



# NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

## Review of recording and identification policy differences in Benthic Invertebrate Component exercises (OS, LR, MB) for Scheme Operation 2014 - 2016 (Years 21, 22, 23)

Author: Tim Worsfold

Reviewer: David Hall, NMBAQCS Project Manager

Approved by: Myles O'Reilly, Contract Manager, SEPA

Contact: [nmbaqc@apemltd.co.uk](mailto:nmbaqc@apemltd.co.uk)

APEM Ltd.

Date of Issue: July 2017



**REVIEW OF RECORDING AND IDENTIFICATION POLICY DIFFERENCES IN BENTHIC  
INVERTEBRATE COMPONENT EXERCISES (OS, LR, MB) FOR SCHEME OPERATION 2014 –  
2016 (YEARS 21, 22, 23)**

<b>1. Introduction</b>	<b>3</b>
1.1 <i>Data reviewed</i>	3
1.1.1 Confidentiality	4
<b>2. Review of recording policy comments ('green notes')</b>	<b>4</b>
2.1 <i>Introduction</i>	4
2.2 <i>Taxonomic errors</i>	4
2.3 <i>Identification and recording policy differences</i>	5
2.4 <i>Nomenclature updates</i>	6
2.5 <i>Spelling errors</i>	6
2.6 <i>Notation differences</i>	6
2.7 <i>Mis-sorted material</i>	6
2.8 <i>Missing material</i>	7
<b>3. Review of recording differences by taxon</b>	<b>7</b>
3.1 <i>Annelida</i>	7
3.2 <i>Arthropoda</i>	10
3.3 <i>Mollusca</i>	11
3.4 <i>Minor phyla</i>	13
<b>4. Conclusion and Recommendations</b>	<b>14</b>
4.1 <i>Standardization of comments</i>	15
4.2 <i>Standardization of identifications (progress towards a TDP)</i>	17
<b>5. References</b>	<b>18</b>

**Linked Documents (embedded in this report):**

Compiled data for recording policy differences (Years 21, 22 and 23)  
Excel File: GreenCommentList\_Full\_RptVersion.xls

## 1. Introduction

The North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme addresses three main areas relating to benthic biological data collection:

1. The processing of macrobenthos samples;
2. The identification of macrobiota;
3. The determination of the physical parameters of sediments.

In relation to the second parameter, standardization of identifications between samples and between laboratories has been an important consideration since the origin of the scheme, with training workshops and four regular modules with exercises designed to assess inter-laboratory variation:

- Invertebrate Ring Test (RT) Module – participants’ identification of two sets of twenty-five invertebrate specimens supplied by APEM Ltd.;
- Invertebrate Laboratory Reference (LR) Module - re-identification by APEM Ltd. of a set of twenty-five specimens supplied by participating laboratories;
- Own Sample (OS) Module - re-analysis by APEM Ltd. of three own samples supplied by participating laboratories;
- Macrobenthic (MB) Module - participants’ full analysis of a whole macrobenthos sample, with audit by APEM Ltd.

All of these exercises include comparisons of specimen identifications between participating laboratories and the scheme’s contractor (currently APEM Ltd.). Where identifications match, they are **recorded in blue** on reports and feedback documents. In many cases, identification differences can be defined as taxonomic errors (**recorded in red**) and corrected, once agreed by the organizations involved. However, there is a wide range of recording differences that do not represent errors as such but which (without data truncation) could cause variation affecting the comparability of data between laboratories. In order to highlight and lessen the impact of these differences, APEM note them (**recorded in green**) in reports and forms but they form no part of any scoring system.

In view of the ultimate aim to reduce variability in data, it has long been suggested (e.g. Hall & Worsfold, 2001; Worsfold et al., 2010) that NMBAQC scheme recording protocols include standardized policies on problems such as taxonomic discrimination levels and juveniles (green comments in current documents). This report provides a review of these ‘green comments’ from recent scheme exercises, as progress towards that aim.

### 1.1 Data reviewed

This report reviews and summarizes recording differences within the Benthic Invertebrates Component of the North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme. The review includes the first three years that were fully reported by APEM Ltd.: i.e. 2014-2016 (Years 21, 22 and 23). Data from three exercises (OS, LR and MB) are included; the MB exercise was suspended after Year 21 (2014); the RT exercise produces data of a different format but is discussed here.

A combined spreadsheet was prepared, with all records from these exercised that included ‘green comments’. Original and emended identifications were included, together with comments and records of laboratory and exercise numbers and years. Spreadsheets of raw data (comments) are linked to this document, for the three years and three modules covered: OS (1117 comments collated), LR (113 comments collated) and MB (38 comments

collated). The list was then sorted by taxonomic groups and by comment types to allow for systematic review.

### 1.1.1 Confidentiality

Each participant was given a confidential, randomly assigned LabCode for each scheme year. Codes are prefixed with the component initials, for example, BI for benthic invertebrates, the Scheme Year and a unique number (between 01 and 44) e.g. Laboratory number one in Scheme Year 2015/2016 (Year 22) was recorded as BI\_2201.

