THE POTENTIAL VALUE OF MARINE MACROFAUNAL SPECIES DATA

by

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Abstract

The philosophy of data in science has been a matter of debate for many centuries. A theory-led view of data would suggest that data are only of use for an original stated purpose. I propose that this view would be falsified if a single alternative use were to be found for data and further suggest that the greater part of the value of data may lie beyond its original stated purpose.

Benthic marine macrofauna data are collected from a large number of samples each year mainly to monitor human impacts. The data have diverse origins, sampling methods and usages. These are reviewed for surveys from the outer Thames region and the ultimate use of data is discussed. A taxonomy of data attributes is suggested. An equivalent classification is provided for attributes of marine species and the nature of the British marine fauna is reviewed in terms of these attributes, along with a thorough revision of the attributes of the prawn *Palaemon longirostris*. The comparability and quality considerations of benthic data are discussed using data from the NMBAQC Scheme. Data from Harwich Haven Authority surveys, designed to assess the impacts of port activities, are used to obtain information on the species recorded, which represents additional use of the data beyond the stated purpose. It is suggested that all data be considered in terms of their full potential use, in addition to their applicability to a stated aim.

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Contents

1. Chapter 1. General introduction

1.1 Prologue

For many years, I have worked with samples collected from the seashore or seabed for the identification and enumeration of their biota. Before this, my interest in marine life had grown, in part, through exploration of rockpools and collecting seashells. I came to learn that a collection is of scientific value only when well curated: that the locality data, date of collection and notes on the type of shore should be carefully retained with each specimen. This advice was available even in basic seashell books (McMillan, 1968). Specimens collected for professional research would, naturally, require yet more careful curation.

Later, as an undergraduate, I learned that a few of the staff and students worked part time in a small laboratory, where samples were analysed from environmental surveys. On a visit to this laboratory, I asked if they could spare any of the shells. This, they kindly did, as the empty shells were not needed for the data project but, when I asked about locality data, it became apparent that the details were not available to the university and that the data from the sample analysis would be unlikely to be used to provide improved knowledge of the species found. It was not an isolated case; over twenty years later, I still work with samples for which there is no direct access to full collection data or precautions to preserve the biological data for posterity. The majority of professionally collected marine samples are less well curated than many amateur shell collections.

1.2 Overview

The reasons for the situation described above are embedded in the culture of data usage, from practical and economic considerations to the philosophy of science and the ways in which we value knowledge. This thesis investigates the diversity of marine invertebrate data and the uses to which they are put. It also explores the value of data and the potential for improved usage.

Of the many potential uses for macrobenthos data, this thesis uses improvements in the knowledge of benthic species as a primary example. Species studies are often

accepted as of value (see Chapter 3). For example, there lives in the Thames estuary, a small worm, *Hypania romijni* (formerly *Alkmaria romijni*), that has received enough attention to have been given an English name: 'tentacled lagoon worm'. It is considered to be of conservation importance and has been designated as 'Nationally Rare' (Sanderson, 1996), later amended to 'Nationally Scarce' (Gilliland & Sanderson, 2000) and assigned protected status in the United Kingdom (Betts, 2001). An understanding of this species' biology and distribution would, therefore, be considered of value and it would be reasonable to design a scientific project to study these attributes. The species is used as an example in the account of data in science (Part 2 of the introduction).

Figure 1.1.1. The 'tentacled lagoon worm' (*Hypania romijni*).

1.2.1 Outline of the thesis

The concept of data, and its place in science, is reviewed in Part 2 of the general introduction. The body of the thesis examines approaches to data in one field: marine benthic macrofauna. A review of the field, with descriptions of past, current and

possible future approaches to data usage, is given in Part 3 of the introduction. Part 4 of the introduction describes the development of the thesis hypothesis and theoretical background. The hypothesis is stated here as:

The greater part of the value of a data unit may lie beyond the stated purpose for which it was originally collected.

Chapter 2 reviews the attributes of data and the ways in which they can be classified, followed by an overview of the diversity of marine benthic macrofaunal data that exist for British waters, with a detailed example for one area. As a parallel exercise, Chapter 3 reviews the attributes of marine species and the ways in which they can be classified, followed by an account of the diversity of marine animals in British waters. Deliberate parallels are drawn between data and species. The nature of data is further explored in Chapter 4, where issues with the applicability of data are addressed, both in terms of their original purpose and potential new uses. Examples of the ways in which existing data might be used to refine our knowledge of marine species are provided in Chapter 5, as a demonstration of the central hypothesis (see below). Finally, the implications of the findings for the progress of benthic ecology and the wider practice of science are treated in Chapter 6.

1.3 Data in the philosophy of science

Approaches to data have been the subject of dispute and changes in practice since before science became accepted as the most appropriate means to study the natural world. The issue has been central to definitions of science and to differences between philosophical schools of thought.

Descriptions of the evolution of science often focus on the interplay between deductive and inductive methods, with further discussion on the reliability of methods and purpose or value. Scientific history is often summarised as a progression from early deductive processes, where facts are derived from authoritative pronouncements, through inductive methods, where truths are extrapolated from observations or data to the hypothetic-deductive method, where a hypothesis is tested

through attempts at falsification, using dedicated data. Sources and uses of data are central to the differences in approach: in inductive research, data (collected without a theoretical bias) lead directly to conclusions whilst, in the hypothetic-deductive method, data are specifically collected as a means to test stated hypotheses. However, the approach to data is not central to criticisms of inductive research and some form of initial data review is generally accepted as essential to theory generation.

Most current interpretations of scientific procedure refer to the hypothetico-deductive method. This usually involves the statement of a specific question, such as 'what are the primary habitat requirements for *Hypania romijni*', followed by the proposition of a hypothesis that would then be subjected to rigorous attempts at falsification, after which the theory would be accepted until a better theory could be found (Popper, 1959). For example, *H. romijni* has been considered to be restricted to lagoonal habitats but is now known to be also found in brackish water in estuaries (Gilliland & Sanderson, 2000). A reasonable hypothesis might be that its distribution is, in part, defined by salinity and substratum type requirements. The proposal could be tested through stratified random sampling to cover a range of salinity and substratum regimes within a defined area (*e.g.* the greater Thames estuary) and repeated in a different area (*e.g.* the Humber estuary). Such a study would be accepted as scientifically valid and could be framed as a component of more general theories, such as prediction of species sediment associations (Compton et al., 2009) or wider theories of ecology, such as heterogeneity of distribution (Scheiner & Willig, 2008).

The scientific relevance of studies such as those summarised above is generally accepted and rarely questioned. They can be regarded as falling within existing research paradigms (Lakatos, 1978), as part of a current 'non-revolutionary' period of 'normal science' (Kuhn, 1962).

The above example implies the collection of data in response to theory proposal (theory-dependent), as stipulated by much current scientific philosophy (Russell, 1946, Quine, 1951, Popper, 1959; Chalmers, 1999). The purpose of the data is to support or reject a pre-defined hypothesis and it is often stated that hypotheses should

ideally be selected before data collection. Efforts to improve the scientific standing of ecology often include increased emphasis on theory (Belovsky *et al*., 2004).

There are, however, problems with the strict falsificationist approach. Much has been written on problems with the meaning of falsifiability and on other philosophical problems (Kuhn, 1962; Lakatos, 1978) and excessive reliance on theory continues to be criticised (Weiner, 1995; Talmont-Kaminski, 1999; Gorard, 2004; Hołyński, 2005).

Model selection (assessment of the probability of competing hypotheses) has recently become a popular alternative in biology (Johnson & Omland, 2004), in particular through Bayesian systems (Cheng *et al*., 1997) and a combination of multiple approaches has been suggested (Stephens *et al*., 2005).

The choices of theories considered worthy of study depend upon the opinions prevalent within the scientific community. While data may be collected with a degree of objectivity, the choice of data collected and the uses to which they are put are based on subjective choice, such that the objectivity of science can be questioned (Latour, 1978; Latour & Woolgar, 1979; Regan *et al*., 2002). The knowledge considered to be most useful and important varies with the needs identified and the people with the most influence at particular times.

Alongside the value of knowledge, it is important to consider the effort needed to obtain it. The cost effectiveness of research is a constant consideration and all organisations that use science must balance the value of knowledge against the effort (cost) of obtaining it (Ferraro *et al*., 1989; Kingston & Riddle, 1989).

A major issue considered here is the impact of current approaches to the treatment of data upon their management and value. Whilst theory-led research has produced many important scientific developments (Chalmers, 1999), I believe that it has also had negative consequences, which will be identified through the course of this thesis, exemplified through the study of marine biological data, due to the way that data have been valued only as far as their relevance to a pre-defined theory. Evidence for the

implicit acceptance of this 'single-purpose' concept of data in benthic ecology can be seen in the lack of a coherent curation system for macroinvertebrate data in the United Kingdom, despite recent efforts to redress the problem, the consequent loss of several data sets (to be further explored in Chapter 3) and in continued efforts to reduce data to the minimum required for a stated single purpose, such as through the promotion of so-called taxonomic sufficiency (Warwick, 1988), the consequences of which are discussed in Chapter 6.

In spite of the above approach, data collected for one purpose (hypothesis) have been found to be valuable in the development of other, sometimes unrelated, ideas. It has been recognised that much biological record data already exists, originally collected for other purposes, which can be used in ecological studies (Par & Cummings, 2005; Costello & Vanden Berghe, 2006; Jones *et al*., 2006; Carollo *et al*., 2009).

Data from marine invertebrate samples have been collated for potential uses beyond their originally stated hypotheses as part of an international project (Somerfield *et al*., 2009b, Vanden Berghe *et al*., 2009) and used to test several general principles of ecological theory (Arvanitidis *et al*., 2009, Escaravage *et al*., 2009, Grémare *et al*., 2009, Renaud *et al*., 2009, Somerfield *et al*., 2009a, Webb *et al*., 2009). There are several other marine invertebrate data collation programmes, extant and completed, operating at national, local and project-specific levels, which aim to provide baseline information for purposes beyond those originally stated for the original data collation. This thesis aims to demonstrate that such data might also be used to study the attributes of multiple species.

The application of previously collected (non-dedicated) data to alternative studies raises questions about the nature of data. Given the many issues with theory-led research, it is reasonable to ask whether knowledge is always best gained through the bespoke collection of data for targeted application to the specific question at hand or whether the data themselves might be considered of wider value and applicable to multiple hypotheses, both extant and yet to be considered.

The original ‘scientific method’ (Bacon, 1620) treated theory as data-dependent and many later developments retained this empiricist basis of scientific growth (Berkeley, 1710; Hume, 1740, 1777; Locke, 1700). Empiricist concepts would provide a suitable framework for the application of data to multiple purposes to be considered of intrinsic value and part of scientific advancement through the steady acquisition of objective data and information and such approaches are still acknowledged to be of some value (Grimaldi & Engel, 2007).

Some recent developments in knowledge management have progressed along apparently empiricist lines. Data mining theory has been developed as a tool to identify both new insights and predictive models from data (Kohavi, 2000). The ‘knowledge hierarchy’ or ‘DIKW’ pyramid (Ackoff, 1989), in which ‘data’ are processed as ‘information’, which in turn aid ‘knowledge’ and, ultimately, lead to ‘wisdom’, has become a widely-recognised model in knowledge literature (Rowley, 2007), and efforts have been made to formalise the concepts (Zins, 2007).

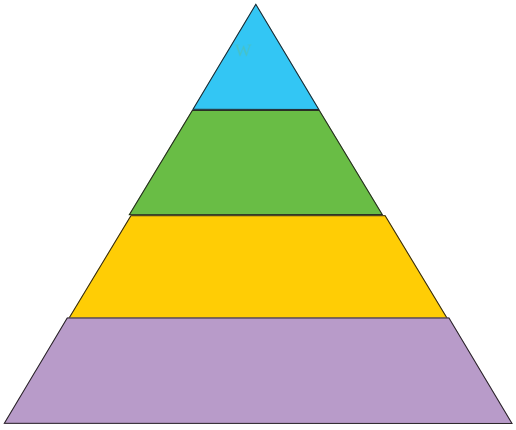


Figure 1.2.1. DIKW pyramid (adapted from Rowley, 2007).

In the DIKW system, a data unit is the most basic component of information; data are symbols that represent properties of objects, events and their environments (Ackoff, 1989). Empirical knowledge and wisdom are based on data in one form or another. Information comprises answers to basic, ‘who’, ‘what’, ‘where’ and ‘when’ questions. A piece of information has been defined as the smallest amount of data needed to update the probability distribution of a hypothesis within a database of hypotheses (Roberts & Eliassi-Rad, 2006). Knowledge relates to ‘how’ questions. Wisdom can

be defined as an evaluated understanding of knowledge, although popular understanding of the concept may be wider than this and discussions are published with only limited reference to information or knowledge (McKenna et al., 2007). There are several variations; some models display the process as a loop or iterative process in which wisdom informs the data collected in new phases. The DIKW hierarchy is usually discussed in terms of the increased value from data through to wisdom and the model implies that each layer of sophistication is dependent upon the lower levels. The whole hierarchy is dependent upon data and information has been defined in terms of its dependence upon data (Allo, 2008), whereas data stand alone, regardless of the use that may be made of them.

Marine macrofaunal data comprise basic field or sample records, as detailed in Chapter 3. Information would include details of species distribution, habitat preference, diversity, abundance or community classification (Chapter 2). Knowledge would equate to the formulation of broader theories and concepts from available information and wisdom, as defined, here, would involve recommendations for the useful application of knowledge, as well as insight into its meaning (Chapter 6). For example, data from a biological survey might be summarised as a series of statistical indices (information), compared with previous data to identify evidence of anthropogenic change (knowledge) and used to inform a mitigation policy (wisdom). This thesis is primarily concerned with the production and application of data to generate information. However, links through to wisdom are essential if we are to ascribe value to data. It is possible to define 'value' (see Part 4) in terms of the potential for data to lead to wisdom.

Despite the apparent success of data collation projects (described above and in Chapter 2), the collection of data in the hope that it may later be promoted to information has been criticised, partly through its association with inductive logic (Frické, 2009). The poem that opens Choruses from 'The Rock' (T.S. Elliott, 1934) includes lines that carry the reverse implication that wisdom might be drowned out by information:

> Where is the wisdom we have lost in knowledge?

Where is the knowledge we have lost in information?

This poem is cited in many discussions on the science of information (Gleick, 2012). The systematic collection of information, such as habitat requirements for the numerous benthic invertebrate species, might be dismissed as poor science, as "science does not progress through the collection of facts" (Chalmers, 1999). Such methods are compared to the 'discredited' inductivist or naive-empiricist methods that characterised earlier periods of scientific development and many important scientists have attacked such approaches:

"I have little patience with scientists who take a board of wood, look for its thinnest part, and drill a great number of holes where drilling is easy" (Albert Einstein, quoted by Philipp Frank in "Einstein's Philosophy of Science," Reviews of Modern Physics, 21(3), July 1949).

… the belief that we can start with pure observations alone, without anything in the nature of a theory is absurd; as may be illustrated by the story of the man who dedicated his life to natural science, wrote down everything he could observe, and bequeathed his priceless collection of observations to the Royal Society to be used as inductive evidence. This story should show us that though beetles may profitably be collected, observations may not (Popper, 1963, *p.46*).

Important statistical problems have been identified with the repeated analysis of existing data (Austin & Goldwasser, 2008) and issues with interpretation of results must be carefully addressed in all research. However, much criticism of data-driven research is ideological, as with Frické's (2009) reference to 'uninspired methodology', and makes reference to Popper's (1959) definitions of scientific method.

Such concerns could potentially be tested as falsifiable hypotheses themselves.

For example, degrees of 'inspiration' offered by different approaches could potentially be subjected to historical analysis, through a study of the origins of ideas. Questions around the origins of theory generation in science (problem solving or responses to data/sensory input) are ultimately connected with questions about the origins of biological learning, for which there is an extensive literature (Kehoe, 1998, Skinner, 1953, Thorndike, 1898).

Popper's (1963) statement that '*though beetles may profitably be collected, observations may not'* provides a testable hypothesis that would predict that data are of use only in the development of a previously stated theory.

1.4 'Wisdom' - the concept of value as applied to data or knowledge

To falsify or prove any statement requires definitions of terms and statements of criteria for testing. Of the terms used here, the most difficult to define is the concept of value, which is discussed further in Chapter 6. Value is interpreted in different ways by different people but there are two main ways in which it is commonly viewed:

- In terms of direct benefit to humanity
- In terms of gain of fundamental knowledge.

Both of these concepts are to some extent subjective but there may be ways in which we can identify measureable components. They relate to practical and theoretical values introduced in the opening paragraph.

Practical or human value is often considered to be the most important consideration in science and failure to adequately address value to humanity has been a source of criticism of science in general. It will always be difficult to define practical values as needs change with time and are seen differently be different people. However, it is be possible to consider past and current uses and predict some possible future concerns.

Theoretical value can be regarded as a measure of how far a theory, and the data used to support it, reaches towards an ultimate aim of a single unifying theory (Chalmers, 1999).

It is possible to give a qualitative (presence/absence) assessment of the value of different units of information or knowledge and that approach has been used in the development of this thesis.

1.5 Data use in studies of marine benthic macrofauna

Many thousands of marine benthic macrofaunal records are collected each year, for a variety of initial purposes. Most remain unpublished and underused. Meanwhile, biological traits, distribution, rarity and ecological requirements (hereafter, collectively called 'taxon attributes') remain poorly-known for the majority of species. Most published information on species ecology is currently limited and derived without full consultation of the existing data. The application of data collected for other purposes to increase our knowledge of species characteristics is the example used in this thesis to demonstrate the wider value of data.

Costello & Vanden Berghe (2006) made a series of predictions for the use of 'ocean biodiversity informatics (OBI)', i.e. collation of existing data.

(i) All marine macrofaunal data can be fitted into a framework to allow maximum efficiency of knowledge acquisition for a species and reveal information beyond the original purpose of the data.

(ii) The basic characteristics of species (taxonomic, ecological and physical) can be summarised and truncated in a tabular form suitable for numerical analyses.

(iii) *Knowledge of the basic characteristics of species will be significantly increased by the use of data originally collected for other purposes*."

On-line data collation projects, such as MBA Gateway and DASSH, already provide a useful resource for workers in marine ecology and their importance is likely to increase. It is important that the value and limitations of the available data are assessed and that recommendations be made to correct any shortfalls, as well as to standardise the collection of the data itself. Marine indicator development and strategic planning will be greatly aided by the efficient use of existing data and a sound knowledge of species ecology.

1.6 Development of the hypothesis

The hypothesis of this thesis has been developed, initially, as a response to the observations on data use in benthic ecology summarised above. I believed that data collected for an original stated purpose, such as ecological impact assessment, had valuable potential for use in other areas, such as the refinement of species distributions. It was also possible that greater knowledge of species distributions (for example) could potentially redefine the original purpose through (for example) a change in the focus of which species or habitats should be monitored. The requirement to reduce costs by restricting the scope of a study to the minimum necessary to answer a question raised questions about wider efficiency. It is cheaper to lay one cable than two but most are familiar with the idea that efficiency would be improved by a plan to lay two in one excavation, if there is a strong likelihood that both will eventually be needed. There are parallels with data use in science, whereby a slight increase in the cost of collecting a little more data may be outweighed by a proportionately greater increase in the value derived from the data (Fig. 1.5.1):

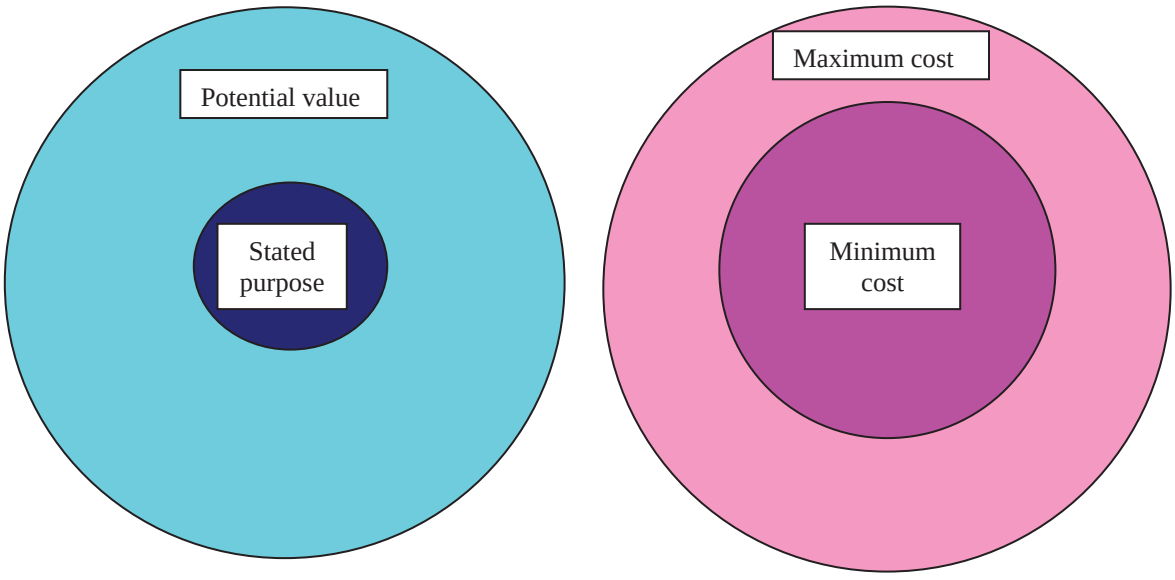


Figure 1.5.1. Heuristic model of the relationship between purpose, value and cost.

In Part 2 of the introduction, the place of data in the growth of knowledge and understanding was represented as a pyramid (Fig. 1.2.1) to illustrate how data are condensed to provide information, which is then further refined as knowledge and eventual wisdom.

My thesis considers the value of a data unit to be related to its:

1 accuracy,

2 precision,

3 connectivity to other data and

4 the sum total of potential uses to which it may be put.

The last two points counter the theory that data are valued only for their applicability to a specific purpose, for which they are stated to have been collected (*i.e.* the view of data deduced from Popper's viewpoint). They are also relevant to ideas developed through network theory (Dunne *et al.*, 2004; Bounsaythip *et al.*, 2005; Proulx *et al.*, 2005).

As part of the development of my thesis, a body of data, however generated, is considered to have the potential to inform multiple hypotheses (Fig. 1.5.2).

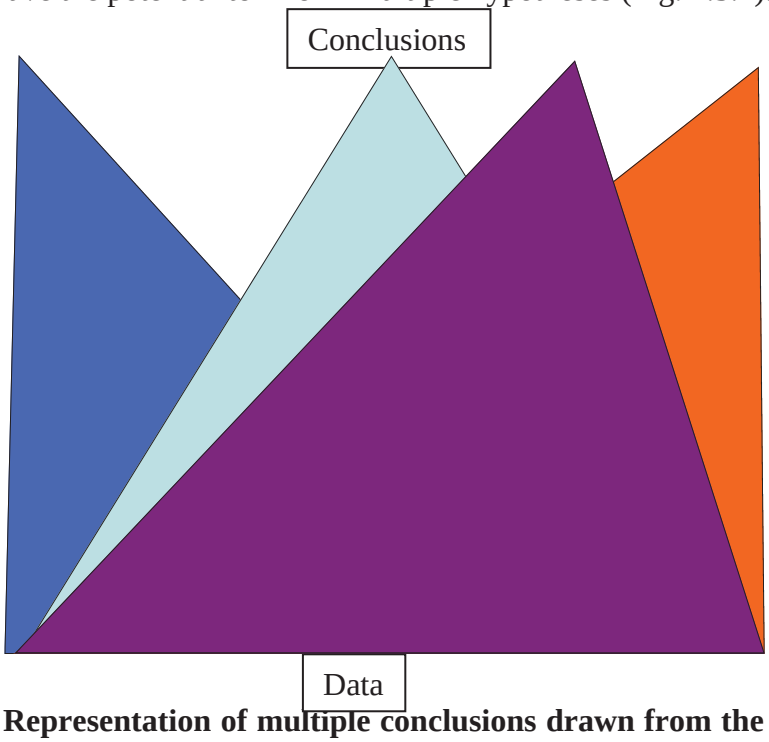


Figure 1.5.2. Representation of multiple conclusions drawn from the same body of data.

The implication is that data may be considered suitable for uses not originally considered when they were collected, which could be considered as a return to inductive reasoning. Criticism of the naive empiricist approach to data has often been made in the same context as dismissal of inductive methods. These, as well as some

practical and ideological concerns were raised in Part 2, which concluded with the suggestion that Popper's (1963) statement that *'though beetles may profitably be collected, observations may not'* provides a testable hypothesis that would predict that data are of use only in the development of a previously stated theory. The present thesis presents a contrasting hypothesis that can be written as:

The greater part of the value of a data unit may lie beyond the stated purpose for which it was originally collected.

or:

The original hypothesis for which data are collected may not be the most important ultimate use for the data.

1.7 Aims of the thesis

The primary aim of this thesis is to demonstrate how selected attributes (broadly defined here as any information that can be ascribed, in this case to species) can be assigned to marine benthic macrofaunal (mid-sized animals living on the seabed) species using data originally collected for a variety of other purposes. Thus the attribute 'associated with subtidal estuarine biotopes' might be assigned to (e.g.) the worm *Hypania romijni*) from data collated from surveys of the Thames, when the original survey objective concerned only the potential impacts of construction. The exercise also leads to questions about scientific method and the meaning of data, as well as the need to clarify the value of attribute information.

The objectives of this thesis are:

(i) to identify procedures for use in the assignment of attributes and
(ii) to demonstrate that existing data can provide information more efficiently than targeted research alone.

The following questions will be considered. To what extent can existing macrofaunal data be adapted to optimise potential use beyond their original purpose? More

specifically, to what extent can basic species characteristics (taxonomic, ecological and physical) be derived from existing data, be summarised and be applied to current questions in marine ecology?

2. Chapter 2. Attributes of marine benthic macrofaunal data

2.1 Introduction

In order to assess the value of data in terms of their original purpose and potential additional uses, it is necessary to review the nature of the data. The purpose of this chapter is to define the concept of data and review the properties associated with data. This is done in general terms and with respect to the example used for this thesis: marine benthic macrofaunal data.

2.1.1 The concept of data

An extensive literature exists for information theory and the nature of data in philosophical and computing technology contexts, with links to wider scientific theory. A useful recent review (Gleick, 2011) includes a history of our creation and management of data.

2.1.2 Marine benthic macrofaunal data

The focus of this study is on data that include species records for marine benthic macrofauna from British waters. The definitions of the above terms are discussed in Chapter 3 but can be summarised as records of small to medium sized animals from the seabed or shore around the British Isles.

Macrobenthos data comprise, in their simplest form, records of species or other taxa, collected within samples. A sample is typically a physical quantity of material (mud or algae, for example) collected from the environment, which may be qualitative (a nonspecified sample size) or quantitative (containing a known surface area or volume of seabed material). However, a sample may also be a more abstract aggregation of records, such as records of animals seen *in situ* within a particular time period. Samples are generally grouped into surveys. Although a survey may be simple to define where a defined number of samples has been collected from an area during a single cruise on a research vessel, the concept is actually abstract and it is often difficult to decide how to assign surveys to samples (e.g. where a defined set of samples is collected during two separate cruises, due to weather conditions). A series

of samples across time and space can be divided into surveys in many possible ways, depending upon the perceptions of the researchers.

A datum record is a taxon identifier linked to a sample identifier. The record of each taxon in each sample will be represented by a quantity. In less abstract terms, the data are usually represented by a matrix of numbers of several different species in several different samples (Figure 2.1.1).

Taxon name	HHAFEL10 12a 47574	HHAFEL10 12b 47575	HHAFEL10 12c 47576	HHAFEL10 13a 47577	HHAFEL10 13b 47578	HHAFEL10 13c 47579	HHAFEL10 32a 47580	HHAFEL10 32b 47581	HHAFEL10 32c 47582	HHAFEL10 33a 47583	HHAFEL10 33b 47584	HHAFEL10 33c 47585
Aphelochaeta "species A"	-	-	-	-	-	-	-	-	-	-	-	-
Aphelochaeta marioni	2	20	5	13	29	10	16	2	17	62	33	26
Protocirrineris chrysoderma	-	-	-	-	-	-	-	-	-	-	-	-
Caulleriella alata	-	-	2	2	-	-	-	-	-	-	-	-
Caulleriella viridis	-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone gibber	-	-	-	-	-	-	-	-	-	-	-	-
Chaetozone zetlandica	35	80	28	78	68	58	-	1	-	5	-	49
Cirratulus (juv)	-	-	-	-	-	-	-	-	-	-	-	-
Cirriformia (juv)	1	1	-	-	-	-	-	-	-	-	-	-
Cirriformia tentaculata	-	-	-	-	-	-	-	-	-	-	-	-
Dodecaceria	-	-	-	-	-	-	-	-	-	1	-	-
Tharyx "species A"	-	-	-	-	1	-	2	3	7	P	1	6
Tharyx killariensis	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.1.1. An example of part of a macrobenthos data matrix.

Table 2.1.1 represents a selection of records from a macrobenthos survey near Felixstowe, Suffolk. Samples are represented by codes in the uppermost row of the table. Taxa are listed in the left hand column. Counts per sample are shown in the body of the table. For example, in Sample HHAFEL10 12b 47575, the analyst counted 20 *Aphelochaeta marioni* and 80 *Chaetozone zetlandica*. The records come from a real data matrix, in this case showing only members of the polychaete worm family Cirratulidae.

Both the taxon and sample identifiers (names or codes) act as links to other information. Sample codes link to abiotic information. The samples in the above example are shown with codes in three parts. They were all collected as part of a single survey coded HHAFEL10, with sample and replicate numbers (12b), as well as numerical codes (e.g. 47575), for use within a particular database. Further information can be derived from these codes, as discussed below. Taxon names (or codes) link to biological information. The taxa listed in the above example are all segmented worms belonging to a single family (Cirratulidae), mostly identified at the species level; taxon names, and the information they contain, are discussed in Chapter 3. The final component of the data, the quantity, also has some intrinsic complexity. Different degrees of count accuracy and precision (count – 20, 80, abundance scale or presence/absence – P/-) are discussed in Chapter 4.

Marine benthic macrofauna data are collected for different initial purposes by different individuals and organisations. A variety of sampling methods may be used and the data take many forms in terms of their content and means of output. In addition, a great variety of associated data may or may not accompany the biological data. It is necessary to review these different data parameters to allow them to be classified for the purposes of further analysis.

2.2 The attributes of data

The primary data under investigation (macrofaunal data in the example used above and for this thesis in general) are here defined as ‘subject data’. The term ‘metadata’, defined by the Data Archive for Seabed Species and Habitats (DASSH) as ‘data about data’ is often used to describe data that are associated with the subject but do not form an integral part of it. It is an imprecise term, as some information, such as sampling position coordinates, could be considered so essential that they are almost part of the subject data, while data from a separate survey on another subject (such as hydrography) are not directly associated but may be used with the subject data, as if they were metadata. I avoid direct reference to metadata in this thesis. Any descriptor that can be applied to data in the broadest sense is here defined as an

'attribute' of data. This section summarises the attributes of benthic data, and proposes a taxonomy.

As an introduction, it is convenient to begin with the origins of data, from the original sources (organisations involved) and stated purposes, followed by the processes involved in producing results (sampling and processing methods), quality and quality control, associated data and, finally, the format of final outputs (data storage, presentation, reports etc.).

2.2.1 Sources of data

In simple terms, the source of data is the organisation or individual that provides the data. The process of data production can be broadly divided into three elements: instigation, fieldwork and laboratory work.

2.2.1.1 Instigation

The instigation component is particularly complex but probably the least thoroughly researched in the scientific literature. Research data may be derived from an experimental design by a researcher at an institution, who can be said to have instigated the data collection and may also have collected and analysed the samples and may, on occasion, also own the data. However, commercial samples in particular may have a more complex hierarchy of responsibility. Sampling may be commissioned by an organisation (which would officially own the data), involved in a potential environmental impact assessment but the collection of the samples is most likely to have been stipulated by a statutory body. Costello & Vanden Berghe (2006) state that most sampling is ultimately of government origin. This is only true in the sense of government stipulation.

Ultimately, government bodies request data in response to laws, statutes or directives that may operate at local, national or international levels. The United Kingdom is a signatory to several international conventions on conservation and pollution management. The British government is also subject to European directives. Most of these directives are met through the provisions of UK law. There are also several national laws. All of the above may have local implementations and there are also

local bylaws and council directives that require environmental considerations to be resolved, sometimes through the production of data.

In the United Kingdom, several government and non-governmental organisations are responsible for advice on compliance with the above directives, which may involve calls for data, as well as specifications for survey design and data quality. Their names and responsibilities have not been consistent over time. Consents for marine works are currently (since 2010) the responsibility of the Marine Management Organisation (MMO) in the coastal waters of England and Wales. Larger operations, such as large power generation projects, however, are under the direct management of the Department for Environment, Food and Rural Affairs (DEFRA). These organisations are advised by bodies with expertise with respect to particular directives or sectors of industry. The semi-commercial Centre for Fisheries and Aquaculture Science (CEFAS), derived from the Ministry of Agriculture Fisheries and Food (MAFF) is an official adviser to DEFRA, particularly for offshore projects and the aggregates and fisheries industries. Fisheries are also considered by the regional Inshore Fisheries and Conservation Authorities (IFCAs), which were established in 2011 to replace the former Sea Fisheries Committees. The national conservation agencies, with the Joint Nature Conservation Committee (JNCC), derived from the Nature Conservancy Council (NCC), as an overarching organisation, and they advise on conservation matters. In England, the statutory conservation body is Natural England (formerly English Nature). The Environment Agency (EA), derived from the National Rivers Authority (NRA), is the principal advisor on pollution-related issues, as well as more general habitat preservation concerns. Other organisations operate in Scotland, Wales and Northern Ireland. In addition, much of the shallow seabed around the UK is owned by the Crown Estate or, occasionally, by other private bodies.

The above organisations may commission survey projects directly, as well as present requirements for others to do so. Several major national benthic macrofauna survey programmes have been carried out on behalf of government agencies. These include the Marine Nature Conservation Review (NMCR) conducted for the JNCC in the late 1980s and early 1990s in order to assess the biodiversity of the British marine biota,

as well as national monitoring programmes on behalf of the Environment Agency. The National Monitoring Programme (NMP) was initiated in the late 1980s and later transposed to the Clean Seas Environmental Monitoring Programme (CSEMP), while another sampling programme was carried out in compliance with the Water Framework Directive (WFD).

Much of the macrofauna data from British seas is collected on behalf of commercial companies and other organisations that were required to produce data by statutory bodies in order to demonstrate that their activities would not cause unacceptable damage to the marine environment. These organisations may be classified according to the sector of industry that they represent. The principal sectors are:

- oil and gas extraction,
- renewable energy,
- aggregate extraction,
- port development,
- other foreshore developments,
- fisheries.

Many companies, consortia and authorities have commissioned data and they cannot all be reviewed here in detail. Some sectors are considered later in more detail in relation to the purposes of data collection.

Some of the types of organization that produce data are illustrated in the following diagram.

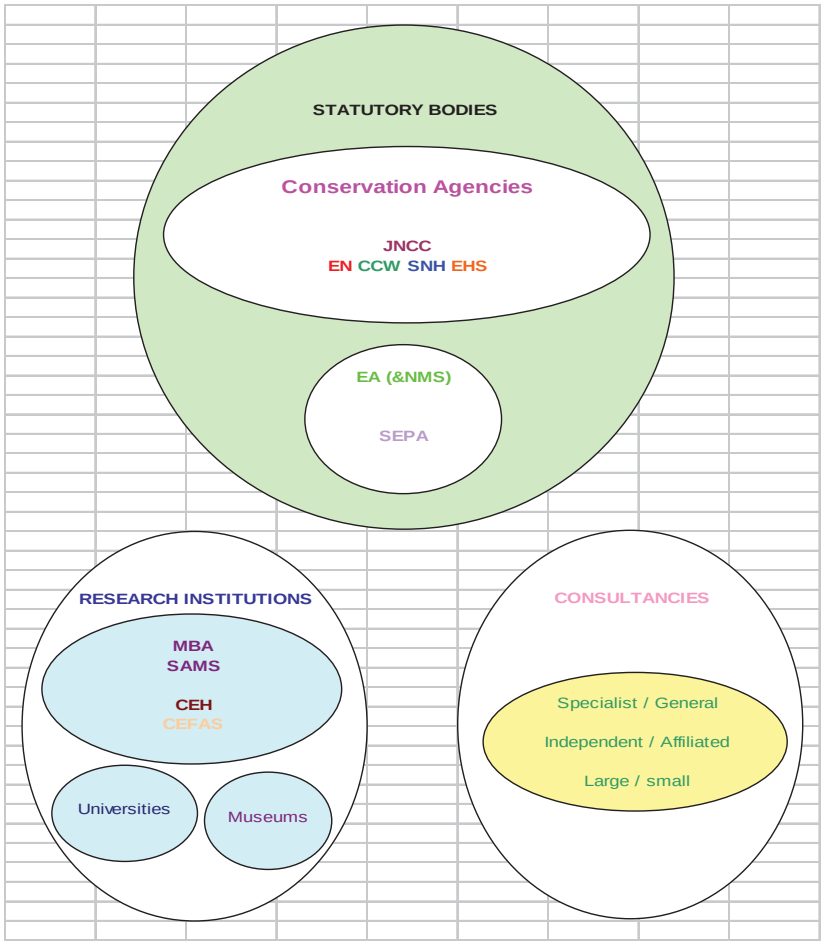


Figure 2.2.1. Representation of sectors and example organisations involved in the instigation of marine macrofaunal data.

The original example (Table 2.1.1) shows data from the Felixstowe area that were collected on behalf of Harwich Haven Authority (HHA). The data requirements were established through a committee of regulators that comprised representatives from CEFAS, the EA, Natural England, Eastern IFCA, the MMO, the RSPB and Suffolk County Council. Reports are circulated to the regulators for review and comments are presented at annual regulators' meetings. The ultimate aim of the process is to ensure compliance with the directives that regulate port development.

The data above illustrate the complexity of the concept of data source. They are considered the property of HHA, which could be regarded as the source of the data, but the influence of regulatory bodies would need to be acknowledged; this potentially represents an additional attribute: stipulation of the data. There may also be a hierarchy of sources between the commissioning and fieldwork stages. An

organisation may be required to produce data by regulations enforced by a consortium of regulatory bodies and then commission a survey from an environmental consultancy. There are several large consultancies in the UK, some of which are branches of multinational corporations. Many do not actually produce data but subcontract smaller companies to carry out different phases of the process and then compile the data, or analyses, into reports. In relation to the above example, many surveys for HHA are commissioned by their consultants: Royal Haskoning (formerly Posford Duvivier and Posford Haskoning). Some subcontracting consultancies are relatively small companies that give responsibility for large sections of the work to others. There may be two or three consultancies in a chain of responsibility for a survey, in addition to the organisation required to commission it by the legislation and regulators.

2.2.1.2 Fieldwork

The actual methods used in fieldwork are discussed below. In terms of data sources, the basic attribute is the person who carried out the fieldwork. For most commercial data, surveys are organised by a consultancy. The government regulatory bodies often complete their own surveys but may subcontract some of them or certain aspects of the work. There may be a distinction between different elements. If a boat is required, the operation of the vessel may be the responsibility of different organisation to the operation of the survey equipment or the preparation of the samples. For the HHA example, the vessel was actually operated by HHA staff, including the position fixing and remote operation of the survey equipment (a Day grab). However, the grab was emptied and the samples prepared by staff from Unicomarine.

2.2.1.3 Laboratory work

As with fieldwork, attributes related to who carried out the laboratory work are distinct from the methods used. After a survey, samples are transported to a laboratory for analysis. The process is detailed below but, in summary, samples are sieved and the fauna extracted (picked, or sorted), identified and counted. All of these components are usually, but not always, completed at the same laboratory but different individuals may be involved. The samples in the example were sieved and

picked at Unicomarine by junior staff, with the efficiency of extraction checked by a more experienced staff member. Identification was also carried out by mid-level staff members but with advice and quality assurance from more senior staff. Different individuals were involved for different samples and, while the details are available at the laboratory, the name of the laboratory may be the only information available to later users. Finally, an external laboratory may carry out analytical quality control (AQC) on a proportion of samples. The details of who completed AQC can be considered as part of the source information.

2.2.2 Original purposes of data

The stated purposes of macrofaunal sampling can be classified into two broad groups: (i) studies of the natural environment and (ii) assessment of human impacts. There is much overlap between the two. Impact assessments usually rely upon an initial survey of the existing environment, while more general studies often include a dimension of conservation assessment, with a consideration of possible future impacts.

Impact assessments may be carried out to monitor a variety of human activities. The most important are listed below in approximate order of significance (in terms of survey effort in British waters):

- pollution impact (oil/gas extraction),
- subtidal disturbance associated with development (offshore energy - windfarms),
- pollution impact (sewage discharge),
- gravel extraction,
- foreshore development (buildings),
- aquaculture,
- subtidal disturbance associated with development (dredging near ports),
- subtidal disturbance associated with development (marinas),
- freshwater abstraction,
- fishing / collecting.

The aim of a survey (and its data) is distinct from the source company and sector of industry discussed above. For example, several surveys may be carried out in the vicinity of a port development. When a new development is proposed on the seabed, the developer is required to apply through a consents process, similar to onshore planning proposals. The first survey is usually for the purpose of characterisation and designed to determine whether there are any features (habitats or species) of conservation importance in the area. Later surveys are designed to monitor the impact of the development. There is often one pre-impact monitoring survey (baseline), followed by one or more post-impact surveys.

The example data (Table 2.1.1) were from a series of surveys required to assess the impact of the dredging of part of Harwich Harbour in order to allow a higher capacity of vessel access to the recently redeveloped port of Felixstowe. There had been characterisation and several monitoring surveys, of which HHAFEL10 was one of those carried out post-impact.

2.2.3 The sampling process

Sampling is carried out by people, for a purpose, according to requirements defined by themselves or by other people/organisations and/or legislation. Although the people involved are part of the actual sampling process, these attributes are considered under sources and purposes, above. It is important to note, however, that while the individual people involved with specific samples are often not specified in later outputs of information connected with the samples, they should be considered as attributes (e.g. that person A sieved Sample 123 is an attribute of Sample 123). Other sampling process attributes are considered below.

2.2.3.1 Surveys and sample codes

As discussed above, surveys and samples are essentially abstract concepts. Surveys may be defined at the instigation phase but are only concretised during the sampling process. A survey will usually be given a name and/or code by one of the organisations involved in the hierarchy but this may not be useable by the others and it is not unusual for different codes to be assigned by the field workers and laboratory or even for samples to be divided between surveys in different ways by different

teams. This situation is yet more prevalent with sample codes. Some form of survey identifier is necessary to identify a sample, as a simple number out of context means nothing. In the example above (Table 2.1.1), the code HHAFEL10 was given to the survey but this code is specific to Unicomarine and the project is described in different ways by the other organisations involved. The sample and replicate numbers (12b) were passed on to most of the organisations but would be meaningless without survey information. The laboratory reference code (47575) identifies the sample without a survey code but only if accessed through the database held at Unicomarine. In order to fully cross-reference the sample, it is necessary to name the organisations involved and to translate between the different ways in which they identify the sample.

2.2.3.2 Date and time

One of the most basic data attributes is the sampling date and it is a relatively simple concept. However, the information is sometimes missing from reports and the dates of extensive surveys may be summarised in terms of a time period, rather than individual dates. Dates are important to relate data to temporal changes, which may concern natural and anthropogenic impacts, seasonal changes, or longer term cycles.

Most surveys have a field sampling log that includes not only the date but the time of sampling for successful and failed (e.g. those that collect less than the required amount of sediment) samples. Times may be important to relate data to daylight, weather and tide states, all of which could also be recorded as attributes in their own right.

2.2.3.3 Location and depth

Sampling position is another basic attribute. Traditionally, sampling data comprised the name or description of a collecting site. More recently (since the availability of accurate positioning equipment), position coordinates are expected. The accuracy of position fixing equipment has improved significantly in recent decades to the extent that error margins are more likely to concern the relationship between the record and the actual sample (is the position taken from the vessel or the sampling equipment?).

The technology used and the means of deployment are data attributes, as are the coordinate system and projection recorded.

The sampling depth is usually, but not always, recorded with the data. On the shore, a qualitative assessment of tidal height may be made from observed zonation patterns (see habitat) but height above/below sea level can also be read from GPS equipment. At sea, depths are usually read from a point on the vessel to the seabed, using a variety of equipment. The record will be strongly affected by waves and will also need to be corrected to chart datum, to account for the state of the tide. Some equipment, as used by HHA, measures depth directly with respect to a fixed datum point. More often, corrected depths are calculated from the time and local tide data. Such calculations have varying degrees of accuracy and constitute data attributes. Depths can also be derived from accurate positions and bathymetry data. Absolute (uncorrected) depths may be important to some interpretations of data.

2.2.3.4 Habitat

Habitat notes have long been associated with collection data. It is clearly important to note whether a sample came from a sandy or pebbly substratum and such information can be conveniently considered as data attributes. In strict terms, habitat relates to the abiotic environment and can be divided into basic components: particle size, shape and composition, each of which could be considered an attribute. The biological component of 'habitat' may be defined by its 'biotope', or by a statement of the dominant species in the sample or its vicinity. Some organisms, such as larger plants or reef building animals may be so dominant as to constitute a substratum in their own right.

A sample may come from a described habitat but individual animals will have inhabited separate microhabitats within it. The scale at which a habitat can be said to become a microhabitat is arbitrary and determined by the sample type. The habitat is a description that can be applied to the whole sample, such as 'muddy sandy gravel' (a standard term based on particular percentages of the three components). An animal living on the underside of one of the pieces of gravel effectively belongs to an underboulder microhabitat, within a mixed substratum habitat. The same species

found in a sample taken entirely from beneath a larger stone belongs to an underboulder habitat but may inhabit a crevice microhabitat. On a practical level, microhabitats cannot usually be distinguished for animals found in samples that have been sieved and stirred, unless they remain attached to their substrata, as with sessile animals or parasites. The information is only rarely recorded.

Increased detail may be derived from separate analyses with its own data, such as granulometry or chemical analyses (see associated data, below). Information on associated biota will come from other records within the same sample.

2.2.4 Sampling methodologies

Sampling methods are a crucial factor in the use of data, as they affect comparability and the types of habitats and animals sampled. A wide variety of methods has been used for macrofaunal sampling; a complete review would be extensive and is beyond the scope of this thesis. However, I have previously worked on a summary of methods available for the monitoring of Special Areas of Conservation (SACs), (Worsfold & Dyer, 1997a & b). Classic published accounts of different sampling methods and their use include Baker & Wolff (1987) and Holme & McIntyre (1984).

Fortunately for data comparability, most macrobenthos samples can be classified into a small number of types (relative to the number of theoretically possible permutations). The most relevant and widespread methods are summarised below.

On soft substrata, intertidal samples are usually collected with a metal or plastic corer. There has been some variability in the sizes of corers used and, to a lesser extent, the method of use (such as the recommended depth of penetration into the substratum). However, the majority of projects, at least in recent years, have used a $0.01m^2$ corer and a stated standardised method (e.g. Dalkin & Barnett, 2001).

Subtidally, similar corers may be used by divers but most samples are collected remotely from a survey vessel. There has been much variability in the types of sampling gear used, partly due to continuous development in the available technology. Remotely operated box or multi-corers may be used for research or in

deep water but grab samplers are the most common gear used for shallow water projects. Day grabs ($0.1m^2$) are used on soft substrata, while Hamon grabs (most are now $0.1m^2$ 'mini-Hamon' grabs) were recently designed for effective collection of quantitative samples in gravel. There is a considerable literature on the effectiveness of different equipment for different purposes (e.g. Boyd, 2002). National protocols are available for the standardisation of methods for the use of grab samplers (Thomas, 2001).

Hard substrata are much less frequently sampled for macrofauna and most methods remain qualitative or limited in their use. Most surveys of hard substrata focus on the larger conspicuous biota. As this thesis concerns the entire marine fauna (although with an emphasis on macrobiota), it is also necessary to note that many other methods are used to sample and record animals that are not part of the macrobenthos. Different sampling methods are appropriate for the recording of different species. Meiofauna, plankton, conspicuous fauna, mobile epifauna and megafauna all have specialised methods. Some of these methods also have the potential to record many macrobiota species, some of which might not be frequently recorded in grab or core samples, and it is important to remember that the distinctions between species on the basis of size and habit are, to a large extent, artificial. In fact, species may be best distinguished in terms of the most efficient method to record them before conclusions (assumptions) are made about their natural attributes.

0.01 m^2 core

0.1 m^2 Hamon grab

1 m^2 quadrat

Figure 2.2.2. Examples of sampling methods.

2.2.5 Sample processing methods

Processing methods have been less well documented than sampling methods, in terms of both published literature and laboratory guidelines. As most of the variation in

laboratory practice relates directly to data quality and applicability, the subject is discussed in more detail in Chapter 4. However, a summary of typical processes, and the main definable attributes, is provided below.

The first and most easily defined attribute is sieve mesh size. Benthic macrofauna samples are sieved over a standard sized mesh in the field and/or in the laboratory. For macrofauna (by definition – see Chapter 3), the standard mesh is either 0.5 mm or 1 mm. Samples may also be preserved either in the field or soon after in the laboratory, before or after sieving. The usual fixative is 80% buffered formaldehyde solution but there may be some variation. Alternative fixatives or concentrations, the time between sample collection and fixation, as well as whether the sample was sieved before or after fixation and the process of sieving can all affect the quality (see below) of the sample. There may also be a protein stain, such as rose Bengal, added to the sample during preservation.

Fixed samples are preserved in sealed containers before extraction of biota. The next stages are usually sieving through a stack of differently sized sieves and elutriation (flotation) of light material. Organisms are then extracted (picked) from coarse fractions by eye, while the fine and light fractions are sorted using a binocular microscope. The term ‘sorting’ is confusing in that it may refer to either extraction/picking or identification. There are attribute variables in the equipment used for extraction and choices over what to extract. Animals may be counted in situ and certain taxa may be ignored. Extracted organisms are then identified and counted. The variability in the accuracy of these processes is a matter of data quality except where decisions are made to reduce taxonomic precision (Chapter 4).

2.2.6 Time and cost

The attributes of time and cost are considered together as they simultaneously have the greatest and least care devoted to their records.

2.2.6.1 Cost

In one sense, cost would be best placed near the discussion of planning and data sources as it is usually established at that stage. However, costs are occasionally re-evaluated after completion of analysis and they are related to time.

There are typically costs associated with each stage of the process, from planning, to survey and laboratory analysis. Typically, a consultancy will quote sampling and analysis costs to take account of the expected time that a sample will take to process and the expertise of the staff required, as well as the costs of the materials involved. In the case of field work, transport costs (especially vessel hire) will be an important consideration. Additional costs are involved in data analysis and report production, which may involve several levels and consultancy fees

Costs are carefully studied and recorded by both the organisation that carries out the work and that which commissions the work. However, they are often not disclosed and are not typically available in association with the data.

2.2.6.2 Time for data production

As with cost, the times taken to carry out different stages of data production are often carefully recorded by the organisation that carried out the task but are rarely disclosed. Recorded times influence costs for future data, as well as the methods used.

2.2.7 Data quality

Data quality may be affected by the effectiveness of the sampling methods or by the accuracy of the sample processing. There is variability in the accuracy of records of depth, time and position and in the quantification and replicability of the sample. Grab samples vary in their efficiency and sample volume may be recorded as a measure of acceptability, as with penetration depth for core samples. There are also variations in sample quality that relate to preservation: specimens from poorly preserved samples may be partially rotten due to limited penetration of fixatives or otherwise damaged due to rough handling. These attributes are often concrete

measureable qualities, although they are intended to represent a more abstract concept.

Laboratory processes show significant variability. It is difficult to categorise data in terms of their quality. A qualitative assessment can be based on a knowledge of which organisations/individuals have been involved in the processing. Individuals may have particular qualifications or a certain number of years of experience but reputation may still be a better indication than the more definitive statements that might be easily tagged as data attributes (i.e., qualifications and accreditation may not be the best indicators of data quality). Similarly, a laboratory may have a specified standard operating procedure, be a member of a quality control scheme (such as NMBAQC) or follow an accreditation system, such as that organised by the International Organisation for Standardisation (ISO). Information on such procedures, memberships and qualifications can be assigned to data but cannot be assumed to be direct measures of quality. Results of actual third party audits of samples can give a more accurate assessment of quality but they can be time-consuming and are applied to only a small number of samples from certain projects. Quality issues are discussed in more detail in Chapter 4.

2.2.8 Associated data

Associated data are data from analyses and records collected from samples that can be connected to the macrobenthos sample. Such data may be derived from a subsample collected with the macrobenthos or from a separate sample collected from the same location and time but using a different method. Seemingly unconnected data, from other surveys but related to the study area could also be considered. Some common examples include:

potentially from the same sample:

- temperature,
- salinity,
- depth of redox layer,
- chemistry,
- granulometry,

- meiofauna;

  from samples at the same station:

- any of the above,
- bathymetry,
- hydrology,
- plankton,
- trawl data (fish and larger benthos);

  from other surveys:

- any of the above,
- tidal data,
- weather records,
- shipping movement data,
- records of human activity/impacts.

