (LR): Eleven laboratories submitted their LR17 specimens for confirmation. Misidentifications were found to be usually for bivalve, amphipod and polychaete species, belonging to genera which are either speciose, or for which keys are inadequate. The majority of taxonomic errors could be attributed to the submitted polychaetes (49 %) and molluscs (40 %).

Analysis of the **Macrobenthic Sample (MB)** by the six participating laboratories and subsequent re-analysis by Thomson Unicomarine provided information on the efficiency of extraction of the fauna, accuracy of enumeration and identification and the reproducibility of biomass estimations. For MB20, natural estuarine samples from the southern North Sea were distributed. Results for this macrobenthic exercise showed a high degree of agreement to the re-analysis by Thomson Unicomarine. Extraction efficiency (of individuals) was on average 96.53% with one laboratory achieving 100 % and all laboratories extracting more than the required 90 % of individuals. Comparison of the results from the laboratories with those from analysis by Thomson Unicomarine (following the NMBAQC macrobenthic analysis guidelines) was made using the Bray-Curtis similarity index (untransformed). The value of the index varied between 82% and 99%. It was better than 90% in 83% of the comparisons and less than 85% in only one laboratory.

The revised protocols of Scheme Year 10 for 'blind' **Own Sample (OS)** audits were continued in this Scheme year. For OS50, OS51, OS52 laboratories were asked to submit full completed data matrices from their previous year's Clean Seas Environment Monitoring Programme (CSEMP 2011) samples, or similar alternative sampling programmes (if not responsible for CSEMP samples). The OS 'Pass/Fail' flagging system, introduced in Scheme Year 8, was continued (see Description of the Scheme Standards for the Benthic Invertebrate Component).
The results for the Own Sample Module were slightly better than those from the Macrobenthic Sample Module. Agreement between the laboratories and Thomson Unicomarine was generally very good. Extraction efficiency was better than 90% in 97% of the comparisons and better than 95% in 93% of all comparisons. All countable faunal specimens were extracted from the sample residues in 56% of the samples. The Bray-Curtis similarity index ranged from 72% to 100% with an average figure of 97%. The Bray-Curtis similarity index was greater than 95% in 83% of comparisons and in most cases (94%) the value of the index was greater than 90%. These samples all achieved 'Pass' flags. Twenty samples (19%) achieved 'Pass- Excellent' flags with Bray-Curtis similarity scores of 100%.

2.3 Issues and recommendations

A number of observations and recommendations have been made from the results of the exercises described above. These are detailed in the component annual report and are abbreviated as follows:

1. Late submission of data or samples by participants continues to result in significant reporting delays.
2. Labs submitting samples for audit must ensure they submit all sorted residue and all faunal fragments.
3. It is the responsibility of participating labs to ensure they return data or submit samples. Labs that have signed up to exercises but do not complete them will still

be charged. CSEMP or any statutory driver labs who fail to submit samples for audit will receive a "deemed fail" flag.

4. Labs need to ensure they follow the standardised protocol for biomass assessment.
5. Labs should make use of the Lab Reference exercise to develop and verify their reference collections.
6. Ring Test participants should complete the "Confidence Level" column to allow the test administrator to gauge the level of difficulty on each taxon.
7. Participants should ensure they are familiar with taxonomic literature produced by, or highlighted by, the scheme. The Scheme has produced a UK Standard Taxonomic Literature database which is available on the NMBAQC web site in the Participants area. Login details can be obtained from the Technical Secretary.
8. Own Sample submission sheets should be completed in full and sample processing should follow the NMBAQC guidelines.
9. Own Sample participants should address all taxonomic errors, including those in samples that have received a Pass flag.
10. Own Sample participants should investigate and address issues raised with samples that fail to achieve targets for sorting efficiency.
11. There is a need for the scheme to develop a Taxonomic Discrimination Policy (TDP) to standardise acceptable identification levels within different taxonomic groups.
12. Participants are actively encouraged to provide more feedback on exercises (whether positive or negative) to ensure they receive the most benefit from their participation.
13. Constructive feedback from participants in Year 19 has highlighted the value of the scheme to participants in assisting them with quality improvements via remedial actions.

2.4 Reports & Taxonomic literature

Benthic Invertebrate Component Annual Report, Year 19 (2012/13)

Barnich, R., 2014. Benthic Invertebrate component - Report from the contractor. Scheme Operation - Year 19 2012/13. A report to the NMBAQC Scheme co-ordinating committee. 27pp, June 2014.

RTB 44 - June 2014

Barnich, R. and Freeston, T., 2014. National Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#44. Report to the NMBAQC Scheme participants. Unicomarine Report NMBAQC RTB#43, 36pp, June 2014.

RTB 43 - April 2013

Hussey, S., Chamberlain, D., Freeston, T. & Gajda, A., 2013. National Marine Biological Analytical Quality Control Scheme. Ring Test Bulletin: RTB#43. Report to the NMBAQC Scheme participants. Unicomarine Report NMBAQC RTB#43, 30pp, April 2013.

MB 20- May 2013

Hussey, S. and Freeston, T. 2013. National Marine Biological Analytical Quality Control Scheme. Macrobenthic Exercise Results - MB20 (Year 19). Report to the NMBAQC Scheme participants. 15pp, May 2013.

Own Sample Module Summary Report OS50, 51 & 52 - June 2014
Barnich, R., 2014. National Marine Biological Analytical Quality Control Scheme. Own Sample Module Summary Report OS50, 51 & 52. Report to the NMBAQC Scheme participants. 24pp, June 2014.