## 2. Review of recording policy comments ('green notes')

### 2.1 Introduction

It is important to note that (with a few exceptions discussed below) the notes considered here have not influenced OS pass/fail scores in any way. It should also be emphasized that all other exercises (RT, LR, MB) are designed as training exercises for the benefit of participants and their results are not used to score or assess laboratory competence. A few notes related to taxonomic errors are discussed in this review, where there may be some debate over the distinction between an error and a policy difference; this is done for greater transparency, to clarify OS audit policy.

Although comments on recording policy have been provided purely for information and without formal structure, they can be classified into a few basic types. The types vary slightly between exercises and years but are similar enough for those from OS, LR and MB to be considered together.

### 2.2 Taxonomic errors

The purpose of this review is to consider comments against taxonomic differences that are not currently scored as errors; it is, however, necessary to also review some error comments for comparison.

Where a participant's identification is considered to be incorrect, the comments cell reads:

"Taxonomic error".

If a vial recorded as one taxon includes several taxa, comments will detail this, e.g.:

"Taxonomic error; mixture, see below";

"Mixture, see below";

"Additional taxon in pot".

The different formats give some indication of the proportion of correctly identified specimens and whether the additional taxa are considered to have been an oversight (e.g., if they are small specimens of a taxon very different from the main taxon present), rather than mis-identifications.

Occasionally, a participant may identify a specimen to a lower (more precise) taxonomic level than would be done at APEM but it may yet be possible to state that the original identification was erroneous. The corrected identification will then be given at the higher (less precise) taxonomic level, with a comment in the format:

"Taxonomic error; not" (followed by the taxon recorded).

Where APEM are uncertain of a taxonomic error, the benefit of doubt is given but a note made:

"Possible taxonomic error".

### 2.3 Identification and recording policy differences

Identification policy differences are one of the greatest sources of variation in macrobenthos data. Each laboratory has different policies for taxonomic resolution and the separation of juveniles and reproductive stages. Also, these policies are rarely written and are liable to change within, as well as between, laboratories; they also change with time, in the light of new knowledge within a laboratory (which may increase or decrease resolution) and newly acquired published research.

As an NMBAQC identification recording policy or detailed taxonomic discrimination protocol has not yet been developed, the current auditors and scheme contractors, APEM, have little option other than to compare with current APEM policy when noting these differences. The following notes have been used purely to describe differences, without any suggestion that one policy should be used in preference to another:

“APEM identification policy;” (usually followed by an explanation);

“APEM policy;” (usually followed by an explanation);

“APEM recording policy;” (usually followed by an explanation);

“Mixture;” (usually followed by another comment).

The distinction between recording policy (usually to indicate distinction of sex or juveniles) and identification policy (to indicate differences in taxonomic levels used) has not always been clear from the format of the notes themselves but is usually obvious in context.

Sometimes, notes may indicate a preference for a particular policy but without consequences in the scoring system, e.g.:

“Improved literature mean these can be speciated”;

“Over cautious identification”;

“Over confident identification”.

In practice, over cautious and over confident have sometimes been used simply to indicate policy differences in taxonomic discrimination.

In the LR exercise, where there are no suggestions of correct levels, the following indicators of taxonomic level changes have been used, purely to indicate the level to which APEM are prepared to go:

“Resolution increased”;

“Resolution reduced”.

Basic comments are often followed by explanatory text or instructions. In the past, some of these have been given without the main comment, e.g.:

“Same size as” (another, specified, specimen); this indicates inconsistent separation of juveniles, where a participant has recorded juveniles (usually at a higher taxonomic level) but some are as large as other identified to species in the same project;

“Specimens <5mm”; to explain why an identification has been dropped to a higher level.

“Poor specimen”; this and the following indicate that a specimen was exceptional and that policy would usually be to use a lower taxonomic level than in this instance;

“Small specimen”;

“Specimen badly damaged”;

“Specimen dried”;

“Combine” (with... details); this indicates that a taxon newly identified by APEM is considered equivalent to another, already recorded by the participant;

“Ignore” (for stats); this note would be appended to a taxon newly identified by APEM but not considered required by the PRP/TDP (e.g. fragments, anthropogenic material, contaminant organisms); also:

“Terrestrial - probably contamination”. (eg. spiders, millipedes, woodlice, insects)

Notes may also be made on aspects of recording policy other than identification. A general example would be:

TDP not followed; (explanation).

For example, records may be given as “present” when a count would usually be expected:

“Taxon should be counted”.

## 2.4 Nomenclature updates

Where a participant has used an alternative name for a taxon, the currently valid (from WoRMS unless otherwise stated) name will be given and a note made. Two different formats have been used:

“Name change”.

On occasion, APEM (and/or a participant) may choose to use a different format from WoRMS, where WoRMS is considered to be outdated (through comparison of literature with edit dates) or for consistency or simplification (such as the exclusion of subgenera); a note will be made:

“WoRMS mis-match”.