2.2.8.1 Additional records from the same data set

The other data from the same sample can be regarded as a special, case of associated data. The records and counts of the other species, along with notes on substrata and other features of the sample are directly connected to the datum in question but not actually part of it.

Similarly, data from other samples may be connected. This is most obvious in the case of other samples from the same survey but any group of samples can be associated if linked through sample type, area or date.

2.2.8.2 Additional information from the same sample

Another special case of associated data comprises other information that can be derived from the data beyond the simple species/count/sample records. One example, microhabitat information, was introduced above and could almost be considered as a separate sampling event. Similarly, further information from the specimens, such as biomass, size, sex or maturity, could be considered as separate taxon record events that may or may not correspond to the lines of data produced for abundance (biomass, for example, may be recorded at phylum - or major taxonomic group – rather than

species levels). The existence of these other data constitutes a series of additional attributes to the primary data.

The potential for additional information can also be indicated by attributes connected to the continued preservation of elements of the sample or information derived from it. There may be photographs of the sample at different stages, from its appearance on deck, before sieving, to individual size fractions and detailed illustrations of specimens. The sample itself may remain preserved in some form. The residue from which animals have been extracted may have been saved for quality assurance and possible remaining specimens. The extracted animals may be preserved, either as single pots per sample or separated into component taxa, with varying levels of labelling and curation. The material preserved, its accessibility and quality are all attributes of the data, as is the preservation of the data themselves.

2.2.9 Usage, fate and accessibility of data

The value of data is often assumed to lie entirely in their demonstration of conclusions related to their stated purpose. Consequently, reports produced form the data are often regarded as complete if they demonstrate their conclusions. Such reports may or may not be published and often do not include the full data. It is also common for scientific publications to include only the results considered necessary for their conclusions. There is usually no editorial requirement for the location of the actual data to be stated. Similarly, commercial reports often exclude raw data and do not state where they can be found. Data from certain ongoing projects are stored in archives (electronic or not) within the organisation responsible and may never be published or used beyond the most basic objectives.

The fate of the specimens (see above) used to produce data is similarly obscure, with the exception of material from taxonomic studies, for which established specimen curation procedures are generally followed.

2.2.9.1 Data usage

The utilisation of data can be regarded as an attribute. Data may be used for their original purpose to produce reports or publications and these can be listed. Archived

data for long-term monitoring projects may not result in direct reports but could be assigned uses in the same way. Any additional use of data beyond the stated purpose, as proposed here, would also constitute attributes.

2.2.9.2 Data accessibility

As discussed, the fate of data is an important attribute that affects usage and value. There are several possible permutations that relate to storage and access:

- electronically stored with full public access,
- stored on paper only, in public domain but difficult to consult,
- electronically stored but permission required for use,
- storage not widely known, no public access,
- presumed lost.

As implied by the above examples, there are several distinct attributes to be considered. The degree of knowledge of the existence of data is distinct from knowledge of their whereabouts. The permission required to use the data is distinct from the practical ease of access.

Some data sets are accessible through public domain websites. Others are similarly placed but require permission for use. Many data belong in the public domain but there has been no requirement for availability and administration charges are made for access. Older data exist only in paper archives, if they were not published with the literature derived from them. This problem is not, however, restricted to old data. I have seen printed modern reports that required scanning or transcription, due to the inaccessibility or possible loss of the original electronic documents.

2.2.9.3 Value

The value of a data set is its usefulness to humanity. This will include its effectiveness in delivery of the stated purpose, combined with the importance of that purpose. It would be difficult to find means of quantifying these concepts and each measure would have its own difficulties. The importance of defining the extent to which dredging for a port development causes damage to the environment must take

account of several factors: how to measure damage, how to decide whether it matters, how to ensure that the data are adequate.

In addition to the stated purpose, it is necessary (and central to this thesis) to consider all of the other purposes to which the data have been and could conceivably be put. It would be necessary to predict such potential applications in order to estimate value but there will always remain a caveat that there may be many possible uses that we cannot yet know. The importance of each application and the suitability of the data would then be added to those for the original stated purpose.

Estimates of value are rarely given for data. This is perhaps unsurprising, given the difficulty of even a qualitative measure. However, the attribute is very important, particularly where resources are limited.

2.3 A taxonomy of data attributes

The attributes discussed above provide different types of information and also differ in the ways they relate to the data under consideration. It should be noted that data from other studies (that may be subject in another context) may represent secondary attributes to the subject data. I have classified attributes into four groups:

- primary (1') attributes are those that give basic information about the sample,
- secondary (2') attributes link the data to other data,
- tertiary (3') attributes relate to human application or value,
- quaternary (4') attributes are abstract concepts or labels (such as sample numbers or survey codes) that provide no information in themselves but are essential for information transfer.

The definitions can be illustrated through the assignment of the attributes discussed to benthic macrofaunal data.

2.3.1.1 Primary (1') attributes

The following attributes can be considered basic (physical) attributes of data, which are integral to the data:

- fieldwork (people, vessel and organisation involved in physical sampling),
- sample type (methodology and equipment),
- laboratory work (individuals and organisation involved),
- laboratory methods (and equipment used),
- sampling date and time,
- location,
- depth,
- Habitat,
- Sample quality (degree of damage),
- Data quality (error margins, QA procedures),
- Location of material and specimens.

2.3.1.2 secondary (2') attributes

The following attributes constitute additional data that can be associated with the primary subject data:

- microhabitat notes,
- biomass data,
- granulometry data,
- chemistry data,
- associated biota,
- meiofauna,
- temperature,
- salinity,
- bathymetry,
- hydrology,
- weather records.

2.3.1.3 tertiary (3') attributes

The following attributes relate to human value:

- stipulation (directives and organisations involved in requirements),
- instigation (organisations involved in planning),
- ownership (organisations involved in commissioning),
- hierarchy of responsibility (organisations involved in execution),
- stated purpose (rationale and hypothesis),
- sector of industry,
- usage (publications based on data),
- cost,
- time taken for analysis,
- fate (means of access),
- value.

2.3.1.4 quaternary (4') attributes

The following qualities are not derived from the data or recorded as data themselves but are means of identifying and manipulating data:

- survey codes,
- sample codes.

2.4 Collation of macrobenthos data

The collation of data from diverse sources has been suggested and attempted many times throughout the history of biological research. The early natural history societies developed specimen and record exchange schemes that became the basis the first studies of distribution (Allen, 1994).

Of the many different data types collected during marine surveys, I have restricted the scope of this thesis to a small number of types that produce comparable benthic macrofauna data. These include grab and core samples, used mainly in subtidal and intertidal habitats, respectively.

More recently, data have been collected onto relational database systems and made publicly available. The first such project to focus on British marine life was the Marine Life Information Network (MarLIN) (www.marlin.ac.uk), which now coordinates the Data Archive for Seabed Species and Habitats (DASSH;

www.dassh.ac.uk) as partners within the Marine Data and Information Partnership (MDIP; www.oceannet.org/MDIP). The system includes data from many environmental surveys, particularly those that were carried out by the Joint Nature Conservation Committee (JNCC) under the Marine Nature Conservation Review (MNCR) programme. There has been voluntary and *ad hoc* addition of data sets from other sources and the project remains active. The National Biodiversity Network (NBN; www.searchnbn.net) includes data for marine, as well as non-marine species.

MarLIN has shared its data collection with an analogous European Union initiative (EurOBIS; www.marbef.org/data/eurobis.php), which is the European component of the Ocean Biogeographic Information System (OBIS; www.iobis.org) and has a similar style of operation (to MarLIN/DASSH). The OBIS system is, in turn, the marine component of Global Biodiversity Information Facility (GBIF; www.gbif.org), which is the information component of the Census of Marine Life (CoML; www.coreocean.org/Dev2Go.web?anchor=coml_home_page), an international 10 year initiative to explore marine biodiversity. The European contribution to GBIF is known as the European Network for Biodiversity Information (ENBI; www.enbi.info/forums/enbi/index.php).

There is also an internet site (www.dvz.be/Portal/links_tax.htm) containing links to a variety of data collation projects, as well as to taxonomic lists (considered in Chapter 3).

Data standardisation is an important concern for any research or monitoring project (Meaden, 2001). This is evident both for large-scale survey programmes and for those studies that have involved information review from multiple surveys. Examples of these are reviewed below.

The most comprehensive attempt to standardise formats for UK marine data has been through the Marine Environmental Data and Information Network (MEDIN). The data classification used by MEDIN has been used here as a starting point for a review of data taxonomy.

There have been many attempts to collate data from certain areas for particular projects, often for a specific monitoring objective. These have resulted in various reports and databases, publicly available or not, that include data reviews with varying levels of completeness and different forms of analysis.

2.5 Review of marine macrobenthos data for the Medway, Swale and outer Thames estuary

Despite the many programmes and initiatives discussed above, there has never been a thorough review of marine macrobenthos data from British waters or even for a small area. All of the above exercises include only the most easily accessible data. I have previously compiled an extensive data review for the Swale, Medway and South Thames Marshes intertidal areas and I have not seen another project completed in the same detail. Despite efforts to obtain all relevant data, it was apparent that several data sets were unavailable or lost (from their original sources) and that others may have remained undetected.

I have here updated that review to include more recent surveys and subtidal areas. Again, the current review cannot be considered complete. Much of the additional data have been collated by Ian Humpheryes of the Environment Agency, in part, for use in a project to classify biotopes. Other data sets have been obtained through surveys known to Unicomarine or the major agencies.

The objective is to classify the data according to the systems developed in this chapter and to further refine the system, as necessary. The data are presented and illustrated to summarise the nature of available data for the area.

2.5.1 Results

The data collation sourced 2,354 macrobenthos samples from the area shown in the following figure. Their positions were originally recorded in either national grid or latitude/longitude format and these have been shown separately in Figure 2.7.1.

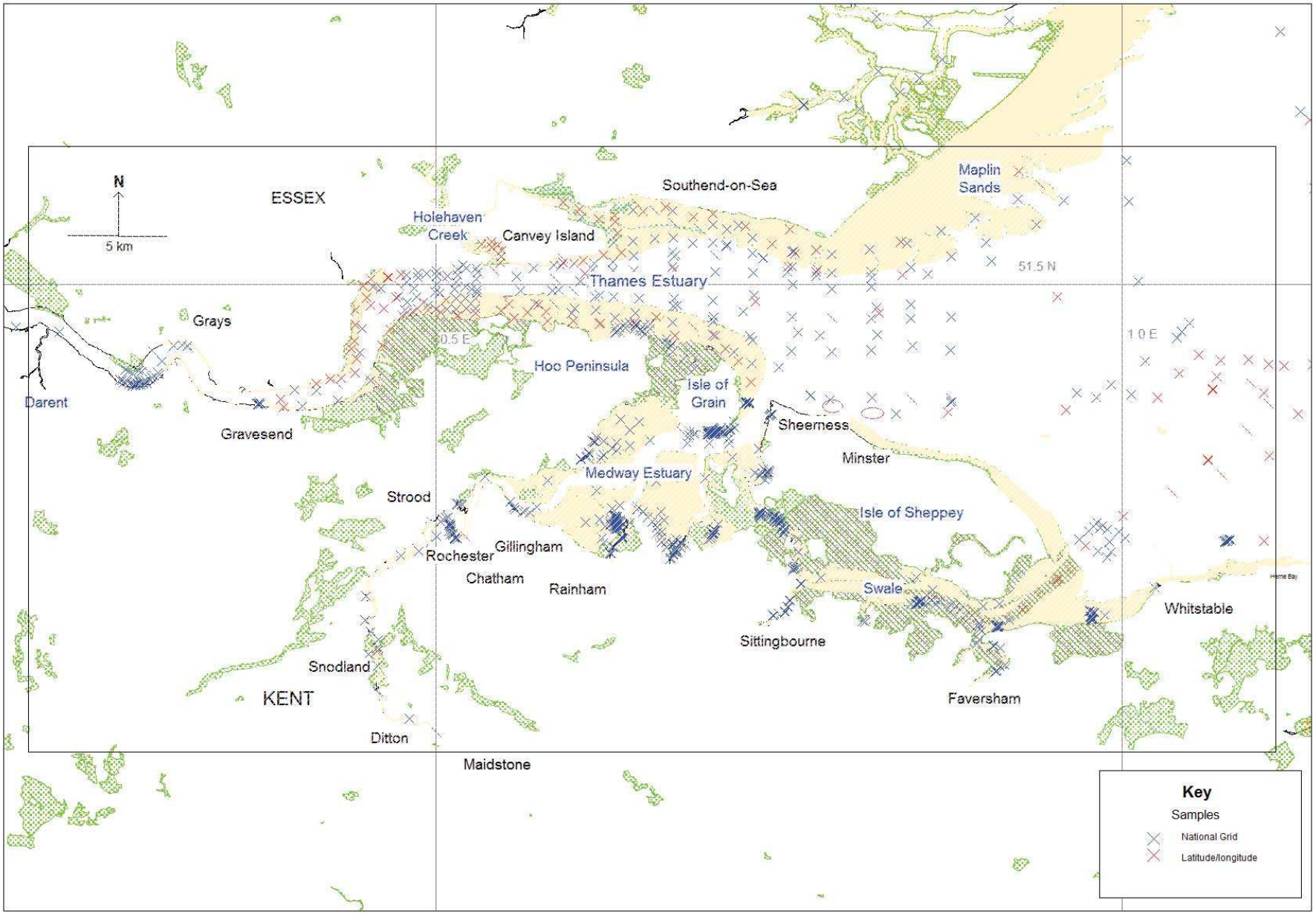


Figure 2.7.1. Map of known marine benthic macrofauna samples from the Swale, Medway and outer Thames Estuary.

The samples were coded as belonging to 71 different surveys. This included several instances of repeat surveys for different years at the same stations, as well as stations belonging to the same programme that may have been sampled by different organisations. Several additional surveys have been identified but sampling positions and other information have not been sourced.

Seventeen different organisations have been identified as having commissioned sampling. These include statutory bodies, as well as companies that required environmental impact assessments. However, the originators of many of the samples were not available at the time of writing. Some of the samples that belong to national monitoring programmes, such as the NMMP, could not be neatly assigned sources (other than NMMP), as several government bodies have been involved in the programme.

The stated purposes of the surveys have been classified into ten different groups but they are rather arbitrary. Some programmes were designed for general environmental monitoring, or the monitoring of pollution impacts, while others were designed to determine the impacts of specific semi-natural phenomena, such blankets of the alga *Ulva* (formerly *Enteromorpha*). Those surveys designed for human impact assessment have not here been separated into characterisation, baseline and monitoring surveys. They were classified, broadly, by industrial sectors (water abstraction, port development, other foreshore development, renewable energy and sewage disposal).

The samples were collected between 1981 and 2012, including at least some for each year since 1990. The proportions of benthic macrofauna samples collected in each year are shown in Figure 2.7.2. There is a bias in coverage, in that the most complete inventory is for the years 1994 to 2004 (the subject of the original commissioned review) as a greater effort was made to source data from this period. The most prolific years were 2003 and 2004.

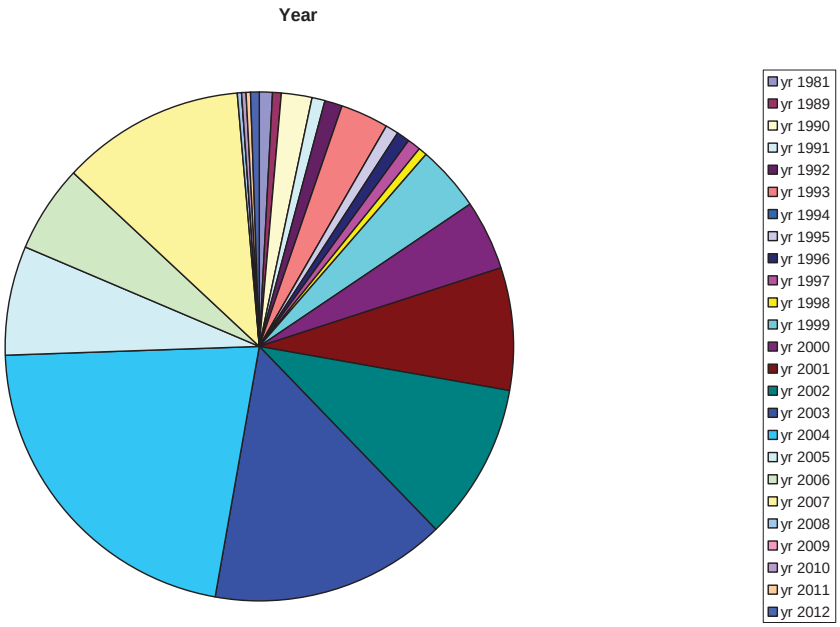


Figure 2.7.2. Proportions of benthic macrofauna samples collected from the Swale, Medway and outer Thames in different years from 1981 to 2012 (legend shows segments clockwise from 12 noon on chart).

Figure 2.7.3 shows that across the time period, some sampling has been carried out in every month. The largest numbers of samples (about 50%) have been collected in the summer but the pattern is not clear across the year. As with years, and despite the large number of surveys, trends are skewed by particular, individual large projects and by the initiation and completion of long term survey programmes.

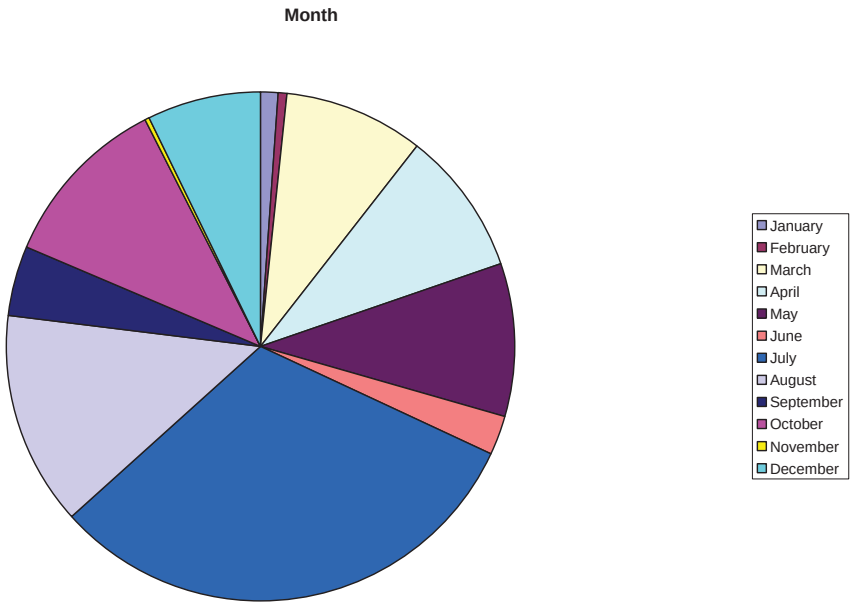


Figure 2.7.3. Proportions of benthic macrofauna samples collected from the Swale, Medway and outer Thames in different months between 1981 and 2012 (legend shows segments clockwise from 12 noon on chart).

2.6 Discussion

Data units are simple quantities that link to a large and complex array of other information – attributes. Some of these attributes are fundamental to the meaning of the data. In the case of marine benthic macrofauna, values link to samples and taxa, each of which link to many other attributes. The attributes of taxa are considered in Chapter 3. The attributes of samples, as shown above, include many different types of information, not all of which is immediately apparent. I have considered them in terms of their origins in the data creation process and developed a classification (Section 1.5) of four categories, according to the types of information that they convey. The system is not perfect and there is much overlap between the attribute categories. Some attributes can be considered to belong to more than one category and some might be regarded as not belonging to the primary data at all. Some attributes are clear, measureable properties of the data, while others, such as purpose or value, are more abstract and, possibly, impossible to measure in any meaningful quantitative way. However, all of these attributes have a link to the primary data and all offer some means of improvement to our understanding of the data. It is likely that future researchers will need to significantly modify the classification system

presented here or continue to use current systems (without a formal system), or to develop new ones. The purpose of the exercise has, however, been served in that the major links have been identified, along with the potential for additional links through the attributes of associated data.

It appears likely that the potential to link data to other information is related to the number of links already established. If data links represent information, there will be a greater potential to derive meaning from data if more attributes are recorded and preserved and if they are maintained accurately and in a meaningful way.

The strict hypothetico-deductive model would dictate that only those data and attributes required for the testing of a hypothesis need be presented or preserved. It might appear that this interpretation is over-prescriptive and not actually followed by the majority of researchers. However, the lack of a coordinated data preservation system and consequent loss and dispersal of many data indicate a disrespect for raw data that is yet more entrenched in practice than it is in theory. There are other reasons for the limited success of data management systems. Without a specified requirement for data submission, poor organisation and apathy there will always be a tendency to regard post-project data management as an afterthought, even where the principle is acknowledged. For example, I have myself failed to submit data sets to repositories due to lack of time and resources. It is worthwhile to ask why there should be so few resources devoted to data care when surveys and analysis may require significant budgets. I would propose that the theoretical view of data as designed for a specific hypothesis has been part of the reason for our careless attitude. There remains much resistance to the preservation of data on ideological grounds. This is evidenced when consultancy staff members question the reason for maintenance and inclusion in reports of data that do not necessarily form part of the 'bottom line' message of a report and when staff at statutory agencies suggest that there is no need to present results unless there is a 'specific purpose' for doing so.

2.6.1.1 Recommendations

The classification of data has always been understood to be important in the maintenance of records and the application of data to purpose. The current focus (e.g.

through MEDIN) is on the development of systems to effectively archive data, for which some form of classification is clearly essential. The information has wider, relevance, however. The prevalence of different data types is directly connected to their fitness to purpose and the purposes themselves are a function of social structures, as are the organisations involved, all of which affect data reliability. It is also clear that the data have the potential for uses beyond their stated purposes and methods of data collation and storage have a critical impact on those potential uses. It is suggested that the value of data lies not in fitness to a stated original purpose but in the potential for use in wider contexts and that this, in turn, may be a function of the number of links to other data, as in network theory. Archive systems are likely to continue to evolve but two wider issues are rarely addressed. The first is that there is a need to view data as having multiple uses from the survey design phase and adapt its collection accordingly. The second is the need to register all data through a unique coding system from the outset. Both of these concerns have legislative implications that will be further discussed in the general discussion (Chapter 6).

3. Chapter 3. A taxonomy of species attributes and how they are assigned

3.1 Introduction

3.1.1 Objectives

The purpose of this chapter is to review the information that can be applied to species and summarise the sources of available knowledge on the British marine fauna, together with the potential uses (value) of such information. The resulting classification of attributes will then provide a basis to identify how much could be effectively determined from data originally collected for other purposes.

3.1.2 The species concept

The species concept is not stable. Most current research takes the biological species (Mayr, 1947) to be the true definition but, in practice, most species definitions are based on morphological or genetic data extrapolated to the biological species concept. The difficulties inherent to species definitions have caused the concept itself to be questioned and alternative taxonomic units have been proposed (Pleijel & Rouse, 2000a; b) but some form of taxonomic unit is essential to any biological study. Because this thesis is concerned with the application of biological sample data to the provision of information on marine macrobenthic species, there is a need to review the importance of that information in biological and environmental studies and their wider value.

3.1.3 Species attributes

Since the species concept was first formalised, it has been understood that different species have different properties. The most basic of these are the physical features that originally lead to the development of a taxonomic hierarchy. For many years taxonomy was seen as the primary purpose for the collation of species information, as evidenced by the high proportion of taxonomic literature in the biological journals of earlier decades, as compared to the late 20th century (Padial *et al.*, 2007); however, research for this thesis showed that descriptive accounts still dominate the literature for all but a few extensively studied species. In recent decades, ecological and

physiological studies have had a tendency to attempt to marginalise taxonomy (e.g. Warwick, 1988) but they have always been reliant upon it in some form.

Each described species has a name and a set of physical features that define it. It also has a taxonomic hierarchy and an array of qualities that relate to its ecology and physiology, as well as to its distribution, economic importance and conservation value. It is surprisingly unusual to see general reference to all such items of information that relate to a species. The term 'trait' is often applied to elements of physiology and biological functioning (e.g. MarLIN; Bremner, et al., 2005). However, as it is not usually applied to names or distribution, the term 'attribute' is used here for all forms of information that can be applied to a species, in analogy to its use for data (Chapter 2).

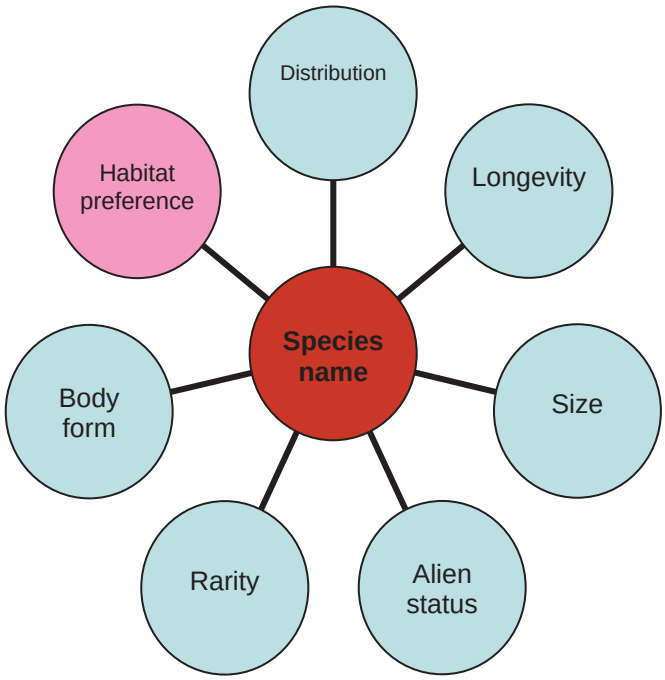


Figure 3.1.1. Representation of attributes that might be assigned to a species.

3.1.4 Data and species included in this study

The focus of my study is on data that include species records for British marine benthic macrofauna but for which the stated purpose was other than the study of species *per se*. The definitions of these concepts all have uncertain boundaries. For the purposes of my thesis, I use the following definitions.

The main subject area of the thesis is data from samples collected for the analysis of benthic macrofauna from United Kingdom marine and estuarine waters, i.e. ‘macrobenthos data’ and the uses to which they may be put.

The concept of ‘benthic macrofauna’ has never been defined clearly enough to allow each species to be definable as ‘benthic macrofauna’ or not and some clarification of the subject is offered here.

British: ‘United Kingdom waters’ can be taken to include those within the UK Exclusive Economic Zone; boundaries can be seen on the Flanders Marine Institute (VLIZ) website (http://www.vliz.be/vmdcdata/marbound). However, the seas around the British Isles are here taken as a geographical, rather than political, unit and include both the Republic of Ireland and the United Kingdom but not the Channel Islands. Species have only been listed as British in the list produced for this thesis if found in shelf waters (<200 m in depth), as was done for the preparation of the Species Directory (Howson, 1987; Howson & Picton, 1997). Species that occur outside this area or at greater depths are considered as possible new records. In practice, most of the thesis has a focus on smaller areas.

Species: as discussed in Section 1, the definition of the species concept remains a matter of debate. However, for most groups of animals, there is a working consensus on which taxa should be considered as species that derives from the current literature. It is common practice to use the World Register of Marine Species (WoRMS), as a standard list of currently recognised valid species and that is followed here, except where published literature is found that is more recent than the latest review of a taxon on WoRMS. On a practical level, data sets that provide species records always include a certain number of identifications at higher taxonomic levels (*e.g.* identified to family or class level) and studies of broad habitats and physiology usually include incidental species records. This study uses data sets for which an attempt has been made to identify all animals present in a sample (whether collected or *in situ*) to species level, where practicable.

Marine: the marine environment is taken here to include intertidal and brackish regions, which merge with non-marine habitats and for which clear definitions are unavailable. The European Register of Marine Species (ERMS; www.marbef.org/data/erms.php) defines the 'marine environment' as "up to the strandline or splash zone above the high tide mark and down to 0.5 (psu, ppt) salinity in estuaries" and that definition is broadly followed here, though estuaries generally have variable salinity and the average tidal limit may be taken as the upper limit of estuarine waters; the salinity definition is considered to include enclosed brackish habitats.

Benthic: all habitats associated with the seabed are considered as benthic. As above, this is here taken to include the substrata of intertidal and brackish environments. I also include both infauna (animals living within the sediment) and epifauna (animals living on the surface of the substratum), as well as mobile animals that inhabit both the seabed and the open water immediately above it (i.e. in transition with nekton and plankton communities) that may be described as epibenthic or demersal.

Macrofauna: are usually defined as inconspicuous (not readily identifiable *in situ*) animals retained on either a 0.5 mm or 1 mm sieve but, on occasion, certain taxonomic groups are included or excluded, despite this distinction. I take 0.5 mm as the distinction here and include conspicuous species (those that may have been identifiable *in situ*), where sampled. Fauna are taken to include animals according to WoRMS (i.e. excluding Protozoa and Fungi).

3.2 The value of species information

Species information is important to most branches of biology, in terms of both practical uses and importance to scientific theory. The practical value is apparent in the need to understand distribution and habitat requirements for species level conservation (Gilliland & Sanderson, 2000; Lieberknecht *et al*., 2003) and for broader biodiversity assessments (Vane-Wright *et al*., 1991; Airoldi *et al*., 2008; Hendriks & Duarte, 2008; Kier *et al*., 2009). Species information is also important in the interpretation of ecological data. For many years, ecological impact assessments used biological sample data mainly as a means for the derivation of summary

statistics (Warwick, 1988) applied to samples or sites, usually without direct reference to the actual species present. The value of the potential information linked to species names has, however, gradually come to be more widely realised. For example, feeding types were used for the development of trophic indices (Codling & Ashley, 1992; Borja *et al*., 2000, 2006; Fleischer *et al*., 2007) and measures of taxonomic distinctness have been used to assess certain impacts (Warwick & Clarke, 1995). More recently, there have been moves to incorporate a much wider range of species information into applied research, including analyses of human impacts and ecosystem functioning (Bremner *et al*., 2003; 2006; Somerfield *et al*., 2008). The theoretical value of species information is equally apparent. Thus most of the broad questions of ecology (Odum, 1971; Weiner, 1995; Scheiner & Willig, 2008) and biogeography (Golikov et al., 1990) require the nature of organisms in their ecosystems to be understood. Even where this is not done directly through species-level assignments, such as through synecological studies of whole ecosystems, the properties of components of the ecosystem are still considered (e.g. Bremner, 2005). Analysis of the function of the physical features of organisms aids the development of ecological theory, as does study of individual species' ecological properties. Species information likewise contributes to taxonomic theory. The definition of each species is supported by detailed accounts of its features, which may be subjected to statistical analysis for taxonomic purposes (Pleijel, 1993). The attributes reviewed in most detail in taxonomic studies are generally physical traits (descriptive features, sometimes also molecular features). These traits define the 'morphospecies' that are most commonly used but shoukd ideally include discussion of reproduction, for definition of true 'biological' species (Mayr, 1947). Physiology, distribution and ecology are also taxonomically important and are often summarised in taxonomic literature (e.g. Woodham & Chambers, 1994) Theories of evolution (Darwin, 1872) and phylogeny (Pleijel & Rouse, 2000a, b; Fitzhugh, 2008) rely on the characterisation of the attributes of taxa, particularly species.

3.3 Species attributes

Despite the ubiquitous nature of species information, there is currently no universally accepted definition of, or classification for, attributes of species, although they are, in effect, used in all branches of biology. The most comprehensive classification is

currently hosted by the Marine Life Information Network (MarLIN), a national web-based information source for marine species, which provides detailed, structured information reviews for a selection of species. MarLIN also links to a subsidiary database (BIOTIC: www.marlin.ac.uk/biotic) that provides information on over 40 biological trait categories on selected benthic species. Another trait review (Marine Ecological Surveys Limited, 2008) includes only genus level information. Definitions of terms vary between the above three resources. Species information potentially includes any details, such as name, taxonomic hierarchy, date of description, official status, distribution, sensitivity to impacts, size or reproductive strategy. Items in the latter parts of the list (i.e. properties of the actual organisms considered) might be called 'traits' but the distinction is not clear. I have, therefore, decided to use the term 'attributes' to describe any conceivable item of information about a species.

3.3.1 Taxon lists

Taxon lists represent a first stage in the collation of species attribute information (Costello, 2000), in that they list the most basic (taxonomic) attributes, generally including species names, authors, dates and a hierarchy of higher taxa. They also often include basic distribution data, either explicitly or implicitly, through the restriction of lists to particular geographical regions. Species lists provide the labels on which to attach additional attribute information.

There are many available lists of marine taxa, with overlapping coverage of different taxonomic groups and geographical regions. The first comprehensive list of British marine biota, (Howson, 1987) was later updated to provide a standard reference (Howson & Picton, 1997) used by most organisations involved in marine life recording. There were, however, several omissions from this Species Directory (in terms of taxonomic coverage) and there have inevitably been many additions and changes to the British marine biota since its publication.

A list of European marine species (Costello *et al*, 2001) has since been published as the first version of the European Register of Marine Species (ERMS), which is now updated at intervals and accessible online (www.marbef.org/data/erms.php). It is one

of several currently available online taxon lists. The non-marine equivalent, Fauna Europaea (www.faunaeur.org) provides a useful overlap for information on splash zone and brackish water fauna.

Other relevant regional lists include the North Atlantic Register of Marine Species (NARMS) (www.vliz.be/vmdcdata/narms), the North East Atlantic Taxa website (NEAT www.tmbl.gu.se/libdb/taxon/taxa.html), the Taxonomic Information System for the Belgian Coastal Area (Tisbe; www.vliz.be/vmdcdata/tisbe), regional register for the northeast Atlantic, Arctic macrozoobenthos database, North Sea Benthos Project 2000 (www.vliz.be/vmdcdata/nsbp) and the North Sea Benthos Survey (www.vliz.be/vmdcdata/nsbs). The NEAT list is divided into authored taxonomic sections: Polychaeta (Hansson, 1998); Bryozoa, Brachiopoda, Phoronida (Hansson, 1998).

There are also several worldwide taxon list projects, such as Marine Species (www.marinespecies.org), which is the taxonomic backbone of OBIS, uBio (universal biological indexer and organizer; www.ubio.org), NameBank, uBioRSS MBLWHOL library, Woods Hole and ETI's World Biodiversity database (www.eti.uva.nl/tools/wbd.php).

Other international lists focus on particular taxonomic groups, such as the Aphia Global Registers of Porifera (World Porifera database; www.vliz.be/vmdcdata/porifera), Nemertina, Cumacea (www.vliz.be/vmdcdata/cumacea), Brachiopoda (www.vliz.be/vmdcdata/brachiopoda) and Phoronida (www.vliz.be/vmdcdata/phoronida), as well as Algaebase (www.algaebase.org), Biogeoinformatics of Hexacorals (http://www.kgs.ku.edu/Hexacoral), the World Database of Proseriata and Kalyptorhynca (www.vliz.be/vmdcdata/rhabditophora), the MANUELA database (nematodes?), Nemys, for nematodes and mysids (http://nemys.ugent.be), CLEMAM, and FishBase (Froese & Pauly, 2007; www.fishbase.org).

3.3.2 Compilations of species attributes

Some of the taxon lists mentioned above include additional information. It is possible to create distribution plots (point sample information) from ERMS, using EurOBIS and Fauna Europaea plot distributions by country.

The Marine Life Information Network (MarLIN) has produced key information reviews (www.marlin.ac.uk/sah) for 703 British marine species. This 'key information' corresponds broadly to the species attribute concept used for this thesis but appears to be purpose specific, rather than used to represent all potential information for a species. The MarLIN classification of key information is, however, the most logical starting point for a summary of species attributes. MarLIN has also produced a standard list of traits (40 categories), with definitions and examples of completed trait assignments for selected species (BIOTIC: www.marlin.ac.uk/biotic). BIOTIC includes species information such as taxonomic classification and distribution as traits, as well as characteristics that might be used in biological traits analysis for the description of ecosystem functioning (Bremner *et al*., 2003).

3.4 The British marine fauna

While many publications and other information sources summarise species attributes in some form, it is difficult to compile an information review that allows the majority of attributes to be reviewed for an entire fauna. There is a continuum between reviews of: 'a few attributes of many species' (such as a species directory) and 'many attributes of a few species' (such as detailed investigation of biology); Figure 3.4.1 shows how available information might be divided across species (not based on actual data).

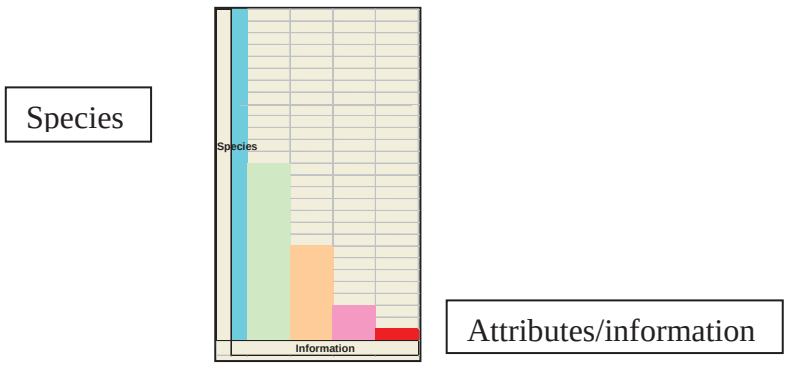


Figure 3.4.1. Representation of the different amounts of information available for different numbers of species in the literature.

The assignment of only the most basic of attributes to all known species is, in effect, the approach of basic taxon lists such as the marine 'Species Directory' for the British Isles (Howson & Picton, 1997) or the World Register of Marine Species (WoRMS). Detailed accounts of aspects of the biology of single species, such as compiled for *Crangon crangon* by Tiews (1970) and Campos & Van der Veer (2008) represent the opposite extreme. The intermediate approach of MarLIN has been to assign large amount of information to a small number of 'key species'.

3.5 The taxonomy of species attributes in marine invertebrates: a review across the British macrobenthos

The assignment of attributes to species is useful to ecological and conservation assessments. Many literature resources provide species lists and descriptions or detailed accounts of the biology of particular species. Systematic reviews of attributes across many species are less common, although attempts are regularly made to estimate the number of species worldwide (Mora *et al*., 2011) or for particular areas and some reviews of characteristics have been carried out as part of the Census of Marine Life (CoML).

For this study, I have compiled a complete list of currently recognised British marine animals and reviewed some easily accessible attributes for all species assigned, together with the literature from which the information was sourced. A full table of information is available electronically. Some of the principal attributes are introduced below. Much of this information has multiple applications for the management of marine resources. It also has implications for the estimation of the level of our knowledge. Some species and attributes are much better known than others and many attributes have a direct bearing on the way in which we can acquire further information.

I have produced a best estimate of numbers of British marine species (as defined above) and Figure 3.5.1 shows the proportions of species from the full list that can be assigned to different salinity cases. Due to the difficulty of obtaining the relevant data, the many terrestrial and freshwater species recorded from transitional habitats

are excluded from this plot but some indication of the number of transitional habitat species can be seen.

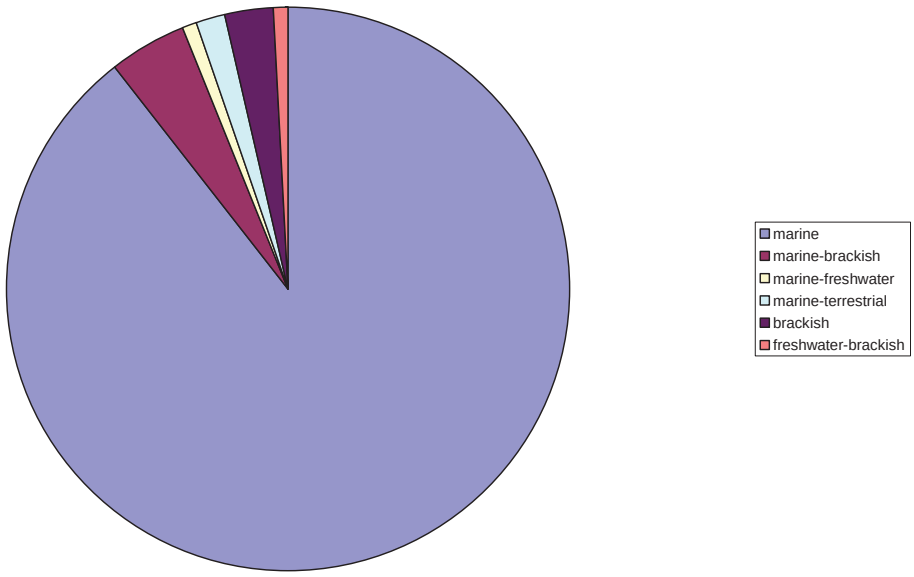


Figure 3.5.1. Proportions of British marine species known plus those from transitional aquatic habitats and areas (legend shows segments clockwise from 12 noon on chart).

The majority of species found in the marine environment can be considered to be entirely marine but there is a significant proportion of species that are difficult to assign to a particular major habitat, such that it will always be impossible to give a definitive number or list of marine species. In legend to Figure 3.5.1, the primary habitat is given first, followed by habitats in which they may occasionally be found. For example, the cockle *Cerastoderma edule* is primarily marine but tolerant of reduced salinity (marine brackish), while the snail *Potamopyrgus antipodarum* is mainly freshwater but can tolerate some salt content (freshwater-brackish). A few species, such as flounder (*Platichthys flesus*), can extend from a fully marine habitat into fully freshwater environments (marine-freshwater).

Figure 3.5.2 shows the proportions of marine species, with their status in British waters.

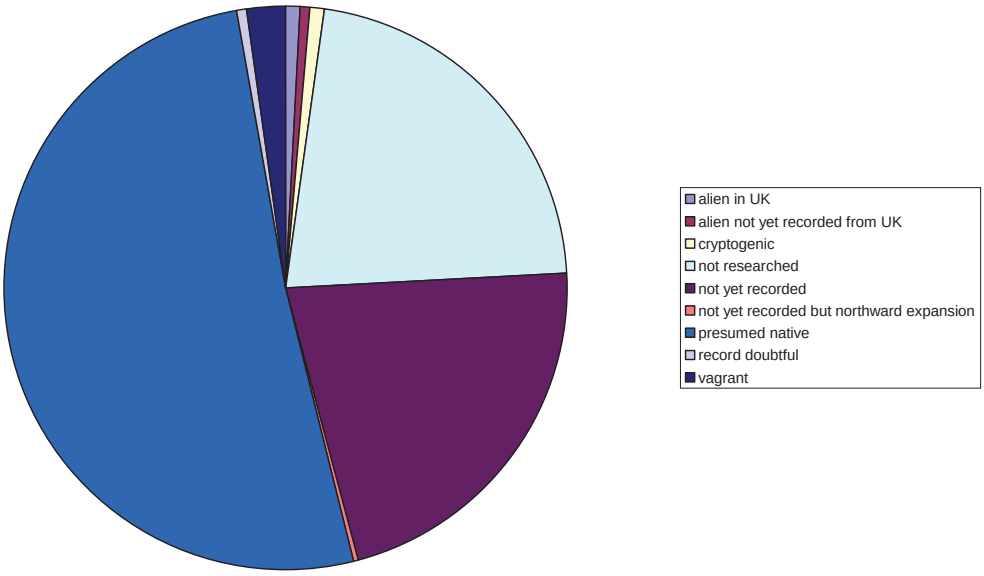


Figure 3.5.2. Proportions of known and potential British marine species with different types of records and alien/native status (legend shows segments clockwise from 12 noon on chart).

As we do not know with certainty which species are present in British waters, the chart includes species known from nearby areas that could potentially be found in UK waters. The Species Directory (Howson & Picton, 1997) included species with records from Brittany and the Netherlands. The 'not researched' species are present on British lists but I have not found direct reference to their records. The 'not yet recorded' species are known from adjacent areas (including deeper water) and are likely to be found at some time. The 'not researched species' are included in the following plots and also in my estimate of the number of British marine species (6,465) but the 'not yet recorded' species are excluded. Vagrant species are those that are sometimes found in British waters as a result of currents but do not live in the area for long periods.

3.5.1.1 Taxonomy

The most basic attribute of a species is its identity. The most widespread formalised taxonomic system is based on that devised by Linnaeus (1758) and updated (for animals) through the International Commission on Zoological Nomenclature (ICZN).

There have, however, been recent attempts to devise alternative systems based on more strictly on cladistic analyses (*e.g.* Pleijel & Rouse, 2000a & b).

The Linnaean system is followed here, although it is recognised that there will always be dispute over the precise definition of a species. Taxonomic issues, such as the possibility that a species represents a complex of cryptic species or that it may be synonymous with another, should also be considered species attributes. Similarly, the assignment of higher taxa (also species attributes) is not always agreed and the number of levels of recognised higher taxa varies between groups.

Associated with taxonomy are several attributes that relate to the definition of a species. These include the author and date of description, the type locality and location of type specimens and available literature and other sources of identification features, keys and illustrations. There is a gradation of literature from the original description, through taxonomic redescriptions, later descriptions with additional features and identification aids to resources designed purely for identification, rather than taxonomy.

A breakdown of the fauna by phyla is shown in Figure 3.5.3.

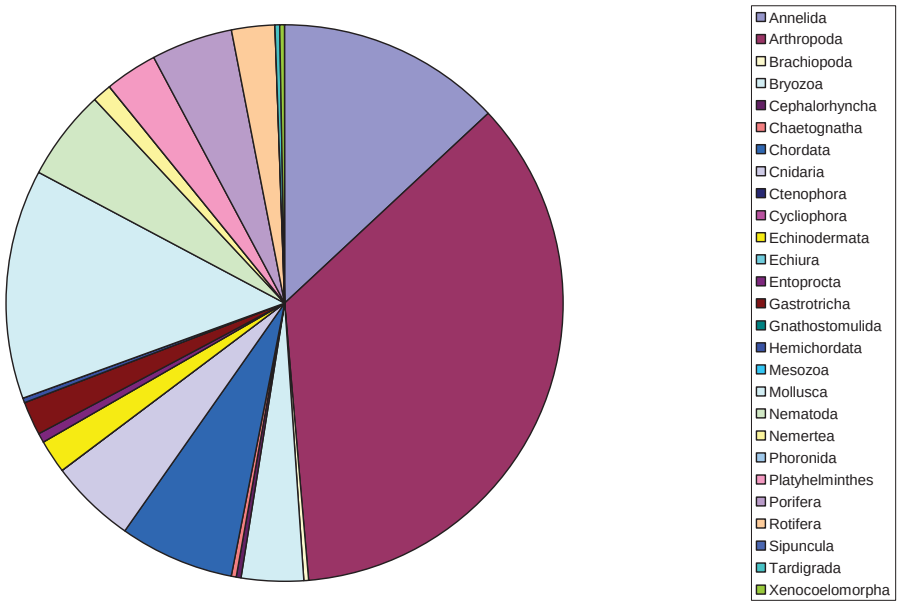


Figure 3.5.3. Proportions of British marine animal species in different phyla (legend shows segments clockwise from 12 noon on chart).

3.5.1.2 Recognition (identification)

Identification issues should be considered separately from taxonomy. The most useful literature and other resources for identification represent species attributes, as do the features described by them.

For many major groups, there is a standard literature that is generally used for identification; this is often in the form of identification keys, illustrations and descriptions in forms other than the original or full taxonomic redescriptions (e.g. the Linnean Society Synopses.). Coverage and detail are important attributes of the literature, to be considered in the assignment of literature to species. It is possible to assign the preferred literature for the identification of each species and to list other sources that contain a description or illustration of the species or key that includes the species.

One of the most important issues in the use of existing data concerns the reliability of the identifications of the species recorded. The significance of identification reliability in the assignment of attributes using different data sources is discussed under respective sections.

The recognisability of a species can be considered an attribute that requires exploration into means of definition and measurement of the concept and the possible development of a taxon recognisability index.

Taxon recognisability affects the likelihood that a species will be accurately recorded, if present in a sample. This is particularly important for rare species. Apart from the possibility of incorrect identification (discussed above), there are also deliberate recording issues that affect species records. Many taxa are routinely recorded at higher taxonomic levels. The choice of levels, and the taxa affected, varies considerably between laboratories (Worsfold & Hall, 2001) and, usually consequently, between projects.

Figure 3.5.4 shows proportions of officially rare species that are best recognisable by different basic methods (*in situ* or laboratory).

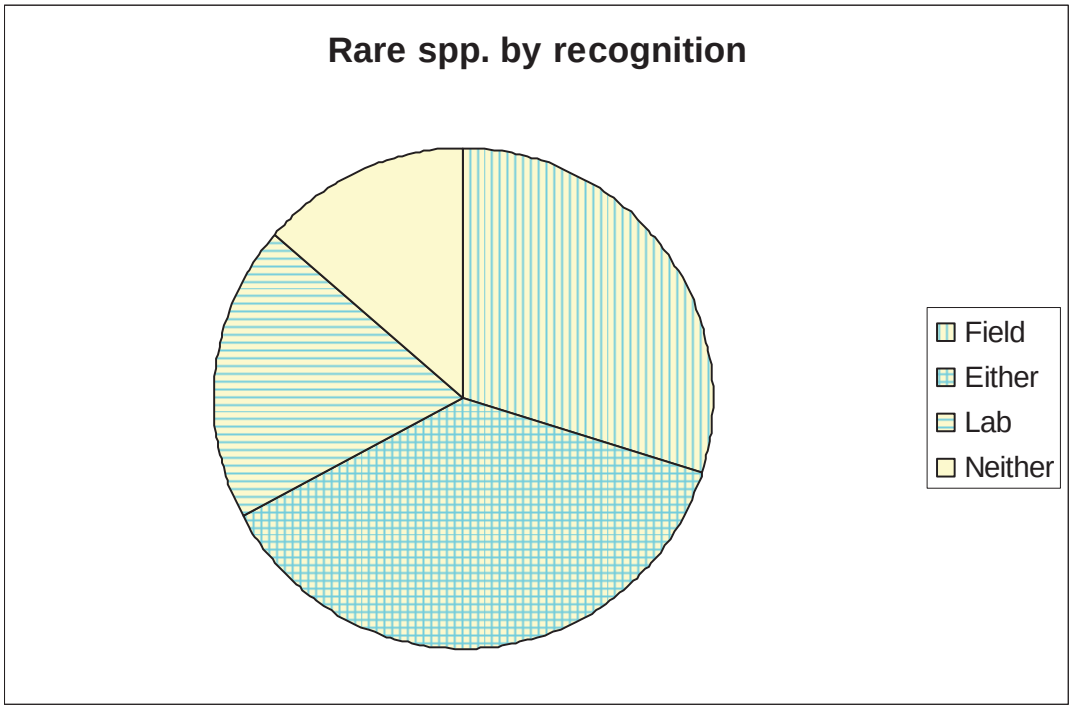


Figure 3.5.4. Proportions of officially rare marine species most easily recognised by either field observation or sample analysis (legend shows segments clockwise from 12 noon on chart).

As the majority of species listed as nationally rare or scarce (Sanderson, 1996) are conspicuous, most are equally recognisable in the field or in the laboratory (e.g. the pink sea fan *Eunicella verrucosa*). However, some, such as *Hypania romijni* are easily recognised by staff familiar with benthos samples but too small to be reliably recorded in the field. Another protected species (*Nematostella vectensis*) is difficult to identify from preserved samples and recognisable in the field only with reference to habitat, which may not be reliable; it is counted as 'neither' in the recognition plot.

3.5.1.3 Biology

Size, form, diet and reproductive strategy can all be considered aspects of biology. Size is considered below. Maximum body size is relevant to the reliability of records and means of recording a species' other attributes. Of the species here regarded as British marine or potentially so, I was able to find maximum size data for a majority, as shown in Figure 3.5.5.

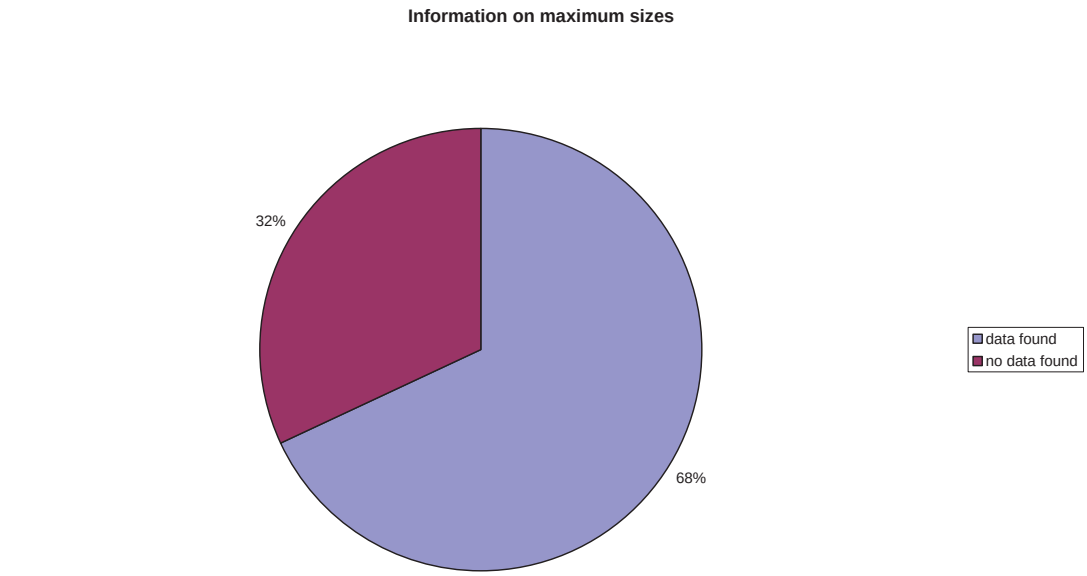


Figure 3.5.5. Available maximum size data for all recorded marine species (legend shows segments clockwise from 12 noon on chart).

