

NMBAQC

NE Atlantic Marine Biological Analytical Quality Control Scheme

Development of standard recording policies for laboratory analysis of north-east Atlantic macrobenthos samples, including a draft Taxonomic Discrimination Protocol (TDP) down to Family level: V1 August 2023



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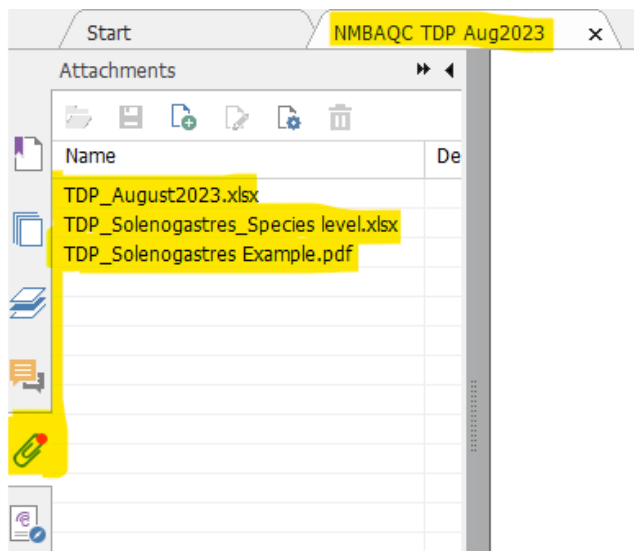


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TDP_Solenogastres
Example.pdf

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1. Introduction

The North East Atlantic Marine Biological Analytical Quality Control (NMBAQC) Scheme undertakes quality assurance exercises relating to marine biological data collection for various ecosystem components. These currently include:

1. Benthic Invertebrates (& Epifauna);
2. Fish;
3. Zooplankton;
4. Phytoplankton;
5. Algae (and seagrasses).

In response to early concerns about lack of consistency between laboratories (e.g. Elliott, 1993), one of the aims of the scheme is to improve data comparability between laboratories. Although the Scheme is divided between the above components and this document is produced for the Benthic Invertebrate component, the scope is better understood to relate to macrobenthos (i.e. to cover all biota found in samples collected from the seabed and sieved over 0.5mm or 1mm mesh, for laboratory examination of biota).

It has long been known that different laboratories have different traditions for taxonomic levels used in the identification of marine macrobenthos, together with different definitions for juvenile and damaged material (Cooper & Rees, 2002; Worsfold & Hall, 2001; 2017). These differences have produced inconsistencies between data sets that could not be resolved through the current NMBAQC audit systems and required data truncation to achieve comparability. This document was designed as progress towards improved standardisation of recording policies for macrobenthos samples between laboratories, including the development of a taxonomic discrimination protocol (TDP) that will allow greater comparability of data between laboratories that follow the protocol. **A TDP is here defined as a set of statements, detailing the required taxonomic resolution output from an identification process.**

1.1 Aims

The aim of this document is to make progress towards a protocol that will define data requirements that would make data sets within the NMBAQC Scheme, and those using NMBAQC methodology, consistent with one another. It is intended as an overarching protocol for any potential macrobenthos sample to allow for multiple uses and comparability across purposes, rather than for a particular sample type (within macrobenthic sampling methods; *in situ* records and meiofaunal samples are excluded) or survey purpose. Although produced as part of the Benthic Invertebrate component, recommendations are made for records of non-invertebrate biota from the same samples due to their importance in defining habitats. However, records of anthropogenic material are excluded from discussion here, until progress is made through other components. The TDP details suggestions as to how different taxa should be quantified and recorded at different sizes and conditions and the taxonomic levels at which they would be identified in order to standardise taxonomic resolution. The aim is to standardise identification levels, taxon by taxon.

It is also hoped that the report and its updates should also prove useful to those tasked with data processing and interpretation. The appendix in particular, with its discussions of different taxa, will give examples of discrepancies to consider when comparing data between laboratories or across time series.

It is intended that amended and updated versions of the protocol will later become the standard against which audits are scored. However, this may be a longer term output; the reason it has not been done before is that standards are difficult to define, due to the complications of size, condition and available literature and possibly more difficult to agree, given the different practices used by each laboratory.

1.2 History

Some initial steps towards a Scheme standard TDP were made in the [Processing Requirements Protocol](#) (PRP) document (Worsfold et al., 2010). It was an integral component of the Processing Requirements Protocol (PRP) (Worsfold et al., 2010), but took longer to develop due to the complexity of the task.

A draft version of this family level TDP was circulated to all laboratories that participated in the NMBAQC Benthic Invertebrates component in November 2021. It was based on APEM practices of the time but acknowledged that there were other laboratories with similar histories and that there would be changes in future versions; that version was a preliminary stage to allow laboratory feedback. Feedback was received from five participant organisations: Fugro (on biomass groups), Hebog Environmental, Marinescope Taxonomy, Natural Resources Wales (NRW) and Thomson Ecology. These comments have been reviewed and incorporated into the discussions within the present document.

In addition, the need for TDP development has been directly considered during each ring test exercise since RT61 (Worsfold et al., 2022), with bulletin discussions within family headings for all included species. Previously, individual problem species had been discussed, sometimes with protocol suggestions.

As the taxonomic level required varies within many families, more detailed protocols will be needed to drill down below family level. A draft was produced for Oligochaeta in 2002 (Hall & Worsfold, 2002) and revised for the PRP (Worsfold et al., 2010); it is now due for further revision. A current example of a detailed TDP is included here for Solenogastres.

1.3 Format

The TDP is a supplement to the previously circulated Processing Requirements Protocol (PRP) (Worsfold et al., 2010), which now requires update. It comprises this text document, with its appendix, together with a series of spreadsheets that list north-east Atlantic marine taxa, with suggested recording policies.

There is a spreadsheet for higher taxa, followed by others for non-animal taxa, minor animal phyla, Cnidaria, Annelida, Arthropoda, Mollusca, Bryozoa, Echinodermata and Chordata. Taxa are listed following the World Register of Marine Species, WoRMS (<http://www.marinespecies.org/index.php>), in taxonomic sequence. All phyla/divisions are included, as well as classes, orders and families for those groups with northeast Atlantic marine representatives and varying policies within the higher taxa.

Recording policies are detailed in columns across each spreadsheet. As well as policies for taxonomic discrimination, policies are included for life stages, extraction, preservation, enumeration and biomass, with discussion notes.

More discursive accounts of the taxa are included in the appendix.

2. Rationale

This version of the TDP is a draft to allow basic principles to be established and tested, as a starting point for future refinement, with input from other organisations. It is hoped that the protocols will eventually become the standard against which audits are scored and the TDP will augment the International Standard 16665:2014 (EN ISO, 2014, updated from EN ISO, 2005) in terms of taxon recording policy.

2.1 Taxa included

This version of the TDP includes suggested policies for taxa down to family level. The tables list basic higher taxonomic levels (phylum/division, class, order, family) for those groups that include marine or brackish water representatives in northern European waters but only where there are recording

policy variations suggested for higher taxonomic levels (e.g. if all members of a phylum are to be recorded at class level, its orders and families are excluded from the list). Intermediate taxonomic levels (superfamilies etc.) are included only where they are considered the most useful level for definitions of recording policy, or where more basic levels are undefined on WoRMS.

Although there had previously been lists of marine species for local areas (e.g., MBA, 1957; Bruce et al., 1963) The first attempts to list them for wider parts of northern Europe were through the UK species directories (Howson, 1987; Howson & Picton, 1997). These were followed by a provisional list of European marine species (Costello et al., 2001), which became the basis of the online European Register of Marine Species (ERMS). An additional subset of WoRMS was created for British waters: Marine Species of the British Isles and Adjacent Seas (MSBIAS). These resources have been reviewed for relevant taxa, together with records noted in literature collated through the NMBAQC scheme taxonomic literature bibliography (Worsfold *et al.*, 2020). However, the review of possible taxa is not comprehensive and it is possible that some families with northern European representatives have been missed. An update would also be needed for the inclusion of biota from Mediterranean and warmer, or deeper north-east Atlantic waters.

The lists include groups whose representatives are not generally considered benthic macrobiota (e.g., including free-swimming, pelagic, parasitic and meiofaunal groups). Suggested policy is to record all biota in samples that have been retained by a stated mesh, regardless of their assumed size or habitat (see Recording Policies, below). In many cases, however, such species would be unlikely to be found and most others would be left at higher levels.

Basic recording policies are tabulated for the taxa listed. Appendix 1 includes more discursive notes by taxon, as an expansion to the recording policy differences document (Worsfold & Hall, 2017). It provides additional information and explanations but is not comprehensive and the tables should be taken to be the standard TDP.

2.2 Recording policy principles

The protocol presented here is based upon the standard practice of the current NMBAQC scheme contractor (APEM Ltd.). It has been developed over many years of trial and error to attain the greatest consistency and precision across many laboratory analysts. However, practices have changed over the years and ideal comparability has yet to be achieved. Some of the policies given here supersede current APEM practice; notes will be made of this in Appendix 1 to give historical context.

As discussed under Future Developments (below), other laboratories have different policies that may be equally valid and resolution of data comparability problems will require continuous feedback. In order to reduce the probability of impasses, it is important to describe the basic principles behind the decisions made here as a framework for future discussion.

The central principle is to **maximise the usefulness of the data** produced. There are three elements to this:

- **ensure maximum comparability** between data sets;
- **maximise the amount of information contained within the data;**
- achieve the **optimal balance of usefulness to practicability** (including cost) of the policies.

2.3 Notes on policy components

The different components of recording policy are described below, with discussion of how the chosen policies reflect the above principles.

2.3.1 Extraction

With a few defined exceptions, all countable units are to be extracted for **countable taxa** (those for which a clear concept of an individual can be defined), along with significant fragments where biomass is required. Certain superabundant taxa may be counted *in situ* within the sample and not extracted from the sediment; this will be defined by abundance in particular samples (see PRP:

Worsfold et al., 2010), not by the taxa themselves. For **non-countable taxa**, a representative example of each taxon is to be extracted. Other items, such as anthropogenic material and seeds may be extracted but are not included as suggested requirements, here.

Only **live-collected** organisms are required. Organisms may be ignored if they were demonstrably dead at the time of sampling (e.g., empty shells, empty cases, unattached epibiota) or would have passed through the mesh (sessile biota seen to be smaller than the mesh; animals that pass through the mesh after re-sieving). The tables do not yet include definitions of live-collected. These will be included in Appendix 1.

All taxa are important. Many studies are tailored to particular questions that may place more emphasis on particular taxa (such as abundant or commercially important species) or categories (such as infauna). However, the quality control of NMBAQC data assumes that all data sets are required as a resource with the potential to answer a range of questions: the collect once, use many times (COUMT) paradigm (e.g. Joukes et al., 2016). The approach requires comparability across all data sources and all taxa. No assumptions are made about the analyses to be applied. It may be justifiable to exclude epibiota from a particular analysis that generates indices based only upon taxa deemed to be infaunal but the exclusion of epibiota (including plants) from the original data will distort attempts to assign biotopes or identify the most important components of the biota.

The requirement to extract all taxa also applies to biota suspected as **contamination**, though again large numbers (hopefully unlikely) may be counted *in situ* within the sample or recorded as 'present', if obvious contamination. Biota may only be dismissed as contamination if it is almost certain that they originated from a different sample (e.g., during laboratory sieving) or from the outside environment (e.g. stored containers, open air). Flying insects, for example, may be assumed to be contamination in a grab sample (they can only have arrived from outside the sample) but not in a core sample (they may have been living on the shore). Taxa considered to be contamination should be noted on the data matrix.

It is difficult to be certain whether **pelagic** taxa represent contamination and some laboratories (e.g., Thomson Ecology) recommend exclusion (or mention outside the main data). Some may have been caught in mid water while the grab was brought up or inadvertently introduced when sieve-washing samples in the field with seawater, while others will have been present in the sample at the time of collection. Whilst definitely pelagic taxa may eventually be excluded from analyses, all should initially be recorded, as there is a continuum between pelagic and benthic habitats / life habits (through nekton, demersal mobile spp., benthopelagic spp. etc.).

Supposed **meiofaunal** taxa are not considered to be contamination, as they will have been present in the sample at the time of collection. Meiofauna are defined by the mesh size used. It is reasonable to re-sieve a sample where it is suspected that large numbers of animals may have become clogged that would otherwise have passed through a sieve. However, attempts to use spurious 'taxonomic definitions of meiofauna' represent an introduction of bias to the data. Any decisions about exclusions of certain taxa for specific analyses should be considered to be a separate exercise.

Parasites should be recorded, unless considered too small to have been retained by the mesh. Some, including most ectocommensals, are likely to have become detached during sieving and should be treated in the same way as other components of the benthos. Sessile parasites (permanently attached to their hosts), such as sacculinid barnacles and melinnacherid copepods should be recorded and left in place, (weighed with their hosts, if biomass is needed). Some, such as notodelphyid copepods and bopyrid isopods, that are unattached but partially enclosed within the host may be extracted and treated separately (and some are likely to have been displaced by sieving) but are best retained with their host for voucher purposes, if possible. A few, such as entoniscid isopods, may not be recognisable as individuals so would be counted as parasitised hosts, if noticed.

2.3.2 Preservation / storage

The majority of organisms should be preserved in **70% industrial methylated spirits (IDA)**. It is understood that samples will mostly have been originally preserved in formaldehyde solution but this is not a requirement. Similarly, the addition of glycerol is optional. Algae lose their colour in alcohol and alternative preservation could be considered but IDA is retained as an acceptable standard. APEM store hard, encrusting organisms (mainly Bryozoa and barnacles) **dry**, following preservation; they are difficult to examine through liquid if attached to large stones, or with a surface film, and use large amounts of space and preservative. Some laboratories (e.g. Thomson Ecology) caution that they may become damaged if transported dry. The damage problem is mainly due to multiple stones rubbing against each other and could potentially be prevented by improved packaging within containers but further discussion and experimentation may be required.

2.3.3 Enumeration

The most basic recording considerations concern enumeration. At the simplest level, there is a need for a policy on what to record. It is suggested here that all biota retained by a stated mesh are recorded at some level. Both animals and non-animal biota (e.g. plants, protists) are to be recorded.

Biota are divided between those to be **counted** and those recorded only as **'present'**. While most colonial taxa are to be recorded as 'present', colonies are counted for Alcyonacea and Pennatulacea, where attachment structures are observed; for these groups, fragments are recorded as 'present', where no attachment structure is found. For colonial hard corals (Scleractinia - rarely found in samples) both polyp and colony counts are recommended. The current suggestion is to record essentially non-countable biota, as defined in the TDP, as 'present'. It is possible to count colonies (e.g. of Hydrozoa or Bryozoa) as individuals or to attempt other estimates of abundance, such as the SACFOR scale used by the NMCR (Hiscock, 1996) and options could be discussed for inclusion in later editions.