In such cases, APEM often approach WoRMS editors to suggest edits and this may be indicated in the notes:

“Synonym; WoRMS has now been updated”.

Sometimes, nomenclature differences may cause confusion as to the species recorded. The benefit of doubt is given, with a note, e.g.:

“Original identification assumed to refer to this species but would be incorrect if”

## 2.5 Spelling errors

Where a difference is considered to be purely a result of a typographical or spelling error, the correct spelling is given and a note made:

“Spelling error”;

“Mis-spelled name”.

Sometimes, a spelling error may correspond with one of the taxon’s synonyms, in which case the difference is considered to be a nomenclature update.

## 2.6 Notation differences

There is some variation between laboratories in the format of qualifying text following taxon names. For example, un-named species may be recorded as ‘Type 1’ or ‘species A’ or a standard type may be used by the participant but not the auditor or vice versa. Also, APEM have added “sp.” to genus names without comment in some Scheme documents. Where a participant has used “spp.” (which would indicate more than one species present), a note may be made:

“Only one taxon present” (OD = spp?)

## 2.7 Mis-sorted material

Where pots appear to have been mis-labelled or specimens mis-placed but the data are correct, a note may be made:

“Processing error;” (followed by an explanation);

“Vial incorrectly labelled;” (followed by an explanation).

## 2.8 Missing material

If an expected (present in the data) taxon vial is not present, the benefit of doubt may be given but a note made:

“Pot not found”

“Specimen not provided; assumed correct”.

Similarly, if a vial has been broken in transit:

“Vial broken; Ignore”.

## 3. Review of recording differences by taxon

As discussed above, many of the differences relate to spelling differences, minor notation differences and nomenclature updates that are provided for information and need not be discussed in more detail. Identification and recording policy differences (excluding definite errors), for OS, LR and MB from Scheme Years 21, 22 and 23, are summarized below by taxonomic group. In each case, unless otherwise stated, APEM have given their identification following the current APEM policy, with a note in green, but without scoring an error.

### 3.1 Annelida

The identification of Scaleworms is highly variable between laboratories. Some use ‘Polynoidae’ for juveniles and all those without scales (with or without qualifiers). APEM retain the same policy for all conditions; currently, most are identified to species but a ‘*Harmothoe impar*’ agg. taxon is used for *H. fernandi*, *H. impar* and *H. mariannae*, and a small proportion of difficult specimens may be left at genus or family. Juvenile Sigalionidae may be left at family or genus and the size of species level determination is variable. As the name ‘*Pholoe inornata*’ has been used for different species, APEM add ‘*sensu* Petersen’ to *Pholoe* species names for clarity. APEM leave juvenile Aphroditidae at family; other laboratories may speciate them, including records of *Laetmonice*, which we have never seen but juvenile *Aphrodite* have similar features.

Members of the *Eteone longa* and *Eumida sanguinea* complexes are given ‘agg.’ at APEM but may be named as species at other laboratories. Others may leave some phyllodocids at family or genus, with or without ‘juv.’.

*Microphthalmus* spp. have been identified to species by some laboratories but are left at genus by APEM, as the features are difficult to see.

*Podarkeopsis* are named as *P. capensis* by some (currently including APEM) but left at genus by others (taxonomic uncertainty).

*Nephtys* are left at genus when small by most laboratories but the size of the divide varies and APEM identify using in-house policy (recorded as juveniles, at genus level, below 17mm).

*Glycera*, always identified to species or complex by APEM, have been identified at higher taxonomic levels by some laboratories (*Glycera* juv.). APEM record *G. lapidum*, with ‘agg.’ as it may be a complex. WoRMS combines *G. rouxi* with *G. unicornis*; this is followed by some laboratories but not all.

Small Goniadidae are left as juveniles at family level by some laboratories (always to species, juveniles undifferentiated by APEM).

*Syllides* are identified to species by some but left at genus by APEM, as G. San Martín was not confident to identify them at the workshop with our compound microscope (oil immersion required). Members of the *Syllis armillaris* complex may be given species names (including *S. hyalina*) by some. APEM now record them as *S. armillaris* agg. Some laboratories use P. Garwood's types (A, B etc.) for *Syllis*; these are converted to current nomenclature in APEM audits, with correction of *S. parapari* and *S. cornuta* records (reversed by Garwood).

The most common UK *Sphaerosyllis* is currently named '*S. c.f. taylori*' at APEM; other laboratories may use a type letter, *S. taylori* or *S. taylori/hystrix* but use of *S. hystrix* (a different species) is a taxonomic error. In RTB 44, the name *S. hystrix* was applied to this species, in error. Further discussion is provided in RTB 48.

Nereididae are left at genus or family by some laboratories at a larger size than at APEM.

*Ophryotrocha* spp. have been identified to species by some laboratories but are left at genus by APEM. *Parougia* are also left at genus by APEM. These genera typically require oil immersion or dissection for identification.