For those with available data, a plot of cumulative numbers of species up to different maximum sizes is shown in Figure 3.5.6. Each species is represented by a point on the line and they are ranked in order of maximum size. Colony sizes are included for colonial species.

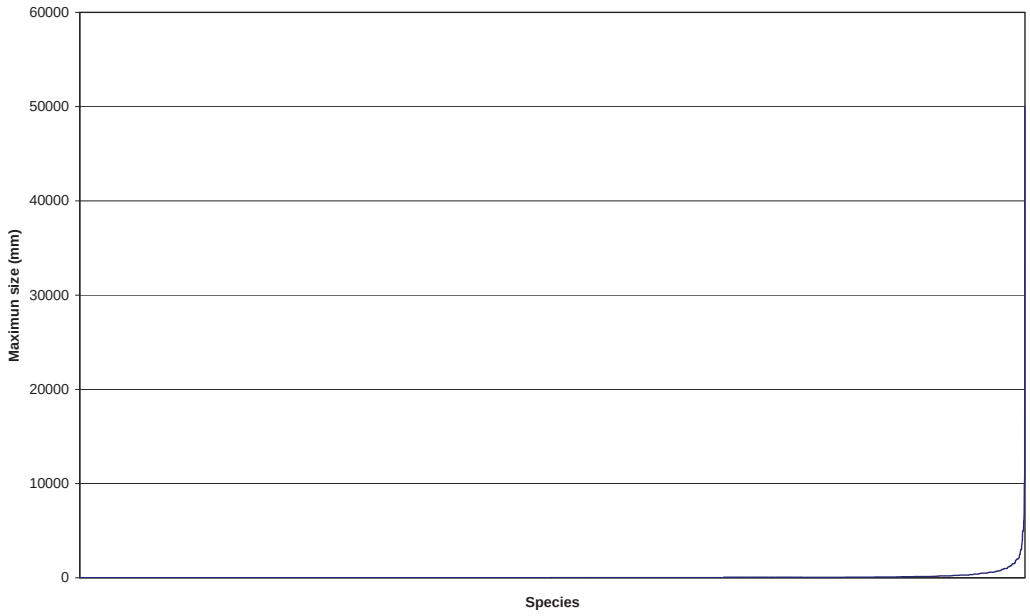


Figure 3.5.6. Cumulative numbers of British marine animal species at each maximum size.

The majority of species are small. There is a long tail of those below 10 cm, followed by a rapidly increasing rate of size increase for each new species added to the sequence. The size range from 10 m to 60 m is represented by a very small proportion of species. Detail for species smaller than 10 cm is shown below:

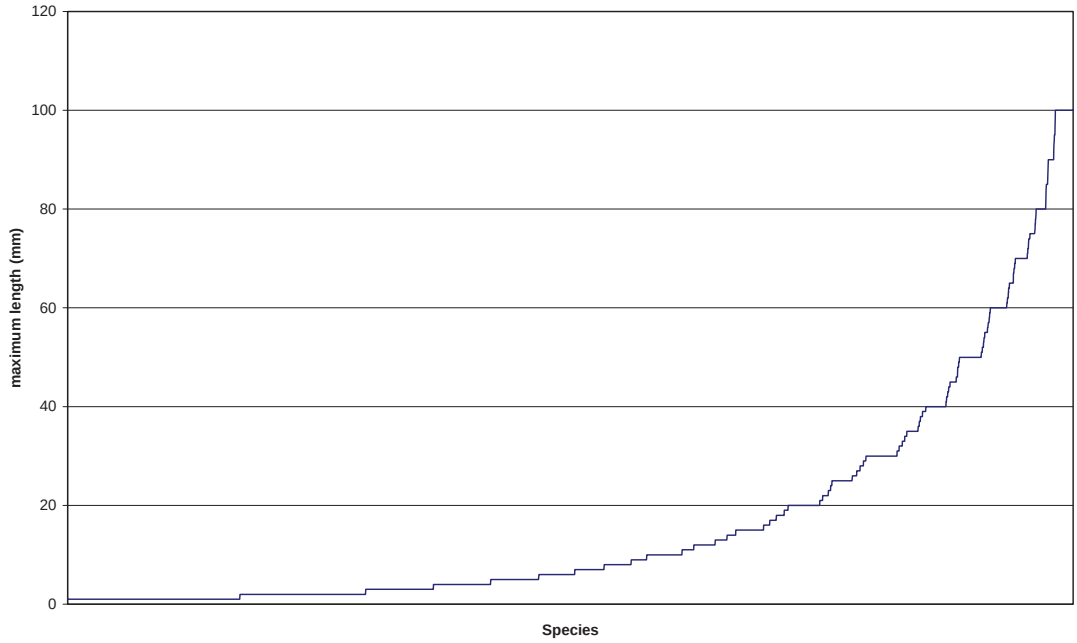


Figure 3.5.7. Cumulative numbers of British marine animal species at maximum sizes below 10 cm.

A complete plot for Mollusca only is shown in Figure 3.5.8.

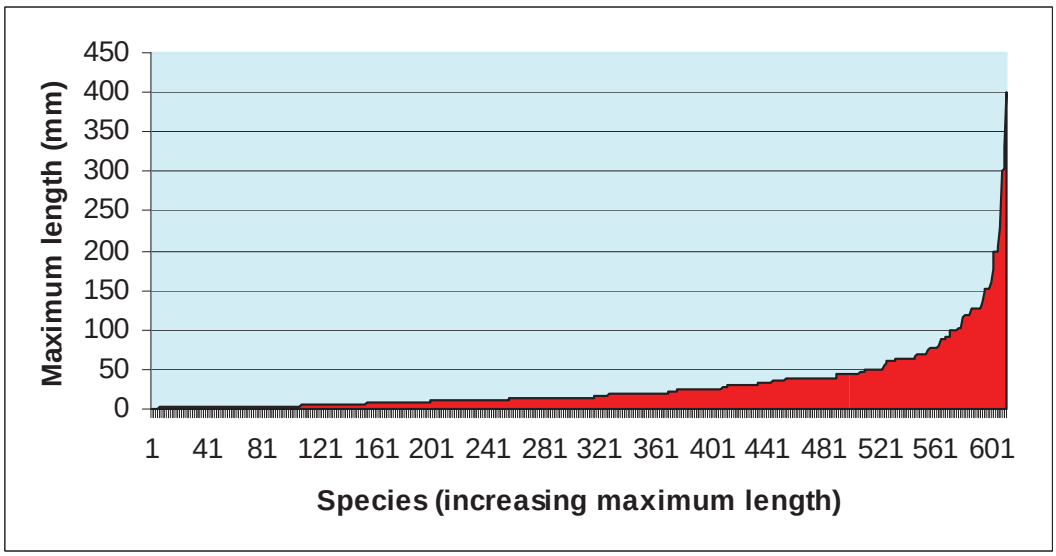


Figure 3.5.8. Cumulative numbers of British marine mollusc species at each maximum size.

3.5.1.4 Distribution

Distribution is generally one of the first attributes to be examined once a species is described. Modern taxonomic literature, for example, Woodham & Chambers (1994) which describes the cirratulid polychaete *Chaetozone gibber*, always includes lists of localities from which a species has been verified under the heading of 'material examined', usually combined with a distribution summary after the actual description. Secondary taxonomic summaries (e.g. identification guides) may expand on these provisional distributions, with reference to published distribution updates.

Original descriptions of species may be followed by publications that analyse and review later distribution data. This has been done most comprehensively for non-marine biota and there are detailed atlases available for British flowering plants (Perring & Walters, 1962), birds (Sharrock, 1976), butterflies (Asher *et al*., 2001) and molluscs (Kerney, 1999). The approach for well-studied groups has been to plot the presence of each species within each of a number of standard geographical units, such as 'vice-counties', 10km squares or tetrads (2km squares). The hope is that coverage (in terms of sampling effort) will be similar for each unit but this is rarely achieved, even for the best-studied groups.

For the UK marine environment, 'marine census areas' (or 'sea areas') have been devised as a standard geographical unit, as a series of approximately 40 areas between 50 and 200 km^2. They have been used for distribution atlases of molluscs (Seaward, 1982; 1990) and brachyuran decapod crustacea (Clark, 1986) and are quoted in distribution summaries of some identification literature (Lincoln, 1979). However, the Joint Nature Conservation Committee (JNCC) devised an alternative division of British waters for use in its area summaries (Hiscock, 1996). Current national and international data collation and mapping projects (such as the National Biodiversity Network - NBN) often plot actual sampling points, rather than using standard units.

Most of the information presented above came from the published literature. However, many of the details are poorly known and could potentially be assigned through interpretation of data originally collected for other purposes.

3.6 Species attribute review for *Palaemon longirostris*

The following review of species attribute information takes the prawn *Palaemon longirostris* H. Milne Edwards, 1837, as an example. The objective is to illustrate the extent of attributes for a species and to show sources of information (which will identify uses for existing data) and problems with classification.

The review includes detailed information derived from both the published literature and existing unpublished data. The applicability of different information sources is also discussed. This *P. longirostris* review is used as a basis for critical assessment of attribute definitions and the resources required and available for the assignment of information to this and other species. Additional traits, and amendments to traits or their definitions, are discussed, as appropriate. The choice of species is arbitrary but it illustrates some useful factors, such as mid-level information availability and ecological importance, as well as some intermediate traits related to size and mobility; these factors help to test attribute classifications. The results represent an attribute review for the species, which can be considered analogous to the systematics section typical of taxonomic reviews as exemplified by Woodham & Chambers (2004) discussed above.

3.6.1 Taxonomy

Taxonomic attributes are not qualities of the organisms themselves (although derived from them) and so cannot be considered under the widely-used term traits; they are here regarded as nominal attributes. The taxonomy section of the BIOTIC website includes the scientific and common names, recent synonyms, the 'MCS' Code and a taxonomic hierarchy. Most of the information in BIOTIC and other details are also found on the MarLIN 'taxonomy and identification' page for species that have a 'full review'. The 'MCS' Code is a reference to the codes listed in the species directory (Howson & Picton, 1997) and the BIOTIC entry for *Crangon crangon* (the most closely related species in MarLIN to *P. macrodactylus*) follows the taxonomy in the Crustacea section (Holmes *et al.*, 1997) of that publication. The more recent European Directory (Costello *et al.*, 2001), used as the basis for the European Register of Marine Species (ERMS) and the World Register of Marine Species (WoRMS) follows a recent review of crustacean taxonomy (Martin & Davis, 2001) in

its Crustacea section (Türkay, 2001). It includes several taxonomic levels additional to those listed by MarLIN that would, along with authorities for all levels, be relevant to a full attribute review. Other useful nominal attributes would include the type locality and location of type material. BIOTIC excludes authors and certain taxonomic levels and erroneously states 'Maxillopoda' as the class for Decapoda.

Taxonomy references given in BIOTIC for *C. crangon* include only simple identification guides (Hayward & Ryland, 1990; Naylor, 2000) and a species list (Howson & Picton, 1997); there is a similar problem in ERMS/WoRMS. The primary taxonomic references for a species are its original description and most recent full description, in this case (Milne Edwards, 1837). Identification literature can be summarised in terms of mention of the species, text description, drawing, photographs (colour / black and white), keys and, crucially, numbers of related species included and for which area.

MarLIN's identification section is used for brief descriptions and comparison with other species. It is important to distinguish identification from taxonomic issues, which would include discussion of the possibility of a species being split or synonymised at a later date and taxonomic confusion in the group.

Identification issues with *P. longirostris* involve confusion with other members of the genus. It is distinguishable from most other European species by its many dorsal rostral teeth, usually 7-8 (Smaldon *et al*., 1993) but this can be variable (de Man, 1915). In British waters, the species most likely to be confused are those with similarly large numbers of dorsal rostral teeth: *P. elegans* Rathke, 1837 and the recently introduced *P. macrodactylus* Rathbun, 1902, both of which may be found in similar habitats. *P. elegans* has a shorter dactylus relative to its propodus. Several recent publications include identification keys to distinguish *P. macrodactylus* (Ashelby *et al*., 2004; Udekem d'Acoz *et al*., 2005; Gonzalez-Ortegon & Cuesta, 2006). Distinguishing features stated between that species and *P. longirostris* include the stronger rostrum dentition in *P. macrodactylus*, the fusion of the flagellae of the outer antennular rami for a longer distance in *P. longirostris* and the more convex and expanded ventral margin of the rostrum in *P. longirostris*. Additionally, the dentition

of peraeopod 2 is stronger in *P. macrodactylus*. The species is reasonably **recognisable** from preserved material, with no incorrect identifications from 13 identifications in a ring test (see Chapter 4) through the National Marine Biological Quality Control (NMBAQC) Scheme (Hall & Worsfold, 2005). Specimens of other palaemonids were however, incorrectly named as *P. longirostris* in the same exercise, including two *P. macrodactylus* and one *P. serratus*. There would be greater possibility of error with *in situ* identifications, particularly for records made since the introduction of *P. macrodactylus* but before it was well-known in Europe.

There follows, in BIOTIC, an '**additional information**' subsection and 'taxonomy references'. 'Additional information' includes identification features and information on productivity and use by birds and humans. Identification issues would make a natural subsection, distinct from taxonomic issues, while the other information fits elsewhere.

3.6.2 Distribution and habitat

Distribution is a fundamental part of the body of knowledge for a species. Recent original taxonomic literature includes lists of material examined for those species fully described which then form the basis of distribution summaries. Identification guides summarise information from the taxonomic literature and, where possible, include additional records. Distributions may be stated as generalised ranges (for widespread species) or lists of individual records (for uncommon or poorly known species). Some guides include more structured data in the form of sea area records and maps may illustrate general distributions or specific records. Additional records may be included in taxonomic updates or in papers that present records. The latter may be included in ecological studies or in local species lists but publication of new distribution information for species is highly sporadic, except where a recording scheme has produced an atlas for a taxonomic group. Identification guides may include anecdotal distribution data.

Most published distributional data for *P. longirostris* is in generalised form. **Globally**, it is recorded in brackish waters from Britain and Germany to the Mediterranean Sea (Smaldon *et al*., 1993; Udekem d'Acoz, 1999). The northern limit

for the species has been cited as the River Geeste, Germany (Gonzalez-Ortegon *et al*., 2005) and the southern limit as Morocco (Lagardere, 1971), although it has recently extended its range to the Baltic coast of Germany (Zettler, 2002) and there are unpublished data for Angola. **Biogeographic range** appears not to be defined in BIOTIC and not researched for any species; the term may refer to standard biogeographic regions or may be identical to global distribution.

The first **British records** (Gurney, 1923) were from rivers flowing into Breydon Water, Norfolk. *P. longirostris* has since been found sporadically around southern coasts (Smaldon *et al*., 1993) and recorded as common in east Norfolk, including Breydon, the Waveney at Haddiscoe and the New Cut (Great Ouse) at King's Lynn (Hamond, 1971). There are also records from the Thames, from Kew through Greenwich to Crossness and Purfleet (obtained from Environment Agency sampling (Attrill, 1998), the Tamar between Calstock and Cargreen (Campbell & Jones, 1989b, c; 1990) and an unconfirmed record from Milford Haven (Welch & Lucas, 2002).

As evidenced in Chapter 2, most records of marine invertebrates remain unpublished and exist in stored data tables or 'grey literature' (unpublished reports). Such records may be incorporated into data capture exercises. Some of the available data for British material are collated by the Marine Life Information Network (MarLIN) through the Data Archive for Seabed Species and Habitats (DASSH; www.dassh.ac.uk) and incorporated into the UK National Biodiversity Network Gateway (www.searchnbn.net). They include old records of *P. longirostris* for east Norfolk and one for the Blackwater Estuary. There are also records from north Wales (Llyn Peninsula) and the Clyde Sea, though these seem unlikely. European data are collated by the European Ocean Biogeographic Information System (EurOBIS) programme, hosted by the Marine Biodiversity and Ecosystem Functioning EU Network of Excellence (MarBEF; www.marbef.org). The EurOBIS map for *P. longirostris* includes some of the DASSH records, along with generalised points to represent the south and west coasts of England. So far as I am aware, all published and unpublished records from the British Isles have been included.

Palaemon longirostris is presumed **native**, as Britain is within its global range. However, Van den Brink & Van der Velde (1986), following Tesch (1922), describe it as 'originally a southern European species', with the implication that it has moved north. There is a sense in which nearly all north European fauna has moved north from southern Europe, since glaciation. Nativeness would depend upon whether human impact assisted dispersal, which is difficult to quantify. Several marine species native to southern and western Europe have been discussed as non-natives where they expand their ranges to the eastern North Sea and Baltic (Wolff, 2005), including *P. longirostris* in Germany (Zettler, 2002) and *P. elegans* in Poland, where the latter has been observed to replace the 'indigenous' *P. adspersus* (Grabowski, 2006).

Habitat preferences are sometimes included under 'distribution' in taxonomic literature or may form a separate 'occurrence' section. The data are generally quoted without analysis from available records. Later ecological studies may add detailed analyses of habitat requirements but these are only available for a few species.

The **depth range** of *P. longirostris* is restricted by dependence on estuaries but few actual records are available. It may be found immediately below the water level (0m) at low tide (present records). It is possible that it would move over the intertidal region at high tide.

Substratum preferences have not been specifically investigated, as the prawns are commonly found in mid water but they have been found alongside hard substrata, including artificial and sometimes amongst *Fucus ceranoides* (Bourdon, 1965), as well as over a variety of sediment types, from mud to mixed gravel. The **physiographic preference** is almost always cited as estuarine, especially the upper brackish reaches of large rivers (Smaldon *et al*., 1993; Gonzalez-Ortegon & Cuesta, 2006). Although lagoons are also mentioned as a habitat by Barnes (1994), Sorbe (1983) states that it is absent from drainage channels. Quantitative ecological data are available for the Seine (Mouny *et al*., 2000). All records of *P. longirostris* are from the sublittoral fringe or shallow water but in the turbid waters of estuaries, **biological zones** may grade from infralittoral to circalittoral (devoid of attached plants or algae)

within a few metres depth. The definitions provided in BIOTIC (from Hiscock, 1990) relate only to hard substrata in open waters. **Wave exposure** in estuaries (where all *P. longirostris* records have been made) ranges from sheltered to ultra sheltered and **tidal stream strength** and **water flow** would be generally high, although current speed data are not available to categorise accurately. *P. longirostris* is tolerant of a wide **salinity** range (Gurney, 1923; Sorbe, 1983) and may be found from the outer reaches of estuaries upstream to beyond the tidal limits (Van den Brink & Van der Velde, 1986). In the Thames (Attrill, 1998), this includes mean quarterly salinities of between 0.08 g/l (at Kew) and 20.20 g/l (at Purfleet). The species is most frequently recorded towards the upstream end of its estuarine range (0-5 psu), though it can tolerate 0-28 ppt (Sorbe, 1983), and its abundance significantly correlates with salinity (Mouny *et al*., 2000). It is found in freshwater conditions near the tidal limit of the Great Ouse at Earith (Willing, 2007) and records from far upstream also exist for the Gironde (Sorbe, 1983) and the Meuse (Van den Brink & Van der Velde, 1986). It is less common further downstream and was absent from a survey of coastal lagoonal and outer estuarine habitats in the Netherlands and Belgium (Udekem d'Acoz *et al*., 2005); it is absent from the open sea (Gurney, 1923). Salinity tolerance has been investigated experimentally (Campbell & Jones, 1989b), as well as osmoregulation, which was found to be very effective between 0.5 and 34 ppt; prawns osmoregulate more effectively in summer than in winter; *P. longirostris* has a greater osmoregulatory capacity, even than most other palaemonids (Campbell & Jones, 1989b). **Other environmental factors** that may influence species distribution include turbidity, which significantly positively correlates with abundance of *P. longirostris* (Mouny *et al*., 2000) and dissolved oxygen, which shows no significant pattern, although anoxic conditions are surmised to eliminate it (Van den Brink & Van der Velde, 1986; Mouny *et al*., 2000). High Ammonia levels may also be detrimental to *P. longirostris* (Van den Brink & Van der Velde, 1986). Some of these factors are considered by MarLIN under 'sensitivity'.

Seasonality is only included in MarLIN in terms of reproductive season but many species exhibit seasonal changes in abundance and distribution. *P. longirostris* are found further upstream with decreased flow in the Thames (Attrill, 1998), which would have a seasonal trend. They have been found more commonly caught in winter

in the Seine (Mouny *et al*., 2000). The species has been observed to migrate from the upper estuary in summer to the outer estuary in winter in Portugal (Marques & Costa, 1984; Cartaxana, 1994) and France (Marchand, 1981; Marchand & Alliot, 1981; Sorbe, 1983). Peaks in numbers have been observed in spring and autumn in freshwater parts of Dutch rivers (Van den Brink & Van der Velde, 1986). **Long term changes** in abundance and distribution can be inferred from records. Gurney (1923) did not find the species in any estuary between Norfolk and the Thames, except Breydon Water. Similarly, in the Netherlands, the species was once commonly recorded, described as rare in the 1960s and 1970s and, later, frequently found once again (Van den Brink & Van der Velde, 1986). There are several possible explanations. Van den Brink & Van der Velde (1986) suggested that cold winters could lead to low numbers in certain years for a species at the northern edge of its range. Changes in water quality may also affect abundance. The water quality of the Thames has greatly improved in the last 30 years (Attrill, 1998) and *P. longirostris* may have found conditions favourable and recolonised since then. Similar improvements are reported for the Rhine and Meuse, with increased oxygen and decreased ammonia corresponding with higher abundance of *P. longirostris* (Van den Brink & Van der Velde, 1986). The species has also extended its range inland since 1970 in the Netherlands, with increased chlorinity, due to salt mine effluent, suggested as a possible cause (Van den Brink & Van der Velde, 1986).

Species associations are not currently summarised by MarLIN, although they are an integral part of the **biotope** concept, which they consider separately. British marine benthic biotopes have been defined by Connor *et al*. (1997a; 1997b; 2004). Different associations are recorded for different size scales and environmental positions of biota. Those listed by Connor *et al*., (2004) are based on conspicuous epibenthic taxa such as would be recorded *in situ*, for hard substrata, while most of their soft substrata biotopes are based on infaunal macrofauna, such as would be recorded by sediment core or grab sampling. It may be convenient to classify scales of species associations in terms of typical sampling method. *Palaemon longirostris* belongs to the suprabenthic or hyperbenthic group of communities (benthic boundary layer), such as would be recorded by trawl, sweep net or epibenthic sledge sampling, and they have not been formally classified for management purposes. However, Mouny et al.

(2000) described an estuarine assemblage, dominated by *Neomysis integer*, *Pomatoschistus microps* and *P. longirostris*.

Palaemon longirostris is most effectively **sampled** by netting, either trawls (Gurney, 1923; Cartaxana, 1994), hand nets (Campbell & Jones, 1989), or fixed nets (Sorbe, 1983). They can also be sampled from the cooling water intakes of power stations (Van den Brink & Van der Velde, 1986).

3.6.3 General biology

The MarLIN database includes **size** ranges and sizes at maturity for males and females; BIOTIC gives a more generalised size category. Measurements for decapod Crustacea are most accurately recorded in terms of carapace length. Total body length (measurements from rostrum tip to telson tip - Van den Brink & Van der Velde, 1986) may provide a more comparable concept of size (in terms of comparison of different taxa and ecological roles). Biomass (wet weight or ash free dry weight) might also be considered a measure of size. Several measures were used by Cartaxana (2003a) and females found to grow larger than males. Total body length is likely to be the measure used by MarLIN and BIOTIC, as well as by Smaldon *et al*. (1993), who state 77mm as the maximum length for *P. longirostris*. Females may reach maturity at 10mm (Sorbe, 1983) but mature female size range is given as 50 – 77 mm by Gurney (1923); 35 – 77 mm for males. Other sex differences, described by de Man (1915), are mostly minor, so the species could be described as having slight **sexual dimorphism**. According to the MarLIN classification, the **growth form** of *P. longirostris* would be categorised as articulate, its **mobility/movement** as swimmer/crawler, **environmental position** as suprabenthic (Mouny *et al*., 2000), which equates to hyperbenthic of Lincoln *et al*. (1998), and **dependency** as independent. **Flexibility** is a problematic concept as it depends upon which part of the animal is considered. In the MarLIN database, for example, the shore crab (*Carcinus maenas*) is listed as not flexible, while the brown shrimp (*Crangon crangon*) is considered highly flexible. Both species, however, have an equally solid carapace and flexible abdomen; their 'flexibility' is in this case a function of the relative proportions of these parts. Crustacea are generally only flexible at certain points, which contrasts with, for example, some polychaetes that can bend at any

point in any direction. *P. longirostris* has body proportions similar to those of *C. crangon* and is more inclined to flex its abdomen so would be considered highly flexible. It is not **toxic** and is edible, as discussed elsewhere.

The **behaviour** of *P. longirostris* has received some attention. Moulting techniques are described by Gurney (1923) and a circadian swimming rhythm observed by Fincham & Furlong (1984). The latter gave way to a tidal rhythm for pre-ovigerous females, with a free-running period of 22 – 23 hours. Temperature-induced variations in activity have also been inferred (Van den Brink & Van der Velde, 1986). Adults **migrate** downstream from the upper to the lower reaches of estuaries to breed (Cartaxana, 1994) and active diel migrations associated with tidal flow are likely but not demonstrated (Smaldon *et al*., 1993). Adults can move towards suitable conditions and have been noted as occurring upstream with decreased flow in the Thames (Attrill, 1998).

Adult dispersal potential can be assumed to be potentially high for any motile species and the migratory behaviour of *P. longirostris* would accentuate this. However, as adults have not been reliably recorded from full salinity waters, it may be incapable of dispersal beyond home water bodies, isolated by salinity and river catchment limits.

The species' '**sociability**' could be described as gregarious, as it is found in dense shoals (Smaldon *et al*., 1993) but it is not clear whether the shoals would be considered as groups or communities, according to the MarLIN definition. *Crangon crangon*, which may also shoal, is listed as solitary.

The **population dynamics**, **growth** and **growth rate** of *P. longirostris* have been studied in Portugal (Cartaxana, 2003a).

Feeding in *Palaemon longirostris* has been examined through stomach analysis and **feeding method** identified as mainly predatory in adults, though they also scavenge (Sorbe, 1983) and can be fed on mussel or fish portions in captivity (Campbell & Jones, 1989c). The **typical food type** for adults (specimens over 15 mm in length) in

the Gironde is mainly Crustacea, particularly mysids, such as *Neomysis* and *Mesopodopsis* (Sorbe, 1983). Post-larvae and juveniles feed upon copepods and larvae may eat diatoms (Sorbe, 1983). Feeding follows the tidal cycle (Sorbe, 1983). Species have been assigned codes for use in ecological analysis. The Infaunal Trophic Index (**ITI**) is based on feeding group, as is the **AMBI** group (Borja et al., 2000), though the latter includes a category for tolerance of high impact. The AMBI group is included under 'distribution' in BIOTIC.

P. longirostris' **toxicity** is non-toxic; it is edible to humans (Hamond, 1971) and liable to **predation** by birds and fish but no predation data are available.

3.6.4 Reproduction / life history

Palaemon longirostris has a gonochoristic **reproductive type**. Its **developmental mechanism** involves carriage of eggs by ovigerous females, followed by release of planktonic larvae. In BIOTIC, Decapoda are described as planktotrophic, in reference to the planktonic larvae, and sometimes also as oviparous, as eggs are produced (though retained by the female). The largest females bear the most eggs (Cartaxana, 1994). The typical **sex ratio** appears to vary, which may be due to non-synchronised migrations (Cartaxana, 1994), with males becoming active earlier in the season than females (Van den Brink & Van der Velde, 1986).

The **reproductive season** is most often described in terms of presence of ovigerous females. In Portugal (Marques & Costa, 1984; Cartaxana, 1994) and Morocco (Lagardère, 1971), it begins in January, reaches a maximum in spring (March, April and May) and lasts until summer. The season may be later in the northern parts of its range. Smaldon *et al*. (1993) note April to August for Britain and similar late starts are quoted for the Netherlands (Holthuis, 1950) and France (Marchand, 1981; Sorbe, 1983). A **gestation period** (females carrying eggs) of 3-4 months has been recorded (Sorbe, 1983). The **reproductive location** is in the lower reaches of estuaries, to which it migrates from upper reaches (Smaldon *et al*., 1993; Cartaxana, 1994). Migration to more saline environments is necessary for completion of the life cycle (Cartaxana, 1994). The eggs do not hatch in fresh water (Gurney, 1924). The **reproductive frequency** has been surmised as an annual cycle, with females

surviving after breeding (Cartaxana, 1994). Two broods are hatched in a season (Gurney, 1923), i.e. annual episodic. Its **age at reproductive maturity** can be inferred as one year (Gurney, 1923). No simple volumetric relationship was found between brood size and carapace length at any egg stage (Cartaxana, 2003b). **Generation time**. The mean **fecundity** was 957,282 SD in Portugal (Cartaxana, 2003b). Numbers of eggs per female range from 300 to 1600, with more for older females (Van den Brink & Van der Velde, 1986).

Egg size has been given as 0.8 – 0.9 mm by 0.65 – 0.7 mm (de Man, 1915) or 0.7 – 0.9 by 0.5 – 0.7 (Van den Brink & Van der Velde, 1986). Mean egg volume may increase by 17% from the early to the late development stage (Cartaxana, 2003b).

3.6.5 Larvae / juveniles

The larval development of *P. longirostris* has been described by Fincham (1979) and descriptions, with keys to palaemonid larvae provided by Fincham & Figueras (1986), from laboratory reared material. Williamson (1957) provides a key for the identification of major groups for decapod larvae. Larvae are released into the water on hatching, as pelagic zoeae, 3-4 mm in length, in the lower estuary (Sorbe, 1983; Fincham & Figueras, 1986). The earliest stages are marine (Gurney, 1923). These pass through a series of moults that can be defined as seven zoeal stages, though there may be fewer stages in the wild than in the laboratory (Fincham & Figueras, 1986). Stage IV may be reached 13 days after hatching (Gurney, 1924). Stage V is found mainly in July (Sorbe, 1983). Length may increase faster in northern, than in southern populations (Fincham & Figueras, 1986). The post-larval (megalopal) stage follows, becomes more epibenthic (settlement) and moves upstream (Sorbe, 1983) when 6mm in length (Smaldon *et al*., 1993). All post-larval stages can be found in the upper reaches of estuaries (Sorbe, 1983). Larvae are more common near the banks of rivers than in the mid channel (Sorbe, 1983). The **Larval/Juvenile dispersal potential** has not been calculated in terms of distance but would be low compared to planktotrophic species from fully marine habitats (Fincham & Figueras, 1986), while high relative to direct developers The possible recolonisation of estuaries in recent years (see ‘long term changes’) may suggest larval dispersal potential between estuaries.

Young prawns, 19 – 25 mm long are found far upstream by late August (Gurney, 1923) and 25 mm juveniles are first recorded between October and December in the Netherlands (Van den Brink & Van der Velde, 1986), so late summer can be said to be the **larval settlement period**, with a **duration of larval stage** of about two months including zoeae and megalopa). There is little growth in winter (Van den Brink & Van der Velde, 1986). One year old females are between 40 – 50 mm in length; two year olds are about 60 – 70 mm (Van den Brink & Van der Velde, 1986). The **life span** of *P. longirostris* has been recorded as two years (Van den Brink & Van der Velde, 1986; Sorbe, 1983) but may be longer, as larger prawns may be more difficult to catch (Cartaxana, 1994).

Regeneration potential is not explained in BIOTIC but may relate to colony regeneration in sessile species.

3.6.6 Sensitivity to impacts

Sensitivity information is included in MarLIN full reviews of species but not in BIOTIC. A table summarises sensitivity to a list of potential impacts in terms of 'intolerance', 'recoverability' and 'sensitivity'; an 'evidence/confidence' assessment is made on the information provided for each impact. A value for each factor for each impact is given on a sliding scale, defined differently for each. Sensitivity to each impact is discussed in a linked text passage that includes references. Sensitivities are generally derived by inference from published information on related topics. *Palaemon longirostris* has been experimentally shown to eliminate polychlorinated biphenyls faster than two other estuarine species: *Hediste diversicolor* and *Platichthys flesus* (Goerke & Weber, 2001).

3.6.7 Importance

Like sensitivity, importance is included in MarLIN full reviews but not in BIOTIC. **National importance**, a measure of rarity, is defined in terms of numbers, or proportion, of 10 X 10 km squares from which a species is recorded (Lieberknecht *et al*., 2003). It has been described as "little known in the British Isles" (Smaldon *et al*., 1993) and as only sporadically known from northwestern Europe (Barnes, 1994). It is not included in the IUCN **Red List** of Threatened Species, **listed under** other

conservation directives or in the review of nationally rare or scarce marine species (Sanderson, 1996). It can, however, be considered to have conservation value due to its patchy distribution and restricted habitat and has been given a 'conservation score' of 5 (/10) (local) by Chadd & Extence (2004), in their review of freshwater species.

Two important biogeographical concepts, **occupying space** and **excluding**, are not defined by MarLIN but would not appear to apply to mobile animals, such as prawns; neither would such animals **provide habitat structure**. *P. longirostris* is likely to be an **important food source** for fish and birds, as it is often the largest invertebrate in its habitat but there is no direct evidence.

P. longirostris has little **commercial importance** in Britain and hence no **management measures**, although it has been eaten and described as lacking flavour and muddy (Hamond, 1971). There is, however, a long history of commercial exploitation in Europe, as in France (Sorbe, 1983), the Netherlands (Holthuis, 1950) for bait and human consumption and I once received a request to supply the species to a seafood merchant. It has a Fishery 3 alpha code: PIQ.

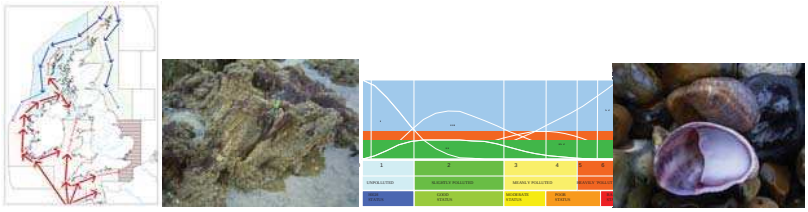
3.7 A taxonomy of species attributes

As with sample data (Chapter 2), species attributes can be broadly classified into four analogous groups:

- primary (1') attributes give basic information about the species,
- secondary (2') attributes link the species to data from other sources,
- tertiary (3') attributes relate to human interest or value,
- quaternary (4') attributes are abstract concepts or labels that provide no information in themselves but are essential for information transfer.

Shape (1’) Flexibility (1’) Reproductive type (1’) Longevity (1’) Body form (1’) Growth pattern (1’)

Distribution (2’) Habitat preference (2’) Sensitivity (2’) Native status (2’)



Most appropriate sampling method (3’) Recognisability (3’) Protected status (3’)

Figure 3.7.1. representations of various species attributes.

3.8 Discussion

Several elements in the content of this chapter relate to the wider aim of this thesis. The application of data to the assignment of species attributes as used here as an example of the wider potential of data. However the **value** of such information should be assessed. Thus the next stage is to explore the potential for different types of data to be used in order to improve our knowledge of marine species. The species information must eventually be compared with the value of the original stated purpose of the data in order to assess whether the greater part of the value derives from the stated purpose or from the wider potential.

While items of information have been associated with species since the origins of the species concept, most attempts to systematically assign attributes to multiple species have been relatively recent and generally associated with the development of tools for

environmental management, such as through biological traits analysis (Bremner et al., 2006). Initially, classifications involved only those attributes and species to be used for particular analyses but the most recent developments (BIOTIC) include attempts to standardise the information available for each species. As the term 'trait', which is often applied to items of species information, is applicable only to those characteristics that can be said to be properties of the organism (such as size or body shape) and not to more abstract concepts (such as a species' taxonomic position or available literature sources), the term 'attribute' can be used to cover any item of information about a species. A standardised classification of attributes would be desirable for a range of potential analyses. The number of 'traits' used in community analyses has been identified as significant to 'power of traits analysis'. The nature of the trait classification system would clearly have an impact on such observations. Significant progress has been made through the MarLIN project. There remains however some potential for further refinement of the classification, some of which has been highlighted through the assignment of available information to attributes for one species that has been carried out here. It is to be expected that future refinements will continue to be made, in much the same way that adjustments continue to be made to other taxonomic systems in biology.

Identification of the sources of information on particular species is a significant component of attribute assignment. In the case of *Palaemon longirostris*, basic physical descriptions were made during the initial establishment of the species, although it awaits a modern redescription. The species has been included in more recent summary literature (identification guides), with the reproduction of some of the original information. Published information on the distributions and habitat preferences of many marine invertebrates is restricted to records included within taxonomic revisions and such records are always necessarily incomplete. For *P. longirostris*, more recent published records have been incorporated within more detailed studies of the species' biology. As with other species, other records are available as unpublished survey data, some but not all of which are available through national and international data collation projects. The reliability of such records requires study, as is also true for some published data, but they have the potential to add significantly to the available information for all species.

3.8.1 Value of the information

How well-known is the prawn *Palaemon longirostris*?

Most of the information has come from publications that detail studies specific to the species. However, the apparent gaps in information might be best filled by the use of data from wider sources, at least for certain attributes. In particular, distribution, rarity and habitat preference might potentially be assigned through the collation of all sample data with the potential to record the species. This would have implications for the original collection and storage of such data.

4. Chapter 4. Applicability of data to the characterisation of marine species

4.1 Introduction

As discussed in Chapter 2, benthic data display a variety of attributes. Surveys are carried out for different initial purposes, by various organisations, with the use of a range of sampling designs and methods and with sorting and identification carried out by one of several different laboratories, by different methods. The resulting variability in the data creates potential problems for data collation and its use in the provision of species attribute information. The purpose of this chapter is to summarise and address these issues.

Most of the chapter is organised, as for Chapter 2, in a data-creation sequence, from survey design to data curation, with a review of variability and potential problems, together with solutions for each stage in the process. A more detailed analysis is provided in the section on data quality, for which the published literature is limited. Implications are discussed in the final part. Firstly, most data comparability issues at each stage have been considered through a national scheme, which is introduced below.

4.2 The NMBAQC Scheme

In 1994, the National Marine Biological Quality Control (NMBAQC) Scheme was established to address quality assurance and analytical quality control for marine samples (www.nmbaqcs.org). The Scheme was originally conceived for National Marine Monitoring Plan (NMMP) samples but has since expanded to consider any marine samples. In 2004, the Scheme became nested within the EU's Biological Effects Quality Assurance in Monitoring (BEQUALM) programme (www.bequalm.org).

Figure 4.2.1. Logos of the NMBAQC Scheme and BEQUALM.

The Scheme has considered data quality issues at all stages in the data-creation process. The details are considered under the separate headings, below.

4.3 Non-uniform sample coverage (survey design)

Survey design means the spatial and temporal arrangement of samples in a survey, or survey programme, and is distinct from sampling methodology, see below. Typically, a benthic survey will have been designed for a specified initial purpose, with a sampling design that reflects its needs. The design may involve multiple methodologies and the collection of various associated non-biological data. The data used in this thesis derive from seabed samples, sorted for enumeration and identification of macrofauna.

The most common arrangements of such samples include regular grids, random samples, stratified random or regular samples (i.e. within defined areas), transects across features of interest and crosses or stars over points of interest. Generally, such features and points will represent potential anthropogenic impacts, such as gravel extraction areas, pipelines, built structures or pollution sources. Sampling plans will typically involve more intense sampling in the immediate Primary Impact Zones, with fewer samples in more distant Secondary Impact Zones, and a smaller number of more distant Reference Stations. There is also considerable variability in the number and arrangement of replicate samples at a station or within an area. Similar considerations affect the timing of surveys, which also show an irregular, non-random distribution.

Much has been written on the usefulness of different designs for their specified purposes for research purposes. There are also national guidelines for survey designs

recommended for impact assessment and monitoring in different sectors of industry, such as aggregate extraction (Ware & Kenny, 2011) or oil and gas (OSPAR, 2004).

4.3.1.1 Implications of differing survey designs

It is not the purpose of this thesis to review the reasons for different survey designs except as a means to understand why data from multiple sources may not be collected according to a statistically random or regular pattern across an area. Any interpretation must be made in appreciation of this.

4.4 Variation in sampling methodology

Sampling methodology is a reference to the technique by which a sample is collected and covers both the equipment used and the details of the procedures followed in the use of that equipment. As with survey design, sampling methodology varies between surveys, partly due to the needs of the stated purpose but also as a result of convenience and tradition.

In addition to the differences in chosen sampling methods, the way in which processes are carried out may differ between survey teams. Standard operating Procedures (SOPs) and national protocols exist for most methods. Cooper & Rees (2002) reviewed twenty three SOPs submitted by NMBAQC Scheme participants, identified the main components of variability and suggested areas for improvement.

4.4.1 Implications of differing sampling methods

Differing sampling methods affect the species recorded and also present a need to standardise data in terms of numbers per unit of surface area. There are two important, and paradoxical, conclusions to be considered in the use of data are:

- comparisons must be made between samples collected by standardised methods or, preferably, a single method and
- it will not be possible to obtain information on every species by use of only one method.

4.5 Differences in laboratory practice

Once the limitations of the available spread of samples and the discrepancies in sampling methods have been addressed, there remain issues with variations in the way

macrofauna are recorded within samples, whether as a result of deliberate differences in practice or unintentional inaccuracies in recording (quality). Many laboratories operate according to a documented SOP. Such documents may be available for review but are occasionally considered confidential.

The procedures used in the analysis of samples from any particular project will be influenced by the laboratory SOP, as well as by national guidelines and by details specified for the project by those responsible for its commission. For example, samples from a characterisation survey for a gravel extraction licence area may need to analysed according to standard guidelines for the industry, as well as conform to requirements specified through the NMBAQC Scheme and to the in-house SOP of the laboratory that carries out the analysis; the latter may, in turn, be embedded in the accreditation systems (such as ISO) of the laboratory.

Some of the more significant factors that can vary at the level of analysis in the laboratory are discussed below.

4.5.1 Mesh size

The sieve mesh size at which sample sediment is sorted is usually stated at the outset of a project and is typically either 0.5 mm or 1 mm for macrobenthos samples. Sieving may be carried out at the sampling site as well as in the laboratory.

It must be recognised that a stated mesh size will not fully standardise the size range of animals recorded in a sample (Gage *et al*., 2002; Schlacher & Wooldridge, 1996). This will depend upon details of the actual sieving process, such as how thoroughly the sediment is agitated and when sieving is carried out relative to sample collection and preservation (Degraer *et al*., 2007), as well as the proportions of the animals (elongate species will be more likely to pass through a sieve than spherical ones of the same size) and the condition and orientation of the specimens. For example, species that are liable to contract will be retained at different mesh sizes for the same sized animal.

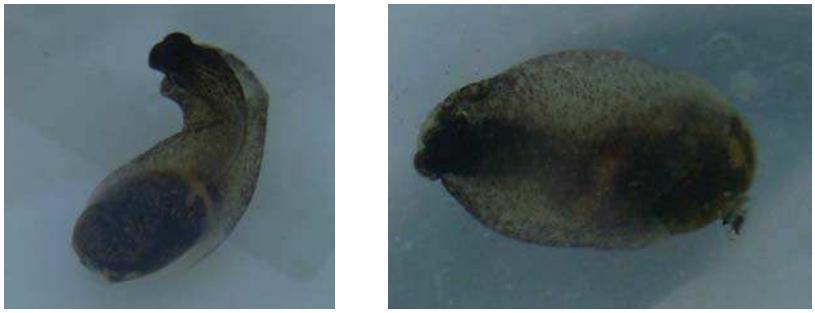


Figure 4.5.1. The slug *Akera bullata* in different postures, as an example of different shapes exhibited in the same individual.

Also, the prevalence of juveniles will skew the numbers of any particular species retained for enumeration such that the recorded count of many typical macrofaunal species may not reflect the true number in the area, if juveniles are considered (Crewe *et al*., 2001).

4.5.2 Subsampling

Subsampling is another process that varies between samples but which should be specified at the outset. If a sample of a given surface area contains very large numbers of individuals or a very large volume of material, it may be deemed necessary to sort only a proportion of the sample, in order to save time. One method that has been approved by the NMBAQC Scheme separates a water-suspended fraction of a sample into four equal parts, to allow analysis of only ¼ of the sample. A simple subsample may be used for large sample volumes. For large numbers of individual animals, the ¼ subsample may be used for counts of the superabundant taxon (as is often the case with oligochaete worms), while the entire sample may be searched for rarer (in terms of abundance within the sample) species. Such techniques have the potential to cause inaccuracies in the data but are generally carried out only where considered necessary and where there is little danger of serious distortion in the results. Also, subsampling will generally affect only a proportion of samples within a survey, such that any inaccuracies will apply to the original study as much as to later applications of the data. Nevertheless, it is useful to identify subsampled samples, and the details of the method used, and to recognise the potential for error in the interpretation of results from collated data.

4.5.3 Recording policy

There are subtle differences in laboratory practice that may not always be explicitly stated in the methods associated with data sets, such as differences in recording policy for the taxa found. These result in inconsistencies between data, such as exclusion of certain taxa, variable records of juveniles and differences in taxonomic discrimination. I have previously designed a questionnaire on laboratory methods that was circulated to NMBAQC Scheme participants and results produced as a report (Worsfold & Hall, 2001; Appendix 2). The issues most relevant to the thesis are summarised below.

4.5.3.1 Non-recorded taxa

Many laboratories have a policy to exclude certain taxa from the data or to ignore them, sometimes at the suggestion of published guidelines (e.g. OSPAR, 2004). For offshore surveys, animals such as flying insects or spiders may be assumed to have entered samples from the vessel or sample containers, rather than the seabed and can be sensibly ignored but the practice may extend to legitimate benthic organisms. Planktonic animals are often ignored, although many may be found close to the seabed. Similarly, mobile species, such as fish, often rest on the seabed but may be ignored and similar policies can even extend to any taxa considered to be epibiont, such as Bryozoa, barnacles, or even gastropods. Organisms that cannot be counted, such as Hydrozoa, Bryozoa, algae and sponges may also be ignored, as may those considered to be meiofaunal, such as Nematoda or copepods. Often, the groups that were ignored are not explicitly stated, or the SOP may become detached from the data (e.g. through loss of details on which laboratory carried out sample analysis).

4.5.3.2 Distinction of juveniles

Juvenile animals are a continuous problem in data comparability and applicability. It is common for identification guides to state that they are only suitable for adult specimens and some data processing guidelines require that juveniles be excluded (e.g. OSPAR, 2004). Unfortunately, standard definitions of juveniles (in terms of sizes or juvenile features) are lacking for most species. As such, each laboratory has different policies on which species require distinction between adults and juveniles and the way in which they are distinguished. In some cases, the distinction is made

on the basis of whether the species is identifiable at a particular size; sometimes the proportion of the specimen to the published maximum size is considered; rarely is the distinction made on actual reproductive maturity, which is impossible to ascertain for most macrobiota. The issue is too complex for a national policy to have been attempted to date and the in-house policies of laboratories are generally in a state of continuous development; they rarely exist within citable documents.

4.5.3.3 Taxonomic discrimination

There is considerable variation in the level of taxonomic discrimination (i.e. the taxonomic level to which a specimen has been identified) applied to different types of organisms. The concept is distinct from the accuracy of identifications (see quality, below). There is also a distinction between the taxonomic identification level required for a project and that which is actually attempted in practice. Several studies have investigated results from samples analysed at, for example species or family level in order to identify taxonomic levels required (taxonomic sufficiency) for a particular statistical analysis (Warwick, 1998). However, most studies in UK waters state a requirement for identification at species level, where practicable, and the variation in identification practicability between laboratories has much potential to impact the applicability of multi-source data to wider use. As with discrimination of juveniles, there is no national policy and individual laboratories have their own procedures (traditions), most of which are under continuous development and unpublished.

4.5.4 Implications of differences in laboratory practice

Data comparability can be addressed through the development of standard protocols and I have been involved in the development of the NMBAQC Scheme's Processing Requirements Protocol (PRP) (Worsfold *et al*., 2010; Appendix 2). This has helped to standardise many elements of laboratory practice, such as to ensure that all taxa are recorded, but several problems remain.

Firstly, the PRP does not yet address the issues of juvenile or taxonomic discrimination. These considerations would require detailed policies to be established for individual species or taxonomic groups and it will take many years for these to be

decided. It is possible, however, that a taxonomic discrimination protocol (TDP) may be developed in future and I have been involved in the production of some draft documents, produced for NMBAQC Scheme, for specific taxonomic groups (Hall & Worsfold, 2002; Appendix 2).

Finally, while compatibility with the PRP is required for samples audited through the Scheme and for many contracted surveys, many projects are carried out outside the remit of the Scheme and it is not always easy to identify which in data separated from their source.

4.6 Variation in data quality

The final element of data applicability is data quality, which varies even between samples collected according to the same protocols and, sometimes, between samples analysed at the same laboratory. For a typical macrobenthos sample, two main elements of data quality can be distinguished: (i) extraction efficiency and (ii) accuracy of identification/enumeration. The first relates to the proportion of animals (retained on the specified mesh) in the original sample that were actually recorded in the data; this usually equates to numbers of animals removed from the sample to a specimen pot, although a few laboratories attempt counts without extraction. Identification accuracy relates to the number of specimens that were correctly identified). Enumeration relates to the accuracy of the count of individuals of each taxon; this is distinct from extraction efficiency (all of the animals of a given taxon could be removed from a sample but incorrectly counted – and vice versa).

Data quality is the main issue addressed through the NMBAQC Scheme. The Scheme is organised into several components, one of which relates to benthic invertebrate samples; there are also components for granulometry and fish data. Four exercises have been designed within the benthic invertebrate component:

- Ring test (RT),
- Laboratory reference (LR),
- Macrobenthos sample (MB),
- Own sample (OS).

The ring test involves the circulation of a collection of specimens to each of the participating laboratories for identification. Care is taken to ensure that the same species are sent to each laboratory and that the size and condition of each specimen is the same for each laboratory. Differences between identifications made by each laboratory are summarised as reports for each circulation; I have been involved in the preparation of most of these reports (e.g. Hall *et al*., 2012; Taylor et al., 2013), the most recent of which is included in Appendix 2. The identities of the laboratories are anonymous and the exercise is aimed at the identification of problem taxa for identification and to assist laboratories with their training towards the improvement and standardisation of data. Where significant problems or disputes are identified, internationally recognised experts may be consulted to confirm identifications.

The laboratory reference exercise allows laboratories to send a collection of problem specimens to the contractors for a second opinion on identifications. The aims are the same as for ring tests and reports are for the use of the participants only.

In the macrobenthos sample exercise, a whole sample is circulated to each participating laboratory for full analysis. The sample may be a replicate collected for the exercise from a point location, or an artificial sample with a known number of individuals of each taxon in a standardised sediment. Data from each laboratory are statistically compared and the samples are re-analysed by the contractor (through a search of the sediment residue for animals missed, as well as checks on all identifications and counts). The reports on all results are presented on the Scheme website (most recently Taylor & Hall, 2012); laboratories remain anonymous.

Own samples are treated in the same way as the macrobenthos sample but have been processed by the participating laboratory, as part of their typical work. The results are presented to the laboratory as a sample audit and reports are posted on the Scheme website, in which laboratories remain anonymous. There are quality standards criteria that must be met for data that are required for the CSEMP and WFD programmes.

A focus on identification is organised through ring test and reference collection check exercises. The results are published on the Scheme website but not written up in the scientific literature.

Figure 4.6.1. Specimen vials prepared for ring tests through the NMBAQC Scheme.

4.6.1.1 Analysis of 'own sample' exercise data

The first NMBAQC Scheme own sample exercise was carried out for a single laboratory in 1995/1996. Since that time, three samples have been audited each year. Standardised quality measures, using Bray-Curtis similarity, were introduced in Scheme Year 8 (2001/2002). Basic statistics on audit results from the NMBAQC Scheme's 'own sample' exercise have been published as tables in the own sample module summary reports, since 2010. There have been four such reports to date, for Scheme years 14 to 17 (2007/2008 to 2010/2011).

For this study, a combined results table was produced for Scheme years 8 to 17. This included data for 681 samples. For each sample, a record was made of the numbers of taxa and individuals recorded by the participating laboratory and the auditor, together with the percentage difference (based on the largest number recorded).