2.3.4 Count criteria

For countable taxa (mostly animals), the countable unit is defined in the TDP. Usually, this is **heads** but other elements are suggested for organisms which do not have an easily defined head.

2.3.5 Life stage (size, age), sex and condition

There have always been two distinct reasons to consider the above parameters, which are often recorded as 'qualifiers' to taxon identifications. Firstly, they represent **increased discrimination** within recorded taxa and provide additional information; this may be valuable to the understanding of populations of particular species or the degree of dominance of certain taxa within sampled habitats. Secondly, they are often treated as **explanations for reduced taxonomic discrimination**, such that a 'juvenile' of a certain family is one that is too small to be identified to the same level as larger individuals.

The second purpose is important and will be discussed further under Taxonomic Discrimination. However, the 'maximise information' principle requires that size/sex qualities are treated as important in themselves. Data analysts often treat the meaning of **'juvenile'** very differently from that intended by laboratory analyst. Some data analyses exclude all individuals recorded as juveniles. This may be due to a belief that abundance of juveniles may indicate a spatfall cohort that may dominate faunal abundance temporarily but not persist to adulthood and hence be less significant from a biomass viewpoint. However, similar argument could be made for short-lived species that quickly grow to a small adult size. It will be many years before the meaning of 'juvenile' is standardised well enough to consider justification of that practice. Meanwhile, it is important to establish a principle that defining juveniles represents provision of information independently of the need to reduce taxonomic precision.

From a biological perspective, the most useful juvenile definition would be based on reproductive maturity of individuals; qualifiers should be added for defined larval stages and eggs, as well as sex, where the forms are markedly different. However, sexual maturity is indeterminable for most species

without detailed anatomical studies. Also, for simplicity and convenience, correlation of defined sizes to be applied for the purposes of both provision of biological information and reasons for reduced discrimination would be useful.

The system suggested here very crudely divides species into different maximum adult sizes, where those that grow largest are defined as juvenile at a larger size and small species are not divided between adults and juveniles. At this stage, a full analysis of the fauna has not been completed but some protocols have defined juveniles as specimens less than 10% of their maximum adult size. Thomson Ecology suggested to add the juvenile qualifier for bivalves where adults reach large sizes, for example adults above 4 cm (juvenile size set at below 10% of adult size); for gastropods, they suggested identification of all sizes to species where possible. For simplicity and consistency, this TDP suggests the same principle for all groups, with a reduced set of size delimiters (**1 mm, 2 mm, 5 mm, 10mm and 17 mm**), which is arbitrary but hopefully reflects dimensions that can be easily estimated and remembered; the 17 mm definition was chosen as the aperture diameter of commonly used sample vials. Both juvenile definitions and reduced taxonomic discrimination levels use these sizes. They correlate for some taxa but not all. For example, *Nephtys* are defined as juvenile and left at Genus level below 17mm; however, Asteriidae are separated as juveniles but identified to species below 10mm and only left at family if below 5mm.

There are other biological traits that provide both additional information and reasons for differences in taxonomic discrimination. Many Cnidaria have separate **medusa** and **polyp** stages and arthropods have defined **larval** stages. These are treated separately from size-defined definitions of juveniles and the principle is to record them as qualifiers. For most taxa, adults are taken as a default, where no qualifier is given. It is also assumed, for example, that hydroids are recorded as the polyp stage and Scyphozoa as the medusa stage, unless otherwise stated. This is indicated in the tables by brackets where assumed, otherwise a qualifier is required. There are additional problems for insects, where larvae are more often recorded in brackish water samples than adults and qualifiers are sometimes missed. Some taxa recorded at higher taxonomic levels may be separated by growth forms, such as **solitary** and **colonial** juvenile ascidians. It may also be desirable to use growth forms as taxonomic units, where greater taxonomic precision is not practicable.

Polychaete **epitokes** may be recorded separately where noticed. Usually, this does not affect taxonomic discrimination and epitokes can be combined with the main species record for analyses of data from multiple sources. Some epitokes are very different from the usual form of a species; others differ only in the presence of natatory chaetae. No requirement is given here to separate epitokes. As they have never been consistently separated, it would not be valid to remove them from analyses.

Some taxa, mainly arthropods, show distinct **sexual dimorphism**. As with juvenile status, it would be preferable to treat this as additional information and record sexes separately for all taxa that show clear differences. However, as this is currently only done where there are taxonomic discrimination differences, we have suggested separation only for certain taxa in this version. For some amphipods (e.g. Aoridae, Ischyroceridae), only adult males may be reliably identified to species and juveniles are not easily separable from females. The juvenile/female specimens are often listed as female and the distinction is based on presence or absence of certain features, not size; the 'female' designation is retained in this version but could be revised in future.

The **condition** of a specimen may preclude species level identification. However, it is rarely necessary to observe every key feature to allow identification, especially where material in good condition exists in the same project. It may be preferable to accept the possibility of identification error (between species already known to a project) than to generate additional spurious data lines (which may need to be assigned to species or treated as additional taxa for analysis). The number of specimens recorded at higher levels than the majority should be kept to a minimum and specific notes added. The number of data lines for what is likely to be a single species must also be minimised.

2.3.6 Taxonomic discrimination

Taxonomic discrimination is a particularly complex aspect of recording policy. In order to maximise usefulness, a principle that **the highest repeatable resolution is desirable** has been adopted. TDP taxonomic levels are given as the **least precise acceptable level** (e.g. if a genus name is given, identifications to species level would be acceptable, but may have their resolution reduced in data analysis; identifications to family level would not be acceptable).

For this version, detail is provided only to family level or above in the tables. There will be more work to be done for many individual families. The term **'varies'**, under 'Taxonomic Level Required' effectively states that the policies within that group are yet to be defined.

Nomenclature should follow the World Register of Marine Species (WoRMS; <http://www.marinespecies.org/index.php>), unless there are explicit reasons to do otherwise. If a laboratory is aware of errors or recent literature not yet incorporated into WoRMS, they may use the more recent nomenclature. In such cases, a note should be added to the matrix and an effort made to inform appropriate WoRMS editors of the need to update. Qualifiers and some other examples of differences from WoRMS are described below.

We recommend exclusion of **subgenera** and subspecies; these are currently inconsistently treated in WoRMS. They also extend column widths in spreadsheets, making printing and reviewing awkward, and add little in terms of information.

Whilst many species have been subdivided or **changed names** through their taxonomic history, there are some for which the problem is particularly confusing because a name has been used for different species within a genus at different times. For example, two species of the amphipod genus *Acidostoma* are widespread in UK waters. Lincoln (1979) lists them as *A. obesum* and *A. sarsi*; however, Stoddart & Lowry (2012) determined that Lincoln's *A. sarsi* was the true *A. obesum* and used another name (*A. neglectum*) for Lincoln's *A. obesum*. There is, therefore, a peculiar problem with the name *Acidostoma obesum*. There are other examples: *Lumbrineris gracilis*, *Malacoceros vulgaris*, *Pista critata*, *Pholoe inornata* and *Pontocrates arcticus*. Adding (e.g.) '*sensu* Stoddart & Lowry' to the name resolves the identity but would only be done once the updated literature had been noticed; it will still be difficult to be sure which species is meant for older data, where the name would include no '*sensu*' clarification. APEM use '*sensu*' for the above examples but it may be more useful to add notes on literature used to data matrices; this would provide more information but would be time-consuming if done for all taxa and take up too much space to be added to all data presentation formats. Some labs (e.g. Thomson Ecology) have recommended time limits on the use of the *sensu* qualifier and noted that the qualifier would be more usefully applied to the older data. This is true but laboratory analysts only generate current data. Further discussion is needed.

Policy is needed to account for **undescribed species**. Where it is known or suspected that a given taxon includes similar species (described or not), an **'aggregate' (agg.)** qualifier may be added. The species included in the aggregate must be defined (this will be done in the TDP, once complete at species level). Where a laboratory has recognised likely undescribed species and records them separately, they may use a qualifier (e.g. **'Type 1'**) for tentative recognition of a likely undescribed species. Where the species may be consistently recognised, they may use a separate taxon name (e.g. **'species A'**). Finally, descriptions for some undescribed species will be circulated through the scheme so that a taxon name such as 'species A' will be defined in scheme literature. In these cases, laboratories are expected to use the scheme definitions. Where a species is similar to a named taxon but there is a probability that it is distinct, **'cf.'** (*confer/conferatur* - compare - to indicate similarity but not certain conspecificity) may be used between the genus and species names. Records assigned to a known species for specimens that are clearly distinct from the named species are considered erroneous, whether or not an accurate species name can be assigned. The same principle applies to undescribed species and to potentially unknown cryptogenic or non-native species.

It is not necessary to add **'sp.'** to records at Genus level but this may be done. As the convention to add 'sp.' is not typically used for taxa higher than Genus (**'indet.'** may, but need not be, used in such

cases), a recording policy difference will be noted for that notation. The same will apply if ‘**spp.**’ is used where only one species is present (*spp.* – *species pluralis*, for multiple species).

Uncertain identifications may be indicated by the use of a ‘?’ qualifier. This would be taken to mean that the taxon has been provisionally identified at the taxonomic level given but that an error is possible at any taxonomic level. Where the identification is considered certain at a higher level, this should be indicated in notes alongside the taxon, along with reasons for the uncertainty, such as **damaged specimens**. Probable names may also be added where an identification is likely but uncertain.

2.3.7 Biomass

The tables include policies for **wet-weight** biomass. It is understood that such data will always be imprecise; however, **dry-weight** biomass results in loss of material that precludes quality control of enumeration. Emphasis is placed on practicality.

2.3.7.1 Weighed taxa

Taxa to be included for biomass are defined. In general, following current traditions, only non-sessile countable animals are included in biomass measures. Useful information could be gained through biomass of sessile organisms but it would be a major shift in practice for most labs and difficult for encrusting taxa, such as most Bryozoa. **Fragments** should be included if large or abundant enough to influence the total biomass (above 10% difference; enough to generate a change in the pass/fail flag), ideally at the same taxonomic levels used for enumeration.

2.3.7.2 Tubes / shells to be weighed

Notes are included on whether shells or tubes need to be removed for biomass. The general principle is that, ideally, coverings are removed if they are not part of the animal (e.g. polychaete tubes, hermit crab shells) but retained if they grew with the animal, rather than being created by it (e.g. shells of molluscs, echinoderms and crustaceans). However, tubes may be retained if removal would be too time-consuming to be practicable (e.g. *Phoronis*, *Galathowenia*).

2.3.7.3 Taxonomic groups for biomass

Biomass is typically carried out by recorded taxa (sometimes shortened to ‘**species level**’). This is the level compatible with NMBAQC audits, due to the need to separate taxa.

Sometimes, however, biomass is carried out only by **major taxonomic groups**. The groups used loosely correspond to Phyla. Strict Phylum groups would be the most logical choice and are favoured by some labs (e.g. Fugro, Grant Rowe, pers. Comm.). However, traditional biomass groups have been inherited from old practices and retained for comparability. An oligochaete/polychaete divide (within the phylum Annelida) has historically been used in transitional waters, where it had some ecological importance. The problem has been further complicated by taxonomic changes. For a time, Arthropoda were divided between phyla, so that Crustacea were one biomass group and non-crustacean arthropods were included with ‘others’. Arthropoda is now re-instated as a phylum (e.g. on WoRMS) and it would be more logical to include (e.g.) Pycnogonida in an arthropod biomass group but separating them may help comparability with historical data. Also, the traditional ‘Polychaeta’ group is no longer considered monophyletic (though potentially due to be reinstated under a different definition; Rouse et al., 2022) and several taxa once considered to be separate phyla (e.g. Pogonophora, Echiura, Sipuncula) are now included as annelids. Unfortunately, combining parts of previous biomass groups creates comparability problems with earlier data. In this version, separate groups are suggested for non-crustacean arthropods (Chelicerata, Myriapoda, Hexapoda – but note that Hexapoda, including insects, are now considered to be nested within Crustacea) and for annelids once considered separate phyla (annelid others), pending further discussion. Major groups for biomass are therefore currently recommended as follows:

- Cnidaria (Pennatulacea, Ceriantharia, some Actiniaria – excluding sessile taxa);

- 'Polychaeta' (excluding Sipuncula, Echiura, Siboglinidae);
- Annelid 'others' (Hirudinea, Sipuncula, Echiura, Siboglinidae)
- Oligochaeta
- Crustacea (excluding Hexapoda, Cirripedia – barnacles - and sessile parasites);
- 'non-crustacean' arthropods (*e.g.* Chelicerata, Insecta);
- Mollusca;
- Echinodermata;
- 'Others': minor phyla (*e.g.* Platyhelminthes, Nemertea, Priapulida, Phoronida, Hemichordata, Chordata – excluding Ascidiacea).

Biomass major groups will always be problematic and recorded taxon levels are recommended.

3. Future developments

The main plan for future development of this project will be expansion and refinement of recording policies and the TDP, including policies through to species level, through scheme component exercises and participant feedback. There will also be consequences in other fields and possibilities for links to other projects.

3.1 Continued TDP development

This is a discussion document. The TDP presented here is intended as a draft to allow collection of standard practices from other laboratories. Practices have changed over the years and ideal comparability has yet to be achieved. The tables presented here broadly reflect APEM current practice but several anomalies have already been noticed and corrected or highlighted for future review. Other laboratories have different traditions, some of which have been reviewed and are described below; it is hoped that more will be incorporated, later.

The underlying principle is to improve resolution wherever possible. Taxonomic workshops and improved literature may allow more precise identifications and greater comparability in future. Where others consider consistently greater resolution is possible, they are invited to demonstrate how. Where they consider resolution should be decreased, APEM will attempt to demonstrate how the stated resolution could be consistently maintained.

The intention is that areas of controversy will be discussed and the TDP updated in future. The following sequence was proposed.

- first draft shared with NMBAQC Scheme participants and initial comments requested before 2021 year end;
- publication of first draft TDP (overview, family level, one family to species level) on Scheme website;
- workshop to agree family level TDP;
- completion of provisional TDP to species level for all groups;
- circulation of each provisional species level TDP for participant feedback;
- workshops or feedback to resolve species level TDP for each group;
- publication of full TDP (overview and all taxa) on Scheme website.

The publication of this version represents completion of the second stage. Further feedback is invited; the need for a family level workshop will be reviewed.