NMBAQC scheme standard taxonomic literature database, 2013
The third version of the NMBAQC scheme standard taxonomic literature database is available to current NMBAQC participants. If you are a current NMBAQC participant, then please email Astrid Fischer for a copy of this database.

For further taxonomic literature, see the NMBAQC web site, Literature and Taxonomic Keys for the invertebrate component.

3 Particle Size Analysis component

Contract Manager: Myles O'Reilly, Scottish Environment Protection Agency.
Component Administrator: David Hall, Richard Arnolds, Thomson Unicomarine.

3.1 Summary of activities

In the Year 19 NMBAQC Scheme eleven laboratories participated in the particle size analysis exercises PS44, PS45, PS46 and PS47; four were government laboratories and seven were private consultancies. Five of the participants were responsible for CSEMP (Clean Seas Environment Monitoring Programme) sample analysis.
This component consisted of one module with four exercises: Analysis of four sediment samples (PS44, PS45, PS46 and PS47) for physical description:

PS44 - Sandy Mud (natural sample)
PS45 - Sand (natural sample)
PS46 - Gravel (artificially created sample)
PS47 - Gravelly Sand (natural sample)

Participants are expected to follow the NMBAQC Best Practice Guidance for Particle Size Analysis (PSA) for Supporting Biological Analysis. This describes standard procedures for collecting and analysing sediment samples including sampling, analysis, data recording and quality assurance. The UK CMAs undertaking PSA in support of biological analysis for CSEMP and WFD monitoring programmes are required to adopt these procedures and recommendations.

The analytical procedures were the same as for the eighteenth year of the Scheme. In previous years the Particle Size exercises (PS) 'Pass/ fail' criteria were based upon z-scores from the major derived statistics with an acceptable range of ±2 standard deviations. The annual report for Scheme Year 16 deemed the use of z-scores inappropriate for such a low number of data returns where two erroneous results can significantly alter the 'Pass/ fail' criteria. The z-score method also assumes that the majority of respondents are correct and raised genuine concerns regarding technique and method bias. Following this, the 'Pass/ fail' criteria are currently under review and alternative flagging criteria are being trialled. Therefore, Scheme Year 19 continues the use of z-scores calculated for each half-phi interval, and multivariate analysis using

Euclidean distance matrices (dendrograms and non-metric MDS plots) trialled in Scheme Year 17 and Year 18 respectively.

The variation within the ten replicate results produced for TUM in-house analysis (using the NMBAQC PSA SOP) was minimal for each of the four exercises; this is partly attributable to the use of only Malvern laser instruments and some standardised protocols, i.e. no use of chemical dispersants or hydrogen-peroxide pre-treatment. In most cases there was reasonably good agreement between participant laboratories for all four PS exercises.

3.2 Summary of results

The samples distributed as PS44 appeared, from analysis of replicates, to be good replicates with little variance. Results from participating laboratories showed a general similarity in distribution curves. Cluster analysis using Euclidean distance showed that two laboratories clustered away from the majority of laboratories. The main discrepancy in one of these particular laboratories' data was characterised by the sharp rise in the cumulative percentage curve between 7.5 and 8 phi and that it did not record phi intervals >8 phi. The other laboratory did not report any data values until phi interval 2.5, leading to a displacement of the cumulative percentage curve by 2 phi. This lab also recorded a greater percentage of silt (75.24%) compared to other laboratories (average silt component of other laboratories was 55.39%).

The samples distributed as PS45 appeared from an analysis of replicates to be good replicates with very little variance. Results from participating laboratories were generally consistent with one another. Cluster analysis shows that three laboratories were discernable from the other laboratories below the ten percent significance interval. One of the laboratories cumulative percentage curve is displaced by half a phi. The second one used alternate methods to the NMBAQC scheme standard. The cumulative percentage curve shows that they recorded slightly lower percentages between 1.0 and 3.0 phi. The final laboratory recorded lower percentages between 1.0 and 1.5 phi.

The samples distributed as PS46 appeared from an analysis of replicates to be good replicates with very little variance. Results from participating laboratories were generally consistent with one another. Cluster analysis using euclidean distance shows that one laboratory is dissimilar to all other participant results. This laboratory did not start recording data until phi interval -3.5. This is shown on the cumulative percentage curve by a displacement of one phi, causing a sharp rise between -3.5 and -3 phi. Following feedback, this anomalous result has been attributed to this particular laboratory not possessing sieve mesh sizes larger than -3.5 phi.

The samples distributed as PS47 appeared from an analysis of replicates to be generally good replicates with some variance. As with PS46, one particular laboratory did not start recording data until phi interval -3.5. This is shown on the cumulative percentage curve by a displacement of one phi, causing a sharp increase between -3.5 and -3 phi. Following feedback, this anomalous result has been attributed to this laboratory not possessing sieve mesh sizes larger than -3.5 phi. There was also a cluster group B comprising two laboratories. Both laboratories recorded a small percentage of silt (0.53% and 0.04% respectively) compared to other laboratories. This is also shown by both laboratories recording results above phi 4.0 and 4.5 respectively. This accounts for the deviation of z-scores for one of the laboratories from phi 4.0 - 12. The differences

shown by this laboratory could also be attributed by adhering to a slightly different methodology than the NMBAQC Scheme standard. A third cluster group C is formed of a single laboratory. This could be attributed to this laboratory recording a higher percentage of particles between phi 0.00 and 1.00 than all other laboratories. A fourth cluster group D is also formed of a single laboratory. The cumulative percentage curve shows that this laboratory has a comparatively higher percentage increase (between 0.5 and 2.5). Finally, cluster groups E (one laboratory), F (three laboratories) and G (two laboratories, and the TUM AVERAGE) have cumulative percentage curves that look very similar to one another. Cluster group E recorded a slightly lower percentage of particles between phi -3.5 and - 3 compared to other laboratories (omitting the one without the relevant sieves).