The Bray-Curtis similarity index for the sample data as recorded by the participating laboratory and auditor was noted for each sample. This was the basis for whether a sample passed or failed its audit. A plot was made of the number of samples that attained each 5% interval of similarity between the original data and the audit results.

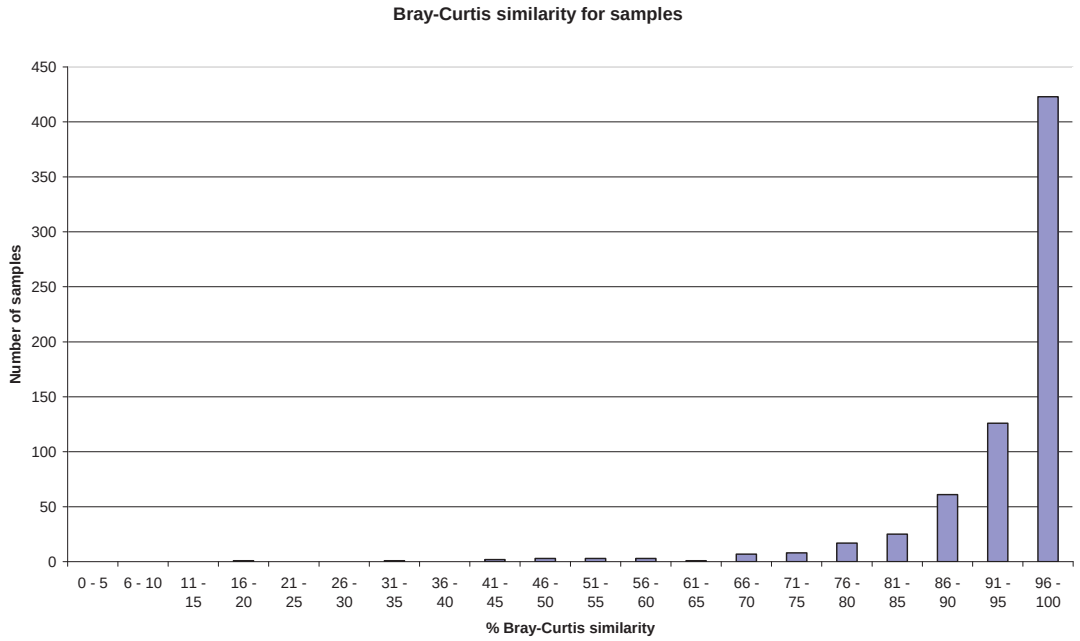


Figure 4.6.2. Numbers of samples submitted through the NMBAQC Scheme within each 5% Bray-Curtis similarity band of comparison between original and audited data.

The majority of samples attained over 90% similarity and the largest category was over 95%. A more detailed plot was produced for high similarity only. The following chart shows numbers of samples that attained over 90% similarity, at 1% intervals.

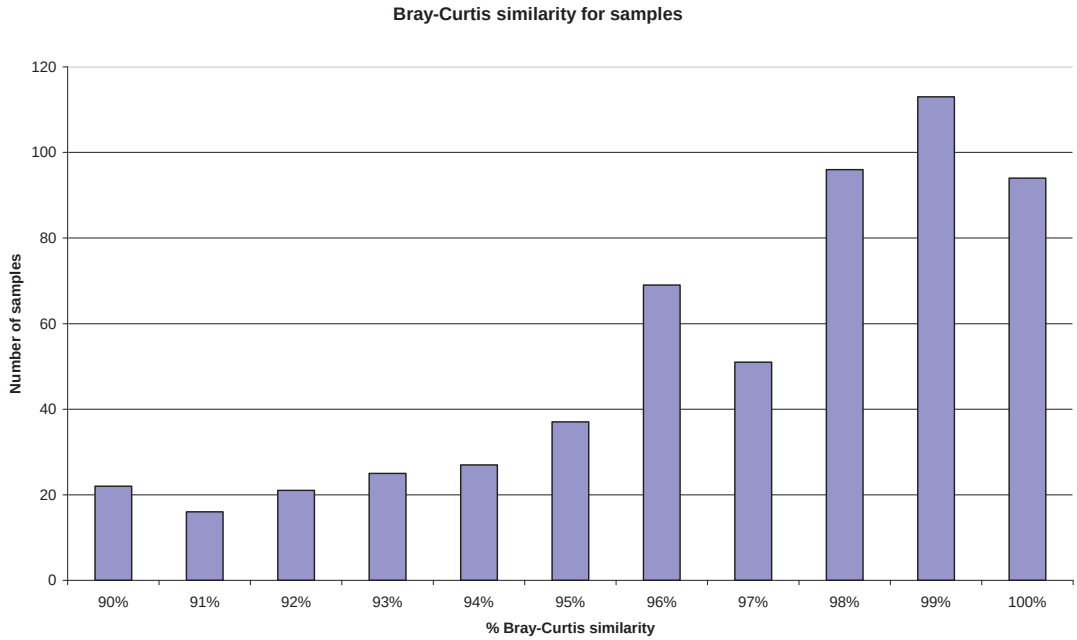


Figure 4.6.3. Numbers of samples submitted through the NMBAQC Scheme within each 1% Bray-Curtis similarity band of comparison between original and audited data, for those samples with a Bray-Curtis similarity above 90%.

In Figure 4.6.3, we can see that the mode peaks at 99% similarity and that large numbers of samples achieve 98% or 100% similarity. It is possible to say, therefore, that, while there are always samples that are poorly analysed, the majority will show similar results to data from a full audit, at least in terms of Bray-Curtis similarity data, for those laboratories that participate in the NMBAQC Scheme own sample exercises.

The count difference for the total number of individuals extracted from the sample was recorded for each sample.

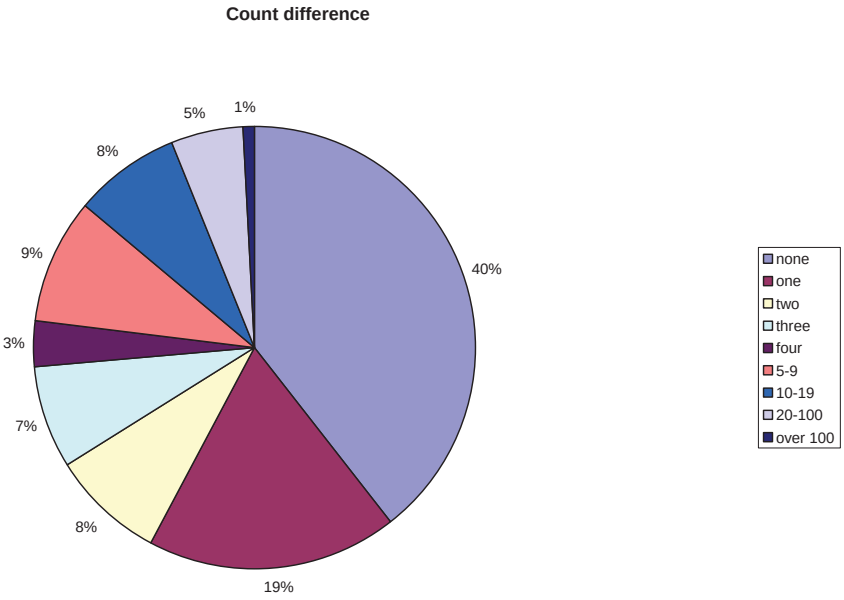


Figure 4.6.4. Proportions of samples submitted through the NMBAQC Scheme within different bands of differences in counts of total numbers of individuals between original and audited data (legend shows segments clockwise from 12 noon on chart).

Count differences ranged from 0 to 507 but over half of the samples had count differences of one or fewer.

The numbers of individuals and taxa missed from the residue were also recorded, along with the numbers of taxa found in the residue that were new to the sample.

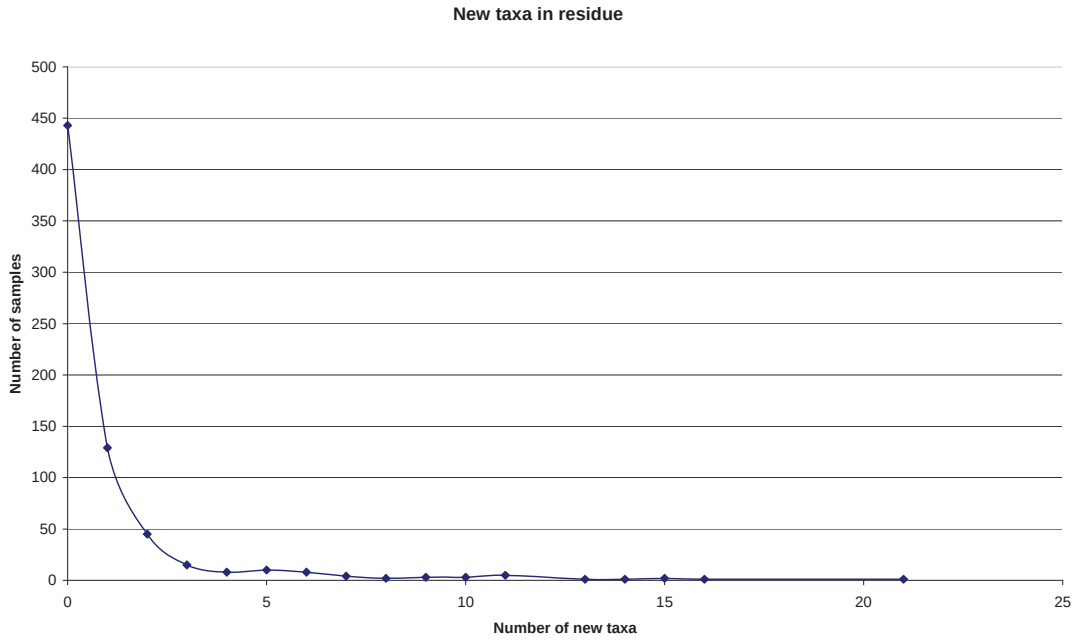


Figure 4.6.5. Numbers of samples submitted through the NMBAQC Scheme found to have different numbers of taxa new to the sample identified in the resort of the sample residue.

The majority of samples had no new taxa in the residue and very few had more than ten.

The number of taxonomic errors was recorded and, for this study, calculated as a percentage of the maximum recorded number of taxa (by either laboratory).

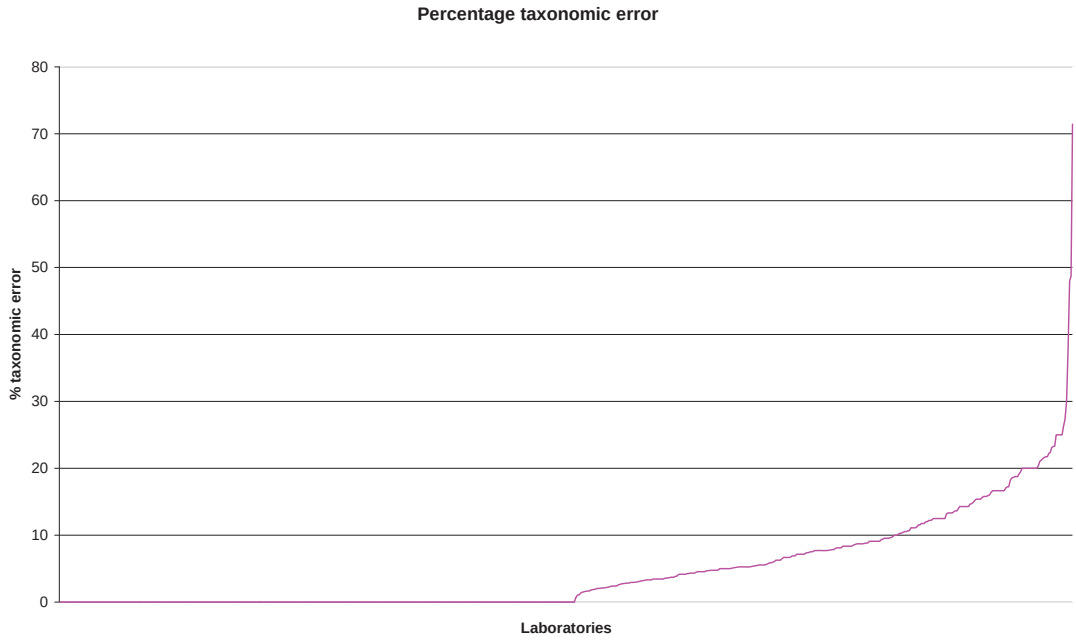


Figure 4.6.6. Samples submitted through the NMBAQC Scheme plotted by percentage taxonomic error, as identified after audit.

About half of the laboratories had no taxonomic errors.

4.6.1.2 Analysis of 'ring test' exercise data

'Ring test' results were combined for all of the exercises carried out to date (1994 to 2012). Four separate tests (of 20 specimens) were circulated for 1994/1995 and three (each with 25 specimens) in 1995/1996. There were two circulations of 25 specimens in each financial year between 1996/1997 and 2012/2013. The number of participants has varied across the period, as shown below (numbers for the first circulation of each financial year).

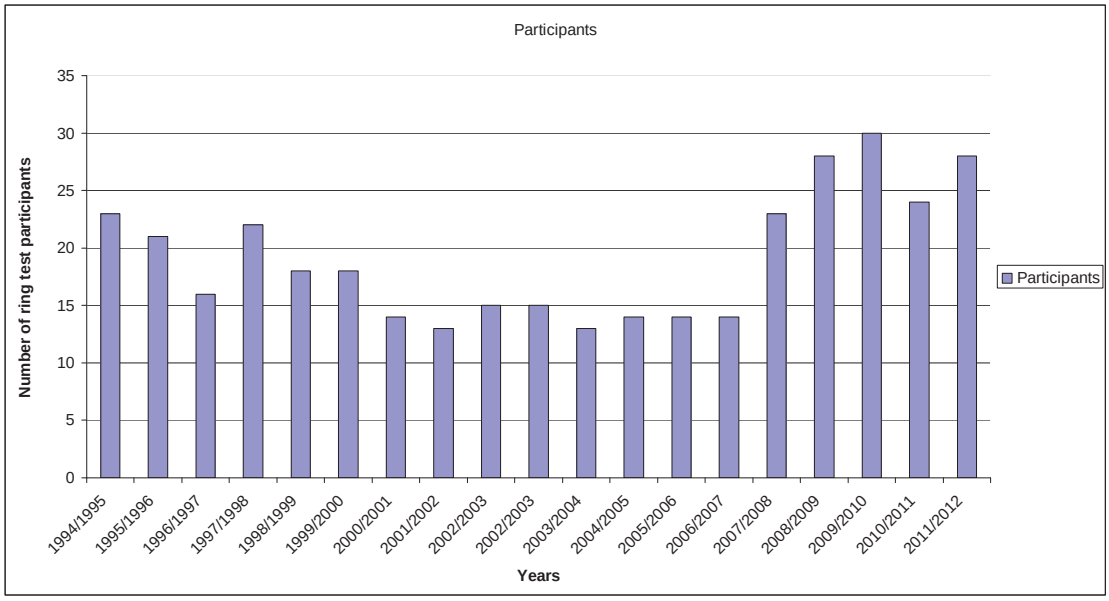


Figure 4.6.7. Numbers of laboratories that participated in NMBAQC ring tests in each year.

The result has been 995 species circulations (excluding fish) and multi-laboratory identifications of 457 species (as many have been circulated more than once).

The numbers of taxonomic errors for each circulation were calculated as percentages to standardise for the numbers of participants and the results are presented as a plot, below.

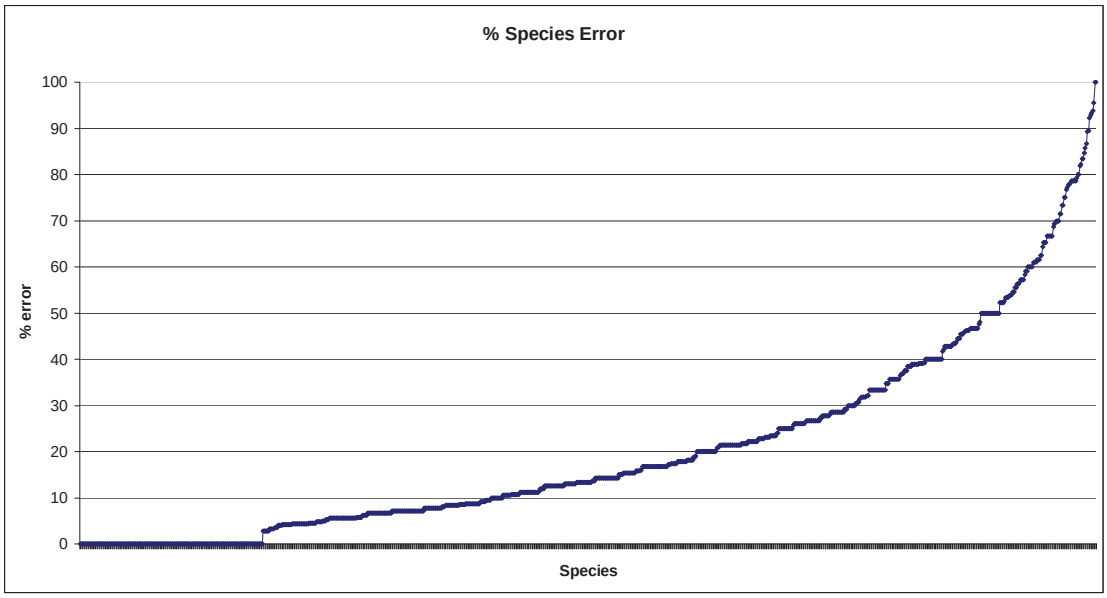


Figure 4.6.8. Species sent through NMBAQC ring tests plotted against the percentage of laboratories that misidentified the specimen.

It would not be meaningful to calculate the average degree of error for a species from these data, as many were selected for their difficulty but all of those species that can be routinely found in large numbers in macrofauna samples have been circulated at some time and it is possible to use the data to illustrate the types of animals that cause difficulties as a caution for use of data. For example, Figure 4.6.8 shows that, for about half of the circulations (species, including multiple circulations of the same species), fewer than 15% of the laboratories identified the specimen incorrectly. The actual numbers are 506 with 0% to 14% error and 449 with 15% to 100% error. The proportions species belonging to the different major taxonomic groups with 0% to 14% error are shown below.

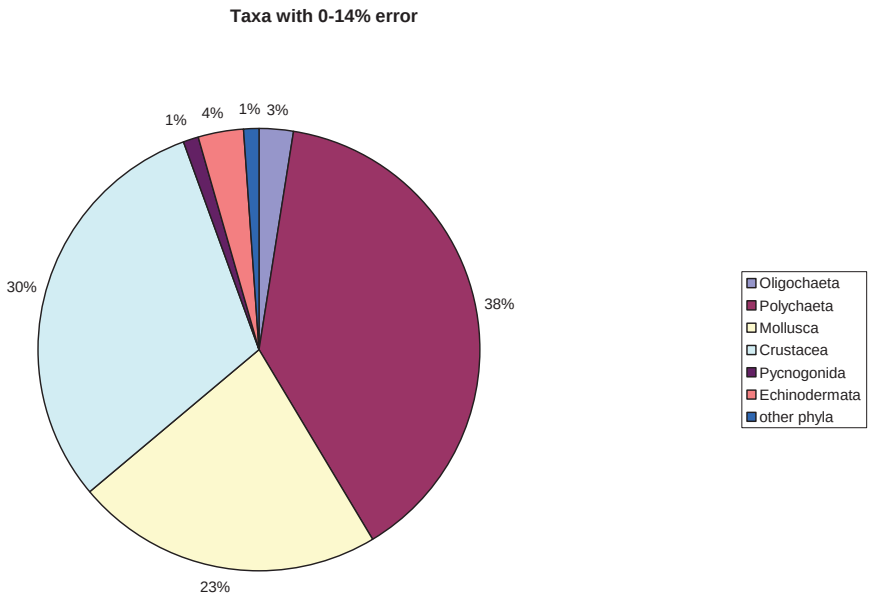


Figure 4.6.9. Proportions of species in major taxonomic groups sent through NMBAQC ring tests with 0-14% identification errors (legend shows segments clockwise from 12 noon on chart).

The actual proportions reflect the numbers of species available for circulation in the ring tests (broadly equivalent to the number of species in each group (see Figure ##). However, an indication of the relative identification difficulty (or inverse recognisability) of species in different taxa can be seen through comparison with the equivalent chart for species with 15% to 100% error (Figure 4.6.10).

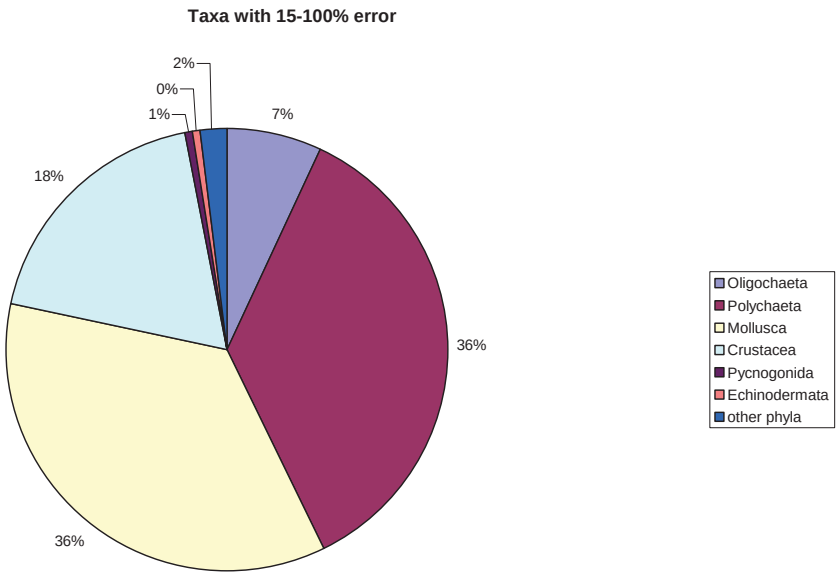


Figure 4.6.10. Proportions of species in major taxonomic groups sent through NMBAQC ring tests with 15-100% identification errors.

One obvious difference is the relative proportions of Mollusca and Crustacea. The circulated mollusc specimens caused more identification problems than the crustaceans. This might seem surprising given the popularity of molluscs as a study group but there are several possible reasons. Crustacea can often be identified using simple 'key features', whereas molluscs often have more subtle differences. This is apparent from the photograph of the five British shallow water species of Nuculidae (Figure 4.6.11).

Figure 4.6.11. The five British shallow water species of Nuculidae at about 3mm; from left to right; top row: *Nucula nitidosa, N nucleus, N. hanleyi*; bottom row: *N. sulcata, Ennucula tenuis*.

There is also often a higher proportion of juvenile molluscs in samples, which was reflected in the circulated specimens. Many identification keys are intended for adult material only and juveniles must be compared using growth series. For example, the slipper limpet (*Crepidula fornicata*), important as a non-native and biotope characterising species, is distinctive and would not be expected to cause identification problems. *C. fornicata* has been the subject of seven ring test circulations, with the following percentage errors (0, 7, 9, 17, 17, 26 and 33%). The wide range reflects the sizes of the specimens circulated. Full size specimens present no problems but juveniles can be difficult (Figure 4.6.12).

Figure 4.6.12. Four species of British gastropods that are distinctive as adults but with similar juvenile whorls; clockwise from left: *Crepidula fornicata, Calyptraea chinensis, Capulus ungaricus, Velutina velutina*.

Outdated literature is another common cause of identification errors. The two 100% error species (*Thyasira sarsi* and *Adontorhina similis*) are bivalve molluscs in the family Thyasiridae. The species are both excluded from the standard text still used for bivalve identification (Tebble, 1966) and required a recent, specialist publication (Oliver & Killeen, 2002). The latter species was described since even that guide (Barry & McCormack, 2007).

Such observations on ring test errors provide a useful insight into areas that would benefit from targeted training and resource notification. In future, it might also be possible to develop an identification difficulty index from the results, validated using audit data.

4.7 Conclusion

Problems associated with fauna extraction efficiency and identification discrepancies will always require audits.

The reliability of species records in typical data would need to be addressed for any use in the assignment of attributes. It is not possible to guarantee accuracy of data but some estimate of likely identification and extraction discrepancies is possible through analysis of audit data. Recommendations for data comparability can then be made in terms of standardised recording policies, records of identifiers, records of taxonomic discrimination (TDP) and storage of material for later checking.

5. Chapter 5. Potential uses of data for species attribute assignment

5.1 Introduction

The focus of this thesis, as discussed in Chapter 1, is to demonstrate that the initial purpose for which data are collected may not be the most valuable output. The most common original reasons for the collection of benthic macrofaunal data were reviewed in Chapter 2. Chapter 3 identified knowledge of species attributes (ecology, distribution and traits) as a field that would be of wider benefit to both pure and applied biology if better known and that may benefit from the application of additional data. The main aim of the current chapter is to show examples of improvements in our knowledge of species gained through the use of data originally collected for other purposes. Some of the issues to be considered in this approach were reviewed in Chapter 4 and are addressed for the examples below. Whilst an improved knowledge of species attributes is the example of the wider value of data chosen for this thesis, there are many other potential uses to which data may be applied. Some of these are considered in Section 2 of this chapter.

Thus the aim of this chapter is to provide examples of species attribute assignment using data originally collected for other purposes. Many papers have already been published that add information on particular species from non-dedicated data, including several with which I have been involved (Ashelby *et al*., 2004; Worsfold, 2005; Townsend *et al*., 2006; Worsfold & Ashelby, 2006; Worsfold, 2006a & b, 2007); these are included in Appendix 1.

Attributes can also be assigned to multiple species from extensive data and the species and attributes most suited can be identified. Some work on distribution (Worsfold, 2008) is included in Appendix 1. Knowledge of rarity, nativeness, distribution, salinity and substratum preference may be significantly improved through use of non-dedicated data and some of the potential is explored in this chapter.

5.2 Information from benthos samples collected for Harwich Haven Authority

As an example of the potential for additional information to be derived from data, I have collated data from a single source to create a basis for further analysis.

5.2.1 Origin of the data

The data are from a series of surveys carried out on behalf of Harwich Haven Authority (HHA), primarily to determine whether their activities (port development: e.g. channel dredging, sediment placement) have an adverse impact on the environment. Many surveys of different types have been carried out over several years. I completed a review of surveys up to 2005 (Worsfold, 2005). Most of the records are from collected quantitative samples (mainly subtidal grab samples) but some *in situ* records (such as noted through biotope mapping exercises) are also included. The records were made by several different biologists but all were staff at Unicomarine and subject to the company's in-house procedures and quality control systems, upon which the NMBAQC Scheme methods (Worsfold *et al*., 2010 – Appendix 2) were based.

5.2.1.1 Usage of data – through original purpose

Over 70 reports have been produced to address the original purpose of the data. These have fed into annual condition assessment reports and public inquiry documents. The success of these documents in satisfying the initial need is best described as satisfactory but limited. The limitations are the result of several factors, most of which can be grouped into two types: (i) difficulties (disagreements) in the definitions of adverse impacts and (ii) limited data (data required for definitive answers would be prohibitively expensive).

The same data have been used to provide general information on the ecology of the region. This has included biotope maps and descriptions of the biological communities present. Some of this information has fed into the original purposes but is also relevant to the development of biotope classifications.

5.2.1.2 Compilation of data subsets

Initially, data from all surveys for HHA were combined to create a species list. This data set was too large for the matrix to be used for abundance data and difficult to standardise due to the many different sampling methods employed and differences in recording policy across the projects. The species list is included in Appendix 3.

A smaller subset of surveys was combined to include only those samples that were collected using a 0.04 m^2 Shipek grab. This data set was standardised in terms of sample type and also analysing laboratory (though not individual analysts). Although the source (ownership) of the data was also standardised, there were multiple original purposes. However, these can be combined under a broad classification of impact assessment of port development activities. The taxon list was truncated to standardise recording policy across surveys.

5.2.2 Potential for uses beyond the original stated purpose

The existing data could be used for calculation of regional taxonomic distinctness (Clark & Warwick, 1998; 1999; Hall & Greenstreet, 1998; Rogers et al., 1999) values. Taxonomic distinctness values for impact-zone data must be compared with those from the wider area for use in assessments. This requires data to be available from the wider area that may not be part of the impact study. Ideally, there would be access to baseline data from a series of standard coastal cells. The HHA data provide baselines for several areas (Stour, Orwell, marine approaches to Harwich/Felixstowe). These are available for comparison with other areas and with the UK fauna as a whole.

For data collected over different periods of time, cyclical (both seasonal and across years) and long term trends can be established for different communities. Such changes may not be related to human impacts but, if known (nationally or regionally), would help identify reasons for change in monitoring studies in other areas.

In assigning species attributes, the results from the data review will be considered in two parts: the complete species list and the Shipek grab data.

5.2.3 Complete species list

The complete taxon list from all records collected to date is shown in Appendix 3. The list includes data from 268 surveys and 1,586 taxa. However, many of these are duplicate records that represent the same species at different life stages or different levels of taxonomic discrimination. For example, Dover sole are represented as '*Solea solea'* but also as '*Solea solea* ?' (for an unusual or damaged specimen of uncertain identity), three different listings for juveniles: 'Soleidae (juv)', '*Solea* (juv)' and '*Solea solea* (juv)', as well as '*Solea solea* (Type A)', to indicate a reversed, left-eyed specimen. These distinctions are, in some cases, due to inconsistencies in recording policy but often an attempt to deliver additional information that may be useful in some circumstances. For many purposes, however, it is necessary to rationalise the data to single species per line, where possible, in a process known as data truncation. After truncation, and removal of non-animal taxa (which are beyond the thesis scope) the number of species can be given as 785.

Each of these species represents a distribution record for the region and effectively exists as a 'Harwich Marine Fauna' of similar information content to those published for other regions: (Bruce *et al*., 1963; Garwood, 1982; Marine Biological Association, 1957).

5.2.4 Records from the standardised data set

The complete data for the 21 Shipek grab surveys (1205 samples) were divided between six combined truncated data matrices, with counts for each taxon in each sample. The taxon list was initially truncated to standardise the records. The raw data matrix is too large to be included in the appendices.

The species attributes for which application of existing data is likely to be most useful include rarity, distribution and non-native status.

5.2.4.1 Abundance

The taxon list for the matrix of HHA Shipek grab data was reduced to animal species only and ranked by total numbers of individuals of each taxon. The total number of samples from which each taxon was recorded is also shown. For taxa that could not

be counted, only the sample tally is shown and the taxa ranked in order of numbers of samples from which they were recorded, at the end of the table (Appendix 4). A plot of abundances of all taxa is shown in Figure 5.2.1.

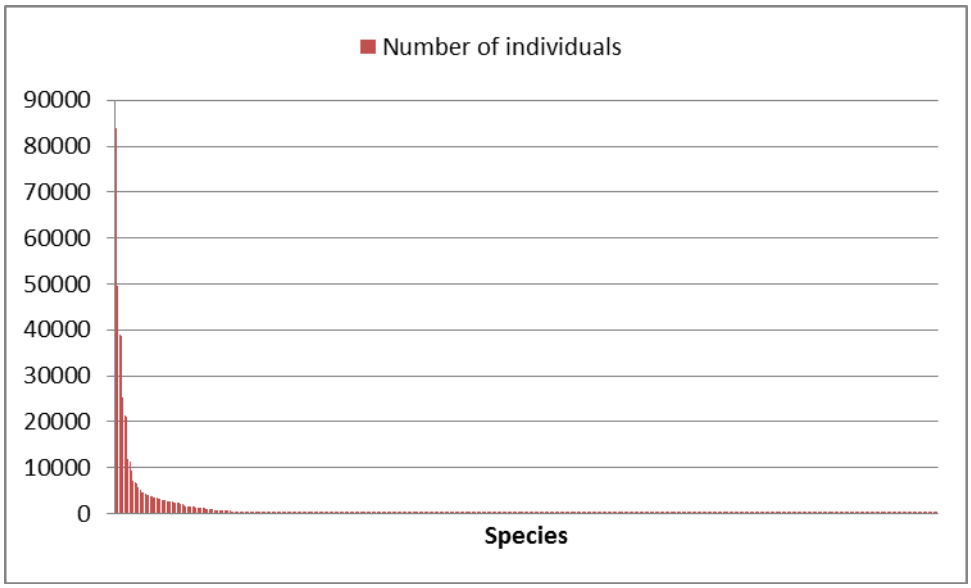


Figure 5.2.1. Total umbers of individuals for each species (most abundant to left) in the HHA data.

The truncated data set includes 485 countable taxa, as well as 113 that could not be assessed quantitatively. The most abundant species across the data was the cirratulid polychaete *Aphelochaeta marioni*, with 83981 individuals across 822 samples. Several other infaunal taxa were found in similarly high numbers. However, the majority of countable taxa were found only rarely, with over half represented by 15 or fewer individuals and 76 represented by only a single individual. It is likely that many of these are at the edge of their habitat preference in the included samples, which have a heavy bias towards subtidal estuarine soft sediments and grabs would have under-recorded mobile or hard substratum species.

Potential new information from existing data:

- identification of species as dominant in certain areas/habitats,
- identification of potentially rare species,
- insights into the distribution of rare and abundant species across the fauna.

5.2.4.2 Distribution

The HHA dataset is from the least diverse British marine region and distribution studies (Worsfold, 2008 - Appendix 1) suggest that most native species found in the southern North Sea are ubiquitous in British waters. New records for the area, Sea Area and region are highlighted for a taxonomic group with good summary information (Mollusca).

The distribution of molluscs in British marine waters was summarised in an atlas, with records noted by Sea Area (Seaward, 1982). This was later updated with a publication that lists these, together with more recent records (Seaward, 1990). These records were derived mainly from published literature or personal records and include few data collected for other purposes.

Appendix 3 has 205 lines of data for molluscan taxa recorded from surveys for HHA, although many of these represent duplicate entries for juveniles or specimens left at higher taxonomic levels. Others may be dubious records from old surveys, when laboratory quality control systems were less rigorous (see Chapter 4). Several species from the data are new records for the Sea Area (13: Thames). These are (Appendix 3) *Skenea serpuloides*, *Omalogyra atomus*, *Brachystomia scalaris*, *Odostomia turrita*, *O. acuta*, *Diaphana minuta*, *Elysia viridis*, *Limapontia capitata*, *Polycera quadrilineata*, *Proctonotus mucroniferus*, *Embletonia pulchra*, *Nucula hanleyi*, *Ennucula tenuis*, *Diplodonta rotundata*, *Semierycina nitida*, *Ensis directus*, *Venerupis philippinarum* and *Alloteuthis subulata*. In addition, the following constitute new live records for Sea Area 13: *Lacuna vincta*, *Rissoa parva* (f. *interrupta*), *Onoba semicostata*, *Alvania semistriata*, *Tornus subcarinatus*, *Epitonium clathrus*, *Turbonilla lactea*, *Odostomia plicata*, *O. unidentata*, *Chrysallida pellucida*, *Noemiamea dolioliformis*, *Goniodoris castanea*, *Goodallia triangularis*, *Moerella donacina*, *Polititapes rhomboids*, *Timoclea ovata* and *Saxicavella jeffreysi*.

As stated above, some of these records may be erroneous and it is necessary to have access to information on the laboratory analysts and their level of confidence to resolve such issues. For example, the records of *Skenea serpuloides*, *Omalogyra atomus* and *Proctonotus mucroniferus* are few and from old surveys and must be

treated with caution. Other records may have been published in more recent literature not reviewed here. This applies to the now widespread non-native species *Ensis directus*, recorded for much of southeast England (van Urk, 1987) and *Venerupis philippinarum*, for which the HHA records have been published (Ashelby, 2005). However, many of the records are of genuine value and the proportion (17%) of molluscan species records from the HHA data that are new to Sea Area 13 is significant, especially given that some of the lines represent higher taxa.

Species distribution records are important to the assessment of conservation objectives. The new records above include live records for species whose habitat preferences are only recently becoming known. For example, the pyramidellid gastropod *Noemiamea dolioliformis* has recently been found likely to be associated with reefs of *Sabellaria* spp. (Killeen & Light, 2000), a UK BAP priority habitat. Another gastropod, *Tornus subcarinatus*, is currently thought to be a specialist living beneath sand-embedded lower shore boulders. The HHA records suggest that it also lives on/under smaller stones, Subtidally. The bivalve *Saxicavella jeffreysi* was associated with soft mud with echiuran worms, a habitat of current interest in the identification of features of conservation interest (I. Humpheryes pers. Comm.).

Potential new information from existing data:

- additional distribution records for British species,
- insights into important habitats as defined by characterising species,
- insights into changes in distribution of species.

5.2.4.3 Non-native status

Non-native species are of interest to many conservation and sustainability objectives (Reise *et al*., 2006). National checklists have been published for the UK (Eno *et al*., 1997; Minchin *et al*., 2013), as well as for Ireland (Minchin, 2007), the Netherlands (Kerckhof *et al*., 2007) and Germany (Golasch & Nehring, 2006). Many non-native species are known from the waters around Harwich and records from HHA surveys have been published (Ashelby, 2005; 2006), including the first British record of the prawn *Palaemon macrodactylus* (Ashelby *et al*., 2004). Non-native and cryptogenic species from British waters were listed as part of this thesis and proportions shown in

Figure 2.5.2. As noted above, species found only in southeast England are often non-native and a higher proportion of such species would be expected in the current data set.

Non-native and cryptogenic species were highlighted in the HHA Shipek grab data. The taxon list was then truncated to include only lines of data that represented single species and to remove duplicate lines of data that potentially represented the same species twice. Proportions of native, non-native and cryptogenic species, according to the criteria used in Chapter 2, in the surveys were calculated (Figure 5.2.2).

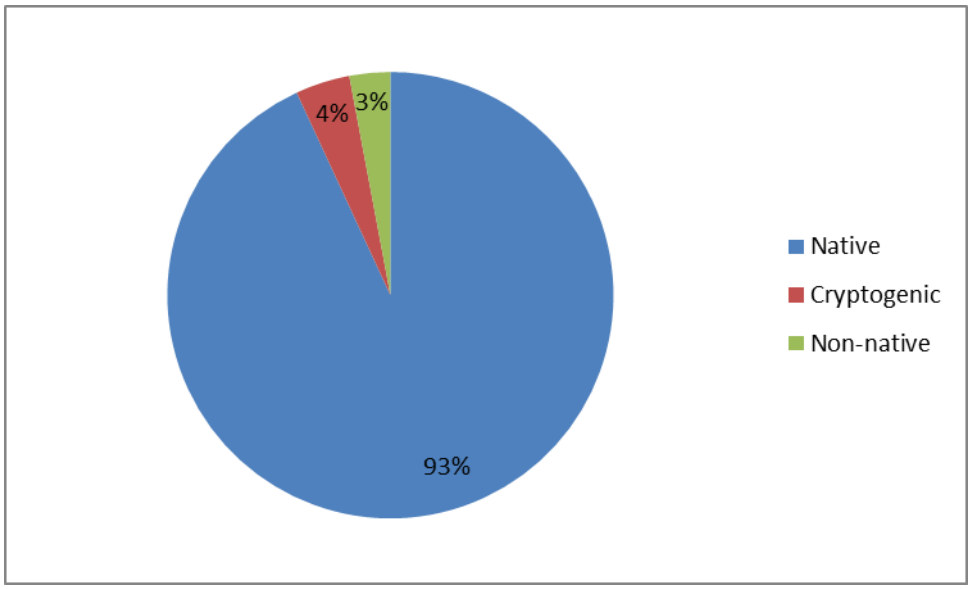


Figure 5.2.2. Proportions of native, cryptogenic and non-native species in the HHA data (legend shows segments clockwise from 12 noon on chart).

The waters around Harwich appear to have 3% non-native and 4% cryptogenic species, in comparison with 1% each of non-native and species for British marine waters as a whole (Figure 2.5.2). The figures for UK waters do, however, include species (native or not) that are possibly, but not confirmed to be, present (a further 1% of which are non-native). The results are consistent with arguments that non-native species are particularly prevalent near port developments (Gollasch & Leppäkoski, 2007), particularly in brackish waters (Minchin *et al*., 2013) and in southeast England (Worsfold, 2008).

Potential new information from existing data:

- records of the spread of non-native species,
- potential identification of species as cryptogenic, that require further research,
- insights into patterns of non-native species arrival in British waters.

5.2.4.4 Identification of taxonomic issues

Several of the taxa in the HHA data were not identifiable to species level. In most cases, this was due to accepted difficulties with recognition of features within difficult groups. However, the data also highlighted several areas where further taxonomic work is required. Those that are known to be problematic are noted in Appendix 4. It is striking that many of the most abundant taxa are subject to taxonomic problems. This may, in part, be due to the greater attention given to abundant species but also serves to highlight how little we know of the animals that live even close to highly populated areas.

In addition to the new records discussed above, species new to science are liable to be found in samples collected for other purposes. For example, a new species of worm was identified from maerl samples off Falmouth (collected for a routine monitoring programme for the EA), during the progress of this thesis (Olivier *et al*., 2012; Appendix 1).

There are several species regularly found in samples from commercial or monitoring projects that are recognisable but cannot be named. Examples of these from HHA data are noted in Appendix 3. Some of these are likely to be unpublished non-native or cryptogenic species (see below); others may be new species. Some records of un-named types in the data recently proved to be recently described or recognised species not previously known from the UK. Members of the family Syllidae, for example, have been subject to recent revision (San Martín, 2003), such that '*Syllis* Species A' is one of the new UK records of *S. columbretensis*, 'Species G', of *S. pontxioi* and '*S. cornuta* agg.' of *S. garciai*. There is a need for a standardised national list of un-named species to allow records to be gathered during the period of taxonomic review. Some initial progress is made towards that, here, and the types highlighted in Appendix 4 will be standardised across UK laboratories as far as current systems allow.

Proportions of species recorded from the HHA Shipek grabs from each of the major phyla are shown in Figure 5.2.3, for comparison with those for the entire British fauna (Figure 3.5.3).

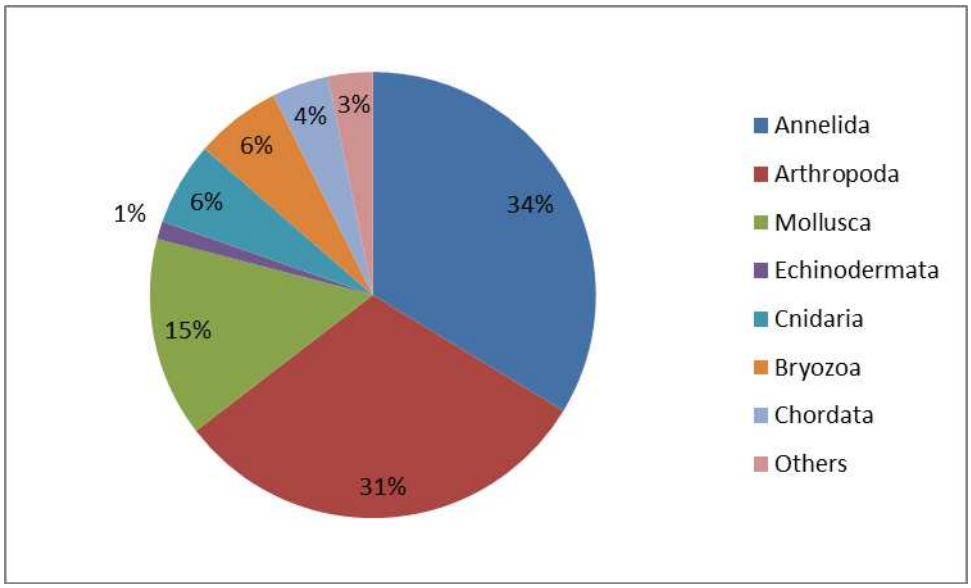


Figure 5.2.3. Proportions of species in the major taxonomic groups in the HHA data (legend shows segments clockwise from 12 noon on chart).

As with the wider UK taxonomic breakdown, the dominant phyla are Annelida, Arthropoda and Mollusca. The proportions of the fauna in the HHA Shipek grab samples are, respectively, 34%, 31% and 15% for these three groups, whilst, for the whole UK marine fauna, they are 34%, 143% and 67%. There is a bias against phyla that belong to predominantly to the nekton, plankton, meiofauna or epifauna in the HHA data, so that little can be inferred from the lower proportion of, e.g. Cnidaria and comparisons are best made on the relative proportions of the three major phyla. The bias also explains the higher proportion of Arthropoda in the UK-wide list, for which a high proportion comprises copepods, not identified for HHA.

The proportion of Mollusca to Annelida is more interesting. At Harwich, there were almost twice as many annelid species as of molluscs. For the UK as a whole, the reverse is true. It is possible that conditions at Harwich are more suitable for annelids than for molluscs or that the sampling methods used caused a bias towards records of annelids. However, both groups are widespread members of the macrobenthos and

the sampling covered a range of habitats. It is likely that the difference is a function of the greater taxonomic effort historically given to Mollusca and that a higher proportion of annelids await discovery. Further research, analysis and (especially) data would be required but it may be possible to tentatively predict a truer figure for the number of annelid species actually present in UK waters from figures such as these.

Potential new information from existing data:

- identification of priority research areas for taxonomic review,
- insights into patterns of discovery of new species in British waters,
- records from British waters of newly recognised species, including those previously identified by 'type' names,
- Possible predictions of true number of species, UK and worldwide.

5.2.4.5 Habitat preference

For most marine benthic macrofaunal species, habitat preferences are known only from anecdotal records (*i.e.* lists of habitat types from which the species has been recorded). It is possible to give a more detailed account through the use of the type of data produced through routine surveys. A subset of the HHA data was used to standardise sample types. This comprised a combined data set of Shipek grab samples for which there was associated sediment granulometry data, from all surveys. The following data analyses were then undertaken.

Cluster analysis (Bray-Curtis untransformed) was carried out on the species to determine which were ecologically related to each other in terms of their distribution across samples. The dendrogram is shown in Figure 5.2.4. Cluster groups were defined through SIMPROF analysis and were taken to represent biological communities (groups of species related by habitat preference).

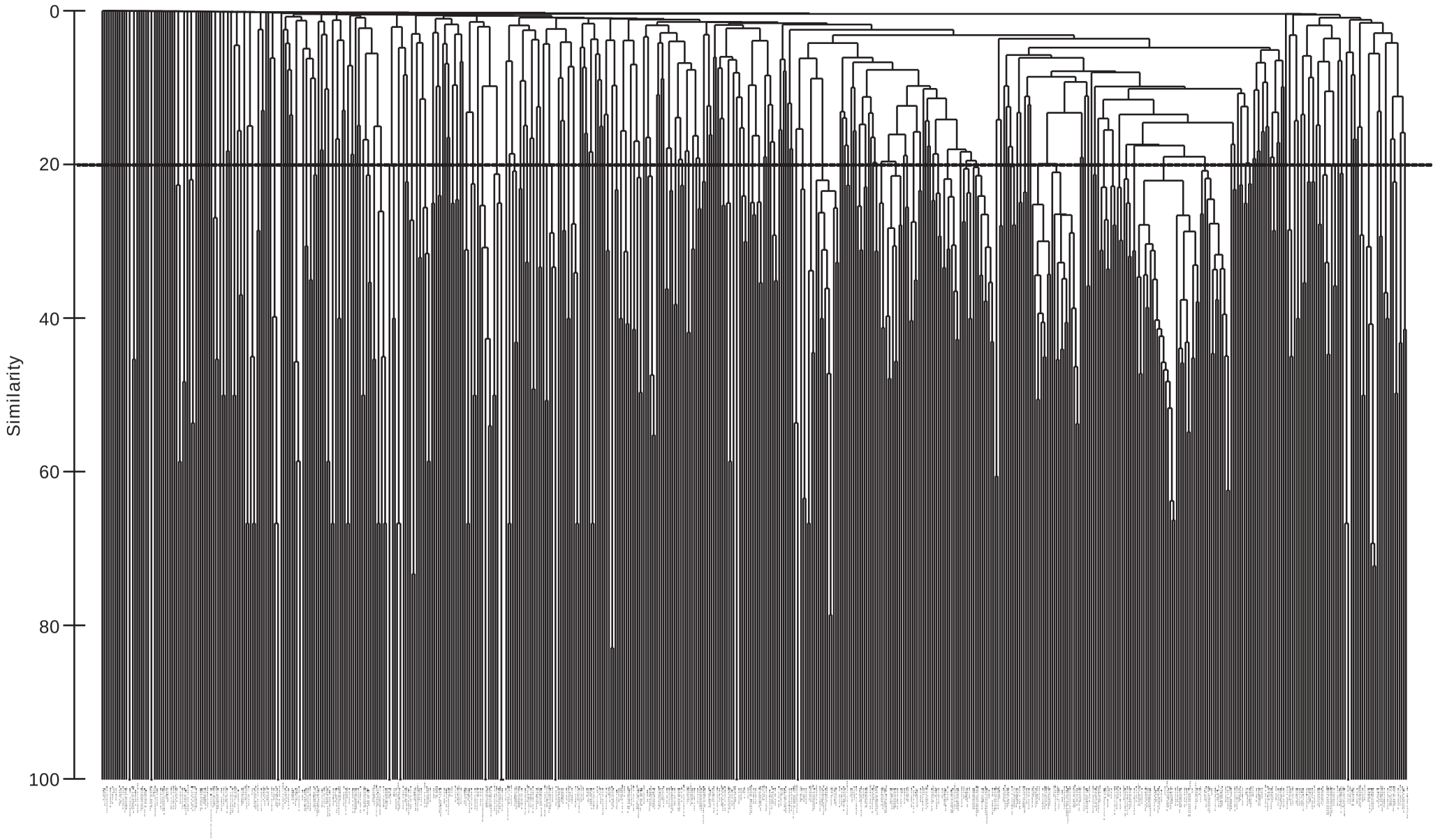


Figure 5.2.4. Dendrogram of species recorded from standardised HHA Shipek grab samples to show community associations.

The results produced a highly complex dendrogram with a very large number of cluster groups identified at 20% similarity. Further analysis and incorporation of sediment data would be required to develop a habitat and community coding system for macrobenthic species. Such procedures could potentially be repeated for other data sets, as a test of repeatability.

Comparative data for the whole sample set are shown in Appendix 5 for representative, biotope defining, species and for cirratulid polychaetes and two non-native species that recently arrived at Harwich. These give some indication of the possibilities of the data.

Potential new information from existing data:

- identification of habitat and salinity preferences for different species,
- information on community associations,
- reassessment of biotope classifications and conservation priorities.

5.3 Discussion

The above exercises represent a preliminary review of the potential of data from non-target sources to provide insights on several important questions that relate to marine species and their relevance to questions of sustainability, conservation and changes due to anthropogenic and natural factors.

The HHA data have established a species list for the region of comparable value to the various published regional 'marine faunas' (Bruce *et al*., 1963; Garwood, 1982; Marine Biological Association, 1957). This list, with its associated quantitative and qualitative data for records linked to temporal, spatial and environmental data, forms the basis of most of the examples of added value to data provided here.

For many of the species recorded, little had been published prior to the present analyses. Many of the proposed conclusions are provisional, having been assigned through the use of a restricted data set. However, they stand as hypotheses that await testing through use of other data and represent an advance on current knowledge.

The information presented is of value in the development of sensitivity and rarity assessments of benthic species. These in turn may lead to advances in predictive models of species occurrence. Such models would be of intrinsic importance to conservation assessment. They would also add to the current advances in species traits analyses that are becoming the next phase in assessments of whole communities and marine spatial planning.

Currently the most common reason for the collection of macrofaunal data is to assess human impacts on biological communities. The decisions about which changes should or should not concern us are often founded on beliefs about the importance and sensitivities of certain species and habitats. If these were to change as a result of information from routine monitoring surveys, then we could reasonably say that their most valuable function was to provide such information and that the impact assessment role was secondary.

6. Chapter 6. General discussion

6.1 Demonstration of the hypothesis

The objective of this thesis was to demonstrate that the value of data may lie outside the stated purpose for their collection. It was necessary to demonstrate that additional information can be derived from data. This has been done through the statement of original purpose for selected data and the reanalysis of data to assign new information. The value of this information has also been discussed.

6.1.1 Summary of chapter conclusions

It was apparent from the literature review in the general introduction that a range of philosophical positions has been applied to data usage and that the subject has been a matter of debate for many centuries. Current understanding of science generally follows Popper's (1959) definition, sometimes explicitly (Mulkay & Gilbert, 1981) but often without direct understanding of reasons for thinking about data in a particular way. There can be little doubt that most of Popper's ideas have had a positive impact on our understanding of science but a widespread belief that data are entirely subject to theory (e.g. Popper, 1963) may have had unfortunate consequences for the progress of fields such a benthic ecology.

The review of data in Chapter 2 showed the diversity of benthic macrofauna data in terms of sample types and also involvement of different organisations, aims, usage and value. It was considered appropriate to develop a classification system for the properties of data, termed attributes. These were classified into four broad groups. Example data from a review of surveys carried out over many years in an area of southeast England showed the variability in data and explored standardisation issues. It was shown that the most difficult attributes to classify were those that related to use and value. It was also clear that many data sets were considered valuable only in terms of their original stated purpose, to the extent that the raw data from some reports had been lost or rendered impossible to obtain. The exercise to recover data from former projects was difficult and inefficient.