We propose that the next stage should be to combine the appendix, below, with the next update to the bibliography of taxonomic literature. The report would be a discussion of taxonomic discrimination policies for all groups, within the headings used for the literature review. The references would be cited in context with their usefulness in identification throughout the history of the NMBAQC scheme. This would include a preliminary historical overview of identification policies, with discussion of identification guides and names used at different times. The history would include insights from workshops and ring tests, with participants feedback. The ecological significance of

different taxa would also be highlighted, with comments on biotope-defining, indicator, common, rare and non-native species, together with notes on remaining taxonomic problems and potential new species.

3.2 Links to other projects

It is hoped that progress beyond this report will link to other projects and establish the Scheme as the primary resource for information for north-east Atlantic benthos; some possible developments beyond the draft circulation stage are listed below:

- development of a Scheme taxon database, coordinated with WoRMS;
- TDP assignments to taxa, on WoRMS;
- continued updates, following workshops, new literature and exercise feedback;
- regular maintenance of TDP, with updates to WoRMS;
- database to incorporate taxon list, TDP and literature; possibly other traits;
- update to UK species directory (MSBIAS), on WoRMS; include on NMBAQC website.

4. Glossary

The following glossary is based on that given by Hiscock et al. (1996), amended where required.

Agglutinating. Forming a test from particles joined together by mucus.

Aggregate. A species complex.

Anthropogenic material. Objects and substances added to the environment by human activity (e.g. litter, seeds from sewage content).

Benthic. Associated with the seabed.

Benthopelagic. Living near the seabed but suspended in mid-water at times.

Benthos. Organisms living on, in or near the seabed.

Biomass. The quantity of organisms expressed in terms of wet or dry weight (mass) or energy.

Biota. Plant and animal life (and other kingdoms) of a site, area or period.

Biotope. A physical habitat with its biological community.

Brackish water. Mixed fresh and seawater (e.g. between 0.5% and 30% salinity).

Calcareous. Containing calcium carbonate (usually as hard structures).

Colony. A group of animals of the same species, living in a connected aggregation.

Colonial. A taxon that forms a colony.

Commensal. A species that derives benefit from another, without adverse effect on the other.

Community. A group of organisms interacting with each other and their environment.

Condition. The quality of preservation or degree of damage of a specimen.

Conservation. Regulation of human use of an ecosystem to sustain diversity of content.

Contamination. Organisms, or other material, within a sample that were not an integral part of the sampled environment at the time of sampling.

Core sample. A sample collected by pushing a hollow cylinder into sediment.

Countable taxa. Organisms that exist as discrete individuals that may be counted.

Cryptogenic. A species that may be non-native but that has not been proved to be non-native.

Data comparability. The degree of difference between data sets that is due to genuine differences between their content (e.g. benthos), rather than due to artefacts of recording differences.

Data line. A taxon, as represented in a data matrix (usually as a spreadsheet row).

Data truncation. Reduction of taxonomic precision or taxa included in data to allow increased data comparability.

Demersal. Living near or on the seabed but capable of active swimming.

Dry weight. Biomass measured after water has been removed (from an organism or sample).

Ectocommensal. A species that lives on and derives benefit from another, without adverse effect on the other.

Encrusting. An organism living on a surface and forming a hard structure over its own surface.

Epibenthic. Living on the surface of the seabed.

Epibenthos. Organisms living on the surface of the seabed.

Epifauna. Animals living on the surface of the seabed.

Epifaunal. Living on the surface of the seabed, as an animal.

Epitoke. A swimming reproductive form of an annelid.

Fragment. A portion of an organism that lacks a countable component (such as the head).

Grab sample. A sample collected by a mechanical device that extracts a portion of sediment.

Growth form. A defined structural type for an organism (sometimes used as an alternative to taxonomic identification).

Infaunal. Living within the sediment.

Larva. The juvenile stage of an organism, where the structure is distinctly different from the adult form.

Live-collected. Organisms judged to have been living at the time of sampling.

Macrobenthos. Benthic organisms larger than standard mesh sieves (0.5mm or 1mm); usually interpreted as excluding the largest species (e.g. megafauna).

Medusa. A pelagic form or stage of a cnidarian.

Meiofauna. Small animals that pass through a 1mm mesh (but retained by a 0.1mm mesh).

Nekton. Actively swimming midwater organisms (able to move independently of currents).

Nomenclature. A defined system of names.

Non-native. Species introduced to an area by human activity (that were not previously present).

Non-Countable taxa. Organisms that exist as colonies or masses that cannot be counted with precision.

Parasite. An organism living on or in a host and obtaining nutrients from it without providing benefit.

Pelagic. Living in open water.

Polyp. A sedentary form or stage of a cnidarian.

Procedural guideline. A recommended process by which the outputs of an analysis may be achieved.

Processing Requirements Protocol (PRP). A statement of the required products or outputs from an analysis process (rather than the means to achieve them; cf. procedural guideline / SOP).

Recording policy. A standardised practice within an organisation for the recording of data (in the context of the TDP, usually a reference to practices for noting and quantifying taxonomic groups).

Ring test (RT). A circulation of specimens of the same species to multiple laboratories, as a test of identification consistency.

Seabed. The sea floor, including the part exposed at low tide as the littoral zone.

Sedentary. Attached or embedded in the substratum but capable of movement from place to place.

Sessile. Permanently attached to the substratum (incapable of movement from place to place).

Sexual dimorphism. Sexes having distinctly different forms.

Solitary. Living as discrete individuals (may be grouped together but not joined).

Species complex. A group of similar species that are difficult to distinguish from each other.

Standard Operating Procedure (SOP). The process by which the outputs of an analysis are to be achieved, as defined by a particular organisation.

Taxon. A taxonomic group of any rank.

Taxonomic Discrimination. Degree of taxonomic resolution.

Taxonomic Discrimination Protocol (TDP). A set of statements, detailing the required taxonomic resolution output from an identification process.

Taxonomic levels. Degrees of precision in identification of biota, usually defined in terms of Linnaean ranks.

Undescribed species. A species that has not yet been formally described in the scientific literature.

Wet weight. Biomass measured with internal water content retained (within an organism or sample).

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7. Appendix: Discussion notes by table and taxon

The following sections provide explanations to supplement the TDP tables, to include discussions of alternative approaches and some potential options for higher taxonomic levels. The original notes were derived from those in the review of recording and identification policy differences (Worsfold et al., 2017). They have since been expanded for some groups, using text from the recent ring test bulletins (61-63), as well as with participant feedback.

The main headings in this version are organised to correlate with those for the separate TDP tables, which have column headings for the different policy considerations; subheadings are then organised by taxonomic groups, with families or sometimes higher taxa as paragraphs with bold type for their names. It has been suggested (e.g. by Thomson Ecology) that the headings would be better organised by consistent taxonomic units. A more consistent taxonomic structure will be adopted if the document is combined with the Scheme's literature review (as suggested above). At this stage, the text is not comprehensive and the tables represent the currently suggested TDP but they will hopefully provide a framework for more expansive discussions and explanations in future updates.

7.1 Kingdoms and phyla

The 'Phyla' table lists all kingdoms and phyla / divisions (following WoRMS) and gives policies for those to be left at Phylum level. Many of these groups include only endoparasites or organisms that would pass through a 0.5mm sieve and, in practice, would not be recorded. They are, however, listed for completeness, with the policy that all organisms would be recorded should they be retained by the stated mesh. Where there are more complex policies for taxa within a phylum / division (which is the case for most of the biota found in benthic samples), directions are given to other tables.

7.2 Plants and protists

7.2.1 Bacteria

Cyanobacteria are found as significantly sized colonies in some samples and '*Beggiatoa*' is a biotope defining taxon (Connor et al., 2004), although the taxonomic position of the marine colonies is unresolved and we are not aware of them having been recorded from macrobenthos samples. Brackish water Cyanobacteria, however, are found in scrape samples and round colonies (sometimes recorded as *Gloiothrichia*, *Nostoc*, Rivulariaceae or Nostocales) are found in some marine samples. Further discussion is needed.

7.2.2 Chromista

'Protozoan' records have been highly variable, both in names used and in recording format (count, presence/absence, ignore). Fugro and Ocean Ecology ignore most. Many taxa in this group have been widely ignored in samples, due to their perception as meiofauna. However, some grow large and may be significant components of the benthos.

Some **Ciliophora** are abundant in samples and epibiont species are sometimes confused with hydroids or entoprocts. APEM record obvious Ciliophora as 'Present', with separation of **Folliculinidae** at family level. Fugro record *Lagotia* as 'present'.

Foraminifera are very sporadically recorded, with varying policies apparent between laboratories, due to their perception as meiofauna and problems with determining whether they were live-collected. However, many grow well over 1mm and some are major components of the benthos, particularly in offshore waters. Agglutinating species, such as Astrorhizidae, may be large and significant in samples and further discussion is needed for policies. With exceptions for listed families, the draft TDP suggests to record large Foraminifera as 'Present', if live collected.

Astrorhizidae (RT6325). The draft TDP suggests genus level identification for Astrorhizidae. APEM (and Ocean Ecology) currently count individuals for those resembling *A. limicola* but record presence/absence for more irregular forms. Fugro count *Astrorhiza* but exclude from biomass. RT63

results suggest species level may be achievable for *Astrorhiza*. Several references will be added to the next literature update; the most useful is probably Gabel (1971).

APEM and Thomson Ecology record *Jaculella* (**Hippocrepinidae**) at Genus. Enumeration and determination of live-collected material needs more discussion

APEM and Thomson Ecology record **Sphaeramminidae** at Family. Enumeration and determination of live-collected material needs more discussion

Brown algae (**Ochrophyta**, currently within Chromista on WoRMS) have been widely ignored in samples (e.g. Hebog; Marinescope only record them if specifically requested) due to the tradition of recording only fauna and difficulty in deciding whether they were live-collected. However, their presence is significant to biotope definitions and as a factor that would influence macrofaunal communities. At APEM, they are recorded as 'Present', if attached or otherwise believed to have been living at the time of collection. TDP at lower levels needs further discussion; APEM separate several taxa that are consistently identifiable from preserved material. Fugro speciate erect algae if requested. Others (e.g. Thomson Ecology) suggest identification at Phylum level.

7.2.3 Plants

Red algae (**Rhodophyta**) have been widely ignored (e.g., Hebog; Marinescope only record them if specifically requested) due to the tradition of recording only fauna and difficulty in deciding whether they were live-collected. However, their presence is significant to biotope definitions and as a factor that would influence macrofaunal communities. TDP at lower levels needs further discussion; APEM identify several taxa that are consistently identifiable from preserved material. Others (e.g. Thomson Ecology) suggest identification at Phylum level, with fewer exceptions (see below). Fugro speciate erect algae if requested. Record as 'Present', if attached or otherwise believed to have been living at the time of collection.

APEM record encrusting coralline algae as **Corallinaceae**, with higher resolution for the branching forms (mostly *Corallina officinalis*). Thomson Ecology use **Corallinaceae** for the branching forms. Fugro speciate Corallinacea, where possible and quantify maerl if requested.

APEM and Thomson Ecology record maerl as **Lithothamniaceae** and separate **Hildenbrandiaceae**.

Thomson Ecology record 'Encrusting Algae' for either brown or red encrusting forms (potentially including some Corallinaceae).

Green algae (**Chlorophyta**) have similarly been widely ignored (e.g. Hebog; Marinescope only record them if specifically requested) due to the tradition of recording only fauna and difficulty in deciding whether they were live-collected. However, their presence is significant to biotope definitions and as a factor that would influence macrofaunal communities. APEM identify several taxa that are consistently identifiable from preserved material. Others (e.g. Thomson Ecology) suggest identification at Phylum level. Fugro speciate erect algae if requested. At APEM, they are recorded as 'Present', if attached or otherwise believed to have been living at the time of collection.

Vascular plants (**Charophyta**, **Tracheophyta**) have also often been ignored but many have conservation importance and may define biotopes and influence macrofauna. APEM record as present, mainly at species level, if rooted. Fugro speciate seagrass, if requested.

Seeds of certain vascular plants may be identified and counted: APEM (Rubus, tomato, kiwi fruit, blueberry, 'others') and Fugro.

7.3 Animals

Animals are counted or recorded as presence / absence depending on their growth form according to taxa discussed below. APEM and Fugro record unidentified animal eggs as presence / absence and exclude them from biomass. Certain eggs may be identified further and / or counted, see below.

7.4 Minor animal phyla (Pogonophora, Echiura and Sipuncula now included in Annelida)

7.4.1 Porifera

Policies between laboratories have been very variable for sponges. Phylum level is probably the most widespread policy (e.g. Thomson Ecology) but some have ignored them or used more precise identifications (Hebog sometimes record at Order or Family if spicules are indicative; Marinescope separate only *Sycon*). APEM (and Ocean Ecology) record most sponges as 'Porifera', 'Present', with more precise identifications for certain more recognizable taxa (e.g. *Sycon*, *Leucosolenia*, *Dysidia fragilis*, *Suberites*, *Cliona*). Fugro identify sponges to species, where possible, as 'present' and refer some to specialists; they biomass some, where requested.

APEM (and Ocean Ecology) currently identify *Sycon* at Genus. Thomson Ecology suggest possible confusion with *Sycetta* and *Scypha* (though *Scypha* is combined with *Sycon* on WorMS), or with fragmented *Leucosolenia*. Family level identification (**Syconidae**) would resolve *Sycetta*. More discussion may be needed on *Leucosolenia*.

7.4.2 Ctenophora

Counted and speciated at APEM, though rare in benthic samples. Ignored at Fugro.

7.4.3 Platyhelminthes

Records of Platyhelminthes have been highly variable between laboratories. The name 'Turbellaria' was, until recently, widely used for large marine flatworms but is now considered paraphyletic. Marinescope leave all at Phylum. APEM record at Phylum for most, with lower levels for some distinctive ones: separate families for some 'microturbellaria' (e.g. Dalyellidae, Typhloplanidae), which may be confused with sacoglossan gastropods, record freshwater planarians at species or genus. Thomson Ecology also leave most at Phylum but separate some freshwater planarians to genus or species. Fugro identify at Class level. APEM and Thomson Ecology also record *Fecampia* eggs.

7.4.4 Nemertea

Nemertea have mainly been counted at Phylum level, with variation in separating some genera or species. *Cerebratulus* have been recorded at Genus by some. APEM leave most Nemertea at phylum, with separation of certain, distinctive taxa, such as *Malacobdella grossa*, *Tubulanus polymorphus* and *Tetrastemma robertianae*. *Cerebratulus* may be safest left as Lineidae, as several genera have cephalic slits. Thomson Ecology leave all at Phylum and suggest Lineidae could also be confused with Valenciiniidae. The latter are described as having no cephalic slits but sometimes with shallow oblique grooves (Gibson, 1994); more discussion is needed. Fugro leave all at Phylum.