Data were provided by all eleven participating laboratories for PS44, PS45, PS46 and PS47. Participating laboratories were asked to provide the sediment description using the Folk triangle post analysis. Two laboratories failed to provide the post analysis description for PS44. For PS44, six laboratories had post-analysis sediment descriptions of Sandy Mud; two laboratories had a post-analysis description of Muddy Sand; and one laboratory of Sandy Silt. For PS45, all participating laboratories recorded the post-analysis sediment description as Sand. All post-analysis sediment descriptions for PS46 were Gravel. For PS47, seven laboratories recorded the post-analysis sediment description as Gravelly Sand; and four laboratories described the sediment as Sandy gravel.

As demonstrated in these and previous PS exercises, possible variations in equipment and methods can result in variable data. In order to eliminate as much variation as possible the NMBAQC's Best Practice Guide was devised for use in Scheme Year 17. Although most laboratories used the methods detailed in this document, a few laboratories still used in-house methodologies. All laboratories involved in CSEMP sample analysis used the NMBAQC PSA SOP for supporting biological data.

3.3 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. Laboratories should endeavour to report their PS results in the requested format, e.g. at half phi intervals. This would enable the direct comparison of data from all participants and simplify the creation of cumulative curve figures. The workbook designed for use in Scheme Year 18 to enable laboratories to provide data in a comparable format has been modified slightly for Year 19 to resolve any issues that have arisen. Participants should review their data prior to submission; zeros should only appear in submitted data where no material was present; dashes, '-', should appear where analysis has not been conducted.
2. Laboratories involved in CSEMP data submission or any samples derived from monitoring required for statutory drivers should endeavour to return data on ALL necessary components of the Scheme in the format requested. This will be required to allow the setting of performance "flags". Non-return of data will result in assignment of a "Fail" flag. For CSEMP laboratories or any statutory driver this deemed "Fail" for no submitted data is to be perceived as far worse than a participatory "Fail" flag.
3. Particle size exercises (PS) over the years have shown differences in the results obtained by different techniques (laser and sieve / pipette), in-house methods

(e.g. pre-treatment) and also differences between equipment (e.g. Malvern Mastersizer 2000, Mastersizer X and Coulter LS230 lasers). PS data indicates that the variance between laser and sieve results is further emphasised by certain sediments characteristics. The overall range of these variances needs to be determined if combining data sets derived from differing methods. The NMBAQC's Best Practice Guide has been developed for use in Scheme Year 17; this has helped to reduce the amount of variation between methods. It is essential that particle size data are presented with a clear description of the method of analysis and equipment used.

4. An improved learning structure to the Scheme through detailed individual exercise reports has been successfully implemented and was continued in this Scheme year. For the PS exercises, detailed results have been forwarded to each participating laboratory as soon possible after the exercise deadlines as practicable. Participants that submit significantly incorrect data are contacted immediately to ensure that in-house checks can be implemented to ensure future quality assurance. The PS44, PS45, PS46 and PS47 reports included the data submission sheets received from all participants as an appendix; Participants are encouraged to review their exercise reports and provide feedback concerning content and format wherever appropriate.
5. The current NMBAQC Scheme standards for PSA are under review. The alternative use of z-scores for each phi-interval, trialled in Scheme Year 17 appears inappropriate for such a low number of data returns where two erroneous results can significantly alter the pass/fail criteria. For example, this can occur if laboratories do not have the representative sieves to analyse the whole range of sediment fractions. The z-score method also assumes that the majority of respondents are correct and raised genuine concerns regarding technique and method bias. Scheme Year 19 (2012/13) follows Year 18 in that z-score analysis was run alongside cluster analysis using Euclidean distance matrices.

3.4 Reports

PSA Component Annual Report, Year 19 (2012/13)

Proctor, A., 2013. Particle Size component - Report from the contractor. Scheme Operation - Year 19 - 2012/13. A report to the NMBAQC Scheme participants. 13pp, August 2013.

PS47 May 2013

Procter, A., and Hussey, S., 2013. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS47. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCps47, 29pp, May 2013.

PS46 May 2013

Procter, A., and Hussey, S., 2013. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS46. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCps46, 28pp, May 2013.

PS45 January 2013

Finbow, L.A., Procter, A, Hussey, S, and Arnold, R., 2013. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS45. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCps43, 28pp, January 2013.

PS44 January 2013

Finbow, L.A., Procter, A, Hussey, S, and Arnold, R., 2013. National Marine Biological Analytical Quality Control Scheme. Particle Size Results: PS44. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCps43, 26pp, January 2013.

4 Fish component

Contract Manager: Myles O'Reilly, Scottish Environment Protection Agency.
Component Administrator: David Hall, Richard Arnold, Thomson Unicomarine.