The most common UK *Lumbrineris* has been given various names due to taxonomic uncertainty. The names *L. aniara*, *L. cingulata*, *L. nr. cingulata*, *L. cf. cingulata*, *L. cingulata* agg. and *L. aniara/cingulata* all refer to this species. Old literature identifies the species as *L. gracilis*, which has since been shown to be a different species: *Hilbigneris gracilis* which occurs in the Mediterranean but has not yet been recorded from UK waters); use of these latter names constitutes a taxonomic error as they now record a different species. There have also been higher taxonomic level identifications (*Lumbrineridae* juv.), with increased resolution by APEM.

APEM always speciate *Scoloplos armiger*, without separation of juveniles but record 'Orbiniidae juv.' for juvenile *Phylo* and *Orbinia*. Policies vary between laboratories; some include small *Scoloplos* in Orbiniidae juv.

*Dipolydora* are identified at a variety of levels by different laboratories. APEM have used '*D. coeca* agg' for the main group of species. Others have attempted speciation or left them at genus. *Scolecopsis* are always identified to species by APEM but may be left at family or genus by others when small (with or without 'juv.'). Spionid identification policies will change with the new workshop guide, due to be published this year. The name *Malacoceros vulgaris* has been used for more than one species and use of '*sensu*' may be needed. The species previously recorded as *M. fuliginosus* is the true *M. vulgaris*; previous *M. vulgaris* records are of *M. girardi*. *Streblospio* are now left at genus by APEM, as the identification features cannot be consistently applied to all specimens; records of *S. shrubsolii* may be genuine or may be from lack of awareness of *S. benedicti*.

*Magelona* are always identified to species by APEM but may be left at family or genus by others when small (with or without 'juv.').

Chaetopteridae are left at genus by APEM but may be speciated by others. There may be more than one UK *Chaetopterus* and the taxonomy is unresolved (M. Petersen pers. Comm.).

*Notomastus* and *Dasybranchus* are left at genus by APEM; we consider the species names added by many other laboratories to be assumptions, rather than true distinction (though



probably usually correct). With *Capitella*, identifications of *C. capitata* are almost always erroneous, in light of recent research and will now be treated as taxonomic errors.

Maldanidae are usually taken to more precise levels at APEM than for some laboratories (although we do leave some at family). We now treat *Euclymene oerstedii* and *E. species A* as *E. oerstedii* agg.; treatment by other laboratories varies. We leave *Notoproctus*, *Nicomache* and *Leiochone* at genus; some other laboratories speciate them. It is now technically a taxonomic error to record *Leiochone* as *Clymenura*.

Taxonomic levels and recording policies for juvenile Opheliidae vary between laboratories. APEM record 'Opheliidae juv.', if there are no gills (adults to species).

Small Arenicolidae are left at family by APEM but may be identified by others.

*Asclerocheilus* are now left at genus by APEM, as there may be other UK species (J. Gil, pers. Comm). but have been speciated or called Scalibregmatidae juv. by others.

Policies vary between laboratories for sizes to record Opheliidae as juvenile, with some separating genera. APEM use Opheliidae juv. for specimens without gills.

*Owenia* are identified to species by some (with or without knowledge that there are more than one now likely in UK waters) but currently left at genus by APEM. The reverse is true for *Galathowenia*.

Some laboratories leave small or damaged Cirratulidae at family level. APEM identify most to species and has standard policies for those left at genus. Some laboratories have left specimens (of *Chaetozone*, *Tharyx*, *Cirratulus*, *Aphelochaeta* and *Caulleriella*) at genus level that APEM took to species. Some have used the name *Monticellina dorsobranchialis* (previous recommendation) for specimens that would now be called *Kirkegaardia* sp.; this is now technically incorrect, as *K. dorsobranchialis* is very unlikely to be a UK species. APEM separate juvenile *Cirriformia* and leave at genus (there are other *Cirriformia* names in the literature of unknown validity, some of which have features similar to juvenile *C. tentaculata*); others may include them with *C. tentaculata*.

Terebellides have, until recently, been assumed to be *T. stroemi* by most (with or without knowledge of another species now known from UK waters and the possibility of others); APEM now leave them at genus, as more species are likely to be recognised; some others identify species.

Small Ampharetidae have been left at family or genus by some but are usually identified to species by APEM. APEM retain separation of three species identified by Holthe (*Ampharete lindstroemi*, *A. baltica* and *A. cf. acutifrons*) although the valid names may later change; others have named all these as *A. lindstroemi* agg.

*Streblosoma* have been identified at genus level by most (including APEM), prior to clarification by I. Jirkov (pers comm. 2016) but can now be more easily assigned to species. APEM leave *Polycirrus* at genus (as tails are required), while some others identify species. Taxonomic uncertainty remains regarding several UK *Polycirrus* species. Policies vary on whether to separate *Lanice conchilega* juveniles. There is also variation in the use of Terebellidae juv.