7.4.5 Nematoda

Nematodes have been treated in a variety of ways by different laboratories over the years. Many (e.g. Fugro unless requested otherwise) have ignored them as meiofauna, although some are much larger than certain regularly recorded polychaetes. If recorded, they are left at Phylum level, with variation in how to count or whether to record as present. SEPA count only those >10mm; these are assumed to be *Pantonema* spp. which are associated with organic enrichment (see Bett & Moore, 1988).

7.4.6 Priapulida

APEM and Fugro count and identify to species.

7.4.7 Entoprocta

Some laboratories may have ignored these as small, sessile taxa. APEM record as 'present', leaving *Barentsia* and *Pedicellina* at genus (Fugro record if colonies obvious) and attempt species

identifications of *Loxosoma* and *Loxosomella*, mostly based on hosts. Fugro leave these at Family level.

7.4.8 *Chaetognatha*

Many laboratories have ignored these as pelagic. However, there is a fairly common benthic species and it is safest to record pelagic species because there is no simple definition of plankton, with the existence of benthopelagic and free swimming species; also, records of all taxa present allow a better understanding of the origins of other taxa in a sample. APEM, Fugro and Thomson Ecology separate the benthic *Spadella cephaloptera* and record other Chaetognatha at higher levels. Marinescope leave all at Phylum. Phylum-level records do not currently define whether benthic and pelagic species were distinguished; more discussion is needed.

7.4.9 *Brachiopoda*

APEM (and Fugro) identify most to species, without separation of adults and juveniles.

7.4.10 *Phoronida*

Laboratory traditions for phoronids have been variable. Some have used species names but these may have been mainly by default. They may be difficult to count due to fragmentation. APEM and Thomson Ecology leave infaunal *Phoronis* at genus but speciate the sessile, aggregating *P. ovalis* and recorded as 'present'. Fugro and Marinescope leave all at Genus and count.

7.4.11 *Hemichordata*

Most laboratories record these if heads are recognised but they may be missed if damaged. Records vary between 'Hemichordata' (Phylum) and **Enteropneusta** (Class). APEM and Thomson Ecology record as Enteropneusta. Fugro identify to species where possible.

7.5 Cnidaria

Cnidaria include a wide variety of forms and habitats: solitary or colonial, pelagic or benthic. They also include several species considered non-native or of conservation importance. There are many identification problems due to changes caused by preservation and the need for specific identification features.

7.5.1 *Staurozoa*

Counted and speciated at APEM and Thomson Ecology (with some at Class).

7.5.2 *Scyphozoa*

Counted and speciated at APEM, though rare in benthic samples. Counted and left at Class at Thomson Ecology. Ignored at Fugro.

7.5.3 *Hydrozoa*

Siphonophorae are probably often ignored as plankton but should be recorded, if seen, for context. APEM and Thomson Ecology record at Order and count.

Recording policies for sessile hydroid colonies have varied between laboratories but most now record colonies as present, at some level, if live-collected. Certain solitary hydroids are counted at APEM. Fugro identify to species where possible and may biomass if requested. Their medusae should be counted and recorded (with a qualifier) at Class level (as at APEM and Thomson Ecology). Most colonies should be considered live-collected if the soft parts of some polyps are preserved and recorded as present. Certain solitary polyps should be counted. There are eleven hydroid families with a 'varies' TDP category, that need more work.

APEM leave most benthic Hydractiniidae, Bougainvilliidae and Campanulariidae at family. Thomson Ecology leave all at Family or Genus. Ocean Ecology leave **Bougainvilliidae**, with **Pandeidae** and

Rathkeidae, as **Filifera**; APEM do this for unbranched colonies (branched **Bougainvilliidae** at Family) but record *Neoturris* (Pandeidae), if on host molluscs.

Lovenellidae (RT6318). The draft TDP flags this family for further work, due to taxonomic confusion. APEM record *Lovenella* at species, as presence/absence, but recognise that there may be confusion with other genera, including operculate hydroids in other families. The confusion with *Phialella quadrata* is well known and a consequence of interpretation of the wording in the standard guide (Cornelius, 1995), in terms of the definition of the main stem when describing ringed structures. RT63 results otherwise suggest species level is achievable.

Sertulariidae (RT6106). The draft TDP flags this family for further work, due to the different taxonomic levels currently used for different taxa by different labs. APEM leave *Sertularia*, *Diphasia* and *Sertularella* at genus and record others at species. RT61 results suggest species level is achievable at least for *Abietinaria*.

7.5.4 *Alcyonacea (includes Gorgonacea)*

Soft corals exist as colonies of multiple polyps; separation of colonies is less discrete than for Pennatulacea. There are questions over whether to count polyps, colonies or leave as present. There are also questions over separating juvenile colonies. The TDP suggestion is to count colonies at species level for most families, with unattached portions recorded as 'present' (APEM, Fugro and Thomson Ecology). Ocean Ecology leave small colonies at Family. Fugro biomass some for quantification and count polyps of encrusting species.

7.5.5 *Pennatulacea*

Sea pens exist as discrete colonies of multiple polyps and there are questions over whether to count polyps, colonies or leave as present. There are also questions over separating juvenile colonies. The TDP suggestion is to count colonies at species level for most families, with unattached portions recorded as 'present' (APEM, Fugro and Thomson Ecology). Fugro biomass as infaunal Cnidaria; Ocean Ecology do not biomass.

7.5.6 *Ceriantharia*

There have been differing policies on separation of juveniles and whether to use a species name for juveniles. As *Cerianthus lloydii* is the only species commonly recorded, juveniles have sometimes been assumed to be this but higher levels may be needed, as other species may be found. APEM separate adults from juveniles at 17mm. Ocean Ecology separate juveniles at 5mm and record at Family. Marinescope, Fugro and Thomson Ecology leave all records at Species without size separation.

7.5.7 *Zoantharia*

As zoantharian polyps are connected, there have been variations over whether or how to count them. The TDP suggests counting polyps at species level.

Epizoanthidae (RT6116). The draft TDP suggests polyp counts and species identifications for epizoanthids, as currently done at APEM (and Fugro and Ocean Ecology). There were many alternative names in RT61, some from different phyla. However, there were also many correct identifications and some of the problems would have been due to unfamiliarity with epibiota identification for certain laboratories and that a single polyp was circulated for a species usually present as several conjoined polyps.

7.5.8 *Actiniaria*

The most common policy for sea anemones has been to count them and record at Class or Order level. Most can be considered sessile epibiota (though many can move a little). Some families can be recorded at lower levels but APEM (and Thomson Ecology) record most at Order. Fugro identify species where possible. APEM only biomass infaunal taxa; Ocean Ecology include all in biomass.

Edwardsiidae and other burrowing anemones have been recorded at family, genus or species in varying formats by different laboratories. APEM recorded most at family level but speciation could be considered for some (e.g. *Edwardsia claparedii*, *Nematostella vectensis*), if practicable. Marinescope and Fugro leave all at family. Fugro biomass as infaunal Cnidaria.

7.5.9 *Corallimorpharia*

APEM (and Fugro and Thomson Ecology) identify at species and count polyps, though they are rare in samples.

7.5.10 *Scleractinia*

Corals may exist as colonies of polyps or as single polyps. As colonial species are rare in British shallow waters and the polyps are large, the suggestion is to count polyps for all, with an additional colony count should colonies be present (APEM, Fugro and Thomson Ecology).

7.6 Annelida

Annelids are one of the most important benthic groups. They have traditionally been divided between polychaetes and oligochaetes but there have been many taxonomic changes. WoRMS currently treats Polychaeta as a class but with a definition that would have been considered paraphyletic (e.g. with oligochaetes nested within) in recent years. The classification in Rouse et al. (2022) has yet to be adopted in WoRMS. It treats Oligochaeta as including Hirudinea and as a clade within Polychaeta. Polychaeta (following Rouse et al., 2022) includes several taxa once considered phyla, such as Siboglinidae, Echiura and Sipuncula, while excluding several families traditionally considered 'polychaetes'. Of the many annelid families, 35 have 'varies' for their TDP and will need further work.

7.6.1 *Phyllodoidea*

Polynoidae (RT6311, RT6320). The identification of Scaleworms is highly variable between laboratories and the draft TDP flags Polynoidae for further work, due to different taxonomic levels currently used for different taxa by different labs, particularly for small and incomplete specimens. Some (e.g. Marinescope) use 'Polynoidae' for juveniles and all those without scales (with or without qualifiers). APEM identify most to species or to species complexes but a few specimens are left at higher taxonomic levels if particularly small and damaged. Current literature (e.g. Barnich & Fiege, 2009) usually requires scales to be examined, which would create an artefact in data if specimens are divided on the basis of condition. Both RT63 circulated polynoids generated many identification discrepancies. Many labs identified RT6311 as one of the species lacking macrotubercles and it seems that juveniles may lack them. A scaleworm guide (Barnich, 2011) was produced following the 2010 NMBAQC scaleworm workshop and *Harmothoe* species had been described in Barnich & Fiege (2009). However, distribution updates have been published since and some new records noted at the workshop remain unpublished. It is likely that further taxonomic changes are to be expected and current descriptions do not include juveniles. RT6320 was also problematic. The most recent key (Barnich et al., 2017) suggests a juvenile size (body width excluding chaetae below 2mm) for leaving *Malmgrenia* at genus, which may be appropriate for *Harmothoe* also but further discussion is needed. Polynoidae will need more work. It would be useful to retain the same policy for all conditions, to remove the variable from the data; most can be identified to species but a '*Harmothoe impar*' agg. taxon has been used at APEM for *H. fernandi*, *H. impar* and *H. mariannae*, and a small proportion of difficult specimens has been left at genus or family. Hebog separate juveniles and use a 'damaged' qualifier for those without scales that require scales. Thomson Ecology suggest species level for specimens with scales, without separation of juveniles; genus level for those without scales, for the genera that require scales.

Sigalionidae (RT6307). now include taxa previously included in Pisionidae and Pholoidae. Juvenile *Sthenelais* have been left at family or genus and the size of species level determination is variable. APEM left them defined as juveniles at family below 5mm in the period between the production of the Scheme scaleworm guide and the synonymy of *S. minor* (once in *Fimbriosthenelais*) with *S. boa*; before and since, genus levels have been used for both *Sthenelais* and *Sigalion* juveniles. The draft TDP suggests species level identification for Pholoidae (now Pholoinae, in practice all *Pholoe*), as

currently done at APEM. Despite nomenclature problems with older data and literature, recent literature, particularly Meißner et al. (2020), has resolved most identification problems and all labs identified RT6307 correctly, suggesting no need for change. As the name '*Pholoe inornata*' has been used for both of the common species at different times (a particular problem, see under Taxonomic Discrimination, above), APEM add 'sensu Petersen' to *Pholoe* species names for clarity. Hebog and Thomson Ecology no longer do this, as the years of confusion have passed, but further discussion is needed for a solution to the wider problem.

Laboratories have had different policies for juvenile **Aphroditidae**. Some speciate them, including records of *Laetmonice*, which APEM have never seen but juvenile *Aphrodite* have similar features. APEM leave juvenile Aphroditidae, below 3mm, at family. Fugro leave at Family below 5mm. Thomson Ecology suggest they can be speciated and that juvenile *Laetmonice* are present in inshore UK waters.

There have been several problems with **Phyllodocidae** and the family will need to be revisited. Members of the *Eteone longa* and *Eumida sanguinea* complexes are given 'agg.' at APEM (and Fugro) but have been named as species at other laboratories. Hebog leave *Eumida* at genus. Others have left other phyllodocids at family or genus, with or without 'juv.'

Glyceridae (RT6309). *Glycera*, identified to species or complex by APEM, without separation of juveniles, have been identified at higher taxonomic levels by some laboratories (e.g. *Glycera* juv. For very small specimens at Marinescope). APEM record *G. lapidum*, with 'agg.' as it may be a complex. WoRMS combines *G. rouxi* with *G. unicornis*; this has been followed by some laboratories but not all. The draft TDP suggests species level identification for Glyceridae, without separation of juveniles, as currently done at APEM. Most labs identified RT6309 correctly. The global glycerid revision (Böggemann, 2002) provides good illustrations and identification resources but the distribution maps suggest that some species may have been synonymised unnecessarily and may be re-validated in future. Some labs leave juveniles at genus but others speciate all; further discussion is needed.

Small **Goniadidae** have been left as juveniles at family level by some laboratories. The suggestion is to record all at species, without qualifiers. *Goniada pallida* is synonymised with *G. vorax* in Böggemann (2005) but remains valid on WoRMS; APEM use *G. pallida*, as the European species.

Hesionidae will need more work. *Podarkeopsis* are named as *P. capensis* by some (currently including APEM) but left at genus by others (e.g. Hebog: taxonomic uncertainty).

Microphthalmus spp. (previously within Hesionidae, now **Microphthalmidae**) have been identified to species by some laboratories but are left at genus by APEM (and Hebog), as the features are difficult to see.

Nereididae (RT6304). Nereididae have been left at genus or family at different sizes by different laboratories. The draft TDP flags Nereididae for further work, due to different taxonomic levels currently used for different taxa by different labs, particularly for small specimens. APEM identify most to species, without separation of juveniles but occasional specimens are left at family level, if particularly small. Multiple literature resources are needed for nereid identification and there have been taxonomic updates and new records for many areas. However, most labs identified RT6304 correctly. More work will be needed.

Syllidae (RT6120). The draft TDP flags this large family for further work, due to taxonomic flux (changes in species recognised over time) and the different taxonomic levels used for different taxa by different labs. APEM identify *Syllis* to species but acknowledge that there are several complexes with taxonomic problems (see RT48) and add 'agg.' to some. Records of *Syllis cornuta* in older data have been confused with *S. parapari* and *S. garciai*. However, most labs identified RT6120 correctly. Members of the *Syllis armillaris* complex may be given species names (including *S. hyalina*) by some. APEM (and Hebog) now record them as *S. armillaris* agg. *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). 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, 2006). The most common UK *Sphaerosyllis* is currently named '*S. cf. taylori*' at APEM (and Hebog); 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. Although many problems were resolved through the Scheme workshop (2012) and key (San Martín & Worsfold, 2015), as well as through RT48 and more recent papers in Scheme literature list, more work will be needed for Syllidae.