The British marine fauna has been subject to many years of study and fashions have changed in terms of how best to acquire and value information. Chapter 3 reviewed the fauna and identified characteristics of each species that could be classified in a similar way to that for data: i.e. into four main groups. Attribute classifications can be summarised by the following diagram, which represents the relationship between species and sample attributes, with respect to a data unit. As with, biological taxonomy, the divisions are not absolute and there are areas of potential overlap, as well as a need for further refinement to the system and discussion of its value.

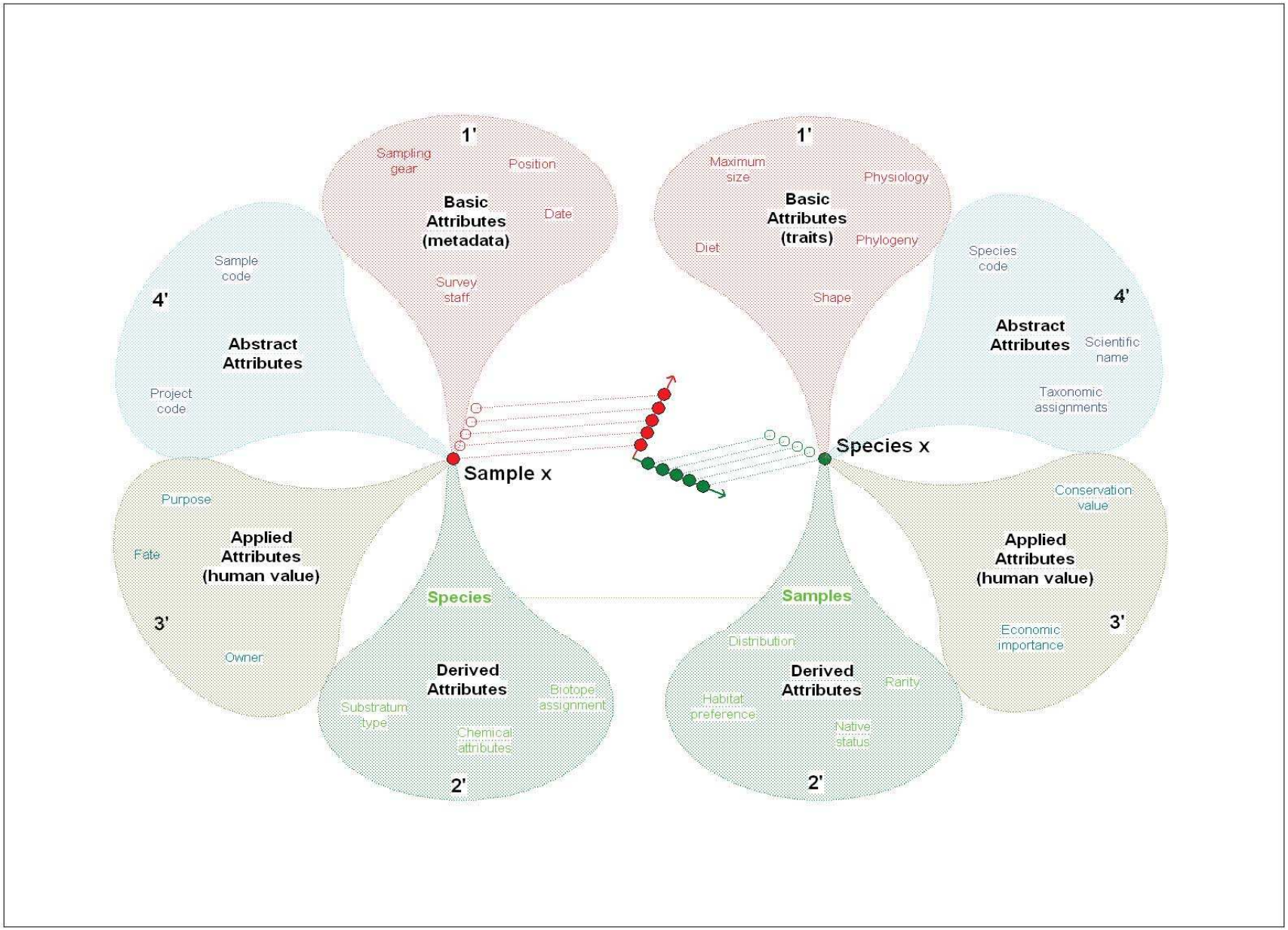


Figure 6.1.1. Diagrammatic representation of the relationship between a (central) data unit and the attributes of its species and samples.

Information is limited for most British marine macrofaunal species and is of use both in the resolution of ecological questions and in the decisions over which questions should be considered relevant.

Concerns over the quality of data were addressed in Chapter 4, where results from a national quality control scheme were used to identify variation in data from multiple sources (laboratories that carried out analysis). The data revealed many widespread problems that caused inconsistencies in both identification of species and quantification of data. Recurring patterns were observed in the results and it is possible to predict many of the problems that might occur with a data set of well defined attributes. It is possible to put safeguards into place in order to resolve most of the problems with data inconsistencies.

A data set from an area that has been extensively sampled was studied in Chapter 5 in order to assess the potential for new information. It would have been possible to carry out many detailed analyses to provide information on a large number of species. This would represent several major research projects. Basic examination of the data revealed significant new knowledge on the distributions of poorly known species, the spread of non-native species and identification of taxonomic research priorities.

6.2 Are the data more important than the conclusions of a research project?

Despite several national and international projects to collate data and many more at regional scales, there remains a tendency for surveys to be designed for a specific purpose, to answer a particular question. Sometimes such questions are only cursorily answered by the eventual data as many are really too broad for the small, short-term surveys to tackle. It is important also to note that many of the original purposes are based on, sometimes inaccurate, assumptions about species, such as habitat preference, non-native status and, especially, rarity. Some of these assumptions could be revised through the use of all available data.

I believe that I have demonstrated that data may have value beyond their original stated purpose, which falsifies the theory that:

though beetles may profitably be collected, observations may not (Popper, 1963).

It would be interesting to further refute this theory through the use of the data supposedly presented to the Royal Society by the man who wrote down all his observations. It is likely that such a collection of data would be highly valuable to natural science as well as to history. We should also note that the current value of the Domesday Book does not lie in its use for land valuation.

I further propose that the greater part of the value of data lies beyond its original stated purpose. This is not yet proven, as it is not yet possible to adequately quantify value or to predict every possible to which data may be put. However, I believe the statement stands as a hypothesis. It is likely that the value of data is related to the number of links it has to other information, as a parallel to network theory. Such ideas are currently under investigation in other fields as part of the 'big data' idea (Callebaut, 2012).

6.3 Implications for data use

The availability of large amounts of biological data with the potential to answer questions that may previously have required dedicated survey work should allow greater information from less effort. This would however depend upon reliable access to data and means of assessing data quality. Systems are already in place to address these issues, although there is a need for improvement in many areas.

6.4 Implications for survey design

The approach has implications for data management. It is suggested that all potential uses of data be considered when planning environmental surveys. This would affect survey design and choices of sample types. It is theoretically possible for all surveys to be nationally registered and based upon an integrated overall survey plan design, with standardisation of sample type, sample treatment and audit processes. Similarly, all data could theoretically be stored, as a routine, on a national system. Such designs appear unpopular when comparisons are made to (for example) personal data and we are becoming accustomed to the idea that data protection means non-disclosure or even destruction. However, it is likely that wider circulation and standardisation of environmental data would significantly improve our understanding of many of the

questions currently being asked through a series of single question, single survey exercises.

6.5 Predictions

Both the philosophy of data and the practicalities of their management and use have been the subject of continuous change over many years and this is likely to continue. I make the following predictions for the future development of this field:

- the ‘big data’ idea, currently applied mainly to other fields, will become more widely applied to biology,
- there will be continued resistance to the apparently inductive nature of data-led science on philosophical grounds,
- the currently disparate attempts to collate macrofaunal data will gradually become more coordinated,
- data collection methods will become increasingly standardized to allow maximum use,
- deposition of data will become more widespread and stipulated,
- data from a range of sources will be used to monitor change in the distributions of marine species, most likely beginning with non-native species,
- there will eventually be real-time access to information on change.

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Appendix 1

Papers and articles published by or including the author that are relevant to this thesis

Ashelby, C.W., Worsfold, T.M. & Fransen, C.H.J.M., 2004. First records of the oriental prawn *Palaemon macrodactylus* (Decapoda: Caridea), an alien species in European waters, with a revised key to British Palaemonidae. *Journal of the Marine Biological Association of the United Kingdom*, 84, 1041-1050.

Worsfold, T.M., 2005. Records of *Photis reinhardi* and *Amphilochoides boecki*, two marine amphipods new to Ireland, from Belfast Lough. *Irish Naturalists' Journal*, 28 (3), 123-125.

Townsend, M., Worsfold, T.M., Smith, P.R.J., Martina, L.J., McNeill, C.L. & Kendall, M.A., 2006. Occurrence of *Sternaspis scutata* (Polychaeta: Sternaspidae) in the English Channel. *Cahiers de Biologie Marine*, 47, 281-285.

Worsfold, T.M., 2006a. British records of the interstitial polychaete *Stygocapitella subterranea* (Annelida: Parergodrilidae). *JMBA2 Biodiversity Records*, 5429, published online.

Worsfold, T.M., 2006b. Identification guides for the NMBAQC Scheme: 1. Scalibregmatidae (Polychaeta) from shallow seas around the British Isles. *Porcupine Marine Natural History Society Newsletter*, 20, 15-18.

Worsfold, T.M. & Ashelby, C.W., 2006. Additional UK records of the non-native prawn *Palaemon macrodactylus* (Crustacea: Decapoda). *JMBA2 Biodiversity Records*, 5547, published online.

Worsfold, T.M., 2007. Identification guides for the NMBAQC Scheme: 2. Goniadidae, with notes on Glyceridae (Polychaeta) from shallow seas around the British Isles. *Porcupine Marine Natural History Society Newsletter*, 22, 19-23.

Worsfold, T.M., 2008. Analysis of species distribution by Sea Area, using data from taxonomic and 'grey' literature: Amphipoda. *Porcupine Marine Natural History Society Newsletter*, 24, 42-47.

Olivier, F., Lana, P., Oliveira, V. & Worsfold, T., 2012. *Dysponetus joeli* sp. nov. (Polychaeta: Chrysopetalidae) from the northeast Atlantic, with a cladistic analysis of the genus and a key to species. *Journal of the Marine Biological Association of the United Kingdom*, 92, 989-996.

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First records of the oriental prawn *Palaemon macrodactylus* (Decapoda: Caridea), an alien species in European waters, with a revised key to British Palaemonidae

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This paper details the first recorded instance of the prawn *Palaemon macrodactylus* in Europe, at the Orwell estuary, Suffolk. The species is native to north-east Asia, including Japan and Korea, and has previously been introduced to other areas outside its natural range. Records of the abundance of caridean species, obtained from routine benthic trawl samples in the Stour and Orwell estuaries, provide a summary of *P. macrodactylus*' habitat preference in reduced-salinity waters. Consistent catches and records of ovigerous females provide evidence for the stability of the Orwell population. A revised key to British Palaemonidae is also provided.

INTRODUCTION

Many exotic marine species have been introduced into Europe since the advent of regular intercontinental transport; a directory of marine introductions to British waters has been compiled (Eno et al., 1997) which records the 51 non-native species known up to 1997. Records of additional introductions continue to be reported in the scientific literature. Many of these introductions include species from East Asia (e.g. Smith et al., 1999; Nishikawa et al., 2000; Baldock & Bishop, 2001), some of which have been reviewed as economically important (Clark et al., 1998; Rainbow et al., 2003). Successful introductions generally involve species from similar latitudes (Eno et al., 1997). The possibility of further introductions should always be considered by those involved in biological monitoring.

This paper details the first recorded occurrence of the oriental prawn *Palaemon macrodactylus* Rathbun 1902 in Europe. The species was found at the Orwell estuary in Suffolk, eastern England, during a series of ecological surveys carried out on the Stour and Orwell estuaries by Unicomarine Ltd on behalf of Harwich Haven Authority. The fish and shrimp monitoring surveys undertaken are described. A benthos survey (Dyer, 2000) and a biotope mapping exercise (Worsfold, 2002) have also been conducted in the area: these found several other non-native species.

Another north-east Asian species, the ascidian *Styela clava* Herdman, believed to have been introduced to Plymouth in 1952 (Carlisle, 1954; Houghton & Millar, 1960), was found during the biotope mapping exercise, as well as during the present fish monitoring surveys. This species had already been recorded by the Marine Nature Conservation Review (Irving, 1998). Other non-native invertebrate species found during the above surveys include the molluscs *Ruditapes phillipinarum* (Adams & Reeve), *Potamopyrgus antipodarum* (Gray), *Crepidula fornicata* (L.), *Crassostrea gigas* (Thunberg), *Mya arenaria* L., *Petricola pholadiformis* Lamarck, and *Ensis americanus* (Gould in Binney), and the barnacle *Elminius modestus* Darwin. The Chinese mitten crab (*Eriocheir sinensis* H. Milne-Edwards) has also been reported to occur in the Stour estuary (Rainbow et al., 2003), but has not been found there by the present authors. In addition, the sponge *Suberites massa* Nardo, found in the Orwell estuary during the biotope and trawl surveys, may be a cryptogenic species, as it has been recorded in British waters only near ports (Eno et al., 1997). A review of the physical and biological features of the Stour and Orwell estuaries is provided in Barne et al. (1988).

Palaemon macrodactylus is a large, edible palaemonid which is native to Japan, Korea and northern China (Rathbun, 1902; Newman, 1963). It was introduced into San Francisco Bay, California, prior to 1957 (Newman, 1963) and has since become well-established along most of the west coast of North America (Ricketts et al., 1968; Cohen, 1996; Williams, 1997; United States Geological Survey, 2002; California Resources Agency, 2002). Newman (1963) has discussed the possible means of introduction, and the expansion of the species' range has been documented by other authors (Ricketts et al., 1968; Cohen, 1996; Williams, 1997; United States Geological Survey, 2002; California Resources Agency, 2002). A number of papers and reports have been published which concern the species' ecology and physiology in American waters (Born, 1968; Sitts & Knight, 1979; Siegfried, 1980, 1982). Instances of the occurrence of the species in two Australian states have also been recorded (Pollard & Hutchings, 1990). However, the only confirmed instance is that recorded for an area near Newcastle, New South Wales (Buckworth, 1979; Holthuis, 1980). There is also an unsubstantiated record from South Australia (Williams et al., 1978, 1982; Carlton, 1985). In the United States,

Table 1. *Caridean species composition and physiochemical data for trawls taken at all stations between December 2001 and November 2002. Figures in parentheses indicate the numbers of ovigerous* Palaemon macrodactylus. *Target trawl positions are also shown.*

		Stour A	Stour 01	Stour 02	Stour 03	Stour 04	Stour 05	Stour 06	Orwell A	Orwell 01	Orwell 02	Orwell 03	Orwell 04	Orwell 05	Orwell 06	Harbour 1	Harbour 2
December 2001																	
Trawl Start Position	N	—	51°56′0.92	51°56′0.96	51°57′0.18	51°57′0.20	51°57′0.02	51°57′0.10	—	51°57′0.37	51°58′0.64	51°59′0.52	51°59′0.43	51°59′0.93	52°00′0.36	—	—
	E	—	01°13′0.92	01°11′0.29	01°11′041	01°11′040	01°10′0.04	01°08′0.20	—	01°17′0.26	01°16′0.50	01°16′0.12	01°16′0.04	01°13′0.71	01°11′0.57	—	—
Trawl Finish Position	N	—	51°59′0.90	51°57′0.20	51°57′0.31	51°57′0.20	51°56′0.86	51°57′0.06	—	51°57′0.48	51°58′0.84	51°59′0.54	51°59′0.50	51°59′0.97	52°00′0.62	—	—
	E	—	01°13′0.52	01°11′0.05	01°10′0.90	01°10′0.99	01°09′0.68	01°07′0.87	—	01°17′0.38	01°16′0.50	01°15′0.88	01°15′0.71	01°13′0.45	01°11′0.35	—	—
Salinity (psu)		—	28.3	29.0	29.2	29.4	28.9	28.6	—	32.7	30.7	30.2	31.1	30.2	30.2	—	—
Water Temperature (°C)		—	4.8	4.8	5.4	6.9	4.9	5.0	—	6.9	5.8	5.6	5.8	5.5	5.5	—	—
Dissolved Oxygen (%)		—	97.3	90.0	93.0	98.0	98.6	97.5	—	101.0	95.0	95.2	97.2	96.6	96.6	—	—
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	—	—	36 (4)	57 (7)	—	—
Palaemon elegans		—	—	—	61	—	28	1	—	—	—	—	—	8	—	—	—
Pandalus montagui		—	5	222	161	140	53	1	—	18	11	42	160	193	219	—	—
Crangon crangon		—	98	239	30	74	55	674	—	544	12430	72	3032	524	1639	—	—
Crangon allmanni		—	—	—	—	—	—	—	—	—	8	—	—	—	—	—	—
Hippolyte varians		—	—	4	—	4	6	—	—	—	—	10	1	72	41	—	—
Thoralus cranchii		—	—	—	1	—	—	—	—	—	—	—	—	4	1	—	—
January 2002																	
Salinity (psu)		—	30.9	30.7	30.3	30.3	27.6	28.1	—	32.1	30.1	28.3	29.5	27.9	27.8	—	—
Water Temperature (°C)		—	4.0	3.9	4.0	4.1	4.2	4.2	—	4.9	4.6	4.7	4.6	4.7	4.7	—	—
Dissolved Oxygen (%)		—	127.5	108.0	116.8	119.8	116.7	121.1	—	114.1	105.3	109.7	118.5	115.4	113.1	—	—
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	—	—	1	32 (3)	—	—
Palaemon elegans		—	—	—	—	—	8	1	—	—	—	6	—	—	8	—	—
Palaemon serratus		—	—	3	—	1	1	—	—	—	—	12	—	1	4	—	—
Pandalus montagui		—	2	219	39	—	13	—	—	8	5	124	83	8	111	—	—
Crangon crangon		—	105	181	6	14	8	1	—	131	1236	438	869	23	80	—	—
Hippolyte varians		—	—	8	28	—	14	—	—	—	—	—	1	1	1	—	—
February 2002																	
Salinity (psu)		—	28.5	28.8	28.4	29.4	27.6	28.2	—	31.9	30.0	29.4	29.3	28.6	27.6	—	—
Water Temperature (°C)		—	8.2	8.2	8.3	8.4	8.5	8.5	—	7.4	7.5	7.6	7.4	7.6	7.5	—	—
Dissolved Oxygen (%)		—	95.4	97.3	95.6	93.0	94.0	93.5	—	96.4	95.1	96.1	92.2	91.5	88.6	—	—
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	—	—	12	24	—	—
Palaemon elegans		—	—	—	39	6	31	—	—	—	—	6	—	36	—	—	—
Palaemon serratus		—	—	12	4	2	2	—	—	1	2	4	4	56	—	—	—
Pandalus montagui		—	1	58	112	10	32	—	—	4	2	96	64	600	52	—	—
Crangon crangon		—	216	98	138	443	198	2300	—	79	680	278	1272	568	1844	—	—
Hippolyte varians		—	—	7	1	1	5	—	—	—	2	22	—	216	8	—	—
Thoralus cranchii		—	—	2	1	—	—	—	—	—	—	—	—	1	—	—	—
March 2002																	
Salinity (psu)		—	31.5	31.4	31.4	31.5	30.3	30.3	—	31.8	31.7	31.7	31.6	31.3	31.6	—	—
Water Temperature (°C)		—	7.5	7.6	7.6	7.7	7.7	7.9	—	7.2	7.2	7.2	7.2	7.1	7.0	—	—
Dissolved Oxygen (%)		—	92.0	96.0	96.1	95.6	94.2	94.8	—	97.5	96.0	95.8	95.6	96.2	95.5	—	—
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	—	—	18	—	—	—
Palaemon elegans		—	—	—	47	2	8	6	—	—	—	4	—	6	—	—	—
Palaemon serratus		—	1	29	2	21	—	4	—	2	—	2	—	6	8	—	—
Pandalus montagui		—	2	16	112	30	38	—	—	4	3	230	16	282	72	—	—
Crangon crangon		—	155	26	95	137	286	510	—	33	169	140	448	608	—	—	—
Hippolyte varians		—	—	1	9	5	6	—	—	—	—	12	—	6	—	—	—
April 2002																	
Salinity (psu)		—	31.4	31.2	30.7	30.1	30.0	30.2	—	31.9	31.7	31.6	31.4	30.4	30.2	—	—
Water Temperature (°C)		—	11.8	11.9	11.5	12.2	12.2	11.8	—	12.3	11.4	11.3	11.3	12.3	12.9	—	—
Dissolved Oxygen (%)		—	98.3	101.7	99.4	97.6	98.9	99.2	—	98.2	98.8	99.2	101.6	99.5	95.2	—	—
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	—	—	24	—	—	—
Palaemon elegans		—	—	1	16	1	12	1	—	—	—	—	—	44	—	—	—
Palaemon serratus		—	1	65	64	29	240	3	—	—	—	155	3	742	100	—	—
Pandalus montagui		—	1	32	48	74	160	1	—	1	3	466	13	1656	276	—	—
Crangon crangon		—	51	164	144	21	64	67	—	39	355	167	432	408	1688	—	—
Hippolyte varians		—	—	3	24	1	—	—	—	—	—	185	6	404	12	—	—
Thoralus cranchii		—	—	1	—	—	—	—	—	—	—	2	—	—	—	—	—
May 2002																	
Trawl Start Position	N	51°57′0.14	51°56′0.92	51°56′0.96	51°57′0.18	—	51°57′0.02	51°57′0.10	51°57′0.96	—	51°58′0.64	51°59′0.52	51°59′0.43	51°59′0.93	52°00′0.36	51°57′0.12	51°17′0.18
	E	01°15′0.48	01°13′0.92	01°11′0.29	01°11′041	—	01°10′0.04	01°08′0.20	01°16′0.90	—	01°16′0.50	01°16′0.12	01°16′0.04	01°13′0.71	01°11′0.57	01°16′0.94	01°17′0.18
Trawl Finish Position	N	51°57′0.14	51°59′0.90	51°57′0.20	51°57′0.31	—	51°56′0.86	51°57′0.06	51°58′0.02	—	51°58′0.84	51°59′0.54	51°59′0.50	51°59′0.97	52°00′0.62	51°17′0.19	51°57′0.06
	E	01°15′0.16	01°13′0.52	01°11′0.05	01°10′0.90	—	01°09′0.68	01°07′0.87	01°16′0.73	—	01°16′0.50	01°15′0.88	01°15′0.71	01°13′0.45	01°11′0.35	01°17′0.19	01°16′0.57
Salinity (psu)		32.4	32.3	32.3	31.8	—	32.0	31.9	32.0	—	31.3	30.9	31.4	30.8	29.8	32.1	32.1
Water Temperature (°C)		14.6	14.8	14.8	14.9	—	14.9	15.1	14.1	—	14.2	14.6	14.5	14.8	15.2	14.3	14.4
Dissolved Oxygen (%)		91.7	94.8	96.6	89.4	—	94.5	95.2	86.8	—	86.2	86.4	86.5	86.4	78.4	88.0	93.8
Palaemon macrodactylus		—	—	—	—	—	—	—	—	—	—	2	—	—	—	—	—
Palaemon elegans		—	—	1	—	—	18	2	—	—	—	—	—	—	—	—	—
Palaemon serratus		—	1	12	6	—	69	—	—	—	1	158	—	4	24	—	2

Continued

Table 1 *(Continued)*

		Stour A	Stour 01	Stour 02	Stour 03	Stour 04	Stour 05	Stour 06	Orwell A	Orwell 01	Orwell 02	Orwell 03	Orwell 04	Orwell 05	Orwell 06	Harbour 1	Harbour 2
	Pandalus montagui	3	—	37	7	—	5	—	—	—	13	8	—	—	40	31	35
	Crangon crangon	15	47	86	1	—	9	20	10	—	47	88	26	232	108	128	60
	Hippolyte varians	—	—	—	4	—	12	—	—	—	—	12	—	—	4	—	—
	Thoralus cranchii	—	—	—	1	—	—	—	—	—	—	—	—	—	—	—	—
	Athanas nitescens	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	—
June 2002																	
Salinity (psu)		33.0	32.9	33.1	29.7	—	32.6	27.8	33.0	—	32.9	32.5	32.4	31.8	31.4	32.8	32.6
Water Temperature (°C)		18.5	19.2	18.6	18.5	—	19.2	20.2	18.6	—	18.7	18.8	18.6	19.0	19.4	18.5	18.3
Dissolved Oxygen (%)		98.8	99.4	96.8	97.8	—	103.9	95.2	99.3	—	100.1	110.9	98.8	114.6	107.4	94.7	97.6
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	—	7 (5)	—	—
	Palaemon elegans	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—
	Palaemon serratus	—	26	24	8	—	—	—	—	—	—	104	7	9	12	2	—
	Pandalus montagui	—	—	32	—	—	1	—	—	—	—	—	—	1	10	—	8
	Crangon crangon	162	30	32	—	—	9	3	432	—	73	26	9	65	9	302	17
	Hippolyte varians	—	—	—	16	—	1	—	—	—	—	4	2	1	2	—	—
	Thoralus cranchii	—	—	4	4	—	—	—	—	—	—	—	—	1	—	—	—
July 2002																	
Salinity (psu)		33.4	33.1	33.5	33.2	—	33.1	33.0	33.2	—	33.0	nd	32.5	31.7	31.1	33.4	33.6
Water Temperature (°C)		21.5	21.9	22.3	23.1	—	23.1	23.7	21.3	—	21.6	nd	21.8	22.1	22.1	20.6	20.2
Dissolved Oxygen (%)		96.4	98.9	96.3	92.9	—	94.6	102.1	97.4	—	111.4	nd	120.2	117.5	111.3	94.8	90.5
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	4 (4)	8 (6)	—	—
	Palaemon elegans	—	—	—	1	—	4	—	—	—	—	—	—	14	2	—	—
	Palaemon serratus	—	—	—	—	—	—	—	—	—	—	—	—	16	42	4	—
	Pandalus montagui	—	—	—	—	—	—	—	—	—	—	—	—	3	—	—	—
	Crangon crangon	284	264	135	4	—	5	21	96	—	508	3100	56	205	611	744	226
	Hippolyte varians	—	—	1	9	—	—	—	—	—	—	100	—	—	—	—	—
	Thoralus cranchii	—	—	1	—	—	1	—	—	—	—	—	—	—	—	—	—
August 2002																	
Salinity (psu)		33.6	33.4	33.3	33.1	—	32.9	32.7	33.6	—	32.9	32.9	33.2	32.8	32.2	33.7	33.6
Water Temperature (°C)		19.3	19.5	19.6	19.5	—	19.7	19.8	19.7	—	20.0	19.8	19.9	19.8	20.0	19.8	18.9
Dissolved Oxygen (%)		85.5	79.5	79.5	77	—	79.1	82.5	87.6	—	75.8	73.6	76.8	72.7	71.2	89.5	87.6
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	—	4 (4)	—	—
	Palaemon elegans	—	—	—	1	—	—	—	—	—	—	—	—	16	4	—	—
	Palaemon serratus	2	—	—	6	—	6	2	4	—	—	15	—	252	25	2	16
	Pandalus montagui	4	—	1	—	—	—	—	—	—	—	—	—	—	—	—	22
	Crangon crangon	522	2600	121	10	—	10	30	576	—	506	18	20416	1768	1032	59	296
September 2002																	
Salinity (psu)		33.3	33.3	33.1	32.7	—	32.2	31.9	32.9	—	32.8	32.5	32.6	32.2	32.0	33.3	33.3
Water Temperature (°C)		16.1	16.1	15.7	15.0	—	14.5	13.9	15.6	—	15.6	15.4	15.5	15.4	15.3	16.2	15.8
Dissolved Oxygen (%)		83.2	83.1	82.3	81.6	—	82.9	85.0	86.9	—	87.9	85.3	85.2	83.1	81.7	83.2	92.7
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	3 (1)	10 (3)	—	—
	Palaemon elegans	1	—	—	—	—	—	1	—	—	—	—	—	5	3	—	—
	Palaemon serratus	3	5	4	21	—	—	—	—	—	—	—	2	121	91	4	51
	Pandalus montagui	8	1	—	—	—	—	—	—	—	—	—	5	—	—	22	36
	Crangon crangon	266	231	4	81	—	368	261	1	—	—	161	681	112	271	279	43
	Hippolyte varians	—	—	—	3	—	—	1	—	—	—	1	—	3	—	1	—
	Thoralus cranchii	—	—	—	2	—	—	—	—	—	—	—	—	1	—	—	—
October 2002																	
Salinity (psu)		32.3	32.3	32.3	31.9	—	31.2	29.2	32.6	—	32.0	32.5	32.1	31.6	30.5	32.6	32.7
Water Temperature (°C)		10.9	10.9	10.9	10.9	—	10.9	10.8	11.4	—	11.6	11.5	11.7	11.6	11.8	11.3	11.4
Dissolved Oxygen (%)		88.4	91.3	91.3	87.6	—	86.5	85.8	91.0	—	96.9	94.4	93.0	88.2	89.3	91.7	92.8
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—
	Palaemon elegans	—	—	—	88	—	—	—	—	—	—	—	—	—	—	—	—
	Palaemon serratus	1	1	4	144	—	16	—	2	—	3	76	—	21	82	3	—
	Pandalus montagui	1	12	15	8	—	—	—	1	—	1	—	—	—	—	15	41
	Pandalina brevirostris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	4
	Crangon crangon	145	386	47	384	—	72	160	40	—	65	10	232	67	35	31	117
	Hippolyte varians	—	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—
	Thoralus cranchii	—	—	—	8	—	—	—	—	—	—	—	—	1	—	—	—
November 2002																	
	Palaemon macrodactylus	—	—	—	—	—	—	—	—	—	—	—	—	—	4	—	—
	Palaemon elegans	—	—	1	—	—	44	—	—	—	—	32	—	200	—	—	—
	Palaemon serratus	1	—	9	4	—	40	—	—	—	—	136	1	1050	8	4	—
	Pandalus montagui	1	5	52	40	—	16	50	4	—	—	188	4	400	4	116	5
	Pandalina brevirostris	—	—	—	—	—	—	—	—	—	—	—	—	—	—	14	—
	Crangon crangon	25	82	17	20	—	104	480	9	—	324	224	121	1300	—	350	206
	Philocheras fasciatus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	—
	Hippolyte varians	—	4	8	4	—	—	—	—	—	—	96	—	50	8	—	—
	Thoralus cranchii	—	—	—	—	—	—	—	—	—	—	4	—	—	—	—	—

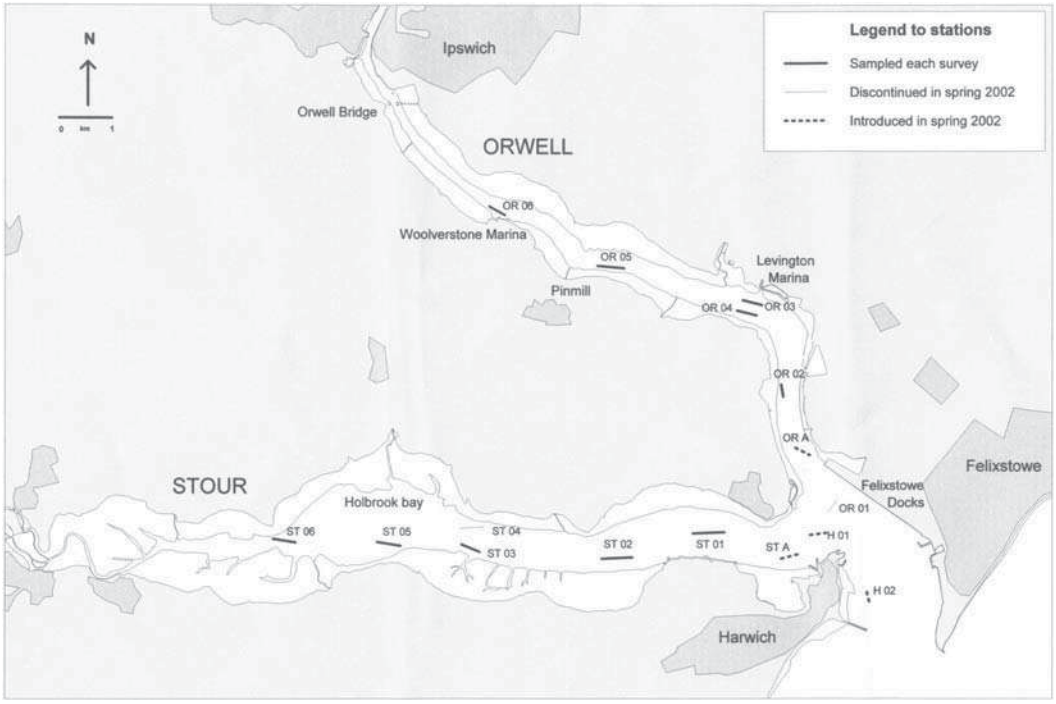

Figure 1. Map of target trawl positions in the Stour and Orwell estuaries, Essex and Suffolk, UK.

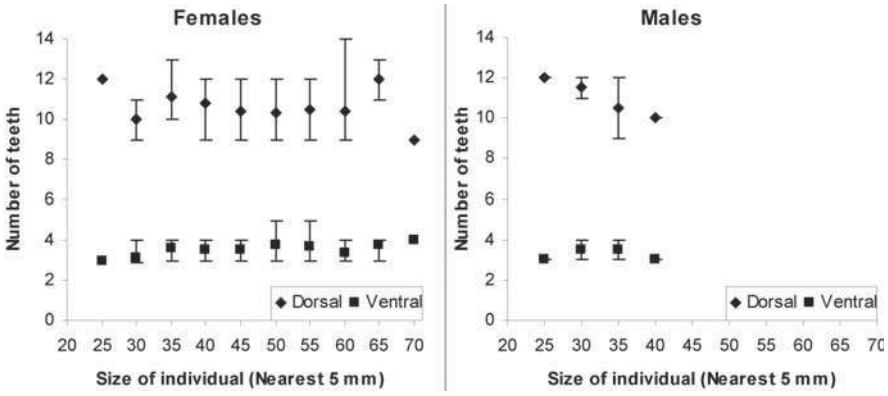

Figure 2. Average number of rostral teeth (dorsal and ventral) in relation to body length for female and male *Palaemon macrodactylus* from the Orwell estuary. Error bars represent the range.

P. macrodactylus has become an intrinsic part of the shrimp fishery and is known as 'oriental shrimp'.

The opportunity is taken here to revise the current standard identification guide to British Palaemonidae (Smaldon et al., 1993) to include *P. macrodactylus*. Another species, *Leander tenuicornis* (Say), which has been recorded from British waters and which is listed in Howson & Picton's (1997) Species Directory, but which is missing from Smaldon et al.'s (1993) standard work, has also been added to the key given here.

MATERIALS AND METHODS

The data considered here were collected as part of a regular monitoring programme (of the fish and shrimp populations of the Stour and Orwell estuaries) conducted

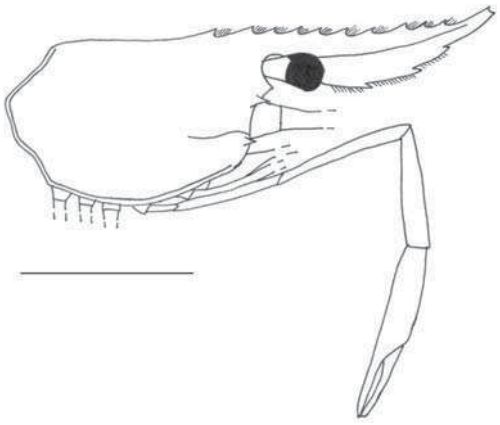

Figure 3. *Palaemon macrodactylus* Rathbun from the Orwell estuary. Lateral view of cephalothorax and pereopod 2. Scale bar: 10 mm.

by Unicomarine Ltd. on behalf of Harwich Haven Authority. The methods used and the results obtained have already been reported in a summary of the data for 2001–2002 (Ashelby et al., 2002). Those methods relevant to the present paper are briefly summarized, below.

Each month, from June 1999 to June 2000, beam trawl samples were taken from six locations on the Stour estuary (Essex and Suffolk), and six on the Orwell estuary (Suffolk). The fish and shrimp in the catch were identified, counted, and measured. Simultaneous records were made of the salinity, temperature and dissolved oxygen content of the water; zooplankton samples were also taken (Dyer, 2001). The sampling positions are shown in Figure 1. The trawls were taken mostly from the seabed, at a depth of 5–6 m below chart datum. The surveys recommenced in December 2001, and now include estimates of the abundance of benthic biota. For each taxon recorded, reference specimens were fixed in a neutral formaldehyde solution and stored in 70% industrial methylated spirits.

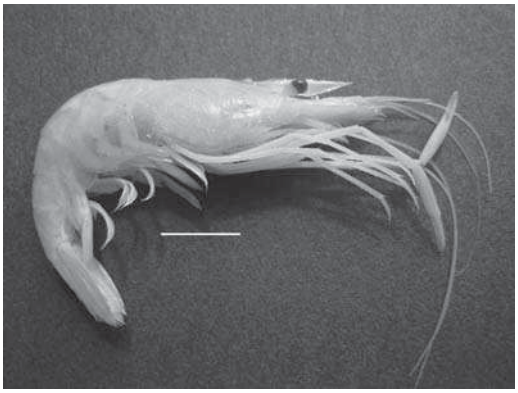

Figure 4. General body form of *Palaemon macrodactylus* Rathbun from the Orwell estuary. Scale bar: 10 mm.

Some of the palaemonid prawns found in the survey of December 2001 were seen to be distinct both from those found previously and from any described in the standard identification guide (Smaldon et al., 1993). Specimens were sent to C. Fransen at the Nationaal Natuurhistorisch Museum, Leiden, for examination. They were subsequently passed on to L.B. Holthuis, who made the initial, tentative identification of *Palaemon macrodactylus*. The identification was confirmed using the description given by Newman (1963) and by the examination of, and comparison with, American material from San Francisco, California (RMNH D 18677), Japanese material from Honshu (RMNH D 32098), and Korean material from Tusan (RMNH D 8985), all of which is held in the collection of the Nationaal Natuurhistorisch Museum, Leiden. Material from the Orwell estuary has been lodged at the Nationaal Natuurhistorisch Museum, Leiden (RMNH D 49812) and at the Natural History Museum, London (NHM 2004.2581–2589).

RESULTS

Distribution

Palaemon macrodactylus was found in the mid reaches of the Orwell estuary, Suffolk. The species was found to the east of Pinmill, Station 5, and close to Woolverstone Marina, Station 6 (Figure 1). Catches of *P. macrodactylus* at these stations have remained consistent. A single specimen was also found at Station 3, close to Levington Marina, in May 2002. The species is noted as being absent from the lower reaches of the Orwell. Two specimens captured by the authors in Holbrook Bay in September 2002, represent the only current recorded instances of the species in the Stour estuary. Salinity at the sites from which *P. macrodactylus* has been recorded ranges from 27.6 to 32.2 ppt. Records of salinity, dissolved oxygen and temperature for stations at which *P. macrodactylus* has been found, or noted as absent, are shown in Table 1, but are unavailable for November 2002. These provide an indication of habitat preference.

Numbers of individuals of all caridean species recorded from the routine surveys in 2001 and 2002, including other Palaemonidae, are also shown in Table 1, highlighting both the identities and the abundance of species that co-occur with *P. macrodactylus*.

Records of ovigerous females

The *P. macrodactylus* population in the Orwell estuary mostly comprises females. Few males have been found. Ovigerous females ranging from 35 mm to 65 mm in length have been encountered. A small proportion of the females caught in December 2001 and January 2002 were seen to be ovigerous. In December ovigerous individuals comprised 11.8% of the total number of females. January showed a slight increase, with 13.3% of captured females bearing eggs. A particularly large ovigerous female, measuring 65 mm, was collected from Station 6 in January 2002. No further ovigerous females were then encountered until June 2002; however, such females were then collected every month from June through to September, inclusive. The proportion of egg-bearing

females encountered in these months was higher than the proportion encountered during the winter. In both June and July, 83.3% of captured females were ovigerous, rising to 100% in August. September saw a marked drop in the number of ovigerous females, with 44.4% of the females caught bearing eggs; none were caught in October. Females carrying very small numbers of eggs (less than 5) were not scored as 'ovigerous'.

Description

The species has been adequately re-described by Newman (1963). However, it is necessary to describe the European specimens in relation to other species likely to be found in similar environments. To this end, a revised key to the British Palaemonidae is presented below. A summary of morphological features (lengths to the nearest 5 mm, counts of rostral teeth and sex) for the Orwell specimens is provided in Figure 2. The cephalothorax is illustrated in Figure 3 and a photograph showing general body form is given (Figure 4). The most useful features, with regard to their ability to aid identification, are summarized below.

Palaemon macrodactylus is a large species, and has been recorded as attaining 51 mm (Newman, 1963), 55 mm Siegfried (1980) and 73 mm (California Resources Agency, 2002) in the United States. Orwell specimens ranged from about 25 to 70 mm (Figure 2). Females are relatively large, ranging from 25 to 70 mm (Figure 2), and averaging 45 mm, in size. The males found in the Orwell population were smaller on average, ranging from 25 to 35 mm in size. There may be up to 15 dorsal rostral teeth (9 to 14 in Orwell specimens, Figures 2 & 3), a greater number than is found in other British species of *Palaemon*. Of these teeth, three (occasionally four) lie behind the orbit. The most posterior tooth is somewhat removed from the others. Females from the Orwell had an average of 11 dorsal rostral teeth. Despite their smaller size, males from the Orwell displayed a greater number of dorsal rostral teeth (9 to 12 in Orwell specimens, Figure 2). The ventral margin has three to five, but usually four, teeth (Figures 2 & 3). The shorter ramus of outer antennular flagellum is fused to the longer ramus for a quarter of its length. The palm of the second pereopod is broad. The body is greenish brown, with brown chromatophores and dull orange joints in a living specimen. The chromatophores are scattered over the body and generally do not form streaks or lines of pigment, as they do in the *Palaemon elegans* Rathke and *Palaemon serratus* (Pennant) found at the same sites. The latter two species also have more reddish brown chromatophores. Similarly, the rostrum of *P. macrodactylus* is translucent in life, lacking the pigment spots found on the rostrum of the other palaemonids found at the same sites. The body is uniformly pale orange after storage in alcohol.

In many respects, *P. macrodactylus* is similar to *Palaemon longirostris* H. Milne-Edwards, and has therefore been placed alongside it in the key. Differences can be found in the numbers and positions of rostral teeth, the density of setae on the rostrum, the breadth of the propodus and the ratio of the fused and free parts of the shorter ramus of the inner antennular flagellum. *Palaemon serratus* is also similar to *P. macrodactylus* but the distal third of the rostrum lacks teeth and streaks of pigment are present on the body. It should be noted that specimens of *P. longirostris* have been found with up to 12 dorsal rostral teeth (de Man, 1915), and that, during the course of the surveys considered here, specimens of *P. serratus* were found in the Orwell which possessed up to nine dorsal rostral teeth.

Key to palaemonid species in British waters

The following key is based on that written by Smaldon (1979) and revised by Holthuis & Fransen (1993). To this, the diagnostic features of *Palaemon macrodactylus* have been added. A further species, *Leander tenuicornis*, which was not included in the original key, has also been included using published descriptions (Squires, 1990; Jayachandran, 2001). Habitat and pigmentation notes have also been added.

1. Rostrum very short, unarmed. Carapace with strong supraorbital spines which are more than half as long as the rostrum; without branchiostegal or hepatic spine. Second pereopods asymmetrical, with swollen chela. Living in sponges . . . . . *Typton spongicola* Costa, 1844
— Rostrum well developed with teeth on dorsal and ventral borders. Carapace without supraorbital spines; with branchiostegal or hepatic spine. Second pereopods symmetrical, chelae slender. 2

2. Carapace with branchiostegal spine; without hepatic spine 3
— Carapace without branchiostegal spine; with hepatic spine, far behind anterior margin . . . . . *Periclimenes sagittifer* (Norman, 1861)

3. Carapace without branchiostegal suture. First pleopod of male with well developed appendix interna on endopod. Rostrum sexually dimorphic: broad and arched in females, slender and upturned in males, with 11–13 dorsal teeth (two of which lie behind the orbit); and 4–7 ventral teeth. Dactylus of pereopod 2 longer than propodus. Warm water species (western in Britain), found among *Sargassum* spp. in the open sea or in shallow water benthic vegetation. . . . . *Leander tenuicornis* (Say, 1818)

— Carapace with branchiostegal suture extending posteriorly from a point on the anterior margin, dorsal to the branchiostegal spine. First pleopod of male without appendix interna on endopod. Rostrum shape variable, with 4–15 dorsal teeth. Dactylus of pereopod 2 equal to or shorter than propodus. Predominantly benthic species.. 4

4. Mandible with palp. Rostrum straight or curved, with five or more dorsal teeth and three or more (in exceptional cases two) ventral teeth. Up to four dorsal teeth lie behind edge of orbit. Brackish or marine 5
— Mandible without palp. Rostrum straight, 4–6 dorsal teeth, two ventral teeth. One dorsal tooth behind edge of orbit. Brackish water species common in saltmarsh pools . . . . . *Palaemonetes varians* (Leach, 1814)

5. Mandibular palp of three segments. Dactyl of pereopod 2 about 0.5 length of propodus. Rostrum variable. Variously pigmented or pigment lacking. . .6
— Mandibular palp of two segments. Rostrum straight or very slightly upcurved; 7–9 dorsal teeth, three (rarely two or four) ventral teeth. Three (occasionally two) of the dorsal teeth behind posterior edge of orbit. Dactyl of pereopod 2=0.33 times length of propodus. Chromatophores form vertical pigment streaks on abdomen. Marine or estuarine. . . . . *Palaemon elegans* Rathke, 1837

6. Rostrum straight, or nearly so, with dorsal teeth extending into distal third. 7
— Rostrum with distinct upward curve, dorsal teeth not extending into distal third. Six or seven (exceptionally up to nine) dorsal teeth, excluding subdistal tooth, four or five ventral teeth. Two of the dorsal teeth lie behind posterior edge of orbit. Merus of pereopod 2=1.25 times length of carpus. Vertical pigment streaks on abdomen. Marine or estuarine; common in rocky areas . . . . *Palaemon serratus* (Pennant, 1777)

7. Rostrum with seven to 15 dorsal rostral teeth (excluding subdistal tooth), of which two to four lie behind the posterior edge of the orbit; most posterior tooth about 1.5 times more distant from first than from next distally 8
— Rostrum with five or six dorsal teeth (excluding subdistal tooth) and three (rarely two or four) ventral teeth. One dorsal tooth behind posterior edge of orbit, second tooth often directly above edge. Lower half of rostrum with scattered red pigment spots. Carpus of pereopod 2 about 1.2×length of merus. Brackish water species. . . . . *Palaemon adspersus* Rathke, 1837

8. Rostrum with seven or eight (up to 12 in exceptional cases) dorsal rostral teeth (excluding subdistal tooth), of which two lie behind the posterior edge of the orbit, and with three or four (rarely five) ventral teeth. Few setae between dorsal rostral teeth. Shorter ramus of antennular flagellum fused for third of its length to longer ramus. Carpus of pereopod 2 equal or slightly longer than merus; palm slender. Brackish water species found in upper reaches of estuaries . . . . . *Palaemon longirostris* H. Milne Edwards, 1837
— Rostrum with nine to 15 (usually ten to 12) dorsal rostral teeth (excluding subdistal teeth), of which three (seldom four) behind posterior edge of orbit, and with three to five (usually four) ventral teeth. Rostrum strongly setose between rostral teeth. Shorter ramus of antennular flagellum fused for a quarter of its length to longer ramus. Carpus of pereopod 2 equal or slightly shorter than merus; palm broad. Commonly estuarine . . . . . *Palaemon macrodactylus* Rathbun, 1902

DISCUSSION

A large species of north-east Asian prawn has been introduced to British waters. The first records of the species in Europe are documented here; but, it is also known to have been previously introduced to San Francisco Bay, western North America (Newman, 1963) and to have spread successfully there (Ricketts et al., 1968; Cohen, 1996; Williams, 1997; United States Geological Survey, 2002; California Resources Agency, 2002). It is tentatively assumed that the species first arrived in the vicinity of the Orwell Estuary some time between June 2000 and December 2001; however, as Carlton (1985) noted, the date of first collection is not necessarily, and indeed is rarely, coincident with the date of introduction.

The species has been found at three locations in the mid reaches of the Orwell estuary, where it was the third most common caridean in December 2001, and at one location in the Stour estuary. It currently lives at salinities of 27.6 to 32.2 ppt in the Orwell estuary. Material from other locations must be examined, in order to confirm that the Orwell was the point of introduction to Europe. The prawns are readily identifiable, once suspected, and can now be searched for in other areas.

The possible means by which marine species may be introduced are summarized by Eno et al. (1997). It is thought that the release of eggs or larvae contained in the ballast water or seawater-intake pipes of large vessels is one of the most common means by which exotic marine species are introduced into waters to which they are not native (Carlton, 1985). Over half of the non-native marine species in British waters are thought to have been introduced in association with shipping, whilst ballast water accounts for about 18% of all introductions (Eno et al., 1997). Decapod larvae have been found in the ballast water of 48% of ships arriving from Japan at the Port of Coos Bay, Oregon, USA, and plankton samples taken from Japanese ballast water have been found to contain up to 367 taxa (Carlton & Geller, 1993). *Palaemon macrodactylus* has pelagic larvae that could be transported in ballast water. The adults also move into the water column at night and are mainly nocturnal (Siegfried, 1982), which may increase the likelihood of them being incorporated into ballast water.

It has been suggested (Dawson, 1973; Williams et al., 1988) that decreased transit times, due to the increased speed of vessels, lead to the survival of greater numbers of the organisms contained in ballast water, which may increase the likelihood of successful introductions. Dawson (1973) suggested that the above may have been the reason for the successful introduction of *P. macrodactylus* to California. Following voyages of about two weeks from Japan to Australia, Williams et al. (1988) found living caridean larvae in the water column, and at least three species of adults and juveniles in the sediment, in the ballast tanks of woodchip carriers.

The Orwell estuary lies between the ports of Felixstowe and Ipswich. Large vessels used to transport goods between continents (including Asia) call at Felixstowe; but, most traffic to Ipswich is local, and comprises smaller vessels (Richard Allen and Ian Webster, personal communication). It is likely that *P. macrodactylus* was transported to the area via international shipping at Felixstowe; however, a detailed study of other estuaries, such as the Thames, will be required for certainty in this matter. Other possible means of introduction include release from aquaria, possibly in association with the restaurant trade.

The fate of the *P. macrodactylus* in European waters should be closely monitored. The species may spread rapidly or slowly, or the present population may remain stable or become extinct. All these possible outcomes have been demonstrated by other species introduced into British waters (Eno et al., 1997). It must be assumed that the species is likely to spread, as it has in North America, where it is now common along most of the Pacific coast. Its spread in North America has been accelerated by its use as bait (Williams, 1997). Consistent catches and records of ovigerous females suggest that the Orwell population is stable.

Palaemon macrodactylus is noted as being very hardy and able to survive a wide range of temperatures, salinities and conditions of oxygen availability (Newman, 1963); such hardiness is also demonstrated by the Orwell specimens (Table 1). It is a strong osmoregulator over the salinity range of 2–150% seawater, and is known to inhabit a wide range of salinities in San Francisco Bay (Born, 1968), where it is not uncommon to capture *P. macrodactylus* in fresh or nearly fresh water (Siegfried, 1980). The upstream limit of its range has been noted as 1 ppt, the downstream limit being set by prey availability (Siegfried, 1980). The species is common in inlets and estuaries, especially in *Zostera* beds (Omori & Chida, 1988a). Further monitoring will be required to confirm any increase in population. *Palaemon macrodactylus* is currently one of the more common carideans in the Orwell estuary, and is often the most common palaemonid in the mid part of the estuary. *Crangon crangon* (L.) and *Pandalus montagui* (Leach) are the most abundant carideans in the estuary as a whole.