*Megalomma* have been identified to species by some (with or without knowledge of more than one UK species since the NMBAQC 2014 workshop). They have been left at genus by APEM since the workshop due to the current taxonomic uncertainty. There have been similar policy changes and differences for other sabellid genera (e.g.: *Euchone*, *Chone*, *Dialychone*, *Jasmineira*, *Pseudopotamilla*).

APEM record serpulids that have lost their opercula as 'Serpulidae'. Other laboratories may speciate or record some as '*Spirobranchus*'.

Although a preliminary TDP is available through the NMBAQC for Oligochaeta, some laboratories have continued to record them only as 'Oligochaeta' and there is a range of other records, such as 'Tubificidae' and '*Tubificoides*'. APEM now use '*T. c.f. galiciensis*' for the species with post-clitellum papillations and open bifid chaetae (as well as hair chaetae) in notopodia; other laboratories use other notations but records of *T. insularis* for this species are regarded as a taxonomic error.

### 3.2 Arthropoda

APEM leave *Callipallene* at genus and aggregate the *Achelia echinata* group, where some other laboratories give species.

The treatment of barnacles is highly variable, partly as a result of taxonomic changes. Barnacles may be unidentifiable due to small size or damage (as they are often scraped from surfaces) and the chosen higher taxon names varies between Cirripedia (previously a class for the whole group, now an infraclass), Thoracica (former order, now superorder for most non-parasitic families), Sessilia (the current order for acorn barnacles), Balanomorpha (it's main suborder) and Balanidae (the most important of the constituent families). APEM record 'Sessilia' for damaged acorn barnacles, juvenile if below 3mm. Others, including parasitic barnacles, are counted and identified to species. A few laboratories still record barnacles as 'present', without counts, but we have not seen recent examples of NMBAQC Scheme participants ignoring them.

Copepoda are usually left as Copepoda at APEM but are taken to varying levels at other laboratories.

Ostracoda are separated into Myodocopida, Podocopida, and certain recognisable species at APEM; some other laboratories leave them as Ostracoda, or may have different recognised species.

There are undescribed UK species of *Pontocrates* that resemble *Synchelidium* in their toothed Gn2 palms. APEM currently call these *Pontocrates* species A and B; other laboratories may leave them at genus or have other systems, but naming them *Synchelidium maculatum* would be a taxonomic error.

Different sizes and degrees of damage are used to leave *Urothoe* at genus at different laboratories; they are almost always speciated at APEM, without differentiation of juveniles.

*Tmetonyx* are left at genus at APEM (due to taxonomic uncertainty); they are speciated at some laboratories.

*Ampelisca* / Ampeliscidae are recorded at genus / family at different sizes at some laboratories compared with APEM and may be left unspciated at varying degrees of damage.

Different sizes and degrees of damage are used to leave *Bathyporeia* at genus at different laboratories; they are almost always speciated at APEM.

APEM identify adult male *Cheirocratus* to species (without qualifiers) but call the others 'Cheirocratus female'; some other laboratories speciate more. APEM consider more evidence required to validate female speciation.

Female and juvenile Aoridae are speciated at some laboratories but left at family at APEM. Again APEM consider more evidence required to validate female speciation.

Different sizes and degrees of damage are used to leave Corophiidae at genus at different laboratories; they are almost always speciated at APEM.

APEM record 'Gnathiidae female' and 'Gnathiidae juvenile' and identify adult males. Other laboratories may use different systems. There is a distinct but undescribed species, named 'species A' at APEM.

APEM identify all *Idotea*; others separate some as unidentified juveniles.

APEM identify all tanaids; others leave some at Tanaidacea, even though adequate keys are available.

Different sizes and degrees as damage are used to leave Diastylidae at family or genus at different laboratories; they are usually speciated at APEM, with a defined policy (4 or fewer pairs of telson spines for specimens shown not to be *D. lucifera*) for juveniles.

Different sizes and degrees of damage are used to leave Paguridae at family or genus at different laboratories. APEM record 'Paguridae juv.' at carapace lengths below 5mm.

Different sizes and degrees of damage are used to leave Portunidae at family or genus at different laboratories. APEM record as 'juv.' for carapace lengths below 10mm., with juvenile *Liocarcinus* left at genus. APEM also separate juveniles for most other decapod genera, with or without reduced taxonomic distinction; policies vary between other laboratories.

Insects are defined as larvae or pupae at APEM and identified at order level, with certain distinctive families recognised; only definite contaminants (e.g. winged insects in offshore samples) are ignored (they appear on the laboratory forms but not in the electronic matrix). Policies vary elsewhere.

### 3.3 Mollusca

APEM identify almost all Caudofoveata and Polyplacophora to species, without separation of juveniles. Many other laboratories leave some juveniles at family or class.

APEM identify almost all trochoids to species, without separation of juveniles. Many other laboratories leave juveniles at family and may do the same with damaged specimens.