Nephtyidae (RT6102). The draft TDP suggests species identifications for nephtyids over 17mm, as currently done at APEM. Juvenile *Nephtys* are left at genus when small by most laboratories but the size of the divide has been variable. Some labs (e.g. Marinescope) use the presence of eyes as the definition for juveniles. The suggestion is to record as juveniles, at genus level, below 17mm. There were some alternative names in RT61, but more correct identifications, for a relatively uncommon species. The policy may need review only for standardisation of juvenile sizes, due to difficulties with determining sizes of damaged specimens.

7.6.2 *Eunicida*

Eunicidae. APEM separate juvenile *Eunice*, *Marphysa* and *Paucibranchia* (which had previously been included in *Marphysa*) and leave juveniles at Genus. Ocean Ecology leave all *Paucibranchia* at genus; APEM sometimes record them at species.

Onuphidae. APEM (and Ocean Ecology) leave *Nothria* at genus.

More work is needed for **Dorvilleidae**. *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.

Lumbrineridae need more work. 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 (e.g. George & Hartmann-Schröder, 1985) 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.; Hebog leave at Family if all chaetae are broken).

7.6.3 *Scolecida*

Orbiniidae (RT6105). The draft TDP flags Orbiniidae for further work, due to different taxonomic levels currently used for different taxa by different labs. Some include small *Scoloplos* in 'Orbiniidae juv.'. APEM always speciate *Scoloplos armiger*, without separation of juveniles but record 'Orbiniidae juv.' for juvenile *Phylo* and *Orbinia* (if the thorax is <5mm), with different policies for other genera. Most labs identified the (large RT6105) specimen correctly. More work is needed.

Paraonidae (RT6115). The draft TDP suggests species identifications for paraonids, as currently done at APEM, although there are sometimes specimens that need qualification as there may still be some taxonomic flux. There were some alternative names in RT61, but more correct identifications, for a difficult species. Some discussion may be needed for taxonomically uncertain specimens.

Capitellidae (RT6322). The draft TDP flags Capitellidae for further work, due to taxonomic flux and different taxonomic levels currently used for different taxa by different labs. APEM (and Fugro) identify most, including *Notomastus*, at genus level; species level for monotypic (in northern Europe) genera. All labs identified RT6322 correctly, other than one leaving it at genus, suggesting species level is possible. Lack of definitive literature prevented this in the past, though many labs defaulted to *N. latericeus*. The species can be separated using Capacciano-Azzati & El-Haddad (2015). With *Capitella*, identifications of *C. capitata* are almost always erroneous, in light of recent research (Blake, 2009), and will now be treated as taxonomic errors.

Maldanidae need more work. They have been taken to more precise levels at APEM (and Fugro) 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. APEM leave *Notoproctus* and *Nicomache* at genus, APEM (and Fugro) leave *Leiochone* at genus; some other laboratories speciate them. It is now technically a taxonomic error to record *Leiochone* as *Clymenura*. Some laboratories (e.g. Fugro) may count pygidia, rather than heads.

Opheliidae (RT6310). The draft TDP flags Opheliidae for further work, due to taxonomic flux and different taxonomic levels currently used for different taxa by different labs. Policies vary between laboratories for sizes to record Opheliidae as juvenile, with some (such as Ocean Ecology) separating genera. APEM identify most *Ophelina* to species but leave juveniles at family level if below 5mm, with the exception of certain small species that rarely exceed that size. Fugro leave *Ophelia* as juveniles to Genus if they have a rounded prostomium. The RT6310 specimen could be identified using Rowe (2010) and most labs identified it correctly. More work is needed.

Small **Arenicolidae** have been left at family by APEM but sometimes identified by others. The suggestion is to leave them at family, without qualifiers (as some species are small as adults), if less than 10mm.

Scalibregmatidae need more work. *Asclerocheilus* are now left at genus by APEM, as there may be other UK species (J. Gil, pers. comm) but are speciated by some (e.g. Marinescope). They have been speciated or called Scalibregmatidae juv. by others.

Travisiidae (RT6313). The draft TDP suggests species identifications for travisiids, as currently done at APEM. *Travisia* were previously included in Opheliidae, then, for a time, in Scalibregmatidae. All labs identified RT6313 correctly, suggesting no need for change.

7.6.4 Echiuroidea (formerly treated as a separate Phylum)

Echiura were once considered a phylum but were later found to be derived annelids. They were then treated as an Order but later (Goto et al., 2020) considered to be a single Family (Thalassematidae), though this has yet to be reflected on WoRMS. They are identified to species at APEM (and Fugro), although there are problems with juveniles, particularly between *Maxmuelleria lankesteri* (which has habitat-defining significance) and *Thalassema thalassemia*. Greenish echiurans with a distinctive bifid proboscis are often referred to *Bonellia viridis*, but it is now known that *Amalosoma eddystonense* shares these characteristics (see Connor, 1990). The latter can be distinguished by its lack of ventral chaetae.

7.6.5 Spionida

Spionidae (RT6303, RT6317). The draft TDP flags this large family for further work, due to taxonomic flux (changes in species recognised over time) and the different taxonomic levels used for different taxa by different labs. *Spiophanes bombyx* and *S. kroyeri* are now considered complexes and given 'agg.' At Fugro (but not yet at APEM). APEM currently attempt identification of *Scolecopsis* (RT6303), which may be left at family or genus by others when small (with or without 'juv. '; Hebog have a juv. category). APEM (and Fugro) use '*Polydora ciliata* agg.' to include *P. ciliata* and *P. calcarea*. APEM (along with Marinescope) attempt identification of and *Dipolydora* (RT6317) to species following the key circulated with RT54 and recent literature and add 'agg.' to some; most *Dipolydora* were previously named as *D. coeca* agg. Many problems were resolved through the Scheme workshops (2008, 2016), as well as through RT54, but an update to the key is still required. There were several identification discrepancies, mostly from within the difficult *Dipolydora coeca* complex, which requires further work and discussion. The name *Malacoceros vulgaris* has been used for more than one species and use of '*sensu*' may be needed. It appears that the species previously recorded as *M. fuliginosus* is the true *M. vulgaris* and that previous *M. vulgaris* records are of *M. girardi*. As these taxa are important indicators of anthropogenic impact it would be helpful to have their revised status fully confirmed in a published paper. *Streblospio* are now left at genus by APEM (and Ocean Ecology, though they previously attempted species identifications), 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*.

7.6.6 Chaetopterida

Chaetopteridae have been speciated by some laboratories. APEM (and Fugro) leave them at genus. Hebog leave at Family, except *Chaetopterus*. The large infaunal species, *Chaetopterus variopedatus*, originally described from the Mediterranean is frequently recorded from British waters but may include more than one species (M. Petersen, 1984). A smaller epifaunal species, *Chaetopterus norvegicus*, attaches its tube to rocks. This taxon has long been submerged in synonymy with *C. variopedatus* but has recently been resurrected and re-described (Moore et al., 2020). SEPA holds specimens of *C. norvegicus* collected in the Firth of Clyde, Scotland, in 1992. North Sea samples sometimes include a small infaunal species, yet to be resolved.

7.6.7 Terebellida

Cirratulidae need more work. Some laboratories have left small or damaged specimens at family or genus level. APEM (and Hebog) identify most to species, with standard policies for those left at genus. Some laboratories have left specimens (of *Chaetozone*, *Tharyx*, *Cirratulus*, *Aphelochaeta* and *Caulleriella*) at genus level that APEM was able to take to species. Some have used the name *Monticellina dorsobranchialis* (previous recommendation) for specimens that would now be called *Kirkegaardia* sp. (at APEM and Fugro and Hebog); this is now technically incorrect, as *K. dorsobranchialis* is very unlikely to be a UK species (type locality in tropical west Africa). APEM separate juvenile *Cirriiformia* and leave at genus (there are other *Cirriiformia* names in the literature of unknown validity, some of which have features similar to juvenile *C. tentaculata*); others included them with *C. tentaculata*. APEM (and Fugro and Hebog) leave *Dodecaceria* at Genus.

Acrocirridae (RT6302). This family was accidentally omitted from the first draft TDP. APEM previously identified *Macrochaeta* at genus level but one species has since been moved to a different genus (Jimi et al., 2020). Most labs identified RT6302 correctly, suggesting that species level may be achievable; Santos & Silva (1993) include a key to all *Macrochaeta*. Ocean Ecology leave at Family, other than *Macrochaeta* (at Genus).

Flabelligeridae. This family was accidentally omitted from the first draft TDP. APEM originally attempted species identifications, mainly using Oug et al. (2011) but more recent revisions have caused some genera to be left at genus.

Ampharetidae (RT6111, RT6118, RT6319). The draft TDP flags Ampharetidae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM identify most to species but leave occasional small, damaged specimens at higher levels. Small specimens have been left at family or genus by some. Most labs identified RT6111 correctly. It is likely that discrepancies were due to use of Holthe (1986), which combines two *Amphicteis* species that are separated in Jirkov & Leontovich (2013). The two ampharetids sent in RT61 would always be identified to species. Most labs identified both specimens correctly but there were several alternatives given for each. For *Hypania invalida*, this may have been due to use of literature that excluded the species (recently introduced in Britain and western Europe but included in Jirkov & Leontovich, 2013). The differences were more surprising for *Ampharete falcata* but specimens would usually be more numerous, with some larger, in a real sample. APEM retain separation of three *Ampharete* species identified by Holthe (1986) (*A. lindstroemi*, *A. baltica* and *A. cf. acutifrons*) although the valid names may later change; others have named all these as *A. lindstroemi* agg. Fugro separate segregates within the *A. lindstroemi* complex (Type H and Type P). Hebog and Marinescope identify ampharetids to Species.

Terebellidae (RT6108). The draft TDP flags Terebellidae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM identify most to species but leave occasional small, damaged specimens at higher levels. *Amphitrite rzhavskiyi*, sent in RT61, would have been identified as *A. cirrata* prior to the recent (Jirkov, 2020) review and most labs either used this name (a literature update lag) or identified the specimen correctly. There were several other alternatives given but most only by a single lab each, suggesting species level identification would be

practicable. *Streblosoma* have been identified at genus level by most (including APEM and Ocean Ecology), prior to clarification by I. Jirkov (pers comm. 2016); they can now be more easily assigned to species but problems remain. There is confusion between *Pista cristata* and *C. bansei*; Fugro leave as *cristata/bansei* if small (<1mm head width); Ocean Ecology leave them at Genus. Policies vary on whether to separate *Lanice conchilega* juveniles (currently not at APEM or Marinescope). Ocean Ecology leave *Loimia* at genus. APEM (and Fugro) leave *Polycirrus* at genus (as tails are required), while some others identify species (e.g., Marinescope, if complete). Taxonomic uncertainty remains regarding several UK *Polycirrus* species. There is variation between laboratories in the use of Terebellidae juv.

Trichobranchidae are currently accepted as a family on WoRMS, though some consider them to be nested in Terebellidae. *Terebellides* have, until recently, been assumed to be *T. stroemi* by most (with or without knowledge of other species such as *T. shetlandica* now known from UK waters (Parapar et al., 2016). Recent studies have indicated that *T. stroemi* is probably restricted to Norwegian waters and that the “*T. stroemi*” from UK inshore waters is probably referable to *T. europaea* or its indistinguishable congener *T. scotica* (see Parapar et al. 2020). APEM (and Fugro) now leave *Terebellides* at genus, as more species are likely to be present; some others identify species.

7.6.8 Sabellida (includes ‘Pogonophora’)

Sabellidae policies have been very variable and more work is needed. Hebog identify most to species. *Acromegalomma* have been identified to species by some (e.g., Marinescope), 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*) Ocean Ecology leave *Acromegalomma*, *Jasmineira*, *Myxicola*, *Paradialychone*, *Parasabella* and *Pseudopotamilla* at Genus.

APEM (and Ocean Ecology) leave **Siboglinidae** (formerly Pogonophora) at Family.

Serpulidae (RT6107). The draft TDP flags Serpulidae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM identify most non-spirorbins to species for specimens that retain an operculum but record ‘Serpulidae’ where the operculum is lost; other laboratories have speciated serpulids without an operculum, or recorded some as ‘*Spirobranchus*’. APEM leave Spirorbinae (such as RT6107) recorded as ‘present’ and at subfamily level. As most labs identified RT6107 correctly, identification at species may be practicable (at least for this and a few other species). However, enumeration is the main problem for Spirorbinae, as the tubes may be found in large numbers and it is difficult to determine the number of live-collected individuals without destroying the tubes. Fugro count low numbers but record ‘present’ if 100s; APEM record ‘present’. This is also a problem for some other serpulids, such as *Salmacina*. Further discussion is needed.

7.6.9 Sipuncula (formerly treated as a separate Phylum)

Sipuncula were once considered a phylum but were recently transferred to Annelida as an order. They have been treated in a variety of ways. Most laboratories have identified large specimens to species but smaller specimens have been counted as juveniles by many laboratories (e.g. Ocean Ecology), at varying sizes (e.g. Sipuncula juv. at Marinescope if <2mm). Thomson Ecology leave some at higher levels without separation of juveniles. Hebog leave juvenile Golfingiidae at Genus. The current TDP suggestion is to identify Sipuncula to species, without separation of juveniles, as at APEM (and Fugro). This can usually be done from external morphology but new guides or workshops may be needed to allow consistent data.

7.6.10 Haplotaxida

Although a preliminary TDP has been available through the NMBAQC for Oligochaeta, some laboratories continued to record them only as ‘Oligochaeta’ (e.g., Thomson Ecology, other than Enchytraeidae and **Naididae**) and there has been a range of other records, such as ‘**Tubificidae**’ and ‘*Tubificoides*’. APEM (and Fugro) record **Enchytraeidae** at Family, except for *Grania*, at Genus. Fugro record species for others where possible. More work is needed. APEM now use ‘*T. 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.

7.6.11 *Hirudinea*

This subclass (leeches) was accidentally excluded from the first draft. Most are freshwater, with some extending into brackish water; these species are usually identified at species level at APEM. The rarer marine species are all in the family **Piscicolidae** and currently left at family, due to incomplete literature. Fugro record species where possible.

7.6.12 *Non-polychaete annelids*

Protodrilidae are left at Family by Fugro, as the genus *Protodrilus* has been split; this has not yet been followed at APEM.

Magelona have been left at family (**Magelonidae** but currently only one genus so family considered redundant by extreme cladists) or genus by some laboratories when small (with or without 'juv.'). The TDP is to always identify to species without qualifiers. *Magelona minuta* is currently unaccepted on WoRMS, due to a rarely-used homonym, and is awaiting ICZN conserved status.

Oweniidae need more work. *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 (and Fugro). The reverse is true for *Galathowenia*. Fugro separate *Owenia* juveniles if the crown has buds, not tentacles. Ocean Ecology leave *Myriochele* at Genus.