A number of studies on the reproductive behaviour of *Palaemon macrodactylus* have been reported that are of relevance here, and these are reviewed below. Omori & Chida (1988a) described reproduction in *P. macrodactylus* in Japan. The breeding season was noted as being mid-April to early October. Second-year females carry eggs earlier than first-year females. Most 0–1 y-old females were found to produce less than 1000 eggs at temperatures of between 15°C and 27°C. Older females were found to produce 500–2800 eggs at similar temperatures. Brood sizes of between 100 and 2000 have been noted for Californian specimens of the species (Siegfried, 1980). These figures are similar to those recorded for other palaemonids, for example the 4300 eggs carried by *Palaemon serratus* (Jensen, 1958). The eggs of *P. macrodactylus* are protected from fungal attack by a symbiotic bacterium (Gil-Turnes et al., 1989). Each age group produces at least two cohorts per year, with five to nine being possible under controlled laboratory conditions entailing a raised temperature and hence an extended breeding season (Omori & Chida, 1988b). It has been suggested that higher salinities may also extend the breeding season of *P. macrodactylus* (Little, 1969). Females may carry a second brood in their ovaries before the first brood is released (Siegfried, 1980). The larvae of *P. macrodactylus* are photopositive (Little, 1969); however, they become photonegative as they develop, prior to recruitment to the benthos (Siegfried et al., 1978). Photoperiod has been noted as an important parameter in controlling spawning (Siegfried, 1980). In California, ovigerous females are found mainly from May to August (Siegfried, 1980); juveniles are recruited to the benthos after May (Siegfried, 1980, 1982). The breeding season observed in the Orwell specimens compares favourably with that described for Japan (Omori & Chida, 1988a) and California (Siegfried, 1980) although it is notably shorter than it is in either of the latter cases. It is possible that the small catch sizes obtained in May and October may have excluded ovigerous females, therefore giving the impression of a comparatively short breeding season. It is also curious that ovigerous females were present in the Orwell during December and January, well outside the breeding seasons described by Omori & Chida (1988a) and Siegfried (1980).

In this species, growth rate is very high in the first year and there is a spurt of growth just before spawning: little growth occurs after spawning until the following year. Sexual characteristics are noted on individuals 20 mm in length (Siegfried, 1980) and females grow faster than, and are larger than, males (Omori & Chida, 1988a). Siegfried (1980) recorded a maximum length of 55 mm for females and 44 mm for males. More large specimens (those over 60 mm) are reported from the Orwell than are reported by the Californian studies considered above, though the California Resources Agency (2002) has recorded a maximum length of 73 mm. Life spans of two to three years have been recorded for individuals of *P. macrodactylus* in Japan (Omori & Chida, 1988a).

The impact *P. macrodactylus* has on the ecology and fisheries of European estuaries should be a subject of further study, as it is not currently possible to predict the implications its introduction may have. A summary of the potential effects of introductions is provided by Eno et al. (1997). Should there be an increase in range, then, as an edible species, *P. macrodactylus* would become part of the prawn fishery. However, it has been described as being of low commercial value in Japan, where it is caught in brash traps (Omori & Chida, 1988a). Were its range to increase, it would also become a food source for fish, along with the native species, as has been noted in California (Ganssle, 1966). Many introduced species have, in the past, proved to be damaging to indigenous biota, although in British waters the effects of non-native species have not generally been as detrimental as those reported in other parts of the world (Eno et al., 1997). There exists the possibility that *P. macrodactylus* may compete with indigenous species for food and habitat, and that it may have an advantage over more vulnerable species.

Like other carideans, *Palaemon macrodactylus* is largely carnivorous, its diet being mainly made up of animal fragments (at least 75%); plant material forms a smaller proportion of its diet (Sitts & Knight, 1979). Newman (1963) noted that in San Francisco Bay *P. macrodactylus* occupied a different ecological niche to the native shrimp species, and so did not seem to have a damaging effect. However, Sitts & Knight (1979) and Siegfried (1982) found that there was dietary overlap, with size-related resource partitioning, between this species and an indigenous species—*Crangon franciscorum* (Stimpson)—in California, with mysids, *Corophium* spp. and polychaetes being the main prey. Copepods have also been reported to be an important prey item (Sitts & Knight, 1979) and are probably the main food of larvae and juveniles. Dietary overlap with the European *Crangon crangon* should also be expected. *Crangon franciscorum* is generally larger than *P. macrodactylus* (Siegfried, 1982), allowing for slight

dietary differences. However, *C. crangon* is of a similar size to *P. macrodactylus*. Therefore, dietary overlap with European *C. crangon* may be expected. In contrast to American waters there are a greater variety of palaemonid taxa in European waters, where habitat and food preferences are more likely to overlap. *Palaemon macrodactylus* currently occurs alongside other palaemonids: several related prawns are found in close proximity in the Orwell (Ashelby et al., 2002; Table 1). There is thus the potential for resource competition to occur; however, it is not known whether the introduced species is either a stronger competitor, or more robust, than any of the native species. The number of eggs produced appears to be similar to the number produced by *P. serratus* (see above).

It is also possible that *P. macrodactylus* may prey on other caridean species. There is evidence of cannibalism when individuals are kept in crowded laboratory conditions (Newman, 1963) and this aspect of the feeding behaviour of the species could be extended to include other carideans in the diet. While little data exists on its competitive interactions, Ricketts et al. (1968) observed that it eclipsed native (American) *Crangon* spp. in terms of numerical abundance, while Siegfried (1980) felt that careful management of water projects may be necessary to protect the native shrimp (*C. franciscorum*) in the Sacramento/San Joaquin Delta. In California, *P. macrodactylus* also serves as an important food resource for fish, including striped bass (Ganssle, 1966; Ricketts et al., 1968) and the larvae are prey for *C. franciscorum* (Siegfried, 1980). It is probable that *P. macrodactylus* may serve as a similar food resource for native *Crangon* and fish species in the Orwell estuary. However, the fact that fungi are associated with the species (Gil-Turnes et al., 1989) raises the possibility that new diseases may be introduced to native prawns.

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Records of *Photis reinhardi* and *Amphilochoides boecki*, two marine amphipods new to Ireland, from Belfast Lough

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The distributions and habitat requirements of marine invertebrates are often included in taxonomic reviews, based on examined material. For poorly-known species, such reviews often remain the primary source of ecological information, in the absence of published results from later surveys. Routine monitoring and impact assessment data, in particular, hold valuable information that will greatly improve our understanding of benthic communities once interpreted from a species ecology viewpoint. This paper illustrates the point with records of two poorly-known amphipods, new to Irish waters.

Monitoring surveys by the Environment and Heritage Service, Northern Ireland (EHS) in the North Channel, at the mouth of Belfast Lough, have found high numbers of invertebrate taxa and individuals, the composition of which varies between stations. Sediment has been collected by Day grab and sieved over 0.5mm and 1mm mesh sieves. Depths given below are approximate (not corrected to chart datum; tidal range, springs, about 3.5m). The species discussed below were only a small component of a rich community of benthic macrofauna. The data are the property of EHS and specimens are held at EHS and Unicomarine, as well as at the National Museum of Scotland (NMS), see below.

Photis reinhardi Kroyer 1842

Myers and McGrath (1981) revised the taxonomy of the genus *Photis* in northern Europe and distinguished two species, *P. reinhardi* and *P. pollex* Walker 1895, that had previously been combined under the former name (Lincoln 1979). They recorded *P. pollex* from localities in Ireland and west coasts of Great Britain but stated that *P. reinhardi* appears to be rare in British waters and restricted to the east coast (of Great Britain). The only *Photis* record listed in the review of Amphipoda in Ireland (Costello *et al.* 1989) is of *P. pollex* from Dublin Bay. The same species is listed from Machrihanish (Scotland) in the *Fauna of the Clyde Sea Area* "as a spur to close scrutiny of records" (Moore 1984).

The present *Photis reinhardi* records are from three stations at the mouth of Belfast Lough: 1 ♀ from 'F02' (54°43'.47N 5°34'.05W; 34m; 8 April 2003), 2 ♂♂ and 1 ♀ from 'F03' (54°43'.47N 5°32'.892W; 51m; 22 April 1997; deposited at NMS: NMSZ:2005.095.0002) and 2 ♀♀ from 'F05' (54°44'.510N, 005°34'.240W; 61m; 16 April 1998). All were retained at 0.5mm. The associated fauna included *P. longicaudata* (Bate & Westwood, 1862) but was dominated by bivalve molluscs, especially *Abra alba* (Wood, 1802), *A. prismatica* (Montagu. 1808) and *Timoclea ovata* (Pennant, 1777). The most similar biotope (Connor *et al.* 2004) would be 'SS.SSA.CmuSa.AalbNuc (*Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment)'. *N. nitidosa* Winckworth 1930 was, however, less abundant than described for the typical form of the biotope and some epifaunal taxa were found, such as the ross worm *Sabellaria spinulosa* Leuckart 1849 and the chiton *Leptochiton asellus* (Gmelin, 1791).

Amphilochoides boecki Sars 1892

Lincoln (1979) knew no confirmed records of *Amphilochoides boecki* from the British Isles. The first confirmed British material was from Lower Loch Fyne on consolidated sand, together with *Antalis entalis*, in 36m (Moore 1982, 1984). Costello *et al.* (1989) included it in their list of amphipods known from Britain but not Ireland and the present record represents the first for Irish waters. The species is distinctive and well-figured by Lincoln (1979).

Three specimens of *Amphilochoides boecki*, one retained at 0.5mm and two at 1mm (one specimen deposited at NMS: NMSZ:2005.095.0001), were found at Station 'SDCS' (54°50'.526N 5°42'.852W; 22m; 4 April 2003). The associated fauna was rich, with large numbers of sessile tubeworms such as ross *Sabellaria spinulosa* and three species of Serpulidae. Sediment fauna included many small brittlestars *Ophiura albida* Forbes 1839, bivalves such as *Timoclea ovata* and the polychaetes *Pholoe inornata* Johnston 1839, *Lumbrineris gracilis* (Ehlers, 1868) and *Galathowenia oculata* Zaks, 1922. The biotope (Connor *et al.* 2004) was close to 'SS.SBR.PoR.SspiMx (*Sabellaria spinulosa* on stable circalittoral mixed sediment)' but shows a transition with 'SS.SCS.CCS.MedLumVen (*Mediomastus fragilis*, *Lumbrineris* spp and venerid bivalves in circalittoral coarse sand or gravel)' and would be considered a crust rather than a reef (Holt *et al.* 1998). The fauna includes both infaunal and epifaunal elements and it is not possible to say to which *A. boecki* would belong, though the Scottish record implies the former.

Discussion

The new records represent only a small number of specimens but have significantly affected the known distribution pattern for *Photis reinhardi*. It was previously recorded (Myers and McGrath 1981) only from the east coast of Britain and from Iceland to the White Sea and Dogger Bank but now shows a more typical northern distribution, to be expected on both sides of the British Isles at similar latitudes. The related *P. pollex* was recorded in Europe only from western Britain and eastern Ireland (Myers and McGrath 1981) but is also found in southern and eastern England (unpublished data held at Unicomarine).

Rarity may be more apparent than real (Moore 1982) and more research is needed to assess the conservation value of marine species. The most extensive review (Sanderson 1996) lists only conspicuous (large) species with the addition of a few subjectively chosen by experts, mainly lagoonal. Most marine data are consequently underused in conservation and impact assessments. It is probable that the distribution and ecology of many macrofaunal benthic invertebrates would be revealed by a thorough review of existing data.

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Occurrence of *Sternaspis scutata* (Polychaeta: Sternaspidae) in the English Channel

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Abstract: Several new records are presented that indicate a substantial increase in the U.K. range of the polychaete *Sternaspis scutata* (Ranzani, 1817). Until recently, this conspicuous polychaete was only recorded from a single location (Portland Harbour) but it is now present at a number of sites in South Devon, a westwards extension of approximately 125 km. The new records include an intertidal location on the Dart estuary, which is of particular interest as intertidal records for this species are rare. It is unclear whether the new records are the consequence of a natural range expansion or relate to human activities.

Résumé : *Présence de* Sternaspis scutata *(Polychaeta : Sternaspidae) en Manche.* Dans cet article sont présentées de nouvelles données qui montrent une extension importante de la distribution de l'annélide polychète *Sternaspis scutata* (Ranzani, 1817) au Royaume-Uni. Jusqu'à récemment (1987-1994) on n'avait enregistré la présence de ce polychète qu'à un seul endroit – le port de Portland – mais des populations ont été observées depuis, dans plusieurs sites de la partie sud du comté du Devon, un déplacement vers l'Ouest d'environ 125 km. De nouvelles populations ont été découvertes dans la zone intertidale de l'estuaire de la Dart, ce qui présente un intérêt particulier du fait que les données intertidales pour cette espèce sont rares. On n'a pas encore déterminé si ces nouvelles récoltes sont le résultat d'un déplacement naturel de l'espèce ou bien si elles sont liées à l'intervention de l'homme.

Keywords: Sternaspis scutata ● Range expansion ● New record ● English Channel

Introduction

The polychaete genus *Sternaspis* (Otto, 1821) comprises over fifteen species (Petersen, 2000) and is recorded from many parts of the world (Rouse & Pleijel, 2001). Members of the genus are moderately sized (up to 30 mm) with a pair of hard ventral shields and multiple branchiae at the posterior end. The anterior end is retractable, with a mouth and narrow prostomium. The first three segments have rows of stout chaetae and the mid segments have embedded capillary notochaetae and a pair of genital papillae on one segment (Petersen, 2000). Sternaspid worms are typically

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found in mud or sandy mud and are thought to be subsurface deposit feeders (Fauchald & Jumars, 1979) that bury head first into the sediment, leaving their gills exposed (Day, 1967). The only species of *Sternaspis* recorded from British waters (Mackie & Erseus, 1997) is *Sternaspis scutata* (Ranzani, 1817). This species has a preference for fine sediment and is widely tolerant of changes in both salinity and turbidity (Petersen, 2000 and references therein). *Sternaspis scutata* is a squat worm, reaching around 30 mm in length and 15 mm width. It has 20-22 body segments, of which the first three have a lateral row of 12 acicular spines and the first seven comprise an introvert. The ventrocaudal shield of this species is striated, rhomboidal in shape and tan brown in colour. Around the shield are 15-17 long bundles of capillary chaetae (Fig. 1).

Until recently, the only recorded U.K. location for *S. scutata* came from a commercial survey in Portland Harbour, completed by the Oil Pollution Research Unit (Hiscock & Hannam, 1986), which was cited by Sanderson (1996). Subsequent surveys at the same location (Ambios Ltd and Unicomarine Ltd, unpublished report) have confirmed the species' presence (see Table 1). According to Fauvel (1927) the nearest occurrence of *S. scutata* to the U.K. is the Bay of Biscay and the North Sea. Recent records from the Bay of Biscay include an intertidal population found in 2001 at the Ile de Ré (pers. comm. D. Fichet). It is also found in the Mediterranean where it can be an important member of the infaunal community, both numerically and in terms of biomass (Salen-Picard & Arlhac, 2002). Other records of *S. scutata* are from the North Sea, Arctic, Antarctic, South Atlantic and Pacific (Fauvel, 1927; Day, 1967; Martin et al., 2000), however, some may require substantiation. More recently, Dauvin et al. (2003) noted that the presence of *S. scutata* in the English Channel could not be confirmed, despite its occurrence both further north and south. One other species of the same genus, *S. fossor* (Stimpson, 1853), has also been listed for Europe (Bellan, 2001).

Materials and methods

In 2004 and 2005, sediment was collected during a number of commercial surveys from sites between Portland Harbour and Plymouth Sound (Fig. 2). Collections were made by different organisations using a range of sampling techniques. Material was washed through sieves of different apertures, depending on the survey, and the fauna retained preserved in 5% formalin. After the material was sufficiently fixed, fauna were washed to remove the formalin, and transferred to 70% ethanol prior to identification.

Results

Specimens of *Sternaspis scutata* were recorded at several of sites at water depths ranging from Low Water Spring

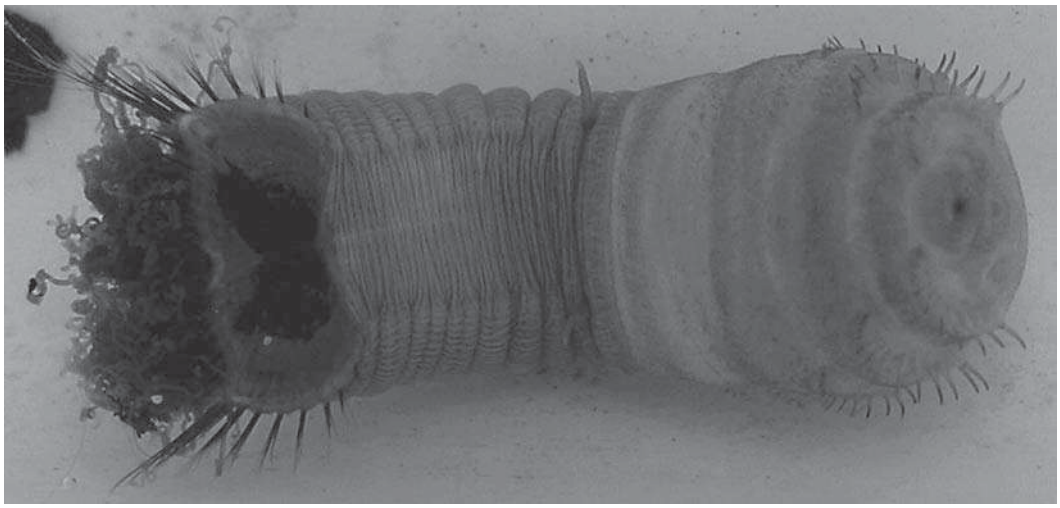

Figure 1. A specimen of *Sternaspis scutata*. Pygidium on the left and prostomium on the right. The first seven segments are introverted revealing the acicular spines (Photo courtesy of Alison Miles, Environmental Agency).

Figure 1. Un spécimen de *Sternaspis scutata.* Pygidium à gauche et prostomium à droite. Les sept premiers segments sont inversés et révèlent les épines aciculaires (photo prise par Alison Miles, Environmental Agency).

Table 1. Recent U.K. records of *Sternaspis scutata.*
Tableau 1. Localisation des récoltes récentes de *Sternaspis scutata* au Royaume Uni.

Date	Location	Water depth (m)	Sediment description	Sampling method	Abundance of *S. scutata*
PORTLAND HARBOUR					
1987	4 sites	7.5-14 m	Mud-muddy shell gravel	Hunter grab	Present
1994	Portland Harbour 50°34.9N 002°26.0W	12 m	Mud and veryfine sand	Day grab	48 in one grab
PLYMOUTH SOUND					
August 2004	Plymouth Sound 50°20.584N, 004°08.600W	8.6 m	Mud	1 x 0.1 m^2 box core	3 individuals
April 2005	Plymouth Sound 50°20.956N, 004°07.841W	10 m	Mud	5 x 0.1 m^2 Day grabs, 1 with *S. scutata*	1 individual
September 2005	Plymouth Sound 50°20.584N, 004°08.600W	8.6 m	Mud	1 x anchor dredge10 x 0.05 m^2 van Veen grabs	22 individuals
DART ESTUARY					
April 2005	Kingswear 50°20.930N, 003°34.525W	Intertidal LWS	Mud with woody detritus	3 x 0.0085 m^2 cores	118 m^{-2}
September 2005	Kingswear 50°20.930N, 003°34.525W	Intertidal LWS	Mud with woody detritus	6 x 0.0085 m^2 cores	334 m^{-2}
LYME BAY					
May 2004	Torbay, 3 stations 50°25.265N, 003°30.551W	12-15 m	Mud - Sandy mud	15 x 0.1 m^2 Day grabs, all with *S. scutata*	Maximum of 1025 in one grab
May 2004	Off Berry Head, 2 stations 50°22.562N, 003°28.840W	19-36 m	Sandy mud	10 x 0.1 m^2 Day grabs, 9 with *S. scutata*	Maximum of 11 in one grab
April 2005	Torbay, 18 stations 50°24.458N - 50°26.764N, 003°31.825W - 003°30.186W	7-15 m	Sandy mud	30 x 0.1 m^2 Day grabs, 22 with *S. scutata*	Maximum of 398 in one grab
August 2005	Brixham Harbour 50°24.343N, 003°30.796W	9 m	Sandy mud	16 x 0.05m^2 van Veen grabs	Maximum of 126 in one grab
September 2005	Northern Torbay 50°44.293N, 003°52.581W	12 m	Sandy mud	1 x 0.1 m^2 Smith-McIntyre grab	55 in one grab
May 2004	Off Otterton Point 50°38.586N, 003°15.863W	16 m	Sandy mud	5 x 0.1 m^2 Day grabs, all with *S. scutata*	Maximum of 49 in one grab

(LWS) to approximately 36 m. The records of *S. scutata* are summarized in Table 1 and a specimen is shown Figure 1. Most specimens found conformed well with the descriptions of *S. scutata* given by Petersen (2000). In this paper the new records of *S. scutata* from the English Channel are presented, representing a considerable expansion of the species' range.

Discussion

In this paper we have assembled recent records of *Sternaspis scutata* from U.K. waters, showing the species to be both more widely distributed (Fig. 2) and more abundant than previous records suggest. In all probability the new information presented here describes an expansion of the species' range: the worm is highly distinctive and hence is unlikely to have been overlooked or mis-identified in previous surveys of the same areas. Some areas such as Plymouth Sound have been sampled regularly for many years. The cause of the expansion is unclear but it comes at a time when other species in Britain are extending their geographical limits and increasing in abundance at sites close to their range edge. Such expansions have been linked to a warming of the marine environment (Stebbing et al., 2002; Beaugrand & Ibanez, 2004; Mieszkowska et al., 2006) but the new records of *S. scutata* do not represent expansion into cooler, more northerly regions. On the contrary, a westward expansion of the species from Portland takes it into more thermally stable water.

Figure 2. Map showing the South-West region of the UK and the sites at which *Sternaspis scutata* have been found. Sites: 1. Portland Harbour, 2. Otterton Point, 3. Torbay, 4. Brixham Harbour 5. Kingswear and 6. Plymouth Sound.

Figure 2. Carte de la région du Sud Ouest du Royaume Uni et des localités où *Sternaspis scutata* a été trouvéE. 1. Port de Portland, 2. Pointe de Otterton, 3. Torbay, 4. Port de Brixham 5. Kingswear et 6. Détroit de Plymouth.

There are no recent records of *S. scutata* from the coast of Northern France, and the origins of the isolated population at Portland Harbour can only be the subject of speculation. Nevertheless, until 1995 Portland Harbour was a major harbour of the Royal Navy and was a training centre for warships from many countries. The possibility that the population first arrived in a ship's ballast water or on a piece of equipment cannot be overlooked. Recent range expansion is one of the defining criteria of a non-native species (Chapman & Carlton, 1994) and there is currently great concern about the ecological impacts of alien species (Bax et al., 2001; Robinson et al., 2005). If the range of *S. scutata* continues to expand in Britain, close attention should be paid to its interaction with other species. Conversely, if *S. scutata* can be considered to be native, then it must be assumed that it should have some conservation status. It is listed as 'Nationally Rare' by Sanderson (1996). It is evident that more research is required to record and quantify further changes in the distribution and abundance of *S. scutata*, as well as to resolve its native or alien status.

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British records of the interstitial polychaete *Stygocapitella subterranea* (Annelida: Parergodrilidae)

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The polychaete Stygocapitella subterranea *is found in upper shore stable coarse substrata and can be regarded as semi-terrestrial. It is known from similar habitats in widely distributed locations of continental Europe. The first two British records, from upper shore damp grit, are summarized here: one site is adjacent to a tidal mudflat near Plymouth and the other site is on the tidal River Thames, London. The two areas have different salinity regimes but similar sediment characteristics, in agreement with published accounts of the species' habitat preferences. It is likely that the species will eventually be found throughout the British Isles and may have been recorded in unpublished data. However, the restricted habitat of* S. subterranea *and the potential threats suggest that some consideration be given to the conservation of the species.*

Keywords: Annelida, Palychaete, Parergodrilidae, *Stygocapitella*, new records, distribution, United Kingdom

INTRODUCTION

Stygocapitella subterranea Knöllner, 1934 was originally described from Kiel Bay, Germany (Knöllner, 1934) and is known from continental Europe between northern Norway and the Black Sea (Westheide, 1977, 1990; Schmidt & Westheide, 2000). Populations from North America (Riser, 1984) have been shown to be genetically, and probably specifically, distinct (Schmidt & Westheide, 2000); those from New Zealand and Australia (Riser, 1984; Hartmann-Schroder, 1996) are also likely to be distinct.

This small (length 1.5–2.6 mm — Westheide, 1990) polychaete inhabits the upper shore of sandy beaches, where the sediment is permanently moist but rarely water-saturated. It shows a preference for the part of the shore closest to the high tide mark and migrates into deeper sediment layers in winter, when it may be found at depths of over 100 cm (Purschke, 1999) and up to 10 metres from the water line on non-tidal beaches (Schmidt, 1970).

The species is of interest to systematists, due to its relationship to terrestrial polychaetes and significance to the phylogeny of annelids as a whole (Purschke, 1999; Rota *et al.*, 2001; Jördens *et al.*, 2004). There are two European terrestrial polychaetes: *Hrabeiella periglandulata* Pizl & Chalupský, 1984 and *Parergodrilus heideri* Reisinger, 1925 (see Fauna Europaea: www.faunaeur.org). The latter is in the same family as *Stygocapitella*, which has been described as inhabiting the transition between marine and terrestrial realms (Purschke, 1999). The only British record of any of the above genera appears to be *Stygocapitella subterranea* which, is here discussed further.

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MATERIALS AND METHODS

Specimens of *Stygocapitella subterranea* were obtained from samples collected during two surveys designed for different purposes. The first survey was a 'ground-truthing' exercise for an assessment of worker comparability in biotope mapping carried out at Millbrook Lake, Cornwall, a tidal mudflat near Plymouth (Worsfold & Dyer, 1997). A sample collected by Tim Worsfold and Martin Dyer, of Unicomarine on 19 April 1996 from damp, stable grit at the high water level near Palmer Point (4.194°W 50.353°N) contained *S. subterranea*.

The second survey was for an environmental impact assessment on the tidal Thames (Dyer & Worsfold, 2000). A sample collected by Martin and Christopher Dyer on 17 September 1999 from upper shore gravel on the south bank of Greenwich Reach, London (0.012°W 51.483°N) contained *S. subterranea*.

In both surveys, the relevant samples were collected with a corer of 0.01 m^2 surface area and penetrated to 15 cm depth.

RESULTS

Stygocapitella subterranea was identified from two samples, one from each of the sites described above (see map, Figure 1). The species is well described and figured in several recent publications (Puschke, 1986; Westheide, 1990; Hartmann-Schröder, 1996; Puschke, 1999). A photograph, of a preserved specimen from Millbrook Lake, is shown in Figure 2 and specimens deposited at the Natural History Museum, London (NHM 2006.600-601). Other specimens are held at Unicomarine.

At Millbrook Lake, ten specimens of *S. subterranea* were found and at Greenwich Reach four specimens of *S. subterranea* were collected. At both sites, enchytraeid

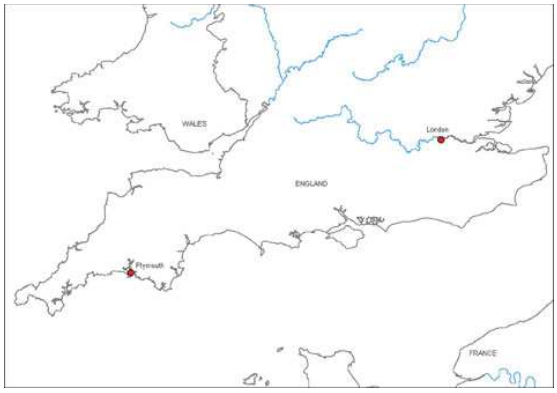

Fig. 1. British records of *Stygocapitella subterranea*.

oligochaetes were dominant and *S. subterranea* was the second most common species in the upper shore samples. Although both habitats comprised upper shore stable, moist, coarse sediments, there were some differences between the sites. Millbrook Lake is a tidal mudflat alongside the Hamoaze, in the Tamar estuary complex. As such, the tidal waters would have near full marine salinity, though this was not measured. Samples from a few metres down the shore included typical marine species, such as *Nephtys hombergii* Savigny, 1818 and *Littorina obtusata* (Linnaeus, 1758). Greenwich Reach, in contrast, has low mean quarterly salinities, between 0.14‰ and 6.82‰, according to Attrill (1998). Samples from lower down the shore were dominated by the oligochaetes *Limnodrilus hoffmeisteri* Claparède, 1862 and *Heterochaeta costata* Claparède, 1862 but no polychaetes were found.

DISCUSSION

As there is a wide distribution of *Stygocapitella subterranea* in Europe (Purschke, 1999), it is not surprising that the species has been found in Britain and the sites are near enough to the type locality to reduce suspicion that they might relate to cryptic species (Schmidt & Westheide, 2000). It is probable that the species is present at many more sites in the British Isles and that there are records in unpublished reports, including some listed as unidentified taxa. The species may have been overlooked due to its restricted habitat and superficial resemblance to an oligochaete. Also the practice at some laboratories of leaving oligochaetes undifferentiated during sample processing may have led to *S. subterranea* remaining unidentified. These new records illustrate the importance of including commercial and other unpublished data in assessments of the distribution and rarity of macrofaunal species.

The habitats recorded in Britain agree with published accounts from German populations in terms of sediment and zonation (Purschke, 1999), though the wide salinity range, noted for the British sites, does not appear to have been mentioned before. The restricted habitat requirements of *S. subterranea* suggest that some consideration should be given to the conservation of the species, or rather to its habitats. Stable, damp, coarse sediments on the upper shore generally occupy only a small proportion of the total intertidal habitat of an area and, as they do not comprise a specific biotope in the current classification (Connor *et al.*, 2004), are liable to be overlooked as important features. Such habitats are also often threatened by foreshore development, particularly in estuaries.

Fig. 2. *Stygocapitella subterranea* from Millbrook Lake; length ~2 mm.

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Identification guides for the NMBAQC Scheme: 1. Scalibregmatidae (Polychaeta) from shallow seas around the British Isles

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The National Marine Biological Analytical Quality Control (NMBAQC) Scheme aims to ensure the quality of marine biological data and has had an emphasis on the processing of benthic macrofaunal samples, particularly for the U.K. National Marine Monitoring Programme (NMMP). The Scheme has highlighted differences in recording practice between laboratories (Worsfold & Hall, 2001) and differences in identification skills for various groups. One of the problems is the lack of a standard guide to marine fauna, such that each laboratory has a different literature collection, often including in-house identification guides.

As an attempt to help the situation, the NMBAQC Co-ordinating Committee has commissioned a literature database for distribution to its members and organises workshops on difficult taxa, for which identification keys are generally produced. In the past, such keys have remained unpublished and often difficult to obtain or even trace their origins. We now intend to publish workshop and in-house laboratory keys to help with data standardisation.

Identification keys are compilations of features found to be useful in the recognition of different taxa. Additional features may exist and some will always be subjective or difficult to find; no key is perfect. It is important to refer to original descriptions and reference material when in doubt. Keys are also subject to revision and it is hoped that this and possible future publications will stimulate corrections and new observations for future circulation. We would also like to request that taxonomists tell us about their new publications so that they can be included in the Scheme's literature database.

Scalibregmatidae

The Scalibregmatidae (or Scalibregmidae), sometimes called maggot worms (Rouse & Pleijel, 2000) are sedentary polychaete worms for which there is no single guide suitable for British species. Most have short bodies with biramous parapodia and no mobile appendages; some have branched gills. They are mostly found in marine subtidal sediments, though the epitokes have been reported swarming in the plankton (Clark, 1954). The Species Directory (Howson & Picton, 1997) lists five species in four genera for shallow water (<200m depth) around the British Isles. Four of these are included in Fauvel (1927) and three in Hartmann-Schroder (1996), which both include *Lipobranchius jeffreysii*, as an additional species; a new species, *Scalibregma celticum*, was described by Mackie (1991).

The following key is adapted from one made at Unicomarine in 2003, which was compiled from the literature detailed above, with the addition of observations made at Unicomarine and feedback through the NMBAQC Scheme. The literature covering each species is indicated by a list of single initials following the authority. Colours refer to alcohol preserved specimens.

1. Body with tapering abdomen; filiform anal cirri; prostomium T-shaped (may appear bilobed in juveniles).....2

- Body short and broad with blunt ended abdomen; pygidium without elongated anal cirri; prostomium rounded or bilobed.....5

2. Branchiae on anterior segments; abdomen with dorsal and ventral cirri, on flattened parapodia; body strongly expanded anteriorly; acicular chaetae absent or blunt spines on first two chaetigers; white or yellowish (*Scalibregma)*.....3

- No branchiae; no dorsal cirri; bluntly projecting posterior parapodia; body not strongly expanded anteriorly; strong acicular chaetae on up to three anterior chaetigers; usually white 4

3. Head with eyes, partly covered by hooded peristomium; short, fine blunt chaetae in parapodia of chaetigers 1 and 2; usually white or cream coloured..... *Scalibregma celticum* Mackie, 1991; M (but see below)

- Head without eyes or hooded peristomium; no blunt chaetae in anterior parapodia; usually yellowish in colour ....*Scalibregma inflatum* Rathke, 1843; F, H, M

4. Eyes present; ventral cirri on posterior segments ....*Sclerocheilus minutus* Grube, 1863; F

- Without eyes; no ventral cirri ....*Asclerocheilus intermedius* (Saint-Joseph, 1894); F, H

5. 4 (to 6) pairs of branched branchiae on chaetigers 2 – 5; no anal papillae; usually yellowish in colour ....*Polyphysia crassa* (Oersted, 1843); F (as *Eumenia*), H

- Without branchiae; anus surrounded by short papillae; usually yellowish in colour .....*Lipobranchius jeffreysi* (McIntosh, 1869); F, H

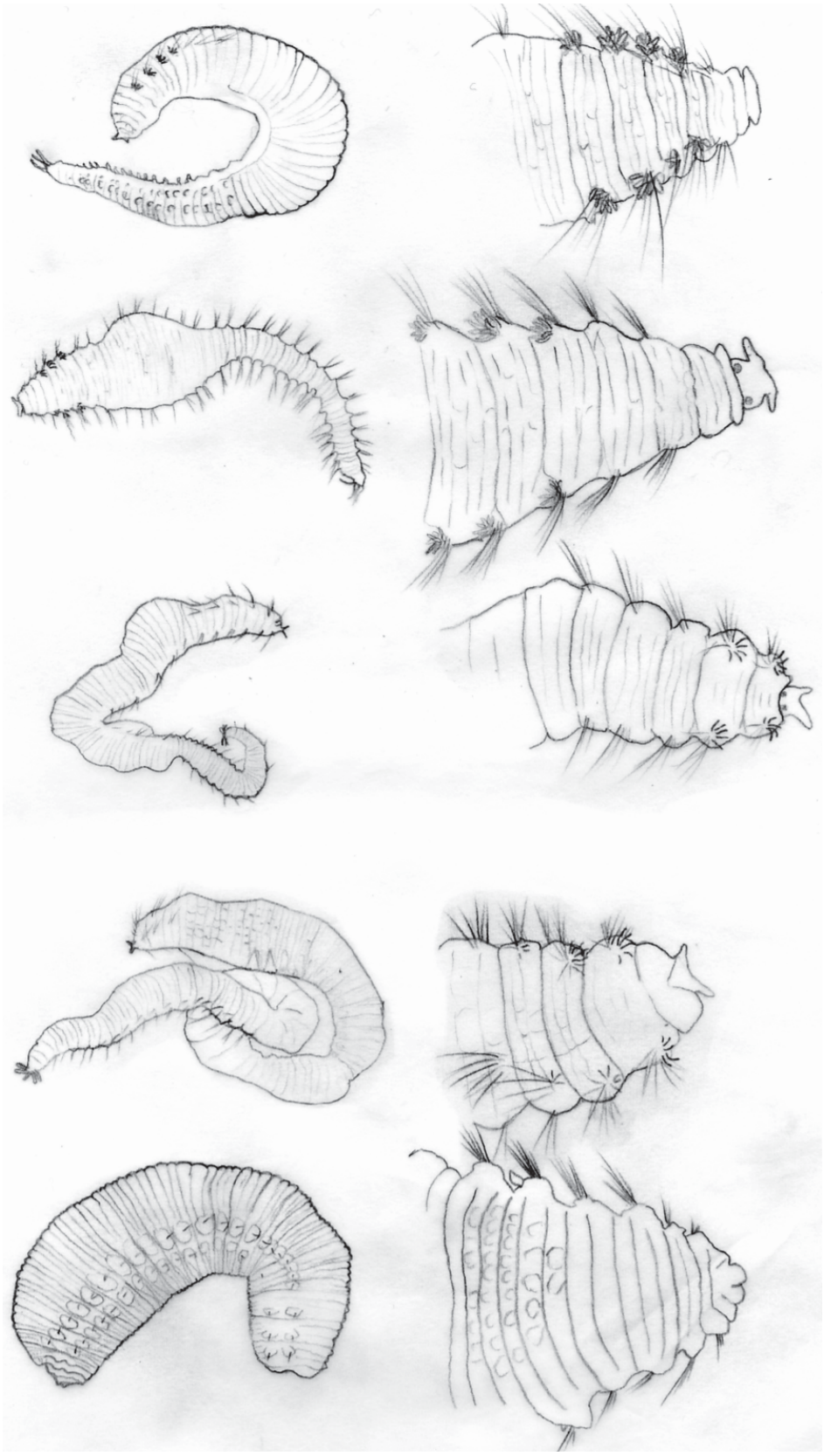

Fig. 1 British shallow-water scalibregmatids. Two views of each of (from top to bottom): *Scalibregma inflatum*, *S. celticum* (3-gill-pair form), *Sclerocheilus minutus*, *Asclerocheilus intermedius* and *Polyphysia crassa*; whole worms on left; dorsal head views on right.

The most well-known scalibregmatid is *Scalibregma inflatum*, which is common all around the coast, mainly in subtidal mud, where it may be dominant. *S. celticum* also appears to be ubiquitous but is found in coarser sediments, including gravels, where it is a small component of the fauna. The two other white scalibregmatids, *Sclerocheilus minutus* and *Asclerocheilus intermedius*, are often found together and with *S. celticum* in gravel, mixed sediment or hard substrata. *S. minutus* appears to be a southern species, absent from the east coast. *Polyphysia crassa* is found in relatively deep, stable muddy sediments and does not seem to be widespread. *Lipobranchius jeffreysi* is treated as a synonym of *P. crassa* in the Species Directory, as it may be the abranchiate juvenile form (Eliason, 1920). However, a small, abranchiate worm found to be morphologically distinct from *L. jeffreysi* was assigned to *P. crassa* by Clark & Dawson (1963), who argued that they were distinct. The taxa are retained as separate in the above key as the issue does not seem to have been resolved but it might be best to combine records for data analysis.

Taxonomic issues remain with the family and other species may be present around the British Isles. Other *Asclerocheilus* species have been suggested (Mackie *et al.*, 1995) and there are discrepancies between published and observed counts of chaetigers with stout chaetae. There may also be other *Scalibregma* species (Mackie, 1991). In particular, animals resembling *S. celticum* but with 3, rather than 4, pairs of gills from the Irish Sea (Mackie *et al.*, 1995) are similar to the American *S. stenocerum* (Bertelsen & Weston, 1980); they are also present in the English Channel, as figured above. The identification of deeper water scalibregmatids requires additional literature (*e.g.* Hartman & Fauchald, 1971; Persson & Pleijel, 2005). The European Register (Costello *et al.*, 2001) lists two additional species: *Pseudoscalibregma parvum* (Hansen, 1878) and *Sclerobregma branchiata* Hartman, 1965, both mapped for deep water in the Celtic Sea on the MarBEF website. The NEAT polychaete list (Hansson, 1998) also includes the genera *Axiokebuita* and *Hyboscolex* and the species *Scalibregma robusta* Zachs, 1925 and *Sclerocheilus deriugeni* Zachs, 1925, both Arctic. It is also possible that the opheliid genus *Travisia* may be transferred to the Scalibregmatidae (Persson & Pleijel, 2005).

Most NMBAQC Scheme participants are able to recognise *Scalibregma inflatum*, which has been sent on the following five ring tests (numbers of participants in brackets): RT2(23), RT8(16), RT14(16), RT18(13) and RT20(15); only two discrepancies were recorded in total, both as *S. celticum*. *Asclerocheilus intermedius* has appeared in one ring test (RT22) and four discrepancies were recorded for 13 participants; one laboratory recorded each of the following: *Sclerocheilus minutus*, *Polyphysia crassa*, *Lipobranchius jeffreysi* and *Paradoneis eliasoni*. None of the other scalibregmatid species has yet been found in sufficient numbers for a ring test.

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Scalibregma celticum – 36772 (East Channel)

Sclerocheilus minutus – 36793 (East Channel)

Asclerocheilus intermedius – 36793 (East Channel)

Polyphysia crassa – 9742 (Loch Spelve) & NMBAQCS MB04 (Oban)

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Additional UK records of the non-native prawn *Palaemon macrodactylus* (Crustacea: Decapoda)

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Since the discovery of the non-native prawn Palaemon macrodactylus *in the Orwell estuary in December 2001, the species is now reported from other estuaries in the greater Thames area: Stour, Medway and Thames. A specimen from archived samples from the Thames is now the earliest European record (1992) but the original site and date of introduction into Europe and Britain remains unknown. Competition with the native* P. longirostris *is a possibility and biologists and naturalists are advised to check prawn specimens from current and archived samples collected from any British or European estuary for* P. macrodactylus.

Keywords: Crustacea, Decapoda, Caridea, *Palaemon macrodactylus*, new records, distribution, United Kingdom, alien species

INTRODUCTION

The prawn *Palaemon macrodactylus* Rathbun, 1902, indigenous to East Asia, has been introduced to many locations outside its native range. Its first appearance as a non-native was from San Francisco Bay (Newman, 1963) and it has since been found in Australia (Buckworth, 1979; Holthuis, 1980; Pollard & Hutchings, 1990; Bruce & Coombes, 1997; Walker & Poore, 2003), Argentina (Spivak *et al.*, 2006), Spain (Cuesta *et al.*, 2004; González-Ortegón *et al.*, 2005), Belgium and the Netherlands (d'Udekem d'Acoz *et al.*, 2005; Faasse, 2005; Tulp, 2006) and Great Britain (Ashelby *et al.*, 2004). The first British records were from beam trawl surveys of the Stour and Orwell estuaries (Essex and Suffolk) in 2002. *Palaemon macrodactylus* has been described and illustrated, with identification keys, by Ashelby *et al.* (2004), d'Udekem d'Acoz *et al.* (2005) and González-Ortegón & Cuesta (2006). Current records are from shallow, estuarine waters.

MATERIALS AND METHODS

Subtidal beam trawl and intertidal trawl sampling continued in the Stour and Orwell estuaries, following the original findings of *Palaemon macrodactylus*, and additional stations with records of the species were noted. It also seemed likely that *P. macrodactylus* could be present in other areas. Staff members from other organizations were contacted for potential specimens. In particular, Renata Kowalik (Zoological Society of London), Kevin O'Connell (Environment Agency), Martin Attrill and Alex Fraser (both University of Plymouth) provided material from the Thames estuary. All material arriving at Unicomarine was carefully checked for *P. macrodactylus*.

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RESULTS

Palaemon macrodactylus was found in one sampling station in each of the Stour and Orwell estuaries, in addition to those already reported by Ashelby *et al.* (2004). Most records are from subtidal beam trawls of the mid Orwell estuary; *P. macrodactylus* has been found at Trawl Stations OR03 (1.268°E 51.992°N), OR05 (1.223°E 51.999°N) and OR06 (1.193°E 52.009°N), most regularly at the latter. There are new finds from the intertidal trawl YF23 (1.280°E 51.981°N) and the beam trawl ST06 (1.180°E 51.958°N) from the Orwell and Stour, respectively in addition to the original Stour record from the intertidal trawl YF9 (1.137°E 51.952°N).

Four specimens found in 0.1 m^2 Day grab samples from Rochester, Kent (0.5013°E 51.3918°N and 0.5144°E 51.3856°N), in connection with an impact assessment (Jones & Worsfold, 2004) on 8 September 2004, represent the first records from the Medway estuary.

A large number of specimens was collected by Renata Kowalik from the water intake to Tilbury Power Station, Thames estuary (0.389°E 51.4515°N) on 29 March 2006. The majority of the palaemonids (169) from the sample were *Palaemon macrodactylus*, though smaller numbers of *P. longirostris* H. Milne-Edwards, 1837 and *P. serratus* (Pennant, 1777) were also present (28 and 7, respectively). Additional specimens from the Thames were found in several one-minute kick net samples from the Environment Agency's routine Thames Tideway samples from Greenwich (0.0096°W 51.484°N), collected on 19 September 2005 and analysed by Unicomarine. Three samples from this location contained 4, 13 and 13 *P. macrodactylus*, along with 5, 7 and 20 *P. longirostris*, respectively. Archived samples from West Thurrock Power Station (0.290°E 51.469°N), collected by Martin Attrill on 13 November 1992 (Attrill *et al.*, 1999) were found to contain one *P. macrodactylus*, in addition to many *P. longirostris*.

Some of the specimens from the Thames have been deposited in the Oxford University Museum of Natural History

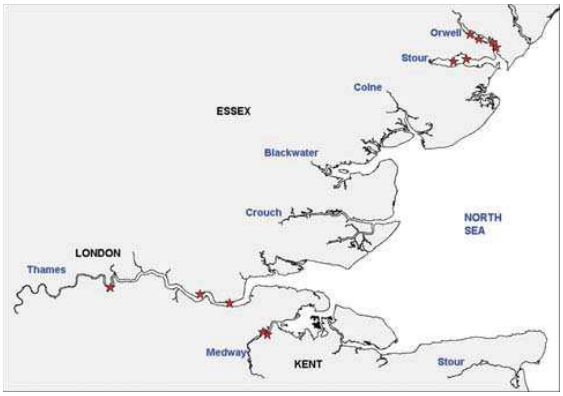

Fig. 1. Current British records of *Palaemon macrodactylus*.

(OUNMH 2006-01-0039 from Tilbury; OUNMH 2006-01-0040 from Greenwich and the 1992 specimen from West Thurrock Power Station: OUNMH 2006-01-041). Material from the Orwell had been deposited at the Nationaal Natuurhistorisch Museum, Leiden (RMNH D 49812) and at the Natural History Museum, London (NHM 2004.2581-2589) after the initial discovery of *P. macrodactylus* in British waters (Ashelby *et al.*, 2004). Additional Orwell specimens have now been deposited at the Oxford University Museum of Natural History (OUNMH 2005-02-001). Those from the Medway are retained at Unicomarine. The recorded distribution of *P. macrodactylus* in Britain is shown in Figure 1.

DISCUSSION

The additional British records of *Palaemon macrodactylus* presented here are unsurprising, given the species' wide range on the continental North Sea coast (d'Udekem d'Acoz *et al.*, 2005). The records also demonstrate that the species has a wider range in Britain than previous records showed. It is highly likely that *P. macrodactylus* will eventually be found in most Essex estuaries and possible that it is also already present in other estuaries outside the area.

It should be noted that almost all current British records are from samples originally collected for purposes other than monitoring of aliens and that the records depend upon recognition of *P. macrodactylus* as distinct from other prawns. Samples that are most likely to include *P. macrodactylus* (e.g. sweep nets and trawls) are often processed in the field, where specific identification of prawns may be problematic. The presence of a longitudinal white stripe extending along the centre of the dorsal surface of both the carapace and the abdomen could be a useful feature for recognizing *P. macrodactylus* in the field (d'Udekem d'Acoz *et al.*, 2005). The pattern is not universally present, however, and was absent in some of the smaller specimens from the Orwell; it should be used only for initial field observations, not definitive identifications.

Much emphasis has recently been placed upon specific studies to monitor particular alien species in British waters (e.g. Marlin, 2006). The results presented here demonstrate that monitoring the spread of non-native marine invertebrates could be greatly improved through the maintenance of specimens from routine surveys, which can then be sent to interested parties. Further information on the spread of *P. macrodactylus* could be gained through the study of palaemonid material from estuaries outside the greater Thames region.

Some potential impacts of the introduction were discussed by Ashelby *et al.* (2004) and by González-Ortegón *et al.* (2005). The new records from the tidal Thames presented here show that *P. macrodactylus* can co-occur with *P. longirostris*, a species considered to have some conservation value (Chadd & Extence, 2004), in British estuaries, potentially occupying overlapping ecological niches. It is possible that *P. macrodactylus* has increased at the expense of *P. longirostris* in the Thames estuary but more data would be needed to confirm this and care should be taken not to assume negative impacts of non-native introductions without evidence (Reise *et al.*, 2006). Competition with indigenous species has been reported in Spain (González-Ortegón *et al.*, 2005).

The date of introduction of *P. macrodactylus* to Europe remains unknown, as does the initial site of arrival. However, the 1992 record from the Thames now represents the earliest from Britain and Europe, indicating that the species was present in the area for many years before it was noticed.

ACKNOWLEDGEMENTS

We are grateful to Renata Kowalik (Zoological Society of London) and Kevin O'Connell (Environment Agency), as well as to Martin Attrill and Alex Fraser (University of Plymouth) for sending palaemonid specimens from the Thames for examination. We would also like to thank Ricardo Perez (Halcrow), Julian Perry (SEEDA) and Sarah Beck (Medway Council) for permission to use the data from the Medway. Staff at Unicomarine processed samples from the Stour, Orwell, Thames and Medway.

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Identification guides for the NMBAQC Scheme: 2. Goniadidae, with notes on Glyceridae (Polychaeta) from shallow seas around the British Isles

Worsfold, T.M., 2007. Identification guides for the NMBAQC Scheme: 2. Goniadidae, with notes on Glyceridae (Polychaeta) from shallow seas around the British Isles. *Porcupine Marine Natural History Society Newsletter*, 22: 19-23.

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The following key and notes are designed to help standardise the processing of benthic macrofaunal samples through the National Marine Biological Analytical Quality Control (NMBAQC) Scheme. It is the second such guide and the aims were summarised in the first (Worsfold, 2006). In addition to providing a summary of identification features and ecological notes, the guides are intended to give some indication of names and taxonomic levels for use through the Scheme.

Goniadidae

The Goniadidae are errant polychaete worms. There has been no guide suitable for British species, though a worldwide revision (Böggemann, 2005) has recently become available. They have elongated bodies with a conical prostomium, bearing four small antennae, as do the related Glyceridae, but Goniadidae have a ring of small jaws, rather than four large jaws. They may also have a row of chevrons on either side of the proboscis and biramous posterior parapodia (both of which are lacking in the Glyceridae. The jaw ring is at the tip of the everted proboscis but appears further back than the chevrons when the proboscis is retracted; mouthparts can often be seen through the body if the skin is pressed or stretched slightly. Goniadids are generally more slender than glycerids and more strongly pigmented. They are mostly found in marine subtidal sediments. The Species Directory (Howson & Picton, 1997) lists seven species in three genera. Four of them are included in Fauvel (1923) and an additional two in Hartmann-Schröder (1996). An additional species is detailed by Walker (1974) and two more liable to be found in British shallow waters are described by Böggemann (2005).

The key is adapted from one made at Unicomarine in 2003, which was compiled mainly from the literature detailed above. Edits have been made using Böggemann (2005) and following the 2006 NMBAQC taxonomic workshop, which included examination of goniadids. Some literature covering each species is indicated by a list of single initials following the authority. Colours refer to alcohol preserved specimens.

1. Posterior neuropodia with 2 pre-chaetal lobes; proboscis with chevrons; neurochaetae all spinigerous; notochaetae capillary or acicular ..... *Goniada* 5

   Posterior neuropodia with 1 pre-chaetal lobe; proboscis with or without chevrons; neurochaetae may include falcigers and spinigers; notochaetae all acicular, where present 2

2. Proboscis without chevrons; neurochaetae with spinigerous blades; prechaetal lobes short .....

   ..... *Glycinde nordmanni* (Malmgren, 1866); F (as *Eone*), H, B

   Proboscis with chevrons; neurochaetae may include spinigers and falcigers; prechaetal lobes long 3

3. All parapodia uniramous (without notochaetae) ..... *Progoniada regularis* Hartman, 1965 B

   Sub-biramous parapodia present (with spine-like notochaetae), following 10-30 uniramous parapodia..... *Goniadella* 4

4. Transitional parapodia with notochaetae arising dorsal to dorsal cirrus; 22-24 uniramous chaetigers; 1-2 spinigerous chaetae per bundle (alongside falcigers); 17-24 proboscis chevrons

   ..... *Goniadella bobretzkii* (Annenkova, 1929); H, W, B

   Transitional parapodia with notochaetae arising at level of dorsal cirrus; 26-30 uniramous chaetigers; 3-5 spinigerous chaetae per bundle (alongside falcigers); 25-30 proboscis chevrons .

   ..... *Goniadella gracilis* (Verrill, 1873); W, B

5. Notochaetae robust, acicular; 60-70 uniramous anterior segments.....

   ..... *Goniada emerita* Audouin & Milne-Edwards, 1834; F, B

   Notochaetae all fine capillaries 6

6. Anterior 17-51 neuropodia with 1 pre-chaetal lobe; first 31-51 parapodia uniramous; no transitional mid region with partially developed notopodia; notopodia with single acicular lobes (excluding dorsal cirrus)..... *Goniada maculata* Oersted, 1843; F, H, B

   From the second to sixth parapodium (to 13th in juveniles), all neuropodia have 2 pre-chaetal lobes; 29-69 uniramous parapodia, which may include 20-50 transitional mid body segments, with partially developed notopodia; notopodia with pre and post-acicular lobes in addition to dorsal cirrus (notopodial pre-chaetal lobes much longer than post-chaetal lobes)..... 7

7. Up to 29 or 38 uniramous anterior parapodia ..... *Goniada norvegica* Oersted, 1845; F, H, B

   Up to 45 or 69 uniramous anterior parapodia .....