4.1 Summary of activities

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

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

The analytical procedures of both modules were the same as for the eighteenth year of the Scheme. The results for each of the Scheme exercises are presented and discussed.
Fish Reverse Ring Test (F_RRT04): The identification of a set of fifteen fish species selected and supplied by the participating laboratories was relatively accurate (17 errors for 325 specimens submitted). The majority of specimens were collected by fish teams during their 2012 autumn monitoring surveys. One recurring error that was highlighted by this exercise concerned the identification of the Grey Mullets with four individuals incorrectly identified. Other recurring errors included Wrasses, Dragonets and Gobies (several species). However, there were differences in the approach to this exercise by the individual laboratories; some laboratories used this as a test for confirming voucher specimens whilst others sought a means of having uncertain or unknowns identified making it difficult to directly compare results.

Fish Ring Test (F_RT06): Fifteen fish specimens were distributed by Thomson Unicomarine Ltd. This fish ring test produced good agreement between the identifications made by the participating laboratories and those made by Thomson Unicomarine Ltd. On average each laboratory recorded 1.05 generic differences and 1.90 specific differences.

4.2 Summary of results

In total twenty-four laboratories / fish teams subscribed to F_RRT04, with twenty-two laboratories returning specimens for verification. Three laboratories submitted data and specimens after the submission deadline (LB1937, LB1941 and LB1942). Three laboratories submitted less than the specified number of taxa (LB1938, LB1949 and LB1953). In total three hundred and twenty five fish samples were submitted for verification.

In the majority of instances, identifications made by Thomson Unicomarine Ltd. were in agreement with those made by the participating laboratories with seventeen errors occurring from a potential three hundred and twenty five. The Grey Mullets (*Liza*

aurata; *Chelon labrosus* and *Liza ramada*), caused the most identification errors, with four of the twenty specimens sent by participating laboratories identified incorrectly (LB1938, LB1940 and LB1952 (2 specimens)). Gobies were the next taxonomic group that were incorrectly identified (*Pomatoschistus microps, P. minutus* and *Gobius niger*). Similar errors were noted in the previous report F_RRT03. There were also discrepancies for Corkwing Wrasse (*Symphodus melops*) and Common Dragonets (*Callionymus lyra*). Potentially difficult taxa could be specifically targeted in future fish ring tests (F_RT exercises) to quantify and resolve problems via the circulation of standardised specimens.

For F_RT06 fifteen fish specimens were circulated to eighteen participating laboratories. As with previous Scheme years, participating laboratories were permitted to supply multiple data entries for each exercise to maximise results and enhance the training aspect of this module. Other aspects of the circulation, in particular the method of scoring results, were the same as for previous circulations. Thirteen of the fifteen specimens were either discarded or retained by the participant laboratories for incorporation into their in-house reference collections or training material. The two preserved specimens (specimen 06; Common Dab (*Limanda limanda*) and specimen 14; Scaldfish (*Arnoglossus laterna*) were requested to be returned to Thomson Unicomarine by 1st October 2013. Eighteen laboratories out of nineteen returned data for this exercise, with twenty one individual data sets in total via multiple data submissions.

F_RT06 contained fifteen fish specimens. The agreement at the generic level was good; twenty-two errors (from a potential three hundred and fifteen) were recorded from the twenty-one data sets received via the eighteen participating laboratories. Agreement at the specific level was also good; forty errors were recorded. The majority of participating laboratories correctly identified each of the specimens. Only a few of the taxa were responsible for the majority of differences and these are described briefly below.

4.3 Fish Issues

For the Ring Test F_RT06 the majority of the generic differences were recorded from Blicca bjoerkna and *Arnoglossus laterna* whereas the majority of specific differences recorded were from *Ammodytes marinus*, with thirteen laboratories recording it as *Ammodytes tobianus*.
Four of the fifteen circulated specimens were correctly identified by all participating laboratories (*Sprattus sprattus, Osmerus eperlanus, Rutilus rutilus* and *Dicentrarchus labrax*). Specimen FRT0603 was also recorded as being correctly identified by all participating laboratories despite not all specimens being re-checked. A mixture of two *Scomber* species had inadvertently been circulated instead of one species as intended. As some specimens had been identified and discarded by participants before this mistake had been realised then any identification as *Scomber* was accepted as not all specimens could be re-checked.. Further details and analysis of results can be found in the Fish Ring Test Bulletins.

Several participants mis-identified species that are perceived to be common and should be readily identifiable (*eg. Limanda limanda* and *Lampetra fluviatilis*). The most common error was for the lesser sandeel (*Ammodytes marinus*). Deterioration of ring test material may also have contributed to some mis-identifications; reasons for this

include fin damage due to repeated examination which could produce inaccurate fin ray counts. Some of the specimens arrived in a deteriorated condition after being in transit. It must be noted that the vast majority of participants would normally encounter frozen or fixed fish specimens and these results do not necessarily reflect identification accuracy in routine fish monitoring surveys.

The F_RT06 results were comparable with those from the five previous exercises RT28 (F_RT01), RT31 (F_RT02), RT33 (F_RT03), F_RT04 and F_RT05 with a high level of agreement between participating laboratories for the majority of distributed species. The F_RT component is considered to provide a valuable training mechanism and be an indicator of problematic groups and possible areas for further targeted exercises or inclusion at taxonomic workshops. Multiple data entries from some laboratories and the inclusion of images in the ring test bulletins (RTB) have further emphasised the learning aspect of these exercises. F_RT06 indicated that the majority of laboratories are using the same literature to identify most specimens; Wheeler 1969, Wheeler 1978 and Maitland & Herdson 2009. However, several of the participating laboratories did not provide information as to the literature used for identification.

4.4 Reports

Fish Component Annual Report, Year 19 (2012/13)
Hussey, S., 2013. Fish component - Report from the contractor. Scheme Operation - Year 19 - 2012/13. A report to the NMBAQC Scheme co-ordinating committee. 16pp, September 2013.