7.7 Arthropoda

Arthropods are the largest benthic group in terms of species, usually second to annelids in abundance. They were, for a time, divided between Crustacea, Chelicerata and Uniramia as separate Phyla and this has impacted biomass comparability, with 'non-Crustacea' having been treated as 'others'. Hexapoda (including insects) are now considered to be nested within (the subphylum) Crustacea. Many arthropod families are absent from the north-east Atlantic and many have 'varies' for their TDP and will need further work.

7.7.1 *Diplopoda*

APEM leave most at class. Fugro identify to species, where possible.

7.7.2 *Chilopoda*

APEM leave most at class. Fugro identify to species, where possible.

7.7.3 *Pycnogonida*

APEM (and Fugro and Thomson Ecology) identify most to species, with juvenile Pycnogonida (with six legs) at class. There has been some variation between laboratories in the speciation of some families.

Callipallenidae need more work. APEM leave *Callipallene* at genus; Marinescope, Ocean Ecology and Thomson Ecology speciate them.

Pycnogonidae (RT6305). The draft TDP suggests species identifications (using Bamber, 2010) for (adult) Pycnogonidae, as currently done at APEM, with juvenile Pycnogonida (with six legs) at class. RT63 results suggest no changes; all labs correctly identified the specimen.

Ammonotheidae (RT6123). The draft TDP flags Ammonotheidae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM identify adults (juvenile Pycnogonida, with six legs, at class) to species or species complexes. The genus *Ammothella* was previously included in *Achelia* and earlier literature used species level features that required fully

mature specimens. Consequently, APEM policy was to record *A. echinata* and '*A. longipes*' as aggregates. Now that they are in different genera, the policy could be to leave them at genus level but RT61 results and the additional features in updated literature (Bamber, 2010) suggest that species level may be achievable.

7.7.4 Arachnida

Spiders and mites are mainly terrestrial and some labs may have ignored them. However, mites (recorded as **Acari**, or Acariformes) are widespread components of the benthos and should be recorded. Spiders (**Araneae**) and **Pseudoscorpionida** may be present in sample containers before sampling (as contamination) but could be genuine records on the shore in saltmarshes etc. APEM (and Fugro) record as Acari.

7.7.5 Hexapoda (inc. Insecta)

Insects and other mainly terrestrial / freshwater arthropods have been ignored by many laboratories. There is some justification for this where the most likely origin is from the air or contamination from other sources (beetles and ants may become trapped in stored sample containers). However, many transitional salinity and surface scrape samples contain insects (especially chironomid larvae) that are true components of the sampled fauna and there is a non-native marine chironomid larva. All sample contents should be recorded for context.

Insect larvae and pupae should be distinguished for those orders that have three distinct phases. Many are aquatic at some stages but not others. Larvae should also be distinguished for other orders, with the exception of apterygote orders. APEM identify most at order level, with certain distinctive families recognised. Fugro identify Collembola to species where possible, insects at Family.

7.7.6 Ostracoda

Some laboratories have ignored ostracods or left them as Ostracoda (e.g., Hebog, Thomson Ecology, Fugro – though they separate Myodocopida), or recognised different distinctive species. We suggest separation into Myodocopida and Podocopida, with optional recognition of certain species. The two other orders appear to be rare but should be researched.

Myodocopida. APEM (and Fugro and Thomson Ecology) speciate the non-native *Eusarsiella zostericola*. SEPA recognise *Cylindroleberis mariae*, *Euphilomedes interpuncta*, *Philomedes macandrei* and *P. lilljeborgi*, though realise that the taxonomy of myodocopids is in need of revision.

Podocopida (RT6114). The draft TDP suggests leaving Podocopida at order level, as there are many species that are difficult to identify, many of which would pass through a 0.5mm sieve. However, APEM (and Fugro) identify certain distinctive species, including *Pterygocythereis jonesii*. Most labs identified this correctly, suggesting that a list of ostracods to be identified at species level could be developed. APEM and Thomson Ecology speciate *P. jonesii*.

7.7.7 Thecostraca

The treatment of barnacles has been highly variable, partly as a result of taxonomic changes. A few laboratories still record barnacles as 'present', without counts, but we have not seen recent examples of NMBAQC Scheme participants ignoring them. Barnacles may have been unidentifiable due to small size or damage (as they are often scraped from surfaces) and the chosen higher taxon names have varied between Cirripedia (e.g. Marinescope; 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. Thomson Ecology suggest combining damaged and juvenile Sessilia. Larger barnacles, including parasitic species, should be counted and identified to species. Ocean Ecology identify Rhizocephala but leave at Balanomorpha below 3mm as they are now classified outside Sessilia on

WoRMS, and to differentiate from Verrucomorpha which are taken to species level at all sizes. Fugro record species where possible.

7.7.8 Copepoda

Copepoda have been taken to varying levels at different laboratories and sometimes ignored as pelagic or meiofaunal, or ectoparasitic (e.g. Hebog). Only a minority of families are pelagic and many are large enough to be retained at 0.5mm. APEM currently leave them at Class level (ie. Copepoda) due to difficulty in recognition of some orders. However, this may be due for revision, as it does not distinguish benthic and pelagic taxa and a qualifier is used for parasitic copepods. Fugro recording policy is project-dependant. Further discussion is needed.

7.7.9 Leptostraca

Identify to species (APEM and Fugro). Ocean Ecology leave males at Genus. Separate larvae, where larval features noted.

7.7.10 Stomatopoda

Identify to species (APEM and Fugro). Separate larvae, where larval features noted.

7.7.11 Mysida

Mysidae (RT6109). The draft TDP suggests species identifications for adult mysids (excluding those with larval features), as currently done at APEM (and Fugro), although there are often occasional specimens that must be left at family, due to missing uropods or antennal scales. As all labs correctly identified RT6109, the policy seems reasonable.

7.7.12 Lophogastrida

Identify to species. Separate larvae, where larval features noted.

7.7.13 Amphipoda

Amphipods are one of the main groups of macrobenthos. The order includes three families that will need more work to resolve a TDP at species level. Most laboratories (e.g. APEM and Fugro) identify most to species.

Lysianassidae has been divided into several families. (e.g., Lowry & Stoddart, 1997) Uristidae needs more work. *Tmetonyx* are speciated at some laboratories (e.g., Marinescope). APEM leave at genus, due to taxonomic uncertainty.

Oedicerotidae need more work. There are UK species of *Pontocrates* that resemble *Synchelidium* in their toothed Gn2 palms. APEM (and Fugro) now name the former *Pontocrates* species A as *P. arcticus*, following Myers & Ashelby (2022). The species assigned to *P. arcticus* by Moore & Beare (1993) was renamed as *Pontocrates moorei*. Other laboratories have left them at genus or had other systems but naming them *Synchelidium maculatum* would be a taxonomic error and the name *Pontocrates arcticus* requires qualification.

Ampeliscidae are recorded at genus or family at different sizes at different laboratories (small *Ampelisca* at genus at APEM and Marinescope) and have been left unspciated at varying degrees of damage. More work is needed.

Different sizes and degrees of damage have been used to leave *Urothoe* (**Urothoidae**) at genus at different laboratories. The TDP is to speciate, without differentiation of juveniles.

Bathyporeiidae (RT6124). The draft TDP suggests species identifications for *Bathyporeia*, as currently done at APEM, without separation of juveniles, although there may be occasional specimens that must be left at genus, if only the anterior of the body is present. As most labs correctly identified RT6124, the policy seems reasonable. Different sizes and degrees of damage have been used to leave *Bathyporeia* at genus at different laboratories.

Melitidae has been divided into several families (e.g., Krapp-Schickel, 2008).

There has been some variation in speciation of juvenile and female *Cheirocratus* (**Cheirocratidae**). The TDP is to identify adult male *Cheirocratus* to species (without qualifiers) but call the others 'Cheirocratus female'. APEM consider more evidence required to validate female speciation.

Calliopiidae. Fugro record '*Apherusa bispinosa* agg.' Due to additional species in the complex.

Hyalidae (RT6308). The draft TDP suggests species identifications for Hyalidae, as currently done at APEM, without separation of juveniles. The standard identification guide for amphipods (Lincoln, 1979) was superseded for hyalids by McGrath & Myers (1989), with later nomenclature changes and additional species. Krapp-schickel & Bousfield (2002) separated *Hyale lubbockiana* from *H. pontica*, with which it had previously been synonymised, and restricted the distribution of *H. pontica* to the Mediterranean region. Specimens from the RT63 source pot, which includes a male (circulated specimens were female) seem to show characteristics of both species (for both sexes), suggesting that further taxonomic work is required. Most labs used the name *H. pontica*, while two used *H. lubbockiana*, probably reflecting low circulation of the paper.

Female and juvenile **Aoridae** have been speciated at some laboratories. APEM consider more evidence required to validate female speciation and suggest leaving at Family.

Ischyroceridae (RT6122). The draft TDP suggests species identifications for adult, male ischyrocerids, with qualifiers for females and juveniles (at Genus at APEM and Ocean Ecology). However, *Microjassa cumbrensis* is identifiable at any stage, as shown by the majority correct identifications. All specimens are typically damaged in samples but features important for recognition are usually present. Most of the identification differences were for other families.

Different sizes and degrees of damage have been used to leave **Corophiidae** at genus at different laboratories. Marinescope leave damaged and very small Corophiidae at family. APEM speciate without qualifiers. The traditional genus *Corophium* was split into several genera (Bousfield & Hoover, 1997). Ocean Ecology leave at Family below 3mm.

Caprellidae (RT6316). The draft TDP suggests species identifications for adult caprellids and for all Caprellidae other than juvenile *Caprella*; these are left at genus if they have the juvenile form (rounded, smooth head). This is the current APEM policy and was derived from the 2012 NMBAQC workshop and guide (Guerra-García, 2014). Most labs identified the specimen correctly, with one using *Parvipalpus onubensis* (Guerra-García et al, 2001), which is not known from northern Europe. Further discussion may be needed on how to define juveniles.

7.7.14 Isopoda

Most laboratories (e.g. APEM and Fugro) identify most to species.

There have been different policies used at different laboratories for **Gnathiidae**. The TDP is to record 'Gnathiidae female' and 'Gnathiidae juvenile' and identify adult males. Ocean Ecology record females and pranzae (juveniles) at Genus. There is a distinct but undescribed species, named *Gnathia* 'species A' at APEM and other potential undescribed members of the *G. oxyuraea* complex are separated at Fugro.

APEM identify those *Astacilla* (**Arcturidae**) previously in *Arcturella* to species but leave others at Genus without separation of juveniles. Ocean ecology separate juveniles of all at 5mm.

Idoteidae (RT6101). APEM previously identified all *Idotea*, without separation of juveniles. Marinescope and Ocean Ecology separate small *Idotea* as juvenile. Since 2023, APEM have been separated juveniles at <5mm. RT6101 specimen was large and most labs identified correctly but discussion may be needed for juveniles.

Sphaeromatidae. APEM identify most to species but leave *Cymodoce* at Genus. Ocean Ecology separate juveniles at 3mm and leave at Family.

Janiridae (RT6104). The draft TDP suggests species identifications for janirids, without qualifiers for juveniles, as currently done at APEM. However, *Jaera* are left at Genus (APEM and Ocean Ecology). Most labs correctly identified RT6104, although it lacked antennae and uropods. However, there are very similar species, one of them non-native, that may not have been considered by all.

Munnidae. APEM (and Ocean Ecology) leave *Munna* at genus.

Ocean Ecology leave Cryptoniscoidea at Superfamily.

7.7.15 *Tanaidacea*

Some laboratories have left many tanaids as 'Tanaidacea'. APEM identify most tanaids at species level. Others (e.g. APEM and Fugro) identify most to species.

Typhlotanidae (RT6110). The draft TDP suggests species identifications for typhlotanids, as currently done at APEM, although there remains some taxonomic flux, particularly for deeper water species. Most labs correctly identified RT6110.

7.7.16 *Cumacea*

Most laboratories (e.g. APEM and Fugro) identify most to species.

Different sizes and degrees of damage have been used to leave **Diastylidae** at family or genus at different laboratories. APEM speciate all, with juveniles separated if 4 or fewer pairs of telson spines (for specimens shown not to be *Diastylis lucifera*). Marinescope and Ocean Ecology identify all where condition allows. Thomson Ecology suggest higher levels where identification not possible, as no consistent separation in the past.

7.7.17 *Euphausiacea*

Most laboratories (e.g. APEM and Fugro) identify most to species. Ocean Ecology leave at Family. Separate larvae, where larval features noted.

7.7.18 *Decapoda*

Most laboratories (e.g. APEM and Fugro) identify most adults to species. Decapod zoeae and megalopa may have been ignored by some; or identified at differing levels. The TDP suggestion is to record them, at Order level, with qualifiers. As most Decapoda grow large, there is a suggestion of separating juveniles, whether or not there is to be a difference in taxonomic resolution.

Many former **Hippolytidae** are now **Thoridae**. Ocean Ecology leave at Genus where no rostral teeth.

APEM separate juvenile **Callianassidae** at 10mm carapace length but identify to Species Fugro separate juveniles at 5mm total body length and leave at Family.

APEM separate juvenile **Axiidae** at 10mm carapace length but identify to Species. Fugro separate juveniles at 5mm total body length and leave at Family.

APEM separate juvenile *Upogebia* (**Upogebiidae**) at 10mm carapace length and leave at Genus Fugro separate juvenile *Upogebia* at 5mm total body length and also leave at Genus.

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

'Paguridae juv.' at carapace lengths below 1mm and *Pagurus* juv. at carapace lengths between 1mm and 3mm.

Different sizes have been used to leave **Galatheidae** at family or genus at different laboratories. APEM separate juveniles at carapace lengths below 5mm and record to species for *Galathea intermedia* but Genus for other Galathea. Fugro use the same size distinction for most but record *G. intermedia* to species without separation of adults and juveniles.

Leucosiidae (RT6113). The draft TDP suggests species identifications for leucosiids (all *Ebalia* in UK waters) over 5mm (carapace width), as currently done at APEM. At Fugro the size separation is 2mm. Most labs correctly identified RT6113 despite it being very similar to another. The policy could be retained unless discussion is needed on the size criterion.

Different sizes and degrees of damage have been used to leave **Portunidae** at family or genus at different laboratories. Most of the genera previously included in Portunidae in British waters have now been transferred to other families within Portunoidea (**Polybiidae** for *Liocarcinus*; **Carcinidae** for *Carcinus*). The TDP (as at APEM) suggests recording as 'juv.' for carapace widths below 10mm., with juvenile *Liocarcinus* left at genus. At Fugro, the separation size is 5mm.