APEM identify almost all Littorinidae, Rissoidae and Hydrobiidae to species, without separation of juveniles. Many other laboratories leave juveniles at family and may do the same with damaged specimens. Records of 'Hydrobiidae' for *Potamopyrgus antipodarum* are now technically a taxonomic error (this species is now in the family Tateidae). There are two as yet un-named cochliopid species in the Thames, named 'Cochliopidae species A' and B at APEM. Other laboratories may have other policies but records of Hydrobiidae for these would be a taxonomic error.

APEM separate *Crepidula fornicata* juveniles; others may not.

APEM separate juvenile Naticidae and leave at family. Other laboratories have varying policies.

Most records of *Vitreolina philippi* should be *V. antiflexa*. This is technically a taxonomic error but included APEM records until recently.

APEM separate adult and juvenile buccinids but identify most to species; juveniles may be left at family level by other laboratories.

APEM identify most Pyramidellidae to species. Other laboratories have varying policies, some leaving some at family.

APEM distinguish genera of Philinidae (*Hermania* sp. was once called *Philine scabra*) and speciate *Philine quadripartita*. Some laboratories leave many at family, sometimes order. Use of 'Philine' for *Hermania* is now technically a taxonomic error, as is 'Philine aperta' (an African species) for *P. quadripartita*.

APEM identify most nudibranchs to genus; Onchidoridae to genus or species, Aeolidiidae to family. Other laboratories have varying policies, some leaving some at much higher levels.

APEM separate juvenile Nuculidae and leave at family. Other laboratories have varying policies.

APEM separate genera for all Mytilidae, with separation of juveniles for *Mytilus* (currently recorded as *M. edulis* but review under consideration), *Gibbomodiola* (to species) and *Modiolus* (to genus); other genera are speciated. Many other laboratories use 'Mytilidae juv.' or have other varying policies.

APEM separate juvenile Pectinidae and Anomiidae and leave at family. Other laboratories have varying policies.

APEM separate most Lucinidae and Ungulinidae into adults and juveniles (all speciated); others may not.

APEM identify almost all Thyasiridae, without separation of juveniles. Many other laboratories leave juveniles at genus, sometimes family, and may do the same with damaged specimens. There may be severe inconsistency within a project.

APEM speciate *Parvicardium* (without separation of juveniles) and, usually, other cardiid genera with segregation of juveniles. Some other laboratories leave all perceived juveniles (some juvenile *Parvicardium* records are adult) at family, sometimes superfamily.

APEM separate mactrids into adults and juveniles and leave *Spisula* and *Lutraria* juveniles at genus. Policies vary between other laboratories, with some leaving juveniles at family; others speciate *Lutraria* at a smaller size than at APEM.

APEM identify almost all *Abra*, without separation of juveniles. Many other laboratories leave juveniles at genus, sometimes family or superfamily, and may do the same with damaged specimens. APEM separate *Scrobicularia plana* juveniles; others may not.

APEM separate genera for all Veneridae, with separation of juveniles for most, either to species or genus. Many other laboratories use 'Veneridae juv.' or have other varying policies. The UK species once included in *Venerupis* are now divided between *Venerupis*, *Ruditapes* and *Polittapes*; use of 'Venerupis juv.' or *Tapes* (which no longer includes any UK species) for the other genera is now a taxonomic error.

APEM identify almost all Tellinidae to species, without separation of juveniles (except *Arcopagia*). Many other laboratories leave juveniles at genus, sometimes family or superfamily, and may do the same with damaged specimens.

APEM separate *Arctica islandica* juveniles; others may not.

Juvenile Pharidae are divided between *Ensis* juv., *Pharus legumen* (divided between adults and juveniles) and *Phaxas pellucidus* (without separation of juveniles) at APEM. Some laboratories use 'Pharidae' and speciation size is variable; others use 'Solenacea' (Solenidae is now a taxonomic error for pharids – all but *Solen*).

APEM speciate all Myidae (with separation of adult and juvenile *Mya*). Others may leave juveniles at genus or family.

APEM separate *Cochlodesma praetenu* into adults and juveniles. Some other laboratories keep them together; others include the juveniles in 'Thracioidea juv.'.

APEM separate *Thracia* into adults and juveniles, with most juveniles left at genus. Some other laboratories keep them together; others include the juveniles in 'Thracioidea juv.'.

### 3.4 Minor phyla

Protozoan records (including Foraminifera) are highly variable, both in names used and in recording format (count, presence/absence, ignore). APEM count *Astrorhiza* sp., and record other large Protozoa as 'Present' if definitely live collected, with separation of in-house types for some Astrorhizidae.

APEM record most sponges as 'Porifera', with more precise identifications for certain more recognizable taxa (e.g. *Sycon*, *Leucosolenia*, *Dysidia fragilis*, *Suberites*, *Cliona*). Other laboratories have varying policies.

APEM leave most benthic Hydractiniidae, Bougainvilliidae and Campanulariidae at family but speciate most Sertulariidae. Records vary between other laboratories.

Edwardsiid anemones are recorded at family, genus or species in varying formats by different laboratories. APEM now record most at family level but may speciate *Edwardsia*

*claparedii* and *Nematostella vectensis*, if practicable. APEM separate adults from juvenile *Cerianthus lloydi* at 17mm; other laboratories may have other policies.