FRT 06 July 2013
Hussey, S., 2013. National Marine Biological Analytical Quality Control Scheme. Fish Ring Test Bulletin: FRT#06. Report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQCfrtb#06, 19pp, July 2013.

RRT 04 - July 2013
Hussey,S., 2013. National Marine Biological Analytical Quality Control Scheme. Fish Reverse Ring Test: FRRT04. Final report to the NMBAQC Scheme participants. Thomson Unicomarine Report NMBAQC FRRT04, 19pp, July 2013.

5 Phytoplankton component

Scheme Administrator: Joe Silke, Marine Institute, Republic of Ireland. Registration and fee collecting arranged through BEQUALM Website (based at CEFAS Lab, Lowestoft).

5.1 Summary of activities

54 Analysts from 29 laboratories from around the world took part in this intercomparison. 51 analysts and 28 laboratories returned results. This year, there are laboratories from Australia and North Africa taking part in this exercise for the first time. There are also two laboratories from South America.

- The bulk (24 laboratories) comes from across Europe: Ireland (4), Northern Ireland (1), Scotland (3), England (7), Netherlands (2), Sweden (2), Spain (4) and Greece (1).
- There were five species of interest in this intercomparison exercise. These were: *Dinophysis acuminate* Ehrenberg, *Phalacroma rotundatum* (Claparéde

& Lachmann) Kofoid & Michener, *Lingulodiniun polyedrum* (Stein) Dodge, *Karenia selliformis* A.J.Haywood, K.A.Steidinger & L.MacKenzie and *Coolia monotis* Meunier.

- The statement of performance certificate, Z-score and identification only takes into account three counts: *D.acuminata, L.polyedrum* and *K.selliformis*.
- The other two counts are not used in the final statement for the reasons outlined here: *C.monotis* is not considered a toxic producing alga and analysts were asked to count only toxic and harmful species in the samples. *P.rotundatum* counts cannot be used because the cell density of this species was found at the limit of detection of the method of 1 cell in 25ml, so we cannot ascertain that all samples contained at least one cell.
- There were other toxic and harmful species found in the samples but these are not considered in this report as these were at very low cell densities and not possibly found in all samples.

5.2 Summary of results

The descriptive statistics for each count using the Anderson-Darling Normality test suggests that the data follows a normal distribution for most counts once outliers are taken out. The Individual charts and Z-scores suggest most analysts performed within the 2 standard deviation of the mean/median of the other analyst's results.

- The median was used to calculate the confidence intervals of the *L.polyedrum* and *Karenia* counts and the mean was used for the D.*acuminata, C.monotis* and *P.rotundatum*. The Z-scores were calculated using these numbers.
- *D.acuminata* and *L.polyedrum* were the easiest species to identify by the analysts and the identification should be correct to species level in this case. *C.monotis* and *K.selliformis* were the most difficult species to identify in the samples. In the case of *Karenia* identification to species level is very difficult so identification to genus is sufficient for a correct answer. This is also the case for *C.monotis*, which should be identified to genus level only.
- While *C.monotis* is not a toxic organism, the *Coolia* genus includes toxic species, so analysts should probably have used the precautionary principle in this case and identify to genus only and count the cells in the samples. Those which decided not to count these species in the sample based on the non-toxic status of *C.monotis* and using light microscopy for their reliable identification tended to over-identify.
- A reliability qualitative measure calculated for the method indicates that the method, in 2012, is more sensitive (93%) than specific (65%) and its efficiency based in the data is 86%. The false positive rate is higher (35%) than the false negative rates (7%) indicating that we are more likely to mis-identify a non-toxic species than the other way around.
- Most analysts performed above the 80% mark for the 'Ocean Teacher' Bequalm Hab quiz exercise. Questions 5 to 10 were nearly perfectly answered by all analysts. Q2 was dropped from the exercise due to the uncertainty regarding its correct answer. The worst answered questions were 4 and 12.

5.3 Reports

Phytoplankton Enumeration And Identification Ring Test, 2012

Salas, R.G., Larsen, J., 2012. BEQUALM Phytoplankton proficiency test in the abundance and composition of marine microalgae 2012 report. PHY-ICN-12-MI1 VR 2.0. 54pp.

6 Macroalgae component

Contract Manager: Clare Scanlan, Scottish Environment Protection Agency.
Component Administrator: Emma Wells, Wells Marine.

6.1 Summary of activities

This report presents the findings of the macroalgae/seagrass component for the fourth year of operation within the National Marine Biological Analytical Quality Control (NMBAQC) Scheme. This component consisted of one macroalgae and one seagrass exercise which was subsequently split into National Marine Biological Analytical Quality Control – Macroalgae and Seagrass % Cover Component OMC RT04 (2013) three alternative means of assessment which may be considered as separate modules from which laboratories could complete one or more module.

The analytical procedures of the exercise remained consistent with previous rounds of the scheme (OMC RT01 – RT03). The results for the exercise are presented and discussed with comments provided on the overall participant performance.

Two sets of fifteen quadrat photographs consisting of 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, 10 x 10 square grid and 5 x 5 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. A number of results deviated from the sample mean and from the % cover as calculated by image analysis. However deviation from the latter was more noticeable. There was a much higher range of results submitted for seagrass which appears to be more difficult to estimate % cover and may be attributed, in part, to its patchy nature. Although there was a slight preference for using method B (10 x 10 square grid) for the macroalgae this was not apparent with the seagrass. It was also noticed that method B for both macroalgae and seagrass resulted in the greatest number of 'Fails' due to overestimation of % cover.