Majidae. APEM (and Fugro) separate juvenile *Eurynome* at 5mm carapace lengths and leave at genus.

Oregoniidae. APEM separate juvenile *Hyas* at 10mm carapace lengths and leave at genus. At Fugro, the separation size is 4mm.

Inachidae. APEM (and Fugro) separate juvenile *Inachus*, *Macropodia* at 5mm carapace lengths and leave at genus. Fugro

7.8 Mollusca

7.8.1 *Caudofoveata*

Many laboratories have left some caudofoveates at class, probably because there are some species, not yet recorded from British waters but that could occur, that cannot be distinguished without dissection. The suggestion is to record them to species, defaulting to common British species where necessary. Although there will be a margin of error, this will provide more information than leaving all at class. Fugro identify to species where possible.

7.8.2 *Solenogastres*

Many laboratories have left Solenogastres at class; there are many species that can only be distinguished by dissection and it is likely that there are many undescribed species in British waters. The draft TDP has selected those families with varying suggested policies as examples of species level TDP. Certain easily recognised species should be identified at species level. Others can be left at class. Fugro identify to species where possible.

7.8.3 *Polyplacophora*

Some laboratories (e.g., Marinescope) have left some juveniles at family or class. APEM (and Fugro and Thomson Ecology) identify all at species level, without qualifiers. Most do not grow large and can be identified with reference to larger material from the same project, if juvenile.

7.8.4 *Trochida*

Trochidae (RT6214). Several genera previously in Trochidae have been moved to other families. Many laboratories have left juvenile and, sometimes, damaged trochoids at family (e.g., Marinescope) and there have been other identification problems and inconsistencies noted in previous circulations and audits, often resulting from attempting to use the umbilicus features given by Graham (1988), which do not consistently work, even for quite large specimens. The updates to the series (e.g., Wigham & Graham., 2017) are effectively reprints with nomenclature updates but little other new information.

Smith (2019) gives updated identification features for *Steromphala*. APEM identify to species, without separation of juveniles, except for *Gibbula magus*. Most do not grow large and can be identified with reference to larger material from the same project, if juvenile. Fugro record '*Steromphala* juv.' Below 2mm. All labs correctly identified the genus for RT6214 (although there were some nomenclature updates) but there were a few species level differences. The specimen was fully grown and most identification discrepancies in the family are known (from audits) to be for smaller specimens, which may require discussion. There are many trochids that are found in samples that represent different habitats, some rare; most are found in low numbers in macrobenthos samples.

Margaritidae (RT6216). The draft TDP suggests species identifications for margaritids (previously included with Trochidae) without separation of juveniles, as currently done at APEM. RT6216 had the joint largest number of discrepancies of RT62 (15, all at family level). The specimens were small and the species would have been unfamiliar to many labs due to its habitat and distribution. With experience and reference collection audits, it should be identifiable. There are few other species in the family, all rare.

7.8.5 *Littorinimorpha*

Littorinidae (RT6218 and RT6225). Some laboratories have left juvenile Littorinidae at family or genus (e.g. Marinescope) and may have done the same with damaged specimens. APEM identify to species, mostly without separation of juveniles. They do not grow large and can be identified with reference to larger material from the same project, if juvenile. Both RT6218 and RT6225 were small *Lacuna*. Most labs correctly identified *L. vincta* but *L. pallidula* generated 9 discrepancies, most at genus or family level. As with *Margarites*, the typical habitats cause littorinids to be uncommon in benthos samples aimed at infauna but they should be identifiable, or correctable, with experience and reference collection audits. Littorinids are mainly intertidal and more commonly recorded *in situ*; most species are found only in low numbers in macrobenthos samples.

Rissoidae (RT6206, RT6207, RT6217 and RT6219). Some laboratories have left some damaged Rissoidae at family. APEM identify to species, unless exceptionally damaged and in small numbers. They can often be identified with reference to other material from the same project, if damaged. All RT62 specimens generated some discrepancies, few for *Rissoa parva* and *Onoba* spp. but seven for *Obtusella intersecta*. Different species in the family are more or less familiar and *O. intersecta* is difficult due to its lack of clear distinguishing features but experience should allow all to be identifiable. Rissoidae is a large family, including species that represent different habitats and distribution patterns, with several that are rare or at the edge of their range in British waters.

Hydrobiidae (RT6204 and RT6212). Some laboratories have left some damaged Hydrobiidae at family. The draft TDP suggests species identifications for hydrobiids without separation of juveniles, as currently done at APEM, unless exceptionally damaged and in small numbers (or, e.g., all female if there is a *ventrosa/neglecta* split). Ocean Ecology record '*Truncatelloidea* juv.' for exceptionally small sizes. They can be identified with reference to other material from the same project, if damaged. RT6204 and RT6212 were both near full size and generated few discrepancies. Smaller specimens have previously caused many problems. It is likely that there are fewer problems in real samples, as they usually include many more specimens to allow size comparisons and occasional extraction of animals from shells, for confirmation. Hydrobiids are important for conservation assessments and salinity indication. Some former hydrobiid species have recently been moved into other families (see below).

Cochliopidae (RT6220). The draft TDP suggests species identifications for cochliopids (previously included with Hydrobiidae) without separation of juveniles, as currently done at APEM; there are two named (one of conservation importance, the other non-native) and one un-named (probably non-native) British species. There were twelve discrepancies in participants' identifications, mostly confusions with similar hydrobiids. While separation of hydrobioids will probably always cause some problems, especially for single specimens, it is likely that many of the differences were due to unfamiliarity with a species only recently named for the UK fauna. Species level identification would be best retained. Records of 'Hydrobiidae' for cochliopids are technically a taxonomic error.

Tateiidae (RT6208). The draft TDP suggests species identifications for the single UK tateid (*Potamopyrgus antipodarum*, previously included with Hydrobiidae) without separation of juveniles, as currently done at APEM. Most labs correctly identified RT6208, but smaller individuals have caused problems in previous circulations. As the species is usually present in large numbers, size-related problems should be less frequent in real samples. Species level identification is best retained. The species is non-native, often abundant and a useful salinity indicator (mainly freshwater but extends into low salinity). Records of 'Hydrobiidae' for *Potamopyrgus antipodarum* are technically a taxonomic error.

Assimineidae (RT6223). The draft TDP suggests species identifications for assimineids (two UK spp.) without separation of juveniles, as currently done at APEM. Most labs correctly identified RT6223, but the other species was named for a circulated rissoid. Species level identification can be considered practicable. The two species are useful habitat indicators, with conservation importance.

Iravadiidae (RT6205). The draft TDP suggests species identifications for iravadiids (two UK spp.) without separation of juveniles, as currently done at APEM. All labs correctly identified RT6205 and species level identifications can be recommended. Iravadiids can be habitat indicators and the other species is uncommon.

Caecidae (RT6201). The draft TDP suggests species identifications for caecids without separation of juveniles, as currently done at APEM. All labs correctly identified RT6201 and species level identifications can be recommended. A similar species has conservation importance.

There has been variation in policy for separating juvenile *Crepidula fornicata* (**Calyptraeidae**). APEM separate at 17mm.

There has been variation in policy for separating and speciating juvenile **Naticidae**. APEM separate at 2mm and leave at family. Fugro separate juvenile *Euspira* at 1mm.

Eulimidae (RT6203). The draft TDP flags Eulimidae for further work, due to different taxonomic levels currently used for different taxa by different labs, including variation in the recognition of juvenile sizes. All labs correctly identified RT6203 but problems remain for other species in the family, as seen in previous ring tests. There are many eulimid species in northern European waters and identification is difficult, especially for the (majority) colourless species. Several species are rare or poorly known and there are several recent newly recorded species for UK waters. There have also been nomenclatural and generic assignment changes. Most records of *Vitreolina philippi* should be *V. antiflexa* (see Van Aartsen, 2000). This is technically a taxonomic error but included APEM records until recently. As ectoparasites on echinoderms (though usually found unattached), they have potential as indicator species. Further discussion is required but use of 'juvenile' in the family is best avoided, as it is usually impossible to distinguish juveniles unless the species name is known.

7.8.6 *Neogastropoda*

Juvenile **Buccinidae** have been left at family level by some laboratories (e.g. Marinescope). APEM separate adult and juvenile buccinids but identify most to species. Fugro separate juveniles at 10mm and leave at Family.

7.8.7 *Mesoneura*

Murchisonellidae (RT6222). The draft TDP suggests species identifications for the single UK murchisonellid (previously included with Pyramidellidae) without separation of juveniles, as currently done at APEM. Most labs correctly identified RT6222, several identified it as a similar member of the Pyramidellidae (the species was once included in the same genus). With experience and audits, identification should be possible. *Ebala nitidissima* is infrequently recorded but occasionally abundant and may be a potential habitat indicator.

7.8.8 *Pylopulmonata*

Pyramidellidae (RT6210 and RT6215). Some laboratories have left some Pyramidellidae at Genus (e.g. Marinescope) or Family. APEM identify to species, unless exceptionally damaged and in small numbers, although there have been changes over time for some genera. Fugro separate juvenile *Turbonilla*, at Genus, below 2mm. Pyramidellids can often be identified with reference to other material from the same project, if damaged. There were five discrepancies for RT6210 and eight for RT6215, all within Pyramidellidae in both cases. Problems have been noted for other species in the family in previous ring tests. Pyramidellidae is one of the largest gastropod families in northern European waters and identification is difficult. Many species are rare or poorly known and there are several newly described species in the area, as well as potential new national records. There have also been several generic, and even family level (see above) reassignments. As ectoparasites on other invertebrates (usually found unattached), they have potential as indicator species. Further discussion is required for suitable policies, preferably with additional training.

7.8.9 *Cephalaspidea*

Retusidae (RT6202, RT6211 and RT6213). The draft TDP suggests species identifications for retusids without separation of juveniles, as currently done at APEM. Only *Retusa umbilicata* generated discrepancies (4). The specimen was subadult and this species has caused problems in previous circulations. Species level identifications can be recommended, with audits. *Retusa* spp. can be common and the sometimes confused *Cylichna alba* is rare and restricted to deeper water.

Philinidae (RT6209 and RT6221). There has been variation in speciation of Philinidae; some laboratories (e.g. Marinescope) have left many at family, sometimes order; more work is needed. The draft TDP flags Philinidae for further work, due to different taxonomic levels currently used for different taxa by different labs, including variation in the recognition of juvenile sizes. APEM currently separate genera (*Hermania* sp. was once called *Philine scabra*) and speciate *Philine quadripartita*. Fugro record juvenile Philinidae at Family below 2mm. and juvenile *Philine*, at Genus, between 2mm and 5mm., with *Hermania* separated at Genus above 2mm. and *Philine* at species above 5mm. (when they would all be *P. quadripartita*) Use of '*Philine*' for *Hermania* is now technically a taxonomic error; as is '*Philine aperta*' (an African species; see Price et al., 2011) for *P. quadripartita*. RT6209 (*Philine denticulate*, now moved to **Aglajidae** and named *Philinissima denticulata*) was small and (consistently) with a damaged shell, matching typical finds in samples; it generated one of the largest numbers of discrepancies (15). The other (RT6221: *Philine quadripartita*) also generated many errors (10) but most of these were effectively nomenclatural: *P. aperta* is the name in Thompson (1988). Current (requiring update) APEM policy broadly follows the suggestion in Thompson (1988) that most required dissection for identification. Philinid identification has been improved by Ohnheiser & Malaquias (2013) and their key (focussed on Scandinavia) allows identification without dissection for many spp. They also described new species and left some potential new spp. un-named; this, together with the need for revision of southern species, suggests further changes to come. Several species previously in *Philine* have since been moved to other genera. Ohnheiser & Malaquias (2013) described *P. indistincta* as indistinguishable from *P. scabra* without dissection; fortunately, these two have been moved to *Hermania*, which can now be used to distinguish them at genus level. Less fortunately, several *Philine* have been moved to *Laona*, (or other genera now moved to **Laonidae**) including *P. quadrata*, which was keyed as requiring dissection for separation from *P. punctata* and other similar spp. They could potentially be separated by sculpture differences but without absolute certainty, or certain taxa could be distinguished at family rather than genus level. More discussion will be needed to establish policies for this family.

7.8.10 *Aplysiida*

Akeridae (RT6224). The draft TDP suggests species identifications for the single UK akerid without separation of juveniles, as currently done at APEM. RT6224 had many discrepancies (7, all at family level). Although the specimens were of a reasonable size and condition, the species would have been unfamiliar to many labs due to its sporadic occurrence in samples. With experience and reference collection audits, it should be identifiable.

7.8.11 Nudibranchia

There is wide variation between labs for all nudibranch identifications, with some leaving all at order (e.g. Hebog, Thomson Ecology) or even subclass level, with others attempting species or genus level identifications. APEM have identified most to genus (see below).

APEM (and Fugro) record *Dendronotus* (**Dendronotidae**) at Genus.

APEM (and Fugro) record *Doto* (**Dotoidae**) at Genus, although Fugro record *D. hystrix* at Species.

Onchidorididae (RT6301). The draft TDP flags Onchidorididae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM currently identify to species for those genera that are monotypic in UK waters (all but *Onchidoris*) and for *Onchidoris muricata*; other *Onchidoris* are currently left at generic level. Fugro leave at Family below 3mm. Several species have recently been moved to separate genera. Most labs correctly identified RT6301 at family level, with more variation for genus, including recent changes in generic placements for related species. Problems remain at species level that may require workshops, as well as discussion. APEM identify Onchidoridae to genus or species.

Polyceridae (RT6324). The draft TDP flags Polyceridae for further work, due to different taxonomic levels currently used for different taxa by different labs. APEM currently identify most to species but leave *Palio* at generic level. Most labs correctly identified RT6324 within Polyceridae, and many to *Polycera*, although several identified as similar members of the Goniadorididae. Species level identifications highlighted recent literature (Korshunova et al., 2021; Sørensen et al., 2020) that separates recently described species using features that would not always be clear in preserved material, suggesting that genus level identifications may be the best achievable for this and related non-monotypic genera.

APEM identify **Aeolidiidae** to family.

Previously, APEM identified *Cuthona* to genus. However, most of the species once assigned to this genus have now been divided between several families, so that the superfamily name **Fionoidea** must now be used, unless greater precision can be achieved. More discussion is needed.

7.8.12 Scaphopoda

APEM (and Fugro and Thomson Ecology) identify most to species, without separation of adults and juveniles. Fugro leave *Antalis* at genus below 10mm.

7.8.13 Nuculida (Protobranchia)

Laboratories have had varying policies for juvenile **Nuculidae**. APEM separate juveniles at family below 2mm. Fugro do this below 1mm, with juveniles at Genus (*Ennucula tenuis* assumed monotypic) between 1mm and 2mm.