Records of Platyhelminthes are highly variable between laboratories. APEM currently record 'Turbellaria' for most of the larger ones and separate families for some distinctive 'microturbellaria' (e.g. Dalyellidae, Typhloplanidae).

APEM currently separate certain nemertean taxa. Other laboratories leave all at phylum, or have different separation policies.

APEM identify most Sipuncula to species, without separation of juveniles. Many other laboratories leave juveniles at family, sometimes phylum.

APEM separate the benthic *Spadella cephaloptera* from other Chaetognatha (recorded as Sagittidae). Some other laboratories record 'Chaetognatha' (for all or for pelagic spp.?).

APEM leave certain bryozoan genera (*Aetea*, *Schizomavella*, *Scruparia*, *Amathia*, *Crisia*) at genus, while some other laboratories speciate them. The reverse has been true for some other taxa (Escarellidae, *Conopeum*). Use of 'Bugula sp.' for species now in *Bugulina* or *Crisularia* is now technically a taxonomic error.

APEM leave infaunal *Phoronis* at genus (the sessile, aggregating *P. ovalis* is speciated and recorded as 'present'), while some other laboratories speciate (or assume species names for) them.

APEM separate Crinoidea and Ophiuroidea juveniles (other than *Amphipholis squamatus*), with or without reduced resolution. Amphipholidae and Ophiuridae juveniles are recorded at family; there are no 'Ophiuroidea' records. There are many variations between other laboratories.

APEM separate Echinoidea juveniles (other than *Echinocyamus pusillus*), with or without reduced resolution. The smallest are recorded at order level (Spatangoida, Camarodonta). Policies vary between other laboratories.

APEM speciate most Synaptidae; some other laboratories leave some at genus or higher. Other holothurians are divided between adults and juveniles, with reduced resolution for the juveniles; again policies vary elsewhere.

APEM leave Didemnidae at genus but speciate most other ascidians, other than *Molgula* or many colonial spp., over 5mm (below which they are 'Ascidiacea juv.'). Other laboratories use a wide variety of formats, at higher or lower levels.

APEM record encrusting coralline algae as Corallinacea and speciate maerl; other laboratories may use 'Lithothamnion' or 'maerl'.

#### 4. Conclusion and Recommendations

The following sections provide some recommendations for updates to NMBAQC processes to improve standardization and comparability between data sets.

#### 4.1 Standardization of comments

In view of potential misunderstandings and the need for improved clarity, we propose that the comments placed against identification comparisons be standardized as far as possible, and that the same format is used across exercises, as appropriate. We propose that all future comments be placed within the following basic categories, with explanations placed after a semi-colon, where appropriate.

The following paragraphs list the proposed future standard comment formats. They could potentially be revised with updates in NMBAQC scheme routine reports. The principle is that errors that affect the audit are highlighted in red, while notes given for information are in green. In the absence of a full TDP, many differences that would affect data comparability must remain green but a format is laid out below, that would allow greater data comparability.

##### Taxonomic error

Used for instances where the some of the specimens within a vial have been incorrectly identified, such that an audit may be influenced. Taxonomic errors include instances where the taxonomic resolution has been decreased by the auditor (previous 'over confident identification') to a level that would include the original identification but where it can confidently be said not to be as originally identified (taxonomic error; not ...). They also include mis-identifications of species that do not yet have a definite binomial name but for which a definition of a type (e.g. 'species A') has been circulated to NMBAQC participants.

##### Mixture

Used for instances where a vial includes more than one species, of which some have been incorrectly identified. 'Mixture' may follow 'taxonomic error' against the same record. If individuals of a different taxon have clearly been missed through a processing error (rather than an identification error), no taxonomic error would be recorded.

##### Over cautious identification

This should be restricted to examples where the participant has used a higher taxonomic level than specified in the NMBAQC scheme Taxonomic Discrimination Protocol (TDP). Currently, the TDP only exists for oligochaetes.

##### Recording policy correction

This should be restricted to examples where the participant has used a recording policy that contradicts that specified in the NMBAQC scheme guidelines (Hall, Worsfold, & O'Reilly, 2010) or TDP. The TDP includes policy on which taxa should be recorded and may be expanded to include juvenile size definitions etc. Future versions should also include policy on whether to count or record as present.

##### Taxonomic edit

Used for instances where the identification of the majority of specimens within a vial has been changed but where there is no influence on any audit (e.g. for the LR exercise). This would previously have been included in 'taxonomic error' but use of 'error' now considered inappropriate for training exercises. The format may also be used in OS for un-named species ('species A' etc.) that have been noticed by a participant but given different designations due to non-circulation of in-house types by the auditor.

#### Taxonomic resolution increased

Used for instances where a lower (more precise) taxonomic level has been used by the auditor compared to the original participant's identification. It illustrates APEM policy but there is no influence on any audit. Some of the notes previously worded as 'APEM identification policy', 'APEM policy', 'APEM recording policy', 'over cautious identification' and 'resolution increased' would be included.