6.2 Summary of results

1. There is evidently still a high degree of error between tests as well as between participants and this may prompt the need for a specific workshop whereby methods may be discussed and possibly % cover estimations compared in the field. It is not possible from the current ring test to conclude which % cover estimation method provides the most accurate results, however it is evident through the number of participants that a 9 x 9 crosshair quadrat, which splits the quadrat into 100 squares, is the most favoured method for macroalgae and for seagrass is an open quadrat, which allowed the analyst to estimate the percent cover in a $0.25m^2$ quadrat without visual obstruction or assistance from gridlines.
2. The image analysis method used during RT04 is considered more objective than skilled eye estimation and likely to produce a more accurate results, RT04 also incorporated ground truthing to pick up subtleties of variations in cover within

the defined affected area. However, this method is still under development and will continue to undergo improvements prior to the next round of tests. Despite this round incorporating a fully classified and ground truthed image analysis method with more accurate results it is recommended at this time that participants should use the Z-scores derived from comparisons with the mean if they are required for internal quality reports.

3. During this fourth cycle of the macroalgae % cover exercise all participating submitted results within the designated timescale. All laboratories should continue to submit results within the requested deadlines as detailed at the beginning of the exercise. In subsequent years reminders will continue to be distributed prior to the completion of the exercise.
4. There are still some issues over the timing of the test and there are suggestions that the time allowed for completion of the test should be extended to accommodate increased workloads. Although this is still the most appropriate time of year to complete the tests, a longer time scale within which to complete the exercises would allow more laboratories to complete all three methodologies for both the seagrass and macroalgae. Consideration will be given to extending the time period to six weeks to ensure ample time for completion.
5. It is accepted that during field sampling it may be possible to estimate % cover of opportunist algae with a higher degree of accuracy. The nature of the photographs can produce difficulties when assessing the density of the algae and the presence of some shadows and the grids can hinder this further. In subsequent test consideration will still remain over the collection and selection of photographs for the exercise. However, it is to be noted that many seagrass beds remain waterlogged regardless of tidal height. It is equally accepted that sometimes it is difficult to accurately count algal cover when obscured under cross hairs, this would not be an issue in the field, but cannot be prevented within the test, therefore it remains important to include the open quadrat test method for a full view of the quadrat. Thought will be given to making the grid lines sharper or thinner. There was no comment this year over the range of % covers included in the test so it is assumed that these were more acceptable.
6. This year there was good approval on the current methods of estimation used and the descriptions provided, therefore no further methods will be considered at this time for future tests. The methods that are currently included within the ring test were those considered to be most frequently used. It is agreed that where laboratories use alternative methods such as subtidal quadrat % cover estimations these methods may not accurately represent their commonly used procedures. However, by completing all three methods for both seagrass and macroalgae it is still possible to compare results with other laboratories in order gauge the level of accuracy.
7. As many laboratories take quadrat photos whilst estimating % cover for in house quality control, it has been suggested that a reverse ring test could be included in the % cover component. This would enable laboratories to submit their own quadrat photos for analysis. This still remains to be discussed for inclusion in future ring tests.

6.3 Taxonomic literature & reports

RM RT07 Final report April 2013

Wells, E., 2013. National Marine Biological Analytical Quality Control Scheme-Macroalgae Identification Component Report -RM RT07 2013 Year 19. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

OMC Seagrass RT04 Results Bulletin year April 2013
Wells, E., 2013. National Marine Biological Analytical Quality Control Scheme-Macroalgae and Seagrass % Cover Component Report - MC RT04 2013. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

OMB RT04 Final Report April 2013
Wells, E., 2013. National Marine Biological Analytical Quality Control Scheme-Macroalgae Biomass Component Report -OMB RT04 2013. Report to the NMBAQC Scheme participants. Wells Marine Surveys.

A new publication for 2012/2013 was Brown, H. & Wilkinson, M. 2012. *Pictures to help with identification of Fucus species from the British Isles*.

7 Epibiota component

Component Administrator: Gavin McNeill, AFBI.

No further activities were undertaken in Year 19 due to time constraints within the committee and a changeover of the Technical Secretary. However, it was decided this would be an item that would be developed further in Year 20 with a Best Practice Guide for the Epibiota component due to be developed.

8 Zooplankton component

Component Administrator: Astrid Fischer, SAHFOS.

8.1 Summary of activities

The National Marine Biological Analytical Quality Control (NMBAQC) and the Sir Alister Hardy Foundation for Ocean Science (SAHFOS, http://www.sahfos.ac.uk) are considering developing a quality control scheme for the analysis of zooplankton samples. The NMBAQC scheme provides a source of external Quality Assurance (QA) for laboratories engaged in the production of marine biological data. Currently there is no quality assurance scheme for zooplankton analysis.

SAHFOS is a world leader in plankton research and has a unique plankton data set stretching over 80 years which has been collected using the Continuous Plankton Recorder (CPR). SAHFOS has global zooplankton identification expertise from the major oceans.

In January 2013 NMBAQC on behalf of SAHFOS sent out a questionnaire to international zooplankton laboratories to gauge the interest in such a scheme component.

8.2 Summary of results

From the received responses to the questionnaire it appears that there is a general interest in quality assurance (QA) for zooplankton analysis, providing it is in the right format. The recommendation is for a QA standard to be set up for the identification of

general zooplankton in the various regions. We recommend that this standard should be in the form of an NMBAQC ring test, similar to the phytoplankton component, to ensure the quality and consistency of zooplankton data collected in the UK which is now integral to work carried out for many European directives such as the Water Framework, Habitats and Marine Strategy Framework Directives.