   ..... *Goniada pallida* Arwidsson, 1898; H, B (as *G. vorax*)

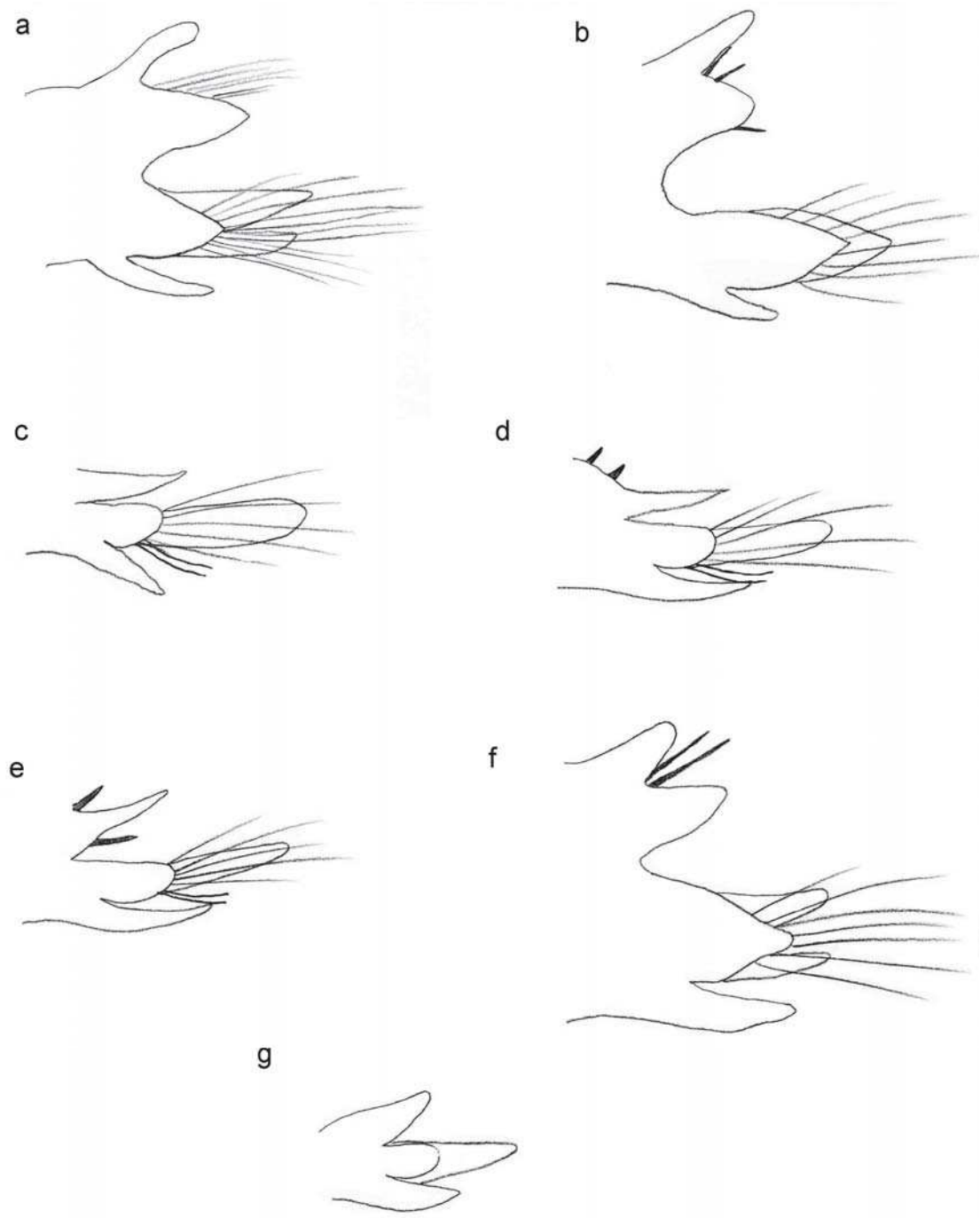

Fig. 1. British goniadids; posterior views of posterior parapodia, from left to right: a) *Goniada maculata* b) *Glycinde nordmanni* c) *Progoniada regularis* d) *Goniadella bobretzkii* e) *Goniadella gracilis* f) *Goniada emerita* and g) anterior parapodium of *Goniada maculata*; c and d adapted from Böggemann, (2005). Photographs have been posted on the MarBEF website (www.marbef.org) and on the NMBAQC Scheme website (www.nmbaqcs.org), along with this article.

Both *Goniada maculata* and *Glycinde nordmanni* are widespread around the coast in subtidal mixed gravel sediment, though neither has been recorded as dominant in any sample we have seen. Both are variegated in shades of brown but *G. nordmanni* is generally glossier, with a more uniform colour and has more distinct eyes. *G. emerita* is often found in subtidal gravel in the south west of the British Isles, where it may be one of the largest polychaetes noted but is rarely seen in large numbers. Fresh specimens are often greenish and iridescent. *G. pallida* seems to be most common in deeper (below 30m), stable muddy sediments, particularly in the north and west. It is glossy with a uniform pale colour, though all our specimens are stained. Members of the genus *Goniadella* are widespread in subtidal moderately clean gravel all around the coast and may occasionally be found in high numbers (up to 100 per m^2). The two species are often not distinguished but all examined for this article were found to be *G. gracilis*, which is small and narrow, yellowish, with brown parapodial lobes. *Progoniada regularis* and *Goniada norvegica* are offshore species, found in deep (over 50m) waters in the North Sea and Atlantic.

Although the recent worldwide revision (Böggemann, 2005) represents the latest view on taxonomic issues, it includes many unlikely species distributions. It may be that some have been introduced globally or that there is a true continuum between different climate and depth bands for some species but, as such distributions have rarely been demonstrated as genuine, it seems best to use names with temperate north Atlantic type localities where available. We would, therefore, recommend continued use of the name *Goniada pallida* for British material, in preference to the Brazilian *G. vorax* (Kinberg, 1865), in spite of Böggemann's synonymy of *G. pallida* with *G. vorax*; the MarBEF website also lists *G. pallida* and not *G. vorax*.

As for all groups, additional species should be expected in deeper water. Possibilities described by Böggemann (2005) include *Bathyglycinde profunda* (Hartman & Fauchald, 1971), *B. sibogana* (Augener & Pettibone in Pettibone, 1970) and *Goniada* cf. *brunnea* Treadwell, 1906, which is reported from the temperate North Atlantic by Böggemann (2005) but its type locality is Hawaii. In addition, the predominantly Mediterranean species *G. hexadentes* Böggemann & Ebiye-Jacobsen 2002 and *G. gigantea* (Verrill, 1885) might one day be found in the south.

No goniadid species has yet been found in sufficient quantity in the same survey for use in any NMBAQC Scheme ring test.

Glyceridae

Most participants would be familiar with the key by O'Connor (1987), as the standard literature for glycerids; it has also been produced as a key and a revised version was presented at the 2006 workshop. Of the 12 species (including one complex) of *Glycera* described there, 10 are listed in the Species Directory (Howson & Picton, 1997); two were considered not British. The deep water *Glycerella atlantica* Wesenberg-Lund, 1950, is also excluded.

A worldwide revision (Böggemann, 2002) is now available. The main changes are as follows. *Glycera gigantea* Quatrefages, 1865 has been synonymised with *G. fallax* Quatrefages, 1850, *G. mimica* Hartman, 1965 has been synonymised with *G. capitata* Ørsted, 1842 and *G. rouxii* Audoin & Milne-Edwards, 1833 has been synonymised with *G. unicornis* Savigny, 1818. The latter synonymy, however has a "?" in Böggemann's list of described glycerids, as does the synonymy of *G. dayi* O'Connor, 1987 with *G. celtica* O'Connor, 1987. We would recommend maintaining *G. rouxii* as separate taxon for the time being. Böggemann uses only proboscis papilla shape to distinguish between *G. alba* (O.F. Müller, 1776) and *G. tridactyla* Schmarda, 1861, which seems to gives different identifications from use of parapodial structure; the separation of these species remains a problem. Böggemann includes 9 *Glycera* with records near the British Isles, including *G. capitata*, which had been considered non-British, and *G. lapidum* Quatrefages, 1866, which had been seen as a complex; we recommend maintaining the aggregate assignment. We are then left with 9 British shallow water species if we maintain the two questionably synonymised taxa as separate.

Glycera tridactyla Schmarda, 1861 may be common in mixed sediments in the south and west but there is much confusion with *G. alba* (O.F. Müller, 1776), which is ubiquitous and common in shallow mixed sediments but never dominant and generally associated with a rich fauna. *G. rouxii* Audoin & Milne-Edwards, 1833 can be common but never dominant in muddy sediments, particularly in the north and west, where it is found with more abundant mud-dwelling species. *G. fallax*

Quatrefages, 1850 is occasionally found in rich, mixed gravel sediments in the south and west. *G. tesselata* Grube, 1863 and *G. celtica* O'Connor, 1987 are not common and are often confused with other species. *G. oxycephala* Ehlers, 1887 and *G. lapidum* agg. Quatrefages, 1866 are ubiquitous and common in mobile sand and gravel, where they may be a dominant component of the biotope but usually not in very high numbers, due to the generally poor fauna of such habitats; *G. lapidum* agg. from muddier habitats are likely to eventually prove distinct. *G. capitata* Ørsted, 1842 is northern and not definitively recorded from British waters.

Most *Glycera* appear white as preserved specimens when small, though larger specimens may be plain brown and some are slightly variegated but less so than *Goniada maculata*.

Glycera lapidum agg. has appeared in one NMBAQC Scheme ring test (RT23) and one discrepancy (*G. tesselata*) was recorded for 15 participants, although names of species in the complex were also used.

Acknowledgements

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Goniada maculata – 19147 (off Harwich)

Goniada maculata – 19147 (off Harwich)

Goniada norvegica (North Sea)

Goniada pallida – 34009 (Belfast Lough)

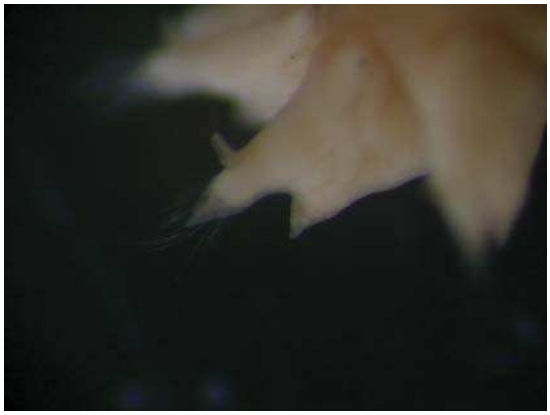
Goniada pallida – 34009 (Belfast Lough)

Goniada pallida – 34009 (Belfast Lough)

Goniada emerita (English Channel)

Goniadella gracilis (Cornwall)

Glycinde nordmanni – 37185 (North Sea)



Glycinde nordmanni – 37185 (North Sea)

Analysis of species distributions by Sea Area, using data from taxonomic and 'grey' literature: Amphipoda

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Introduction

A glance at an atlas of marine fauna by Marine Census or Sea Areas (e.g. Seaward, 1982) shows repeating distribution patterns that reflect the influence of warm or cold waters. It is generally known that warm water species have a western distribution in the British Isles and this is reflected in the recent division of marine ecoregions (Spalding *et al.*, 2007) between the 'North Sea' and 'Celtic Seas', with a boundary running north-south along Great Britain (Scottish north coast to central Channel). Cold water species, however, often appear to have a northern, rather than an eastern distribution. Lincoln (1979) lists records of Amphipoda by Sea Area but does not provide maps by species; he also discusses biogeography and lists species by geographic sub-regions ('faunules'). Dauvin & Bellan-Santini (2004) analysed species lists from several European regions and identified species that belonged to different faunules but did not quantify the patterns discussed above.

There appears to be a need to objectively test whether the available distribution data support the observed patterns and the consequent prediction that species richness would be highest in the southwest and lowest in the southeast. This will provide a predictive framework for other benthic taxa, once demonstrated for a manageable and moderately well-known group (Amphipoda: Gammaridea) and inform future research into the factors that affect such distribution patterns and the nature of the data required to define the patterns. The aim of this study is therefore to investigate possibilities for the use of data derived from a range of sources in order to quantify distribution patterns. This is done through the compilation of records from published and unpublished data and the analysis of different data combinations by use of standard methods.

Methods

In order to identify biogeographical boundaries, Sea Area records of gammaridean amphipods were collected. Sea Area locations are shown numbered on Figures 1, 2 and all subsequent maps. The study was restricted to shallow water and intertidal species, so excluded Sea Areas with no intertidal zone (4, 8, 10 and 40) and species known only from water depths below 50m (as Sea Areas 13, 24 & 25 have no seabed below 50m). Three separate data matrices were prepared: records from Lincoln (1979), those from the Unicorn database (all records from samples analysed at Unicomarine since 1985) and combined records from all accessible sources (Lincoln, Unicorn and other literature – see Addendum).

Records were first analysed as presence/absence data, using Bray-Curtis similarity (Clarke, & Gorley, 2001) in order to determine whether the available data would allow the identification of faunules and determine their boundaries. This was done separately for the three data sets, excluding Sea Areas without records.

As the coverage of data used may not have been even enough for fine resolution through cluster analysis, Sea Areas were then grouped into four regional blocks (shown on Figure 1 and others), chosen to reflect estimated biogeographic patterns and to ensure good data coverage for each major block. The four blocks were defined as southwest (SW), northwest (NW), northeast (NE) and southeast (SE). Although the SE block included only three sea areas, it had high sampling effort (Figure 3). The number of species recorded from each regional block was calculated, as well as the number recorded from each combination (permutation) of regional block records. Sea Area maps were produced for species that represented each permutation.

Results

Cluster analysis (Bray-Curtis similarity) of Sea Area records taken only from Lincoln (1979) showed no discernable pattern. Results for Unicorn data appeared to reflect sampling effort, rather than true biogeographic patterns (Figure 3) but the effect was not so marked as might be expected. This can be seen in the relative uniformity of species recorded for most areas (Figure 1), despite greater differences in sampling effort (Figure 2).

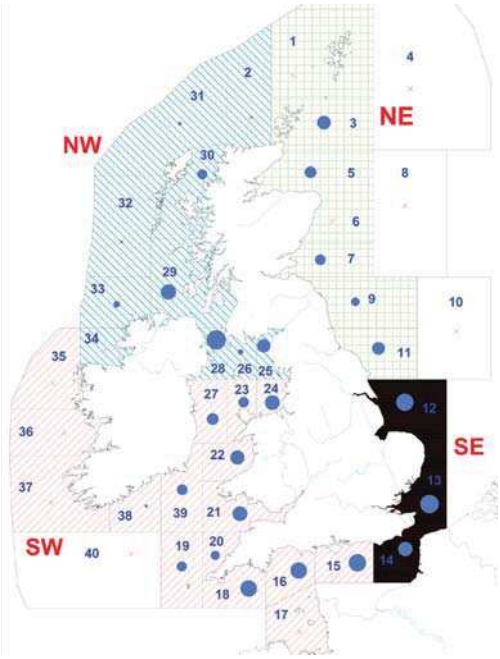

Fig. 1. Relative numbers of species recorded for each sea area (represented by sizes of circles) in data held on the Unicorn database at Unicomarine.

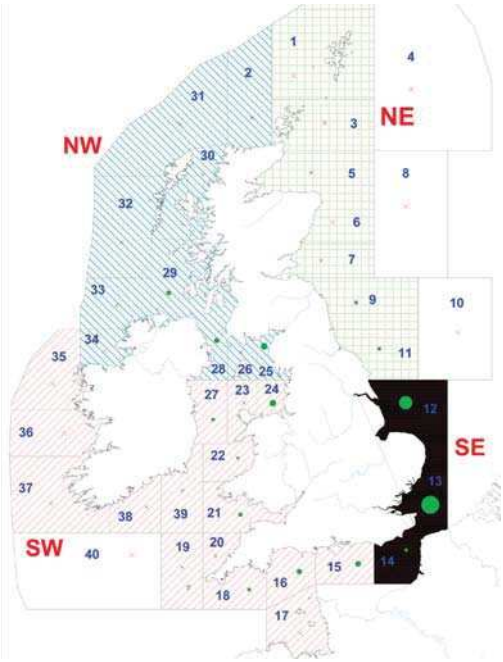

Fig. 2. Relative numbers of samples available for each sea area (represented by sizes of circles) in data held on the Unicorn database at Unicomarine.

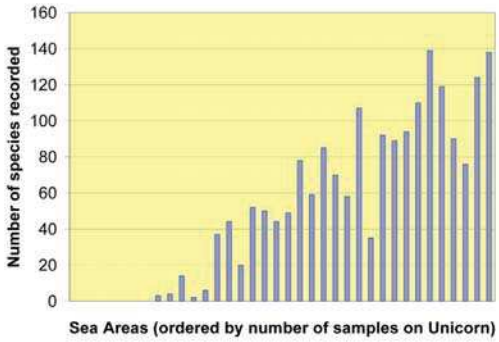

Fig. 3. Numbers of species recorded for each sea area (represented by column lengths) in data held on the Unicorn database at Unicomarine, with sea areas ordered by numbers of samples available.

The number of species recorded from each sea area using the combined data appeared fairly uniform (Figure 4) but still showed limited records for some areas (*e.g.* northwest Scotland) that were likely to be due to low sampling effort.

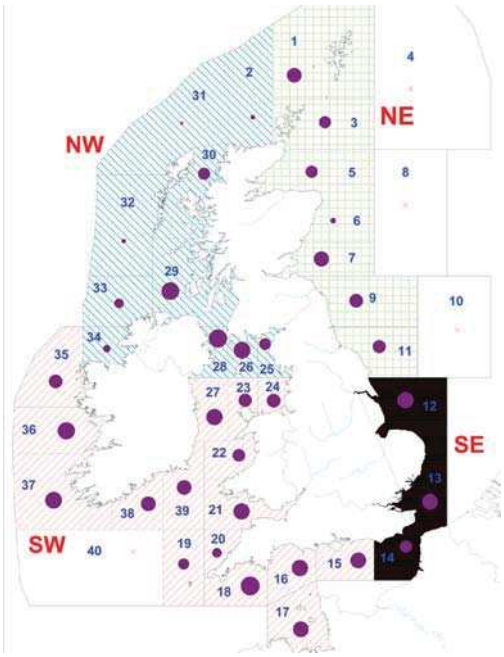

Fig. 4. Relative numbers of species recorded for each sea area (represented by sizes of circles) in all data sourced for this study.

Provisional faunules could be identified as cluster groups and plotted on a sea area map. They showed similarity between neighbouring areas but there appears to be insufficient data to allow detailed identification of faunule boundaries.

A decreasing scale of biodiversity was seen in the

species records by major regional blocks, from the relatively species rich SW, through NW and NE to the relatively species poor SE (Figure 5).

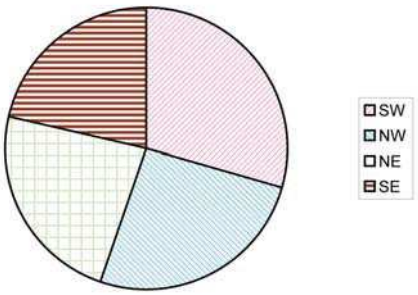

Fig. 5. Number of species recorded from each major regional block.

A similar pattern was seen in the numbers of species with different distribution permutations (Figure 6). The largest group (to the left of the chart) represents those species (47%) that have been recorded from all four regional blocks. The second largest group (10%) was for those species found in all areas except the SE (XSE in Figure 6). The third largest group (8%) included those species recorded only from the SW (NB: in Figure 6 'SW' represents SW only).

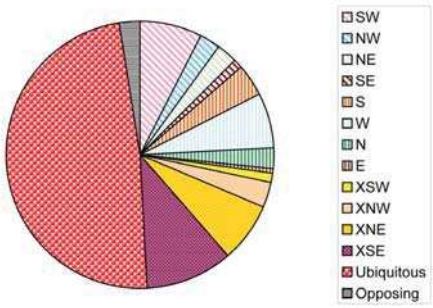

Fig. 6. Numbers of species recorded from different permutations of distribution between regional blocks. The key lists permutations in sequence, as they appear clockwise in the chart, beginning with the '12:00' position.

Improved detail could be seen on Sea Area maps produced for individual species chosen to represent each permutation. One example is shown below (Figure 7) to represent 'distributed in all regions but the SE', the most common regional distribution permutation (other than ubiquitous).

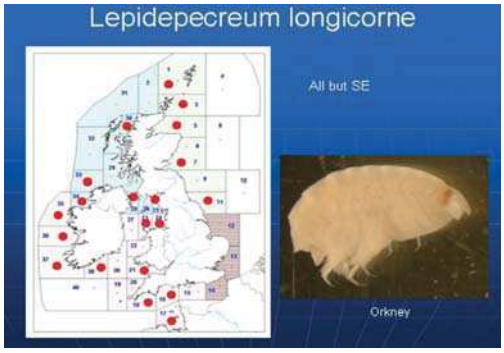

Fig. 7. Sea area distributions and photograph for Lepedepecreum longicorne.

Discussion

While it was not possible to confidently identify regional faunule boundaries with the data collated to date, this analysis provides quantitative evidence for a commonly observed pattern in the marine biogeography of the British Isles: that is, species richness is highest in the southwest and lowest in the southeast. These patterns could be explained in terms of sensitivity to low winter temperatures or high summer temperatures, respectively for warm or cold water species:

(i) highest species richness in the southwest, as a result of warm water species, followed by the northwest and northeast,

(ii) moderately increased species richness in the northwest and northeast, as a result of cold water species,

(iii) low species richness in the southeast, by default.

The concepts are illustrated by the following figure.

Fig. 8. Stylised warm and cold water faunal influences around the British Isles; numbers of species involved are indicated by thickness of arrows, which do not necessarily imply short-term movement of animals.

There are other potential explanations for the observed patterns. There may be low larval dispersal to the southeast, due to the greater movement of water over deeper areas. Another explanation might be that habitat diversity is low in the southeast. The fact that the area is deficient in deep water habitats was factored out as far as possible, through the elimination of deep water species and offshore Sea Areas from the analyses. The low diversity of some other habitats, such as hard substratum communities remains a potential explanation for the pattern, although the absence of certain biogenic habitats could be considered a function of low species richness in itself.

Distributions are imperfectly known for most marine invertebrates and many sea areas lack comprehensive records. In order to achieve both a confirmation and an explanation of the pattern presented here, better standardisation of data would be required. A more thorough data review would eliminate many of the gaps in coverage. Additional data sources have been discovered since the completion of the analyses described here, and there are undoubtedly others. For example, regional reports for the Marine Nature Conservation Review could be used, as well as additional unpublished data sets, such as those held by statutory bodies and consultancies. Standardisation of data in terms of habitats sampled and numbers of samples collected would eliminate many of the variables in explanation. It may also be possible to statistically confirm the patterns by use of data for other taxonomic groups.

Conclusion

The analyses have shown that biogeographic patterns can be identified and quantified through the compilation of data from a range of sources. Further work is required to refine knowledge of the patterns and to determine optimum methods for the collection and use of data for studies of distribution in marine macrofauna. Figures have been provided for relative species richness between regions that are available for testing by use of other taxonomic groups. It is hoped that more standardised data compilation methods will one day allow more detailed analysis of distribution patterns, with clarification of causes and changes with time.

Acknowledgements

This study was undertaken as part of the research requirement in fulfilment of a higher degree at Canterbury Christ Church University. I am grateful to Nigel Grist (Unicomarine) for compilation of data from the Unicorn database and to Chris Ashelby (Unicomarine) and Georges Dussart (Canterbury Christ Church University) for comments on the text.

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Dysponetus joeli sp. nov. (Polychaeta: Chrysopetalidae) from the north-east Atlantic, with a cladistic analysis of the genus and a key to species

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We describe Dysponetus joeli *sp. nov. from shallow maerl habitats in the north-east Atlantic (English Channel and Bay of Biscay).* Dysponetus joeli *differs from congeneric species by a unique combination of characters, including a large syllid-like pharynx, 2–4 simple serrated neurochaetae (closely similar to notochaetae, but much smaller and more delicate), D-shaped chaetal spines and ventral cirri on the third segment. A phylogenetic parsimony analysis based on morphological traits suggests that* Dysponetus *is not monophyletic unless it includes the closely related genera* Vigtorniella *and* Pseudodysponetus*, which are well delineated inside the dysponetid clade. Chaetal spines seem to be secondarily derived from paleae and to have originated in infaunal dysponetid forms. They should not be considered as plesiomorphic, but as evidence to support the clade made up by* Dysponetus – Vigtorniella *and* Pseudodysponetus *as delineated by a phylogenetic analysis.*

Keywords: Polychaeta, Chrysopetalidae, *Dysponetus*, English Channel, Chausey Archipelago, Cornwall, Bay of Biscay, phylogeny, maerl

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INTRODUCTION

Chrysopetalidae is a small polychaete taxon with 12 currently recognized genera and about 50 valid species (Tzetlin *et al.*, 2002; Wiklund *et al.*, 2009), although one species does not fit into a currently recognized genus. These taxa are keyed out in Muir & Bamber (2008). The monophyly of the group is weakly supported by the presence of golden paleal notochaetae (Fauchald & Rouse, 1997), which were conversely regarded as a primitive feature by Westheide & Watson Russell (1992). Synapomorphic characters are clearly needed to clarify the position of the chrysopetalids within the Phyllodocida, since they have been alternatively treated as either a basal (Fauchald & Rouse, 1997) or derived clade (Pleijel & Dahlgren, 1998). A cladistic analysis by Dahlgren *et al.* (2000) indicated a well-delineated chrysopetalid clade but was inconclusive on the identification of the sister-group, which may be either the hesionids or nereidids. Unfortunately none of the recent major phylogenomic analyses of annelids (Zrzavý *et al.*, 2009; Struck *et al.*, 2011) included chrysopetalids as a terminal taxon.

Most epibenthic shallow-water chrysopetalids share typically flattened notochaetae (Dahlgren *et al.*, 2004). These paleae cover the dorsum completely and most probably act as functional scales, similar to those of some other Phyllodocida families *sensu* Fauchald & Rouse (1997). By contrast, these paleae are typically missing or are replaced by chaetal spines with D-shaped cross-sections in a group of still poorly-known, smaller (<1 cm long) infaunal forms, usually with 20–80 segments, made up of *Acanthopale*, *Dysponetus* and *Vigtorniella*, as previously suggested by Dahlgren & Pleijel (1995) and *Pseudodysponetus* Böggemann, 2009. These roundish rather than flattened notochaetae do not cover the dorsum completely (Tzetlin *et al.*, 2002). This species group is present at both shallow and abyssal depths, associated with coarse substrata, whale remains (Wiklund *et al.*, 2009) or muddy deep-sea basins (Böggemann, 2009). *Dysponetus* was formally delineated by the presence of circular notochaetae, a mouth appendage, a single pygidial projection and accessory simple neurochaetae (Dahlgren, 1996).

Tzetlin *et al.* (2002) carried out scanning electron microscopy (SEM) studies of *Chrysopetalum* and *Dysponetus* but found no circular muscle fibres. To determine whether the transverse muscle elements observed were parapodial muscles or reduced circular muscles, a reconstruction of the entire muscle system was carried out in the small species *Dysponetus pygmaeus* Levinsen, 1879 by labelling muscle fibres and using confocal laser scanning microscopy. Proof of the absence of circular fibres in the Chrysopetalidae would be of special interest because this taxon is considered

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to possess several plesiomorphic characters and to be close to the annelid stem species by some authors (Butterfield 1990, 1994; Westheide & Watson Russell, 1992; Butterfield & Nicholas, 1996; Dahlgren, 2000). An assessment of the phylogenetic significance of this feature would provoke a thorough reinvestigation of polychaete muscle systems.

With the exception of recently described or redescribed species (Dahlgren, 1996; Böggemann, 2009), most of the twelve taxa currently referred to *Dysponetus* remain poorly known (Dahlgren, 1996, 2000). All the known species are minute and occur in a range of different habitats, such as calcareous algae, '*Amphioxus* sand' or deep-sea muds. They show a wider diversity of chaetal morphology than has been previously suggested (Dahlgren *et al.*, 2004). Their small size, fragile bodies and marked contraction during preservation make it difficult to determine homologies of anterior parapodial structures. Given the lack of data on many *Dysponetus* species and their range of habitats and chaetal forms, it is possible that future work will show the genus, as currently defined, to be polyphyletic.

In this paper we describe a new *Dysponetus* species from shallow maerl beds located in the English Channel and the Bay of Biscay.

MATERIALS AND METHODS

Specimens of *Dysponetus joeli* sp. nov. were collected from subtidal grab samples taken from the English Channel (Chausey Archipelago, Normandy, France; Helford Estuary, Cornwall, UK) or in the Bay of Biscay (Glénans archipelago, France), North Atlantic Ocean. All the specimens were associated with maerl beds which form very diverse but fragile habitats (Grall & Hall-Spencer, 2003). The samples were collected between 2006 and 2010 using Day, Van Veen or Smith–McIntyre grabs (1/10 m^2, 15 cm substratum depth) and then sieved through a 0.5 or 1 mm mesh (Table 1), with the retained material fixed in buffered formaldehyde solution. The samples were sorted in laboratory and the specimens preserved in either 4.5% formaldehyde solution or 70% denatured ethanol.

All observations and measurements were carried out on fixed specimens, without prior relaxation. Specimens were post-fixed for 1 hour in 1% osmium in distilled water. Dehydration was carried out by transferring them to 50%, 70%, 90% and 100% ethanol, each for 15 minutes, and then through at least two changes of 100% ethanol at 30 minutes and 1 hour. Specimens selected for SEM BAL-TEC CPD 030 (SEM) were critical-point dried and subsequently coated with 102 Å of gold with a SCD-030-BALZERS Union FL9496. They were examined with a GOL JSM6360LZ electron microscope, connected to a computer analyser at the Centro de Microscopia Eletronica, Universidade Federal do Paraná.

The phylogenetic position of *D. joeli* sp. nov. was tested using a dataset of morphological characters modified and expanded from Dahlgren (2000), with additional species described by Böggemann (2009) and in this paper. Polarity determinations were carried out by outgroup comparison with *Acanthopale perkinsi*, *Chrysopetalum debile*, *Paleanotus chrysolepis*, *Vigtorniella zaikai* and *Pseudodysponetus fragmentosus*. These are accepted taxa which belong to the chrysopetalids, a family still in need of further phylogenetic investigation to assess its internal affinities. All characters were treated as unordered. Under this method, when a character state is scored as absent, all dependent characters are scored as inapplicable, yet parsimony programs treat lack of information (?) and inapplicable characters (–) identically (Pleijel, 1995). The matrix was analysed using the parsimony method, with the software Mesquite version 2.74 (Maddison & Maddison, 2010). All useable characters were included in the matrix. Tree search using a heuristic search was carried out with 100 replicates of random taxa. The unrooted majority rules consensus tree was chosen to trace the history of all characters and to describe the phylogenetic position of the new *Dysponetus* material among other *Dysponetus* species. Each character's history was estimated using the reconstructed method with parsimony ancestral state implemented in Mesquite version 2.74 (Maddison & Maddison, 2010).

Holotype and paratypes of the new species are deposited in the collections of the Muséum National d'Histoire Naturelle of Paris (France).

SYSTEMATICS

Family CHRYSOPETALIDAE Ehlers, 1864

Genus *Dysponetus* Levinsen, 1879

Type species *Dysponetus pygmaeus* Levinsen, 1879, by monotypy (=*Taphus* Webster & Benedict, 1887)—Levinsen, 1883, Annenkova, 1935.

Dysponetus joeli sp. nov.

(Figures 1–3)

DESCRIPTION

Holotype 3.1 mm (MNHN POLY TYPE 1533, Chausey) for 19 segments, posterior part missing (Figure 1). Paratype, 3

Table 1. Locations, geographical coordinates (WGS 84), depth, sampling dates, station codes, mesh sizes and mean abundances of the new species.

Location	Coordinates	Depth (below chart datum)	Sampling date	Station code	Mesh size	Mean abundance
Chausey	48°55.570N 001°48.270W	10.0 m	18 April 2006	SSMM01	1 mm circular	4.0 ind.m^{-2}
Glénans	47°43.967N 004°00.672W	4.5 m	22 December 2009	M GL1	1 mm square	3.3 ind.m^{-2}
Glénans	47°43.708N 003°58.076W	2.0 m	22 December 2009	M GL3	1 mm square	3.3 ind.m^{-2}
Helford Estuary	50°05.878N 005°05.758W	8.2 m	2 April 2009	Hel 7.7a	0.5 mm square	6.7 ind.m^{-2}

fragments of a posteriorly incomplete individual (MNHN POLY TYPE 1534, Chausey). Holotype width 0.17 mm without parapodia, constant all along the body, with the exception of successively smaller 3–4 posterior segments, which renders the body posteriorly tapered, not wider than 0.13 mm. Fixed specimens whitish, opaque, eyes reddish, with golden chaetae. Four additional paratypes (2 from Glénans, MNHN TYPE 1536 and MNHN TYPE 1537 and 2 from the Helford Estuary, MNHN POLY TYPE 1535) were examined. Two SEM preparations were also deposited as MNHN POLY TYPE ADD. 1533 and ADD. 1536. Body very small (between 3.5 and 4 mm in all examined specimens), cylindrical, truncate and ventrally flat. Prostomium trapezoidal to rounded, longer than wide, surrounded laterally by first two segments. Four large eyes, evident even in fixed specimens. Diameter of anterior pair of eyes two to three times that of posterior ones, which are closer together. Pigments concentrated on posterior half of the first pair of eyes and on anterior half of the latter, in a typically inverted pattern (Figure 1A–D). Median and lateral antennae missing in holotype and paratypes, but prostomial scars visible subdistally. Palps stout, oval, twice as long as wide, not extending ventrally but ventral subdistal scars visible at the sides of the pronounced single buccal appendage, with blunt tip, on lower lip (Figure 1A–B). Pharynx visible through body wall, extending at least to segment 8. Musculature of pharynx resembles that of syllids, with single pair of harpoon-shaped chitinous jaws 0.059 mm long (Figure 1A, D & E), golden as seen through body wall, but not evident in all examined individuals. First two segments with tentacular cirri, one pair per segment (Figure 1A). First segment achaetous, with dorsal cirrus scar. Second segment with notochaetae only. Two anterior segments dorsally displaced and encircling the head. Notochaetae are ventral heterogomph bidentate falcigers (successively longer upwards); ventral cirri globular–elongated, present in all remaining segments. At least 11–12 neurochaetae per fascicle. Parapodia biramous from segment 3; notopodia reduced; broadly rounded dorsal cirri conical with an elongated digitiform distal part, inserted posteriorly on lower side of notopodia and less developed than ventral cirri (Figure 2A). Single protruding noto- and neuroaciculae in each parapodium (Figure 3A–B). Notoaciculae strongly evident in segment 1. Notoaciculae and neuroaciculae clearly chambered (barred), as seen through parapodial lobes or dissected (Figure 3B, C). Notopodial lobes 3 to 5 times less pronounced than neuropodial lobes (Figure 2A). Notochaetae internally chambered (barred), D-shaped in cross-section, with 14–18 alternating denticles in each of two dorsal rows, clearly separated by a sulcus or median fissure. Denticles are truncate but sharply pointed (Figure 2B, C). Barred sections of notochaetae, arranged in two chambers (Figure 3B), extend for about 2/3 of total chaetal length down to the insertion point in body wall, where chaetae display a small torsion. About 20 notochaetae

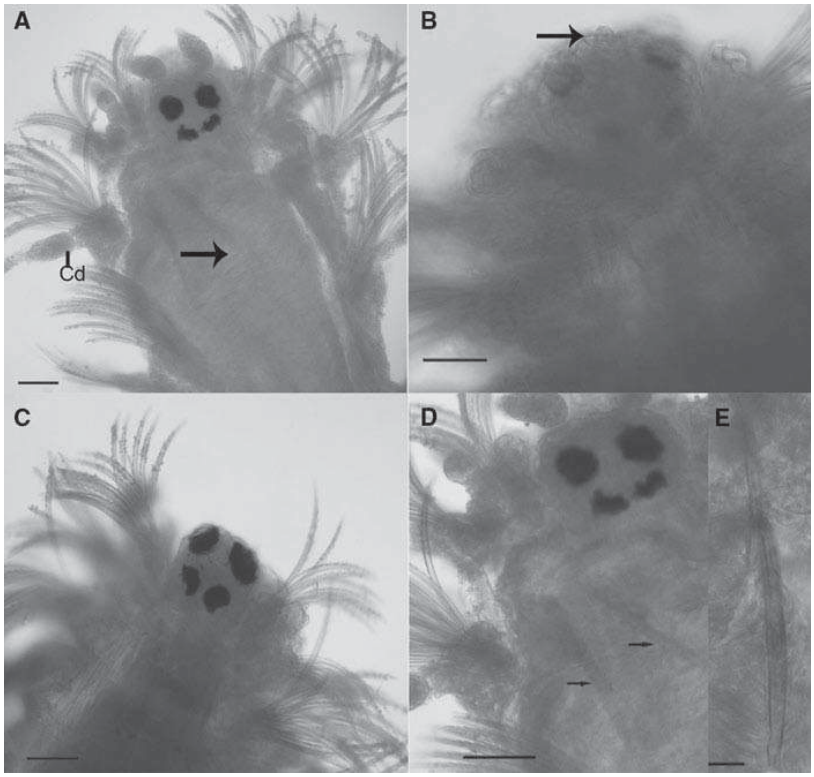

Fig. 1. (A–D) Variation in the appearance of eyes in *Dysponetus joeli* sp. nov. fixed animal: (A) paratype Glénans, anterior part, with a pair of stout palps and syllid-like proboscis (arrow) and (B) holotype, scar of median antenna; (D–E) paratype Glénans, harpoon-shaped chitinous jaws. Cd, dorsal cirri. Scale bars: A–D, 50 μm; E 10 μm.

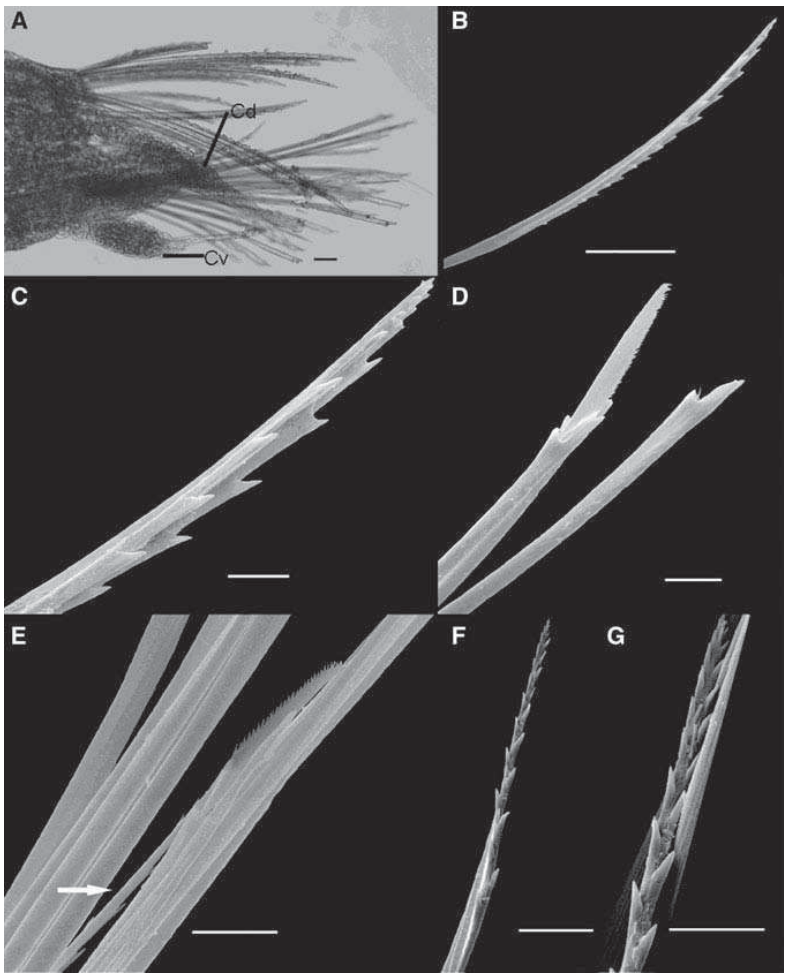

Fig. 2. (A) Median parapodium of *Dysponetus joeli* sp. nov. with dorsal cirrus inserted posteriorly on lower side of notopodium and elongate ventral cirrus; (B) overall view of a notochaetae; (C) details of notochaetae, with two rows of alternating denticles; (D) neurochaetae (compound heterogomph finely bidentate falcigers); (E) fascicle of simple dentate neurochaeta indicated by arrow; (F–G) details of simple neurochaetae, with two rows of alternating denticles. Cd, dorsal cirri; Cv, ventral cirri. Scale bars: A–B, 50 μm; C–F, 10 μm; G, 5 μm.

per fascicle. Neuropodia well developed, elongate and tapering. Neurochaetae of two types:

(1) compound heterogomph finely bidentate falcigers (Figure 2D): 20–25 in each anterior and mid-body parapodium. Blades finely dentate for about 1/5 the length of whole chaeta when fully developed but shorter in the ventral part of the bundle. Articulation protected by a hyaline veil, and more robust (small peak) at the insertion point of blade;
(2) 2–4 simple chaetae placed dorsally in each neuropodial fascicle, closely similar to notochaetae, but smaller, more curved and with two rows of spines not separated by a sulcus or median fissure as in the notochaetae (Figure 2 E–G).

Pygidium with a single projection, inserted posteroventrally, macerated in the only complete individual (MNHN TYPE 1536), with no visible cirri or similar structures. Eggs visible in fragmented posterior segments in paratypes from Glénans.

REMARKS

Table 2, modified from Dahlgren (2000), compares *Dysponetus joeli* sp. nov. to all the other congeneric species and Figure 4 delineates its phylogenetic relationships with other members of the *Dysponetus* group. *Dysponetus joeli* differs from congeneric species by a unique combination of characters, including a large syllid-like pharynx, 2–4 simple serrated neurochaetae (closely similar to notochaetae, but much smaller and more delicate), D-shaped chaetal spines and ventral cirri on the third segment. The serration of the simple neurochaetae clearly differs from those previously reported for *Dysponetus caecus* (Langerhans, 1880) in the redescription provided by Dahlgren & Pleijel (1995). Although a more thorough analysis and additional data, both morphological and molecular, would be necessary for a full resolution of the phylogeny and potential cryptic species, it is important that species are described soon after discovery to allow new records to be made for ecological and conservation studies. For this reason, we have provisionally defined the species using a unique combination of

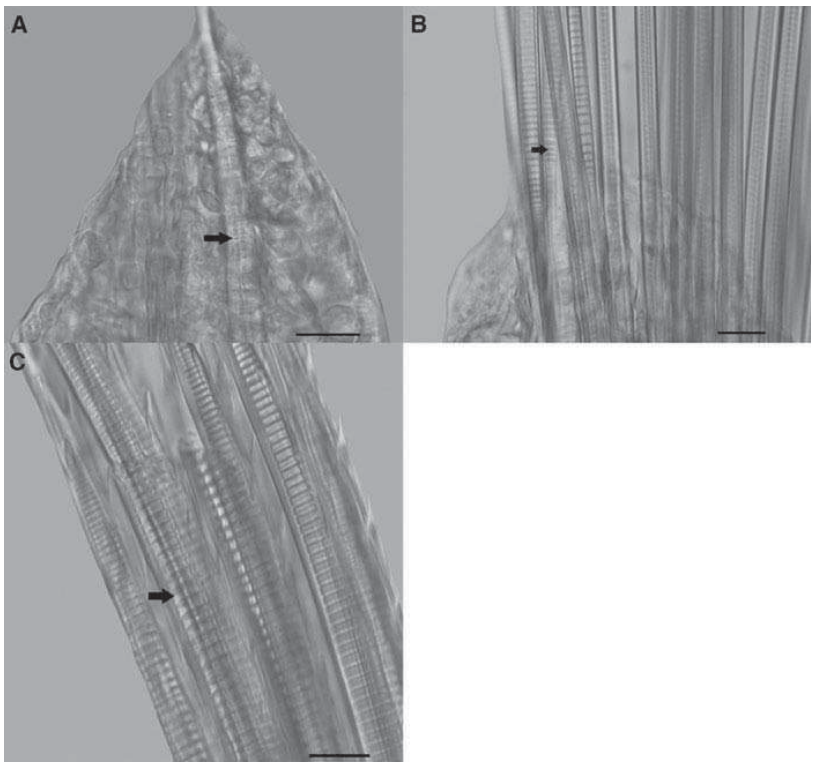

Fig. 3. (A) Notoacicula (indicated by arrow); (B) neuroacicula (arrow) and barred neurochaetae (arrow) of *Dysponetus joeli* sp. nov.; (C) barred notochaetae. Scale bars: A–C, 10 μm.

characters and regard it as a hypothesis (Fitzhugh, 2005) available for testing with more complete data at another time.

The presence of eyes and reduced notopodia with conical dorsal cirri, inserted posteriorly on the lower side of notopodia, are characters shared by *D. caecus*, *D. joeli* and *A. perkinsi* (see San Martín, 1986; Böggemann, 2009). According to Dahlgren (1996), eyes are usually visible in live specimens, but may disappear in fixed material, as in *Dysponetus bipapillatus*. Based on morphological characters, Dahlgren & Pleijel (1995) examined the generic allocation of the closely related *Chrysopetalum caecum* (Laubier, 1964, 1968) in a parsimony analysis together with the type species of the other chrysopetalid genera. Since their results indicated that *C. caecum* shares a more recent ancestor with members of *Dysponetus* than with any other chrysopetalid genus, it was accordingly transferred from *Chrysopetalum* to *Dysponetus*. *Dysponetus caecus* was redescribed from collected specimens from France (Mediterranean), Scotland, and Sweden, and a neotype was designated from Banyuls-sur-Mer, France. The presently known distribution for *D. caecus* ranges from the western Mediterranean and Madeira to northern Europe (Dahlgren, 2000).

Most of the *Dysponetus* species have an achaetous first segment with the exception of *D. bulbosus* which is described with notochaetae. The second segment exhibits more variation between taxa, but all known forms have dorsal cirri and chaetae. Some species of *Dysponetus* lack ventral cirri on the third segment (e.g. *D. bidentatus*, *D. bipapillatus* and *D. macroculatus*). As stated by Perkins (1985) and Dahlgren (1996), tentacular segments and head structures exhibit marked variation within the chrysopetalids. Due to head contraction during preservation in all *D. joeli* sp. nov. examined individuals, it is difficult to determine the development of anterior cirri, and dorsal and ventral rami of first two segments, since first segment is reduced and only indistinctly separated dorsally from prostomium.

According to Kisseleva (1992), *Dysponetus* is characterized by numerous traits, such as biramous parapodia, notopodia with simple toothed chaetae (or a few paleae, as in *D. paleophorus*), long dorsal cirri, inserted below the chaetae, neuropodia with compound heterogomph chaetae, and the lack of a neuropodial ramus on the first segment. In cases where there is a neuropodial ramus on the first segment (as in *D. bulbosus* Hartmann-Schröder, 1982), it lacks chaetae and ventral cirri. The buccal apparatus is of the stylet type.

The clearly related *Vigtorniella* Kisseleva, 1996 is diagnosed by the peculiar structure of the peristomial segment. Besides a notopodial ramus with typical lightly bent, toothed chaetae with transverse striation and long dorsal cirri, there is a well developed neuropodial ramus with a short aciculum, a bundle of special simple chaetae and cirri of the same length or slightly longer than the neuropodial process. It differs from *Dysponetus* in lacking eyes, only two antennae and small plates (not stylets) in the proboscis. The presence of dorsal chaetae on the first peristomial segments was considered a juvenile trait, since they are absent in worms with

Table 2. Character matrix of *Dysponetus* species (expanded and modified from Dahlgren, 2000). Question marks represent missing values, dashes represent missing characters in examined specimens. Numerals correspond to the characters in the list below, and numerals within parentheses to the character states.

Character Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13
Dysponetus bidentatus	1	1	1	2	1	0	1	0	0	0	0	0	0
Dysponetus bipapillatus	1	1	1	0	1	0	1	1	0	0	0	0	0
Dysponetus bulbosus	1	1	1	2	?	0	0	?	1	1	1	0	0
Dysponetus caecus	1	1	1	0	1	0	1	1	1	0	0	0	0
Dysponetus gracilis	0	0	0	0	2	0	0	1	1	0	1	1	1
Dysponetus hebes	0	0	0	1	2	0	0	?	?	0	1	0	0
Dysponetus macroculatus	1	1	1	2	1	?	1	1	0	0	0	0	0
Dysponetus paleophorus	0	0	0	0	2	0	0	0	1	0	1	1	0
Dysponetus pygmaeus	0	0	0	0	2	0	0	0	1	0	1	0	0
Dysponetys profundus	0	0	0	0	0	0	1	0	0	0	1	0	0
Dysponetus hesionides	1	1	1	0	0	0	1	1	0	0	1	0	0
Dysponetus joeli	?	1	1	2	1	0	0	0	1	0	0	0	0
Acanthopale perkinsi	1	1	1	2	3	1	1	1	1	0	1	0	0
Chrysopetalum debili	1	1	1	2	3	1	1	1	1	0	0	0	0
Paleaonotus chrysolepis	1	1	1	2	0	0	1	0	1	0	1	1	1
Vigtorniella zaikai	–	1	1	0	0	0	1	1	1	1	1	0	0
Pseudodysponetus fragmentosus	1	1	1	0	0	0	1	1	0	0	0	0	0

Obs: distinct eyes are absent in *D. hesionides*, but some specimens have pigmented eye-like spots; antennae of *P. fragmentosus* are biarticulated.
1. Shape of median antenna: sphaerical (0); elongated (1).
2. Shape of lateral antennae: sphaerical (0); elongated (1).
3. Shape of palps: spherical (0); elongated (1).
4. Eyes: absent (0); one pair (1); two pairs (2).
5. Mouth appendage: absent (0); single papilla (1); double papillae (2); puriform projection (3).
6. Caruncule: absent (0); present (1).
7. Ventral cirri segment 1: absent (0); present (1).
8. Ventral cirri segment 2: absent (0); present (1).
9. Ventral cirri segment 3: absent (0); present (1).
10. Notochaetae on segment 1: absent (0); present (1).
11. Neurochaetae on segment 2: absent (0); present (1).
12. Shape of main fan notochaetae: spines (0); paleae (1).
13. Long spinigerous neurochaetae: absent (0); present (1).

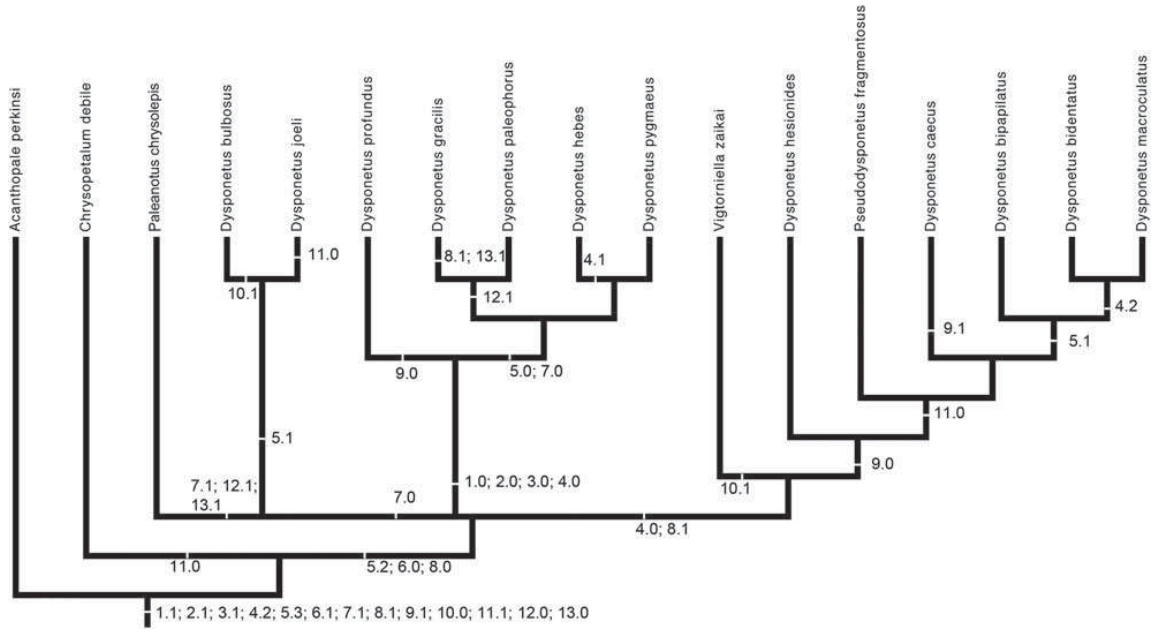

Fig. 4. Delineation of *Dysponetus joeli* sp. nov. in a phylogenetic analysis of 14 dysponetid taxa with *Acanthopale*, *Chrysopetalum* and *Paleanotus* as outgroups; unrooted majority rules consensus tree computed from three original trees 30 steps (CI = 0.53, RI= 0.73).

more segments. Two pairs of dental plates are present in nectochaetes, but one of them is lost in adults (Kisseleva, 1992).