#### Taxonomic resolution decreased

Used for instances where a higher (less precise) taxonomic level has been used by the auditor compared to the original participant's identification. It would usually illustrate APEM policy but there is no influence on any audit. An explanation may be included, either to explain policy, or to explain why the conclusion may be an exception to the usual policy (e.g.: 'small specimen', 'specimen badly damaged', 'specimen dried'). Some of the notes previously worded as 'APEM identification policy', 'APEM policy', 'APEM recording policy', 'over confident identification' and 'resolution decreased' would be included.

#### Recording policy difference

Used for instances where a different recording policy has been used by the auditor compared to the original participant's identification, particularly with respect to determinations of juveniles, sex, growth forms etc. It illustrates APEM policy but there is no influence on any audit. Some of the notes previously worded as 'APEM policy' or 'APEM recording policy' would be included.

#### Specimen(s) unavailable

Used whenever specimens are not available for checking for any reason. An explanation would follow and might include: 'vial broken', 'pot not found', 'specimen not provided'.

#### Pot not found

##### Specimen not provided

Used when vial with material is missing or not provided.

#### Specimen(s) not found

Used when specimens cannot be found within a vial provided.

#### Nomenclature update

Used when the auditor has used a synonym considered to be more valid than that used by the participant. Usually this will follow WoRMS; otherwise an explanation will be given. Some of the notes previously worded as 'name change' or 'APEM recording policy' would be included.

#### Spelling error

Used where a difference is considered to be purely a result of a typographical or spelling error, the correct spelling is given and a note made.

#### Notation error

Used where the format of a record (other than identification, nomenclature or spelling) has been corrected.



## 4.2 Standardization of identifications (progress towards a TDP)

Currently, identification differences are only scored as taxonomic errors where the original was incorrect; other differences are noted as described above. We have previously suggested that taxonomic records should be standardized through the development of a taxonomic discrimination protocol (TDP). Currently, the preliminary TDP in Worsfold et al. (2010) includes only higher taxa and Oligochaeta.

At this stage, we cannot say that APEM policy is better or worse than any other and we do not yet have a comprehensive document in-house (we have never heard that any laboratory has this). However, presentation of APEM policy as a spreadsheet available for comment by participants may be the best way to begin working towards an agreed NMBAQC policy. We can also begin by stating some basic principles.

Identifications should be to the lowest taxonomic level that is consistently practicable. This means that where some laboratories are able to identify to a more precise level, others should be encouraged to do so, through workshops and other Scheme resources.

Consistency is as important as certainty. There is a belief that identifications should be taken only as far as is certain. This sounds sensible and is good policy for single specimens but; firstly, nothing is absolutely certain and the policy taken to its logical conclusion would leave most records at higher taxonomic levels. Secondly, multiple records of the same taxon at different taxonomic levels can give the illusion of multiple taxa in a data set, with respect to analysis. Identification of species only when (e.g.) tails or certain appendages are present will skew data on the basis of preservation condition, rather than community composition.

Similarly, separation of juveniles or unidentifiable material should be based on clearly repeatable rules (such as standard sizes). Some laboratories separate juveniles on the basis of size or age, whether or not they have been identified to species, while others appear to use the term juvenile to mean unidentifiable to species as key features are not yet developed or discernible. However these are different concepts and purposes. The former provides some information on the population structure while the latter is simply a reason for a higher level identification. It seems reasonable to standardize juvenile sizes for taxa that grow large, whether or not they can be identified. Unidentifiable material should not automatically be considered juvenile.

## 4.3 Conclusion

Standardisation of recording and identification policies aims to produce biological datasets which are inter-comparable. This facilitates the analysis and assessment of data at a national or international level. Hence the development of an agreed NMBAQC recording and identification policy and TDP would be beneficial if adopted by the Competent Monitoring Authorities (CMAs) and their contractors. Although such a policy or TDP would still be subject to updates, proper document control would enable relevant versions to be cross matched with specific datasets improving their comparability.

In the short term there is a need to review and standardize NMBAQC exercise comments and circulate clarifications. There is also a need to review and circulate APEM recording policies as a basis for the development of NMBAQC guidelines for recording and identification.

## 5. References

Hall, D.J. and Worsfold, T.M. (2001) *National Marine Biological Analytical Quality Control Scheme. [Own Sample Format and Standards Review: Current Problems and Proposed Solutions](#)*. Report to the NMBAQC Committee. April 2001.

Hall, D.J. (2010) *National Marine Biological Analytical Quality Control Scheme. [Description of Scheme Standards for the Benthic Invertebrate Component from Scheme Year 8 \(2001/02\)](#)*. Report to the NMBAQC Scheme participants. February 2010.

Worsfold, T.M., Hall, D.J. and O'Reilly, M. (Ed.) (2010) *[Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol: Version 1.0, June 2010](#)*. Report to the NMBAQC Committee. June 2010.