As most zooplankton research being carried out is very area dependent, the test should be divided in geographical areas of interest to participants. The test could be in the form of a series of images per species, much the same as the HELCOM Ring test for the Baltic area. Alternatively, an Own Sample submission process, similar to the benthic invertebrate component could be an option.

The way forward is to organise an international workshop, possibly in conjunction with the ICES Working Group on Zooplankton Ecology, so that the whole zooplankton community can contribute to developing best practice guidance for zooplankton analysis procedures and to discuss the development of a zooplankton ring-test as a form of external quality control.

8.3 Taxonomic literature

There is no current NMBAQC literature database for the zooplankton component. However, some relevant starting points may be:
ICES Plankton Identification Leaflets, 1939-2001 (Including Fiches d'Identijication du Zooplancton and ICES Identijication Leaflets for Plankton, 1-187, and Fiches d'Identijication des Oeufs et Larves de Poissons, 1-6)

Boltovskoy, D., Ed. (1999). South Atlantic Zooplankton. Vol. 1 & 2. Leiden, the Netherlands, Backhuys Publishers., a summary online version can be found here: http://species-identification.org/species.php?species_group=zsao&menuentry=inleiding

Faune de France books- in French but with good illustrations. Includes books with information on echinoderms, polychaetes, pycnogonids, amphipods, molluscs, copepods, decapods and bryozoans. See the section 'Invertébrés divers' on http://www.faunedefrance.org/BibliothequeVirtuelleNumerique

http://copepodes.obs-banyuls.fr/en/ which is an excellent site for identification of copepods.

Zooplankton Identification Manual for North European Seas (ZIMNES), http://192.171.193.133/index.php

Appendix 1 - NMBAQC Co-ordinating Committee – Year 19 - 2012/2013

Name	Organisation	Position
Tim Mackie	Environment & Heritage Service, NI	Chair
Amanda Prior	Environment Agency	Finance Manager
Myles O'Reilly	Scottish Environment Protection Agency	Invertebrate Contract Manager
Joe Silke/ Rafael Salas	Marine Institute, Ireland	Phytoplankton Contract Manager
Clare Scanlan	Scottish Environment Protection Agency	Macroalgae Contract Manager
Carol Milner	APEM Ltd	Contractors Representative
Gavin McNeill/ James Strong	Agri-Food and Biosciences Institute	Epibiota Contract manager
Keith Cooper/ Claire Mason	Centre for Environment, Fisheries & Aquaculture Science	CMA Representative
Jessika Haapkylä (April-Dec)/ Astrid Fischer (Jan-March)	Sir Alister Hardy Foundation for Ocean Science	Technical Secretary

Appendix 2 - NMBAQC scheme participation for Year 19

ORGANISATION	BENTHIC INVERTS	PARTICLE SIZE	FISH	MACROALGAE	PHYTO
Agri Food Biosciences Institute	✓	✓	✓		✓
Apem Ltd	✓		✓		✓
Bantry Marine Institute					✓
Biotikos Limited	✓				
Cefas	✓	✓			✓
Center De Balear De Biologia Aplicada (CBBA, Spain)					✓
Centre Régional de l'INRH, Morocco					✓
Certificaciones Del Peru S.A					✓
CLS					✓
CMACS Ltd	✓	✓			
Corben LTD					✓
CCW	✓			✓	
eCOAST Research Centre, Belgium	✓				
Ecospan Environmental Ltd	✓				
EMU limited	✓	✓	✓	✓	
Environment Agency	✓		✓	✓	
Environmental Protection Agency				✓	✓
Estonian Marine Institute				✓	
Fish Vet group	✓				
Fugro ERT	✓	✓	✓	✓	
Fugro Survey Limited	✓				
Galway Marine Instiute					✓
Gardline Environmental PSA laboratory		✓			
Grontmij Nederland B.V, Team Ecologie	✓				
Hebog Environmental Ltd	✓				

ORGANISATION	BENTHIC INVERTS	PARTICLE SIZE	FISH	MACROALGAE	PHYTO
Hunter Biological	✓				
ILVO	✓				
IMARES	✓				✓
INRH, 2, rue de Tiznit, Casablanca					✓
Institut de Ciències del Mar -CSIC					✓
Institut National des sciences et Technologies de la Mer- Tunisia					✓
Institute of Estuarine & Coastal Studies	✓	✓	✓		
Instituto de Fomento Pesquero, Chile					✓
Intecmar, Galicia, Spain					✓
IRTA, Spain					✓
Isle of Man Government Laboratory					✓
Jacobs	✓				
Kenneth Pye Associates Ltd		✓			
Koeman En Bijkerk bv, The Netherlands	✓				✓
Laboratorio De Control De Calidad De Los Recursos Pesqueros, Spain					✓
Marine Ecological Surveys Ltd (MESL)	✓				
Marine Farm Services, Shetland Seafood Quality Control (SSQC)	✓				
Marine Invertebrate Ecological Services	✓				
Marine Scotland	✓	✓			✓
Microalgal Services Australia					✓