7.8.14 Arcida

Limopsidae (RT6312). The draft TDP suggests species identifications for Limopsidae, as currently done at APEM, with separation of juveniles at 5mm (at species level). RT6312 were small but over 5mm and most labs identified them correctly. All discrepancies were with the similar *Limopsis minuta*, which can be distinguished by use of growth series, suggesting no need for change.

7.8.15 Mytilida

There have been varying policies for juvenile **Mytilidae**. Many laboratories (e.g. Fugro and Marinescope, if <1mm) have used 'Mytilidae juv.'. Ocean Ecology do this for *Mytilus* and *Modiolus* but speciate *Gibbomodiola*, *Crenella* and *Musculus* at all sizes APEM separate genera for all Mytilidae, with separation of juveniles below 5mm for *Mytilus* (currently recorded as *M. edulis* but review under consideration), *Gibbomodiola* (to species) and *Modiolus* (to genus); Fugro do the same for these

genera between 1mm and 5mm. Other genera are speciated at all sizes at APEM, while Fugro have a 0mm to 3mm category for juvenile *Musculus*.

7.8.16 *Pectinida*

There have been varying policies for juvenile **Pectinidae**. APEM separate juveniles at 2mm and leave at family. 2mm to 5mm specimens are recorded as juveniles at Species at APEM. Fugro separate juveniles at 3mm and leave at Superfamily. APEM speciate **Propeamussiidae** without separation of adults and juveniles.

APEM (and Fugro) separate juvenile **Anomiidae** at 10mm and leave at family.

7.8.17 *Limida*

APEM speciate **Limidae** without separation of adults and juveniles. Fugro separate juvenile *Limatula* at 3mm and leave at Genus.

7.8.18 *Ostreida*

Ostreidae (RT633). The draft TDP suggests species identifications for Ostreidae, as currently done at APEM, with separation of juveniles at 17mm (at species level). All labs correctly identified RT633 despite it's being a fairly recent, though well-known introduction, with several related similar species, suggesting no need for change.

7.8.19 *Carditida*

APEM (and Fugro) separate juvenile *Astarte* (**Astartidae**) at 5mm and leave at Genus, though Fugro speciate if there is a crenulate margin.

7.8.20 *Lucinida*

Lucinidae (RT6315). There have been varying policies for juvenile Lucinidae and Ungulinidae. The draft TDP suggests species identifications for Lucinidae, as currently done at APEM, with separation of juveniles at 5mm (at species level). Most labs correctly identified RT6315, suggesting no need for change.

Thyasiridae (RT6125). Many laboratories have left juvenile Thyasiridae at genus, sometimes family, and may have done the same with damaged specimens. There have been severe inconsistencies within some projects. APEM identify almost all Thyasiridae, without separation of juveniles. Fugro leave *Thyasira* and *Parathyasira* at Family below 2mm. All labs correctly identified RT6125, but problems remain for other species in the family that may require discussion.

7.8.21 *Galeommatida*

Basterotiidae (RT6112). The draft TDP suggests species identifications for Basterotiidae (there are 2 UK species; one restricted to deep offshore waters but confusion with other families is possible), without separation of juveniles, as currently done at APEM. Most labs correctly identified RT6112. *Saxicavella jeffreysi* may be commensal with the echiuran *Maxmuelleria lankesteri* (see Oliver, 2013) and an indicator of habitats of conservation importance.

7.8.22 *Venerida*

Cyrenidae (RT6119). The draft TDP suggests species identifications for the only currently recorded UK cyrenid (a non-native mainly freshwater species that reaches low salinity regions of estuaries), with separation of juveniles (identified at species) at 5mm, as currently done at APEM. Most labs correctly identified RT6119; the alternative names were for fully marine species (in other families) and may not have been a problem in a real sample with more immediate knowledge of provenance.

Arcticidae. Some laboratories may not have separated *Arctica islandica* juveniles. APEM do so at 17mm (Fugro separate at 10mm).

Veneridae. Many laboratories have used 'Veneridae juv.' for all small venerids (e.g. Marinescope; Fugro if below 2mm for *Chamelea*, *Clausinella* and *Venus*) or have had other varying policies. APEM (and Fugro) speciate *Timoclea ovata* at all sizes without separation of juveniles. APEM separate genera for all Veneridae, with separation of juveniles for most, either to species or genus. The UK species once included in *Venerupis* (Tapetinae) 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 separate Tapetinae at Genus below 3mm and speciate as juveniles between 3mm and 10mm; Fugro record them as 'Tapetinae juv.' below 3mm and speciate above without further separation of juveniles. APEM (and Fugro) record 'Dosinia juv.' Below 10mm and speciate above

Mastridae (RT6121). Policies for mastrids have varied widely between laboratories, with some leaving juveniles at family (Fugro record those below 2mm as 'Mastrinae juv.');

others speciate *Lutraria* at a smaller size (adult *Lutraria* size is 10mm at Fugro) than at APEM. The draft TDP flags Mastridae for further work, due to different taxonomic levels currently used for different taxa by different labs, particularly in the recognition of juvenile sizes. APEM identify adults (over 5mm for *Spisula*, as at Fugro, and *Mastra*; over 40mm for *Lutraria*) to species, with separation of juveniles at 10mm (species level as juvenile at 5-10mm). Fugro speciate *Mastra* and *Spisula subtruncata* if over 2mm without separation of adults and juveniles. RT6121 was small but over 10mm and most labs identified it correctly. More discussion will be needed to establish juvenile policies for this family.

7.8.23 *Cardiida*

Some other laboratories have left all perceived **Cardiidae** juveniles (some juvenile *Parvicardium* records have been adult) at family (Fugro record 'Cardiidae juv.' Below 1mm, except *Laevicardium*, which they speciate at all sizes without separation of adults and juveniles); sometimes superfamily (there is only one living family in Cardioidea; use of superfamilies usually results from their being the main key unit in Tebble, 1956). APEM speciate *Parvicardium* and *Papillocardium* (without separation of juveniles) and, usually, other cardiid genera with segregation of juveniles. Fugro record *Acanthocardia* and *Cerastoderma* at Genus as juveniles between 1mm and 5mm. APEM separate *Acanthocardia* and *Laevicardium* juveniles at 10mm (Genus for *Acanthocardia*). APEM (and Fugro) separate juvenile *Cerastoderma* below 5mm, speciated at APEM (Genus at Fugro). More work is needed.

Semelidae. Many laboratories have left juvenile *Abra* at genus (e.g. Fugro if <3mm; Marinescope, if <2mm), sometimes family or superfamily, and may have done the same with damaged specimens. More work is needed. APEM identify almost all *Abra*, without separation of juveniles. Laboratories have also varied in separation of *Scrobicularia plana* juveniles. APEM separate them at 10mm.

Many laboratories have left juvenile **Tellinidae** at genus, sometimes family (*Angulus* and *Fabulina* below 1mm at Fugro; below 3mm at Ocean Ecology) or superfamily, and may have done the same with damaged specimens. More work is needed. APEM identify almost all to species, without separation of juveniles (except *Arcopagia*). Marinescope occasionally leave small tellinids at family.

Psammobiidae (RT6117). The draft TDP suggests species identifications for psammobiids (all are *Gari* in UK waters), with separation of juveniles (identified at species level) at 5mm, as currently done at APEM. Fugro leave juveniles at Genus below 5mm. Most labs correctly identified RT6117 and nearly all identified the genus, although it was very small. However, more discussion may be needed to establish juvenile policies for this family.

7.8.24 *Myida*

Many laboratories have left juvenile **Myidae** at genus, sometimes family. APEM speciate all Myidae (with separation of adult and juvenile *Mya* at 10mm). Fugro also separate juvenile *Mya* below 10mm but leave at Genus.

Piddocks, **Pholadidae**, are significant in chalk samples. APEM (and Fugro) record 'Pholadidae juv.' Below 5mm. APEM speciate pholadids as juveniles between 5mm and 10mm. Fugro record *Barnea* at genus (juv.) for these sizes.

7.8.25 *Adapedonta*

Some laboratories have used 'Pharidae' for juveniles and speciation size has been variable (below 1mm at Fugro). Others have used 'Solenacea'. More work is needed. Juvenile Pharidae are divided between *Ensis* juv., *Pharus legumen* (divided between adults and juveniles at 40mm) and *Phaxas pellucidus* (without separation of juveniles) at APEM. Fugro record *Pharus* and *Phaxas* at species if over 1mm, without separation of juveniles, with '*Ensis* juv.' Between 1mm and 10mm.

Solenidae is now a taxonomic error for pharids – all but *Solen*.

7.8.26 *Anomalodesmata*

Periplomatidae. Some laboratories have kept adult and juvenile *Cochlodesma praetenu* together. Others have included juveniles in 'Thracioidea juv.' (Fugro, if below 3mm). APEM separate *Cochlodesma praetenu* into adults and juveniles at 5mm. Fugro speciate without separation of juveniles above 3mm.

Thraciidae. Some laboratories have kept adult and juvenile *Thracia* together and speciated. Others have included juveniles in 'Thracioidea juv.' (Fugro, if below 3mm). APEM separate *Thracia* into adults and juveniles at 10mm (Fugro record '*Thracia* juv.' Between 3mm and 5mm), with most juveniles left at genus.

APEM (and Fugro) separate juvenile **Cuspidariidae** at Genus below 5mm. Fugro also separate at Family below 2mm.

7.8.27 *Cephalopoda*

APEM (and Fugro) identify to species, where possible.

7.9 Bryozoa

There have been many differences in bryozoan policy between laboratories and some have formerly ignored them. There are eight families highlighted for further work. APEM leave some genera (*Aetea*, *Cellaria*, *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 technically a taxonomic error. Fugro, Marinescope and Thomson Ecology try to speciate all Bryozoa. Hebog leave at *Schizomavella*, *Scruparia* and *Cellaria* at Genus. Fugro may biomass some, if requested.

Nolellidae (RT6306). The previous draft TDP suggested genus level identifications for nolellids. This reflected current APEM policy for *Nolella* but was an oversight for *Anguinella*, which is identified at species level; all recorded as presence/absence. Most labs correctly identified RT6306 but several identified as unrelated species, often in different phyla; this was probably due to general unfamiliarity with epifauna, suggesting no need for change.

Eucrateidae (RT6314). The draft TDP suggests species level identifications for Eucrateidae (one species in UK waters), to be recorded as presence/absence, as currently done at APEM. All labs correctly identified RT6314, suggesting no need for change.

7.10 Echinodermata

7.10.1 *Crinoidea*

Identify to species. Separate juveniles, at Order (Thomson Ecology suggest Class), if <2mm.

7.10.2 Ophiuroidea

There have been many variations between laboratories for ophiuroids. APEM separate juveniles, with or without reduced resolution but always at least to family; there are no 'Ophiuroidea' records. Thomson Ecology (and Fugro) use 'Ophiuroidea juv.' where the disc is less than 1 mm in diameter; Thomson Ecology identify larger specimens to species, genus or family without qualifier.

Amphiuridae. APEM (and Fugro) record juvenile amphiurids <3mm (other than *Amphipholis squamatus*, which do not grow large) at Family. Thomson Ecology have suggested that, "where identification to family, genus or species is possible, there should not be a juvenile qualifier: otherwise for projects with many small ophiuroids there will often be two lines, for example Amphiuridae juv. and Amphiuridae (fragments or badly damaged individuals) which usually will end up being merged anyway; Juv should only be added to smallest individuals, which due to their size have to be left at higher level". APEM assign fragments to species, unless no comparative material is available.

Ophiotrichidae (RT6103). The draft TDP suggests species identifications for ophiotrichids, with separation of juveniles (identified at species level) at 3mm, as currently done at APEM. All labs correctly identified the circulated specimen. However, most consistency problems with echinoderms are for juveniles and more discussion may be needed to standardise policies.

Ophiuridae. APEM (and Fugro) record juveniles <3mm at family.

7.10.3 Asteroidea

APEM (and Fugro and Ocean Ecology) identify to species and separate juveniles, at Class, if <5mm (total diameter).

7.10.4 Echinoidea

There have been variations between laboratories for echinoids. APEM separate Echinoidea juveniles (other than *Echinocyamus pusillus*, which do not grow large), with or without reduced resolution. At APEM (and Fugro), the smallest (below 10mm) are recorded at order level (Spatangoida, Camarodonta). Fugro record '*Echinocardium juv.*' Between 5mm and 10mm. Thomson Ecology leave some at Class and use the infraorder, Echinoidea, for Camarodonta. Fugro use 'Echinoidea Type A' for a distinctive small taxon (within 'Camarodonta juv.', at APEM).

7.10.5 Holothurioidea

There have been many variations between laboratories for holothurians. APEM divided holothurians (other than Synaptidae) between adults and juveniles, with reduced resolutions for juvenile Dendrochirotida. Thomson Ecology leave some juveniles at Class.

Cucumariidae (RT6321). The draft TDP suggests species identifications for cucumariids, with separation of juveniles (identified at order level: Dendrochirotida) at 10mm, as currently done at APEM (and Fugro, though they use 'Cucumariidae', as formerly done at APEM). Most labs correctly identified RT6321, which was small but over 10mm, suggesting no need for change. However, most consistency problems with echinoderms are for juveniles and more discussion may be needed to standardise policies.

APEM speciate most **Synaptidae**, without separation of juveniles.

7.11 Chordata

7.11.1 Ascidiacea

Different laboratories have used a wide variety of formats for Ascidiacea, at higher or lower levels. APEM leave most Didemnidae at Family but speciate most other ascidians, other than *Molgula* or many colonial spp., over 5mm (below which they are 'Ascidiacea juv.'). Thomson Ecology (and Fugro)

identify to species where possible and do not separate juveniles. Most laboratories (e.g. APEM, Fugro) record encrusting and stolonal species as 'present' and count solitary spp.

7.11.2 Leptocardii (Cephalochordata)

APEM (and Fugro) identify to species, without separation of adults and juveniles. Fugro exclude from biomass.

7.11.3 Vertebrata

Fish (the term Pisces represents a paraphyletic group and is best avoided; most of those found in samples belong to **Teleostei**) are not a major component of benthic samples and have sometimes been dismissed. Most are too large and active to be captured by grabs or cores. There are, however, several species (e.g., some Gobiidae and Ammodytidae) that are closely associated with the seabed and regularly recorded in benthic surveys, where the data may be useful where fish surveys are lacking. The TDP recommends recording them all (as at APEM and Fugro, though Fugro exclude from biomass), although most are unlikely to be found. Fish eggs should also be recorded and counted.

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