ORGANISATION	BENTHIC INVERTS	PARTICLE SIZE	FISH	MACROALGAE	PHYTO
Monitor Taskforce Royal Netherlands Institute for Sea Research	✓				
Myriad Taxonomy	✓				
National Laboratory Service		✓			
Natural England	✓				
NIEA Northern Ireland Environment Agency	✓	✓	✓	✓	
Precision Marine Survey Ltd	✓		✓		
RSSL Tanger/M'diq, Morocco					✓
SAMS Research Services, Scotland					✓
School of Biology University of Thessaloniki, Greece					✓
SEPA	✓	✓	✓	✓	✓
Scottish Natural Heritage					
Sir Alister Hardy Foundation for Ocean Science (SAHFOS)					✓
Swedish Meteorological and Hydrological Institute, Sweden					✓
Thomson Unicomarine Ltd				✓	
Universite de Brest	✓				
WEAQ AB					✓
	32	12	9	9	30

Appendix 3 - Invertebrate Taxonomic Workshop Programme

Day	Session	Discussion / Demonstration / Practical	Aims	Session Leader
Monday 5th Nov. 2012	8:00am	Arrival. Registration. Laboratory set-up	Register participants. Laboratory set-up	David Hall (Thomson Unicomarine Ltd.)
	10:00am	Introduction. General Information.	Welcome participants. Q & A session regarding workshop. Outline timetable	David Hall (Thomson Unicomarine Ltd.)
	10:15am	Introduction - the Dove Marine Laboratory. Brief details. Local information. Lab. rules (H&S issues)	To give brief history of the Dove Marine Lab. and facilities. Areas of local interest. Pub & food guide.	Jane Delaney (Dove Marine Laboratory)
	10:30am	Discussion / Demonstration - Introduction to selected Caprellidea. Literature. Problem areas. Identification techniques.	To introduce the major features / terminology used or identification of Caprellidea.	José Guerra García (Universidad de Sevilla)
	1:00pm	Buffet lunch		
	pm	Practical - Examination & identification of range of Caprellidea taxa from reference material.	To obtain identification experience. View / verify reference material.	José Guerra García (Universidad de Sevilla)
Tuesday 6th Nov. 2012	9:00am	Introduction / Discussion / Demonstration - Syllidae. Literature. Problem areas. Identification techniques.	To introduce the major features / terminology used or identification of Syllidae.	Guillermo San Martin (Universidad Autónoma de Madrid)
	am	Practical - Examination & identification of range of Syllidae taxa from reference material.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)

Day	Session	Discussion / Demonstration / Practical	Aims	Session Leader
Tuesday 6th Nov. 2012	1:00pm	Buffet lunch		
	pm	Discussion / Demonstration - Syllidae families. Literature. Problem areas. Identification techniques.	To introduce the major features / terminology used or identification of Syllidae.	Guillermo San Martin (Universidad Autónoma de Madrid)
	pm	Practical - Examination & identification of range of Syllidae taxa from reference material.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)
	4.00pm	Blue Reef aquarium group trip		
Wednesday 7th Nov. 2012	9:00am	Discussion / Demonstration - Syllidae families. Literature. Problem areas. Identification techniques.	To introduce the major features / terminology used or identification of Syllidae.	Guillermo San Martin (Universidad Autónoma de Madrid)
	am	Discussion / Demonstration - Syllidae families. Literature. Problem areas. Identification techniques.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)
	1:00pm	Buffet lunch		
	pm	Discussion / Demonstration - Syllidae families. Literature. Problem areas. Identification techniques.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)
	pm	Practical - Examination & identification of range of Syllidae taxa from reference material.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)

Day	Session	Discussion / Demonstration / Practical	Aims	Session Leader
Thursday 8th Nov. 2012	9:00am	Discussion / Demonstration - Syllidae families. Literature. Problem areas. Identification techniques.	To introduce the major features / terminology used or identification of Syllidae.	Guillermo San Martin (Universidad Autónoma de Madrid)
	am/pm	Practical - Examination & identification of range of Syllidae taxa from reference material.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)
	1:00pm	Buffet lunch		
	4:00pm	Practical continued.	To obtain identification experience. View / verify reference material.	Guillermo San Martin (Universidad Autónoma de Madrid)
	7.30pm	Workshop Dinner - Spanish restaurant, El Torero, Newcastle		
Friday 9th Nov. 2012	9.00am	Workshop feedback. Group photograph. Equipment pack up.	Distribute / collect workshop feedback forms. Pack up equipment & prepare for departure.	David Hall (Thomson Unicomarine Ltd.)
	10.00am	Tea & coffee; Departure		

Appendix 4 - BEQUALM/NMBAQC Scheme Taxonomic Workshop
Hillerød, Denmark 2-4 December 2012

Workshop agenda Bequalm Phytoplankton Intercomparison workshop

Sunday, 2 Dec 2012
Arrival of participants in the afternoon. Sunday dinner at 18:00pm

Monday, 3 Dec 2012
Breakfast 8:00 am
Morning session:
Intercomparison exercise results (RSalas)
Enumeration and identification exercise results.
Ocean teacher online HABs quiz exercise results.

Lunch 12:00-13:30 pm

Afternoon session:
Discussion of exercise and ideas for 2013 (All)
Lecture and microscope demonstration of the Karenia group (J.Larsen)
Presentation on Azadinium genera (R.Salas)

Discussion
Dinner 18:00pm

Tuesday, 4 Dec 2012
Breakfast 08:00 am

Morning session:
Lecture and microscope demonstration of the Diplopsalis group (J.Larsen) and microscopic
demonstration using fluorescence microscopy and oil immersion of mixed samples focusing on
toxic and potentially toxic species with reference to the IOC taxonomic reference list. (J.Larsen)

Lunch 13:00 pm
Afternoon session: Departure of participants