The closely related *Pseudodysponetus* has notochaetae almost circular in cross-section, rather than the more typically flattened notochaetae of related species. *Pseudodysponetus fragmentosus* Böggemann, 2009 is unique among chrysopetalids in having two anterior achaetous segments with dorsal cirri only and acicular notochaetae starting from segment seven or eight (=chaetiger five or six), which should prevent any misidentification. However, anterior fragments of *P. fragmentosus* with only four chaetigers and, therefore, without notochaetae, could be erroneously referred to other families of polychaetes, e.g. Syllidae (Böggemann, 2009).

PHYLOGENETIC ANALYSIS

Our parsimony analysis supports the hypothesis that the dysponetid clades are well separated from paleate chrysopetalid taxa (Figure 4), as previously suggested by Dahlgren (2000). Despite their putative morphological differences, both *Vigtorniella* and *Pseudodysponetus* are delineated inside the dysponetid clades, which are supported by the presence of chaetal spines instead of paleae. Dorsal spines may have originated in those infaunal forms living in calcareous, coarse sediments as a secondary derivation from paleae, although some species with this character were described from muddy deep-sea basins (Böggemann, 2009). As such, they should not be considered as plesiomorphic, but as evidence to support the clades made up of *Dysponetus*, *Vigtorniella* and *Pseudodysponetus*, and probably *Paleanotus*, as delineated by our parsimony analysis (Figure 4). Other probable synapomorphies are the infaunal mode of life and a small size in comparison to 'golden-paleate' chrysopetalids (Böggemann, 2009; Wiklund *et al.*, 2009). However, in the absence of a thorough revision of these three 'dysponetid' taxa, we refrain from proposing formal systematic changes at present.

HABITAT

The species is currently known from shallow maerl (2–10 m) beds with low organic content. The associated benthic assemblages are generally species rich (>100 species at the Chausey Islands) and dominated by interstitial polychaetes (dorvilleids, pisionids, polygordiids and syllids), vagile macrofauna such as amphipods (e.g. *Guernea (Guernea) coalita* Norman, 1868) and polynoid polychaetes and small molluscs (e.g. *Caecum glabrum* Montagu, 1803 and *Leptochiton cancellatus* Sowerby, 1840).

ETYMOLOGY

The species is named in honour of Joël Olivier, father of the first author, who died during the preparation of this paper. He was fascinated by the sea, which explains why all of his children share the same passion for the marine environment.

DISTRIBUTION

Currently known only from type localities off north-west France and south-west England; could be expected in maerl habitats outside this area.

KEY TO WORLDWIDE SPECIES OF *DYSPONETUS* AND *PSEUDODYSPONETUS*

1. First segment achaetous, with one or two pairs of cirri; numerous notopodial chaetae on all chaetigers, usually carrying two alternating rows of spines; antennae and palps uni- or biarticulated 2
– First two segments achaetous, each one with one pair of cirri; up to six smooth, acicular notopodial chaetae starting from chaetigers 5–6; both antennae and palps biarticulated ..... *Pseudodysponetus fragmentosus* Böggemann, 2009
2. Antennae and palps more or less distinctly biarticulate. 3
– Antennae and palps simple and globular or elongated 4
3. Mouth smooth, without conical appendages; dorsal cirri with short cirrophores; notopodial chaetae with two longitudinal rows of alternating spines .... *Dysponetus hesionides* Böggemann, 2009
– Single mouth appendage on lower lip; dorsal cirri with elongated cirrophores; notopodial chaetae with two longitudinal rows of large alternating spines which are integrated into one row in distal part of tip .... *Dysponetus caecus* (Langerhans, 1880)
4. Ventral cirri lacking on third segment 5
– Ventral cirri present on third segment..... 7
5. Ventral cirri present on second segment; anterior median antenna..... 6
– Ventral cirri lacking on second segment; dorsal median antenna ..... *Dysponetus bidentatus* Day, 1954
6. 4 minute eyes .. *Dysponetus bipapillatus* Dahlgren, 1996
– 4 large eyes.... *Dysponetus macroculatus* Dahlgren, 1996
7. Few or numerous expanded paleae 8
– Few or numerous curved notopodial chaetal spines .. 9
8. Ventral cirri on second segment .... *Dysponetus gracilis* ..... Hartman, 1965
– Ventral cirri lacking on second segment..... ..... *Dysponetus paleophorus* Hartmann-Schröder, 1974
9. First segment with one pair of cirri 10
– First segment with two pairs of cirri .... *Dysponetus profundus* Böggemann, 2009
10. Palps globular; eyes absent or minute; unidentate neurochaetae 11
– Palps elongated; 4 large eyes; bidentate neurochaetae 12
11. Anterior median antenna; one pair of minute eyes (not visible in preserved specimens) [after Dahlgren & Pleijel, 1995] .... *Dysponetus hebes* (Webster & Benedict, 1887)
– Dorsal median antenna; no eyes. *Dysponetus pygmaeus* Levinsen, 1879
12. Notochaetae on first segment; neurochaetae on second segment ..... *Dysponetus bulbosus* Hartmann-Schröder, 1982
– No notochaetae on first segment; no neurochaetae on second segment ..... *Dysponetus joeli* sp. nov.

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Appendix 2

NMBAQC Scheme publications by or including the author that are relevant to this thesis

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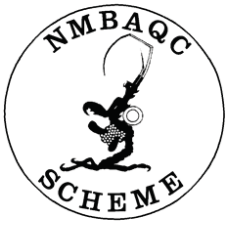

National Marine Biological Analytical Quality Control Scheme

Sorting Methods Questionnaire

Client NMBAQC Scheme
Authors Tim Worsfold & David Hall

Report NMBAQCsortmeth
August 2001

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1. Introduction

Standard operating procedures (SOPs) in marine biological sample collection and analysis were reviewed for the National Marine Biological Analytical Quality Control Scheme (NMBAQCS) by Cooper & Rees (2000). However, that report focussed primarily on sampling methods and safety and did not deal with all issues concerning the fundamental requirements of processing of macrobenthos samples.

Few agencies or other organisations that commission samples for analysis of macrobenthos give clear guidelines as to the required treatment of samples. Laboratories that carry out sample analysis generally develop their own in-house practices. The practices are often not explicitly written down but become established through tradition. As the agencies requiring data do not give clear guidelines and as they often subcontract their sample analysis to more than one laboratory, it is important to ascertain the consistency of practice between laboratories. Consistency is particularly important where data collected by different organisations are to be used for comparative purposes, as with the National Marine Monitoring Plan (NMMP).

2. Methods

On 20th October 2000, a questionnaire (Appendix 1) was sent to twenty participants of the NMBAQC Scheme. Reminders for outstanding questionnaires were circulated on 26th January 2001. The purpose was to evaluate the consistency of sample processing and, consequently, of data quality between different laboratories that carry out NMMP macrobenthos sample analysis. The questions were designed to highlight areas of likely discrepancy between different laboratory practices that had been noticed during examination of data sets submitted through the NMBAQC Scheme. The ordering of the questions on the questionnaire was random but here the most basic sample handling issues are dealt with first, followed by more detailed issues of specimen identification and enumeration. The questions from the questionnaire (Appendix 1) are quoted in the text below with question numbers in brackets.

2.1 Sample collection

There are many issues relating to the sampling process itself that are beyond the scope of this report. The design of the sampling grid, numbers of replicate samples, sampling type and methodology all have a great impact on the value of the final data set. They must be considered elsewhere. Some aspects of sampling, however, have a more direct impact on the nature of the samples themselves, as received for further analysis. The type and nature of the preservative have a great affect upon the quality of the samples and specimens contained within them. Factors include formaldehyde concentration and the addition of buffers such as borax. The nature of the sediment affects the effectiveness of preservation. The amount of water contained within sediment changes the concentration of added preservative. Coarse sediments with many empty shells need less buffer (for preventing the decomposition of mollusc shells) than soft muds. The degree and style of any processing (e.g. sieving) before preservation affects the condition of preserved biota. There is also a need for clear labelling of samples. These issues were considered by Cooper & Rees (2000).

One of the questions on the form (stated below) was concerned with the addition of stain to the samples. Stains are generally added at the same time as the preservative as part of the sample collection process.

> "Do you routinely use any form of staining in your sample processing? If so give details and reasons for use" (Q.7)

2.2 Initial sample processing

Most of this report is concerned with laboratory processing. Generally, samples for macrofaunal analyses arrive at the laboratory (which may or may not be directly connected to the organisation that originally collected the samples) contained in watertight containers with a volume of sediment and associated biota preserved in formaldehyde. The required remit is generally no more precise than e.g. extraction, identification and enumeration of macrofauna to the lowest taxonomic level possible. Instructions for biomass, reference collections and return of specimens and residues are often provided but there is much room for different interpretations with most of the other requirements. We asked laboratories to describe their methods for a hypothetical complex sample:

> "If your samples contained stones with *Pomatoceros* tubes, *Sabellaria* reefs, barnacles, hydroids and encrusting bryozoans attached, how would you proceed with the sorting?" (Q.5)

Samples with very large volumes of sediment are not generally searched in their entirety due to time (cost) restraints. It is therefore necessary to ask how different laboratories subsample such sediments:

> "If your samples contained several litres of 0.5-1mm and 1-4mm sediment fractions, how would you process these fractions?" (Q.6)

2.3 Extraction of fauna

Extraction of fauna may seem to be a simple requirement. However, the title has already assumed that plant material need not be extracted or recorded. Plants may be an important aspect of the biology within certain samples. Many laboratories also assume that only benthic animals need be extracted, some assume only macrofauna should be recorded and some assume that only infauna are required. The assumptions are not consistent and are rarely defined in protocols. In addition, the terms benthic, macrofauna and infauna are not clearly defined and interpretations have been known to vary between laboratories. The following questions were asked of participating laboratories. Some examples of problem taxa were provided (see Appendix 1).

> "Which of the following do you routinely extract and record:"
> "List any additional taxa that you would not record:" (Q. 4A & 4B)

In addition to macrofauna, some laboratories extract, or require extraction of, anthropogenic items or seeds. Protocols are usually more clear with such requirements but routines were investigated with the following question:

"List any additional materials (non-faunal) that you record" (Q.4C)

2.4 Recording of fauna

The issues considered so far concern only the basic processes of extracting animals from a sample. Greater discrepancies might be expected with the actual recording and identification. One of the simplest issues is how to record fragmented animals.

"What constitutes a countable individual for the following taxa:" (Q.2)

Identification involves many more sources of inconsistency and error than those connected with whether or not a particular identification is "correct". The usual requirement of "lowest taxonomic level possible" appears not to recognise the fact that different levels of identification are possible for different laboratories. Individual laboratories may have established traditions of identification levels for different taxa at different sizes but they may not be consistent between laboratories. Small individuals are often recorded as juveniles. We attempted to test the consistency of recording of juveniles in different taxa and the sizes at which they were considered to be juveniles:

"Please list all taxa that you separate into adults and juveniles" (Q.1)

Laboratory traditions concerned with taxa that are considered too difficult to identify to species were compared by the following question:

"List all taxa which you would normally identify at a higher taxonomic level than species:" (Q.3)

Finally, we asked for participating laboratories to provide any further comments that might be relevant to the study:

"If you have any further comments please use the reverse of this sheet". (Q.8)

3. Results

The questionnaire was sent to twenty laboratories that participate in the NMBAQC Scheme, including government organisations and independent consultancies. Twelve laboratories provided full returns, which would have included some from the same organisation. Another laboratory provided an additional response with comments loosely related to the questionnaire. A high proportion of other respondents had also misunderstood the purpose of the survey and the form layout.

3.1 Staining

Rose Bengal was routinely used by ten of the laboratories that responded to the questionnaire. The reason generally given was that it increased sorting efficiency or that it could be used to distinguish live-collected material from debris. Some specified light stain, in recognition of the problems that can be caused by the masking of

specimens and features in pink liquid. Methyl blue and Crystal violet were each mentioned by one laboratory for use in enhancing identification features. Two laboratories did not use stain.

3.2 Initial sample processing

3.2.1 Processing complex samples

The most thorough method of processing such a sample would be first to separate the stones and *Sabellaria* from the sediment. Obvious animals, including the *Pomatoceros* worms would then be removed from the stones for examination. Encrusting life would be examined while attached to the stones. *Sabellaria* reefs would be crushed to extract the worms and other associated fauna for counting. Old *Pomatoceros* tubes would be treated in the same way. The sediment would then be separated into light and heavy fractions for sorting under the microscope by separate size fractions.

Most (seven) laboratories mentioned separate examination of stones and picking off *Pomatoceros* etc. There was much variation in the recording of sessile taxa, though seven participants said that stones would be examined. That issue will be dealt with in more detail later. *Sabellaria* reefs were not specifically mentioned by all laboratories. Four laboratories said they would be crushed, while four said they would be broken up. Two laboratories noted the fact that other species (besides *Sabellaria*) would be present in the tubes. One laboratory suggested that the portions of reef would be sub-sampled by weight.

3.2.2 Processing large samples

Some form of decanting of light fractions (containing most of the fauna) would be necessary, here, and was mentioned by eight laboratories. Separation of the float into size fractions would also be useful and was also suggested by eight laboratories. One laboratory stated that separation of fractions was not done. Most workers would then need to save time by avoiding a thorough search of the heavy portions. However, two laboratories (one of which did not collect large volume samples) said that all would be fully sorted by fraction separation and searching manageable portions. Five laboratories mentioned quick sorting of handfuls in a tray by eye for molluscs. There was one suggestion of sub-sampling by weight. Successive extractions of lighter residue by stronger water jets until no more animals were found were mentioned by two laboratories.

3.3 Extraction of fauna

3.3.1 Taxa routinely extracted

The different approaches adopted by different laboratories with respect to which organisms to extract and record are summarised in Table 1. Six groups of sessile animals, seven groups of small invertebrates and invertebrate fragments were suggested in the questionnaire. Some participants stated that certain taxa would be recorded on data sheets but not included in the data sent for the NMMP. The results

show that there was very little agreement on which organisms to record and no two laboratories appeared to have the same protocols.

Of the sessile animals, hydroids and tunicates were each extracted by eight laboratories and ignored by four. Sponges, erect bryozoa and barnacles were each extracted by seven laboratories and ignored by five. Encrusting bryozoa were ignored by half of the laboratories to return the questionnaire. A few laboratories stated that they would count the colonial taxa (presumably colony counts) but most recorded them only as present. Solitary tunicates were counted by all that recorded them, while barnacles were counted by three laboratories (i.e. recorded only as present by four). Recording criteria varied from simple presence to the presence of various internal organs to attachment to the substratum. The taxonomic level for recording varied from species to phylum for many taxa.

Nematodes were extracted by nine laboratories and ignored by three. Insect larvae were recorded by eight of the laboratories and benthic copepods by six (half of the returns). Five laboratories extracted parasites, hard (podocopid) ostracods and pelagic copepods. Soft (myodocopid) ostracods were ignored by most but extracted by four laboratories. There was much variation between laboratories with respect to whether the above extracted taxa were counted or only recorded as present. Taxonomic levels for recording were similarly variable. Head presence was the usual recording criterion.

Invertebrate fragments were extracted by eight laboratories for biomass purposes but counted by none. They were generally assigned to species.

The following additional taxa were each listed as not recorded by one laboratory: anthozoa, decapoda, pelagic decapod larvae, foraminifera, periwinkles and anything deemed non-benthic. It is likely that some of these (e.g. pelagic larvae, foraminifera) would also have been ignored by other laboratories while others (e.g. decapoda, periwinkles) would be recorded by most.

3.3.2 Additional materials recorded

Anthropogenic materials and seeds were recorded by a minority of laboratories and a few others stated that they would record them if asked. There was little correlation between laboratories on materials to be recorded or on whether to count them or record as present (see Table 2). They were not generally weighed.

3.4 Recording of fauna

3.4.1 Countable individuals

Several taxa were listed for participants to suggest recording criteria. Most animals are recorded on the basis of the presence of a head but some taxa are problematic. Heads were still suggested by most laboratories for the problem groups but tails were sometimes used for maldanids and mysids. One participant said that separate counts would be made for heads and tails. There was further confusion with molluscs. Some said that whole animals would be needed or simply that there needed to be flesh in the shell. Siphons or hinges were used for bivalves. Gastropod counts could be based on

heads, opercula or shell apices. Ophiuroid counts were based on oral discs for some and upper discs for others. One laboratory said that the whole animal would be needed for amphipods. The results are summarised in Table 3.

3.4.2 Adults and juveniles

This question confused some, who took it to be a taxonomic issue. Most laboratories said that separation of juveniles was based on whether or not they could be identified. Several taxa were generally listed, with a note on the taxonomic level to which the juveniles would be identified. The results are summarised in Table 4. Different participants suggested different taxa and the size considered being juvenile varied. The only consistently separated taxon was that suggested as an example (*Nephtys*). Some participants gave lengths at which they would be considered juvenile and identified only to genus. The lengths varied from 0.5 to 3 cm. Subdermal eyespots were mentioned by two laboratories. The usual criterion for other taxa, too small to identify, would be expected to vary depending upon skill.

3.4.3 Identification at higher taxonomic levels than species

Table 5 shows the range of taxa that would not be identified to species by different laboratories. Nemertea and nematoda were mentioned by most but there was some variation in the taxonomic level to which they were recorded. Other groups were generally mentioned each by two or three laboratories, with much variation in the final identification level. The reason given was usually concerned with the difficulty of identifying certain groups.

3.4.4 Further comments

Additional comments were made by only one laboratory, recognising the problem of inconsistent recording policies between laboratories.

4. Conclusions

It is clear from the results of the questionnaire that there is little or no consistency in recording criteria between different laboratories participating in the NMBAQC Scheme. Recording consistency is important if data from different laboratories is to be compared, as is the case with NMMP data.

Some of the differences in practice, such as staining and different extraction procedures, would only be a problem if they affected the quality of sample sorting, which could be tested by quality control procedures. However, as NMBAQCS results show that sorting efficiency is often poor, it may be necessary to suggest a common approach.

Inconsistencies in recording policies are a more serious problem. Currently, sample quality control operates on the individual laboratories' procedures such that, for example, hydroids will not be recorded if the participant did not record them. Unfortunately, this means that results from different laboratories are not truly comparable. It is important that a standard approach be developed as soon as possible

so that maximum benefit can be derived from the data. Standardised extraction and recording procedures should be produced through the NMBAQC Scheme.

Differences in the taxonomic levels to which animals are identified also reduce the comparability of data. Current quality control procedures, again, do not highlight the problems as identifications to higher taxonomic levels are taken to be correct. Reduction of data to the lowest common denominator (i.e. highest taxonomic level) is a poor short-term solution to the use of the data that will not ensure maximum benefit. It would be difficult to standardise definitions for juveniles and required taxonomic levels for identification, as they would necessarily differ for different species and higher taxa. However, such a system is necessary for adequate quality control and some priority should be given to its development. It is suggested that representatives from the organisations involved in NMMP processing and individuals with relevant taxonomic expertise (museum staff, etc.) should be tasked with producing an NMMP extraction and recording protocol.

Development of the standard approaches suggested above should be applied firstly, and most urgently, to NMMP data. A comprehensive set of protocols for all laboratories processing the samples must be produced. Ideally, the same protocols should then be applied to all sampling, so that data from a variety of sources can be used in many ways.

5. References

Cooper, K., & Rees, H., 2000. Review of standard operating procedures (SOPs*)*. NMBAQC. National Marine Biological Analytical Quality Control Scheme.

Table 1. Extraction and recording.

Taxa	Nos. of labs Extracted		Counted		Biomass		Recording criteria	Nos. of labs	Taxonomic level	Nos. of labs
e.g. Hydroids	*Yes*	*No*	*Yes*	*No*	*Yes*	*No*	*Polyps present*	-	*Species*	-
Hydroids	8	4	1	11	1	6	Polyps	4	Species	7
							Present	3	Order	1
							Substrate attachment + polyps	1		
Sponges	7	5	1	11		6	Present	4	Species	3
							Attached	1	Phylum	2
							Living colony	1	Genus	1
									Varies	1
Encrusting Bryozoans	6	6	1	11		7	Present	3	Species	7
							Zooid membranes	2	Phylum	1
							Polypides present	1		
							Animal in situ	1		
Erect Bryozoans	7	5	2	10	1	6	Zooid membranes	2	Species	7
							Present	2	Phylum	1
							Polypides present	1		
							Animal in situ	1		
							Number of colonies	1		
Solitary Tunicates	8	4	8	4	2	5	Present	3	Species	6
							Inards present	2	Genus/species	1
							Animal in situ	1	Class	1
Colonial Tunicates	8	4	2	10	1	6	Present	3	Species	6
							Inards present	2	Genus/species	1
							Animal in situ	1	Class	1
Barnacles	7	5	3	9	1	6	Present	4	Species	6
							Inards present	2	Barnacle sp	1
							Animal in situ	1		
Hard Ostracods (Podocopida - benthic)	5	7	3	9	2	3	Presence	2	Order	3
							Heads	1	Class	2
							Number	1		
Soft Ostracods (Myodocopida - pelagic)	4	8	4	8	2	2	Number	3	Order	1
							Presence	1	Class	1
									Species	1
Benthic Copepods	6	6	4	8	3	3	Presence	3	Order	2
							Heads	1	Species	1
							Number	1	Subclass	1
							Whole animal	1	Family	1
									Class	1
Pelagic Copepods	5	7	3	9	2	3	Presence	3	Order	2
							Number	1	Subclass	1
							Whole animal	1	Class	1
Nematodes	9	3	9	3	5	2	Number	2	Phylum	7
							Presence	2	3 species identified	1
							Heads	1		
							Whole animal	1		
Invertebrate fragments	8	4	0	12	7		Polychaete bits	1	Species	1
Aquatic Insect larvae	8	4	4	8	2	4	Present	3	Family	3
							Heads	1	phylum	1
							Number	1	Order	1
									Insect larvae	1
Parasites	5	7	3	9	2	3	Heads	2	Species	2
							Presence	2	Order	1

Additional taxa not recorded:

The following were listed as not recorded by one laboratory each

Anthozoa
Decapoda
Pelagic decapod larvae
Foraminifera
Periwinkles etc.; anything deemed non-benthic

Table 2. Additional materials (non-faunal) recorded.

	Number of laboratories								
Taxa	**Extracted**			**Counted**			**Recording criteria**		**Included in biomass**
e.g. Tomato pips	*Yes*	*No*	*If asked*	*Yes*	*No*	*If asked*	*Presence*	*Number*	*No*
Tomato pips	2	7	2	2	4	1	3	1	5
Raspberry pips	1	8	2	1	5	1	1	1	4
Kiwi pips	1	8	2	1	5	1	1	1	4
Anthoprogenic matter	3	6	2	2	4	0	5	0	5
Glass splatter	0	8	2	0	4	0	1	0	3
Metal splatter	0	8	2	0	4	0	1	0	3
Others									
Wood	0	1	0	0	1	0	1	0	1
Leaf litter	0	1	0	0	1	0	1	0	1
Coal	0	1	0	0	1	0	1	0	1

Table 3. Definition of a countable individual.

Taxon	Criteria for enumeration	Nos. of labs
Maldanidae	Head	8
	Head & some of body	1
	Heads or tails (genus dependant)	1
	Separate tail count	1
	Heads or tails (whichever most common)	1
Oweniidae	Occupied tube	1
MYSIDACEA	Head	5
	Antennules & telson (most of body)	2
	Carapace	1
	Separate tail count	1
	Eyes & rostrum	1
	Enough to identify	1
	Heads (tails for some spp.)	1
AMPHIPODA	Antennules & telson (most of body)	1
GASTROPODA	Head	4
	Animal present	3
	Shell & animal	2
	Whole animal	1
	Most of spire (esp. top)	1
	75% animal	1
	Aperture/operculum	1
PELECYPODA	Hinge presence	5
	Animal present	3
	Whole animal with hinge	2
	Siphons	1
	Tissue in complete shell	1
Ensis	Siphons	1
ECHINODERMATA	Oral disc	1
OPHIUROIDEA	Disc	1
	Oral area	1
ECHINOIDEA	Mouth	1
HOLOTHURIA	Oral area	1
Phoronis	Occupied tube	1
Others	Any other part	2

Table 4. Separation of adults and juveniles.

Taxa	Nos. of labs	Criteria for age division	Nos. of labs	Taxonomic level used for juveniles	Nos. of labs
Various / none specified	3	Too small to identify to species	3	Lowest possible	3
Others not specified	3				
juv/sp issue	1				
SIPUNCULA	1	Too small to identify to species	1	Genus	1
Harmothoe	1	Too small to identify to species	1	Genus	1
Nephtys	9	Too small to identify to species	3	Genus	9
		Presence of subdermal eyespots	2		
		3 cm	1		
		2 cm	1		
		1 cm	1		
		0.5 cm	1		
Nereididae	4	Small size	2	Family	2
		30 chaetigers	1	Genus	2
		Too small to identify to species	1		
Glyceridae	2	1 cm	1	Genus	2
		Too small to identify to species	1		
Eteone	1	Too small to identify to species	1	Genus	1
Eumida	2	Too small to identify to species	2	Genus	2
Lumbrineris	1	Too small to identify to species	1	Genus	1
Magelona	1	Too small to identify to species	1	Genus	1
Cirratulidae	1	Too small to identify to species	1	Family	1
Cirriformia	1	Presence of subdermal eyespots	1	Genus	1
Cirratulus	1	Single pair of eyes	1	Genus	1
Maldanidae	1	Too small to identify to species	1	Family	1
Ampharete	1	Too small to identify to species	1	Genus	1
Terebellidae	1	Too small to identify to species	1	Subfamily	1
Tubificidae	1	Too small to identify to species	1	Family	1
Corophium	2	Small size	1	Genus	2
		Too small to identify to species	1		
Ampelisca	1	Too small to identify to species	1	Genus	1
Bathyporeia	1	Too small to identify to species	1	Genus	1
Amphipods	1	Too small to identify to species	1	Genus or family	1
Gammaropsis	1	Too small to identify to species	1	Genus	1
Lembos	1	Too small to identify to species	1	Genus	1
Gnathia	1	Too small to identify to species	1	Genus	1
Diastylis	1	Too small to identify to species	1	Genus	1
Pagurus	1	Too small to identify to species	1	Genus	1
Portunidae/brachyurhyncha	2	5 mm.	1	Species if possible, or family	1
		Zoeae	1	Family	1
GASTROPODA	1	1 mm	1	Class	1
Philine	1	Too small to identify to species	1	Genus	1
Nucula	2	Too small to identify to species	2	Genus	2
Mytilidae	1	Too small to identify to species	1	Family	1
Mytilus	1	Too small to identify to species	1	Genus	1
Anomia	1	Too small to identify to species	1	Genus	1
Chlamys	1	Too small to identify to species	1	Genus	1
Cerastoderma / Acanthocardia	2	5 mm.	1	Species	1
		Small size	1	Superfamily	1
Parvicardium	2	Too small to identify to species	2	Genus	2
Mya spp.	2	5 mm.	1	Species	1
		Too small to identify to species	1	Genus	1
Dosinia	1	Too small to identify to species	1	Genus	1
Tellinacea	2	small size	1	Superfamily	1
		Too small to identify to species	1	Family	1
Abra	3	Too small to identify to species	3	Genus	3
Scrobicularia plana	1	5 mm.	1	Species	1
Spisula	1	Too small to identify to species	1	Genus	1
Thracia	3	Too small to identify to species	2	Genus	1
		5 mm.	1	Genus	2
Gari	1	5 mm.	1	Genus	1
Ensis	1	Too small to identify to species	1	Genus	1
PELECYPODA	2	1 mm	1	Class	1
		Too small to identify to species	1	Genus or family	1
Echinoidea	1	1 cm	1	Species if possible or genus	1
Amphiura	3	Too small to identify to species	3	Genus	3
Ophiura	2	Too small to identify to species	2	Genus	2

Table 5. Taxa normally identified at a higher taxonomic level than species.

Taxa	Nos. of labs	Taxonomic level	Nos. of labs	Explanation (if necessary)
Others (not defined)	2			
Meiofauna	1	Class	1	
PORIFERA	1	Phylum	1	Key features difficult to determine confidently
Anthozoa	1	Various	1	Key features difficult to determine confidently
Campanulariidae	1	Family	1	Key features difficult to determine confidently
Obelia	1	Genus	1	
TURBELLARIA	3	Phylum	1	
		Subphylum	2	
NEMATODA	8	Phylum	7	Key features difficult to determine confidently
		Genus	1	
NEMERTEA	11	Phylum	9	Key features difficult to determine confidently
		Order	1	
		Family/Genus	1	
Tubulanus	1	Genus	1	
SIPUNCULA	2	Phylum	2	
Golfingia	1	Genus	1	
Polynoidae	2	Genus	2	If damaged
Autolytus	2	Genus	2	Key features difficult to determine confidently
Syllidae	1	Various	1	Lack of experience
Syllis	1	Genus	1	Taxonomic confusion
Ophryotrocha	2	Genus	2	
Polydora	1	Genus	1	
Tharyx	1	Genus	1	Taxonomic confusion
Cossura	1	Genus	1	
Protodrilus	1	Genus	1	
Maldanidae	2	Genus	2	If tails missing
Amphartete	1	Genus	1	
Sabellidae	1	Family	1	If small
OLIGOCHAETA	3	Family	1	Specialised techniques; scattered literature
		Order	2	Clearing (COSHH)
Tubificidae	1	Family	1	
Enchytraeidae	3	Family	3	
Halicaridae	1	Family	1	
Lysianassidae	1	Family	1	
Aoridae	3	Family	3	morphological similarity
Isaeidae	1	Genus	1	morphological similarity
TANAIDACEA	2	Order	2	
Gnathia	2	Genus	2	Juveniles & females
DECAPODA	1	Genus	1	If no legs
CRUSTACEA	3	Various		Females sometimes indeterminable
				Larvae not done
OPISTHOBRANCHS	1	Genus	1	
GASTROPODS	1	Various	1	
Philine	1	Genus	1	
NUDIBRANCHIA	1	Order	1	
	1	Family	1	
BIVALVIA	1	Family	1	If small, key features not discernable
ECHINODERMS	1	Family	1	Experience
OPHIUROIDEA	1	Family	1	If small
TUNICATES	2	Genus	1	
		Subphylum	1	

Appendix 1. The sample sorting methods questionnaire sent to participants.

NMBAQCS Sorting Methods Questionnaire.

LabCode: _____

If your laboratory carries out NMMP sample analysis and your NMMP and non-NMMP sample analysis procedures differ please produce a copy of this questionnaire for both methods.

This questionnaire has been completed according to NMMP/regular/all (please delete appropriately) sample sorting procedures employed within this laboratory.

1.) Please list all taxa that you separate into adults and juveniles:

Taxa	**Criteria for age division**	**Taxonomic level used for adults/juveniles**
e.g. Nephtys	*Presence of subdermal eyespots*	*Genus*

2.) What constitutes a countable individual for the following taxa:

Taxa	**Criteria for enumeration**
e.g. Bivalves	*Hinge presence*
Bivalves	
Gastropods	
Maldanids	
Mysids	
Please list others (if other than presence of head)…..	

3.) List all taxa which you would normally identify at a higher taxonomic level than species:

Taxa	**Taxonomic level**	**Explanation (if necessary)**
e.g. Autolytus	*Genus*	*Key features difficult to determine confidently*

4.A) Which of the following do you routinely extract and record:

Taxa	Extracted	Counted	Recording criteria	Taxonomic level	Included in biomass
e.g. Hydroids	*Yes*	*No*	*Polyps present*	*Species*	*No*
Hydroids					
Sponges					
Encrusting Bryozoans					
Erect Bryozoans					
Solitary Tunicates					
Colonial Tunicates					
Barnacles					
Hard Ostracods (Podocopida - benthic)					
Soft Ostracods (Myodocopida - pelagic)					
Benthic Copepods					
Pelagic Copepods					
Nematodes					
Invertebrate fragments					
Aquatic Insect larvae					
Parasites					

4.B) List any additional taxa that you would not record:

4.C) List any additional materials (non-faunal) that you record:

Taxa	Extracted	Counted	Recording criteria	Taxonomic level	Included in biomass
e.g. Tomato pips	*Yes*	*Yes*	*Presence*	*n/a*	*No*
Tomato pips					
Raspberry pips					
Kiwi pips					
Anthoprogenic matter					
Glass splatter					
Metal splatter					
Please list others……..					

5.) If your samples contained stones with *Pomatoceros* tubes, *Sabellaria* reefs, barnacles, hydroids and encrusting bryozoans attached, how would you proceed with the sorting?

6.) If your samples contained several litres of 0.5-1mm and 1-4mm sediment fractions, how would you process these fractions?

7.) Do you routinely use any form of staining in your sample processing? If so give details and reasons for use.

8.) If you have any further comments please use the reverse of this sheet.

Thank you for taking the time to complete this questionnaire. Please return your completed copy as soon as possible to:

David Hall, Unicomarine Ltd., 7 Diamond Centre, Works Road, Letchworth, Hertfordshire, SG6 1LW
FAX: 01462-483103
E-mail: davidhall@unicomarine.com

Questionnaires will be collated and conclusions will be included in the NMBAQC Scheme Year Seven Annual Report.

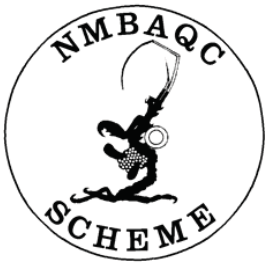
Appendix III. NMMP Oligochaete SOP (provisional).

Unicomarine Ltd. Extraction/Recording/Biomass SOP for Macrobenthic Samples
NMMP Version 1.1 Oligochaeta

			Extracted*		Preservation		Recorded/Identification				Biomass			Key literature (not comprehensive)
Class	Family	Genus	All	In part	Alcohol	Dried	Enumeration	Present/absent	Tax. level**	Juv. separated	Weighed	Fragments incl.	Tubes/shells incl.	
Oligochaeta			☑		☑		☑		Varied	☑☒	☑	☑	n/a	Brinkhurst, 1971 & 1982; 1994 Oligochaete workhop notes; In-house tables & notes.
	Naididae		☑		☑		☑		Varied		☑	☑	n/a	
		Amphichaeta	☑		☑		☑		Species		☑	☑	n/a	
		Chaetogaster	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
		Nais	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971, 1982
		Paranais	☑		☑		☑		Species		☑	☑	n/a	
		Stylaria	☑		☑		☑		Species		☑	☑	n/a	
		Uncinais	☑		☑		☑		Species		☑	☑	n/a	
	Tubificidae		☑		☑		☑		Varied (Family, except where stated below)		☑	☑	n/a	Brinkhurst 1971, 1982; In-house notes.
		Monopylephorus	☑		☑		☑		Family (except M.irroratus to species)		☑	☑	n/a	
		Limnodriloides	☑		☑		☑		Genus		☑	☑	n/a	
		Clitellio	☑		☑		☑		Species		☑	☑	n/a	
		Heterochaeta	☑		☑		☑		Species		☑	☑	n/a	
		Limnodrilus	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
		Tubifex	☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
		Tubificoides	☑		☑		☑		Species (except T.brownae, T.crenacoleus, T.diazi and T.pseudogaster, all as T.pseudogaster agg.)		☑	☑	n/a	
		Psammoryctides	☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Enchytraeidae		☑		☑		☑		Family (except Grania spp. to genus)		☑	☑	n/a	Brinkhurst 1982
		Grania	☑		☑		☑		Genus		☑	☑	n/a	
	Branchiobdellidae		☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
	Aeolosomatidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Haplotaxidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Lumbriculidae		☑		☑		☑		Family		☑	☑	n/a	Brinkhurst 1971
	Dorydrilidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Glossoscolecidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Lumbricidae		☑		☑		☑		Family (except Eiseniella tetraedra to species)		☑	☑	n/a	Brinkhurst 1982

*=some taxa will be counted in situ/subsampled if present in high numbers

**=minimum level required (good condition given)



National Marine Biological Analytical Quality Control Scheme

Oligochaeta Questionnaire Report: Including Provisional NMMP Standard Policy for Oligochaete Identification.

Client
Authors

NMBAQC Scheme
David Hall & Tim Worsfold

Report NMBAQColigquest
July 2002

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1. Introduction

The exercises of the National Marine Biological Analytical Quality Control (NMBAQC) Scheme conducted over the past eight years have shown that there is little or no consistency in recording between laboratories (Worsfold & Hall, 2001). Oligochaetes are identified to a variety of taxonomic levels by the participants and standardisation is required. Ring test nineteen (RT19) was selected to target 'oligochaetes and similar fauna' and assess comparative levels of identification. In addition to the ring test, all participating laboratories were sent a questionnaire to enable the ring test results to be qualified and to gather general information on levels of oligochaete identification.

RT19 comprised twenty-five single specimens and was distributed to eighteen ring test participant laboratories on 17th January 2002. One cirratulid and two capitellid species were included in the ring test due to their oligochaete-like features. Nine Tubificidae species were distributed, including repeated taxa. They accounted for seventeen of the twenty-two oligochaetes. The remaining five oligochaete specimens were repetitions of two Naididae species. All oligochaetes distributed within RT19 were readily identifiable on gross morphological features. Unfortunately the original intention to send oligochaetes from a variety of habitats was hindered as no external expert could be appointed within the timescale required. This meant that the expert help required to assist in the compilation of enchytraeids and *Tubificoides pseudogaster* aggregate species was lacking. The three non-oligochaete ring test specimens were included to highlight the problems associated with laboratories that do not routinely identify oligochaetes beyond class and the potential problems of these laboratories not being able to distinguish between oligochaetes and some polychaetes. Habitat notes were provided for each specimen (sediment, salinity, depth and geographical location). The participating laboratories were given ten weeks to complete RT19. Results were received from ten of the eighteen participants.

This report reviews the questionnaire returns to give an overview of current approaches to oligochaete identification amongst the NMBAQC Scheme participants. Reference is made, where relevant, to the RT19 results. Recommendations for National Marine Monitoring Plan (NMMP) standardisation are given, where appropriate, as a precursor to standard operating procedures (SOPs). SOPs in marine biological sample collection and analysis were reviewed for the NMBAQC Scheme by Cooper & Rees (2000). However, that report focussed primarily on sampling methods and safety and did not deal with all issues concerning the fundamental requirements of processing of macrobenthos samples (Worsfold & Hall, 2001).

Few agencies or other organisations that commission samples for analysis of macrobenthos give clear guidelines as to the required treatment of samples. Laboratories that carry out sample analysis generally develop their own in-house practices. The practices are often not explicitly written down but become established through tradition. As the agencies requiring data do not give clear guidelines and as they often subcontract their sample analysis to more than one laboratory, it is important to evolve and maintain consistency of practice between laboratories.

Consistency is particularly important where data collected by different organisations are to be used for comparative purposes, as with the NMMP (Worsfold & Hall, 2001).

2. Methods

The RT19 data returns were scored and a ring test bulletin (RTB19 – Appendix I) was posted on the Scheme web site (www.nmbaqcs.org) and circulated to participating laboratories. RTB19 gave reasons for differences in identifications and participating laboratories were instructed to retain the RT19 specimens for review in light of these results. All specimens will subsequently be returned to Unicomarine Ltd., as they are part of an in-house museum collection and may be included in future ring tests to assess participant development.

On 2nd April 2002, a questionnaire (Appendix II) was sent, via email, to nineteen participants of the ring test component of the NMBAQC Scheme. Reminders for outstanding questionnaires were circulated on 11th and 16th April 2002. The purpose was to evaluate the expertise level, policy and techniques for oligochaete identification between different laboratories that carry out NMMP macrobenthos sample analysis and also to qualify the results obtained in RT19.

Section one of the questionnaire contained questions that were designed to determine how often oligochaetes are encountered and the current approaches for identification, including use of literature and reference specimens. The second section of the questionnaire comprised questions directly related to RT19 and was for completion only by laboratories that had supplied data for this exercise. The questions sought to ascertain the methods used, time taken and difficulty experienced in completing RT19. The questions from the questionnaire are quoted in the text below with question numbers in brackets.

2.1 Current Data - Quantity and Quality

The quality and quantity of oligochaete data residing on the NMMP database can be inferred by comparing current laboratory protocols for oligochaete identification and how often oligochaetes are encountered.

Two questions on the form (stated below) were concerned with the quantity and quality of oligochaetes encountered in participants usual samples:

> "How often do you encounter oligochaetes in your macrobenthic samples?" (Q.1A)
>
> "At what taxonomic level do you normally identify oligochaetes? Give qualifying comments (e.g. species but Enchytraeids to family)" (Q.1B)

Both questions gathered quantifiable data, with space provided for qualitative comments.

2.2 Importance of Oligochaete Identification

Many laboratories may have preconceived ideas regarding the importance of oligochaete identification and this may affect their approach. We asked laboratories to describe how important they considered oligochaete identification:

> "How important do you consider oligochaete identification? Add comments" (Q.1C)

The responses were to be free form to permit discussion.

2.3 Identification Tools - Experience, Methods, Training and Literature

The ability to correctly identify oligochaetes to species is often a combination of many factors, such as experience, training, access to and understanding of literature, availability of equipment and chemicals, access to verified reference specimens and an understanding of the ecological requirements of different oligochaetes. These can all be described as identification tools. It is important to discover and understand which tools are being applied to identify oligochaetes and which are not. Participants were asked to rank keys/tables, publication/descriptions, reference material, experience/memory and habitat information in order of importance:

> "Place the following identification aids in rank order of importance for oligochaete identification at your laboratory" (Q.1D)

The availability and relevance of literature is suspected to be a major problem for ecologists identifying oligochaetes, therefore the participants' opinions were sought:

> "Do you find your oligochaete literature adequate? Add comments" (Q.1E)

The level of training and experience in oligochaete identification greatly affects the identifiers confidence with oligochaetes and the literature. Two questions were associated with training and ranking experience:

> "Did you attend the 1994 Oligochaete workshop hosted by Unicomarine Ltd.? Add comments" (Q.1F)

> "How would you rank your experience with oligochaete identification?" (Q.1G)

Oligochaetes are often dismissed for detailed examination due to the time constraints involved with compound microscopy and clearing specimens. Hence the time available for identification may directly relate to the method of examination employed. Laboratories may have opted not to use compound microscopy and or clearing techniques and consequently decided to identify to either family or class on the basis of economics. Participants were asked to select which methods they normally use for oligochaete identification from stereomicroscopy of gross morphological features, compound microscopy of temporary mounts for chaetal examination and compound microscopy of permanent cleared mounts for examination of internal anatomy:

> "What methods do you normally use for oligochaete identification?" (Q.1H)

2.4 Ring Test

The second section of the questionnaire comprised eight questions relating to the completion of the ring test (RT19). This section was only to be completed by laboratories that provided data for the 'oligochaete and similar fauna' target ring test.

All ring test participants received accompanying habitat notes for each of the specimens to be identified. The usefulness of the habitat notes was investigated as the availability of literature and ecological notes for oligochaetes is often perceived to be poor:

> "Did you find the habitat notes supplied with the ring test useful? Give comments" (Q.2A)

All of the oligochaete ring test specimens could be identified using gross morphological features and examination of chaetal structures using a compound microscope. There should, therefore, have been no need for clearing procedures and subsequent examination of internal structures (penes and other reproductive systems). Participants were asked to provide specific details of any clearing undertaken:

> "Did you clear any of the ring test specimens? Give numbers, examples and reasons" (Q.2B)

The use of verified comparative material when identifying specimens is extremely helpful. The maintenance of reference material is considered to be a standard requirement for identification and is promoted as best practice. Participants were asked to detail which of the ring test specimens they identified with the aid of comparative specimens:

> "Did you use reference material to assist your identifications? Give examples" (Q.2C)

Oligochaetes are perceived by many ecologists as time consuming and difficult to identify to species. The resultant identifications can commonly be qualified with uncertainty. Several questions were asked to determine this information:

> "How long did the ring test take to complete?" (Q.2D)

> "How many people were involved in the ring test identifications?" (Q.2E)

> "How difficult did you find the ring test?" (Q.2F)

> "How many of the 25 RT specimens do you think you identified correctly to species?" (Q.2G)

Finally, we asked participating laboratories to provide any further comments relevant to the ring test and suggestions for future target ring tests:

> "Please use the space below if you have any further comments regarding the ring test, or suggestions for future target ring tests" (Q.2H)

3. Results

The questionnaire was sent to nineteen laboratories, including government organisations and independent consultancies. All laboratories provided returns, which would have included some from the same organisation. RT19 was sent to eighteen laboratories. Nine laboratories decided not to participate in the ring test due to time constraints, this was the highest number of abstaining laboratories for any of the ring tests to date. However, the questionnaire that followed the ring test was returned by all ring test subscribers and one non-subscriber.

The responses for sections 1 and 2 of the questionnaire are presented in Tables 1A-1H and 2A-2H, respectively. These appear in the same order and format as found in the original questionnaire.

3.1 Current Data – Quantity and Quality

All participating laboratories encounter oligochaetes in their macrobenthic samples (Table 1A). The majority of respondents (53%) stated that they 'often' encountered oligochaetes in their macrobenthic samples; three laboratories 'always' encountered oligochaetes; two laboratories stated that they 'rarely' encountered oligochaetes.

Several permutations of levels of oligochaete identification were received (Table 1B). Two laboratories identify their oligochaetes to class, one of which stated that they rarely encountered oligochaetes. Three laboratories stated that they identify their oligochaetes to family, one of which stated that they rarely encountered oligochaetes. One of the laboratories that gave family level identification as their standard stated that the level of identification would normally depend upon client requirements and existing data. One laboratory indicated that family level identification would be used apart from easily recognisable species, such as *Tubificoides benedii* and *Heterochaeta costata*. The majority of laboratories (74%) stated that they would identify to species, wherever possible. Half of these laboratories added that they would identify enchytraeids to family or genus. One laboratory identifies naids to family. One laboratory stated that they identify naids to species, but tubificids and enchytraeids to family.

3.2 Importance of Oligochaete Identification

When asked to consider the importance of oligochaete identification the participating laboratories gave a variety of responses (Table 1C). Responses ranged from 'extremely important' to 'not important'. Two laboratories did not respond to this question.

3.3 Identification Tools – Experience, Methods, Training and Literature

Table 1D shows the ranked scores for importance given to the primary identification tools by laboratories. Twelve laboratories selected 'keys and tables' as their most important aid for identification, one ranked it as their least important (however, this laboratory has possibly confused the ranking system); one laboratory selected 'publications and descriptions' as their most useful identification aid, five stated them as least useful; four laboratories selected 'reference material' as most important, five

reported that it was least useful; three laboratories chose 'experience and memory' as most important, one chose it as their least useful; one laboratory chose 'habitat data' as most important, six listed it as least important.

Table 1E shows the participating laboratories' responses on the adequacy of their oligochaete literature. Ten laboratories stated that their oligochaete literature was inadequate, nine laboratories commented that their literature was adequate for family or local identifications. The majority of laboratories suggested several possible improvements. A full list of comments provided by responding laboratories is provided in Table 1E.

The 1994 Oligocheate workshop, hosted by Unicomarine Ltd., was attended by thirty-five delegates from various organisations. The chief demonstrator, Mike Milligan (Center for Systematics and Taxonomy, Florida), led practical classes on clearing techniques and general identification of Oligochaeta, concentrating mainly upon tubificids and especially *Tubificoides* spp. The workshop was extremely well received and confirmed geographical records of U.K. oligochaetes were compiled. A portfolio of workshop notes was produced containing several significant items of literature (Baker, 1983; Baker & Brinkhurst, 1981; Brinkhurst 1971, 1982, 1985 & 1986; Brinkhurst & Baker, 1979; Erséus, 1982). Most of the workshop participants felt that the Tubificidae features table version 2 (Unicomarine, 1994) was of particular use, which was reflected in the questionnaire responses regarding the adequacy of literature (Table 1E). Eleven of the respondent laboratories have had either current or past staff that attended the 1994 Oligochaeta workshop. Eight laboratories did not have any attendees, past or present, at the workshop but two of these laboratories did state that they have the workshop literature. Several comments were given regarding the workshop and resultant literature (Table 1F).

Table 1G shows how each of the participating laboratories rated their experience with oligochaete identification. All laboratories rated their identification experience as either little or reasonable.

Two participating laboratories when identifying oligochaetes study only temporary slide preparations to examine chaetal structure using a compound microscope. A combination of chaetal examination and studying gross morphological features using a stereomicroscope are the methods used by 89% of laboratories. Four laboratories stated that they would normally prepare permanent slide mounts in order to identify their oligochaetes using internal anatomy. Three laboratories stated that they would clear a subsample of oligochaetes for species differentiation and one laboratory noted that they would clear as a final method for identification when other methods are ineffective. The comments given by responding laboratories regarding identification methods are listed in Table 1H.

3.4 Ring Test

Nine of the ten RT19 participants found the habitat notes supplied useful, one did not. There was a range of comments regarding how useful the habitat notes were. Full details and comments are listed in Table 2A.

Three of the ten participant laboratories cleared single differing oligochaete ring test specimens (Table 2B) in order to examine internal anatomy in the absence of conclusive external features. Therefore in total only three specimens from a potential two hundred and twenty were examined for internal anatomy.

Table 2C lists the participants use of in-house reference material during completion of the ring test. Seven out of the ten laboratories stated that they had either no or limited oligochaete reference material available. One laboratory did not give reasons for not using reference material.

Tables 2D and 2E detail how many members of staff participated in the ring test from each laboratory and how long (in total) the ring test took to complete. One laboratory did not give a time for ring test completion. The ring test took between six and twenty-seven hours to complete, with an average duration of over thirteen hours (approximately two working days). This equates to an average of less than two identifications per hour. The highest number of staff involved in the ring test from a single laboratory was five. The ring test was completed by single individuals at six laboratories. The average number of staff participating from a single laboratory was two.

Table 2F shows how difficult the participants rated the ring test. The responses are clearly skewed towards 'hard', with no respondent classifying the ring test as easy. When asked to predict the number of correct species identifications attained eight out of ten participants underrated their abilities (Table 2G). The average RT19 score achieved was 69% correct species identifications. Only two laboratories predicted their species identification scores to be above 60%. The average predicted score was approximately 53%. Two laboratories correctly predicted their scores.

Table 2H gives the participants responses for further comments. Comments were made by seven laboratories. The majority of comments received were ring test result qualifying comments.

4. Discussion

The questionnaire data shows that all NMBAQC Scheme ring test subscribing laboratories encounter oliochaetes in their macrobenthic samples and that the majority of these laboratories attempt to identify most oliochaetes to species. However, a number of laboratories showed variations in their identification policies towards tubificids, naids and enchytraeids. These variations, although minor in many cases, when examined as combined data from all laboratories would result in a significant loss of specific detail. Two laboratories that normally would not identify their oligochaetes beyond class, achieved the lowest number of correct identifications for RT19. One such laboratory identified the *Capitella capitata* specimen as *Tubificoides amplivasatus*. Under normal macrobenthic processing conditions how many specimens could potentially be assigned to the wrong class? Such problems can arise when entire faunal groups are not examined or understood in sufficient detail. Gaps in faunal knowledge must be bridged to achieve data comparability. A major problem confronting analysts of combined data from several laboratory sources is that of having to reduce each taxon to the lowest common denominator (i.e. highest

taxonomic level). For example, an entry of 'Tubificidae' could result in all tubificids being lumped to family. However the Tubificidae specimen could have simply been in poor condition with no discernible features beyond the family level. A recording system should be agreed to counter the discrepancy. Identification consistency is important if data from different laboratories is to be compared, as is the case with NMMP data. There is a need for a standard policy for NMMP oligochaete identification.

There was an overwhelming indication that RT19 was found by participants to be very challenging although most achieved better results than they expected. Single oligochaete specimens are rarely easy to identify. This, coupled with many laboratories' discomfort with oligochaete identification, was reflected in their difficulty ranking for this exercise. This lack of confidence with oligochaete identification was reiterated by the participants' low predictions of their RT19 scores. Those laboratories that do not routinely encounter or identify oligochaetes must be commended for their participation in RT19. Several supposedly more experienced laboratories decided not to participate. The inexperienced laboratories invariably achieved the lowest RT19 scores. They are, however, very likely to have achieved disproportionate gains in knowledge, as compared with more experienced laboratories, particularly those that did not participate. The majority (six out of ten) of laboratories provided RT19 data produced by solitary workers. The practice of solitary identifiers is not recommended. Even experienced staff function much better with an additional staff member with which to discuss their identifications. An element of quality control / assurance can be achieved by such practice.

The habitat notes appear to have been of limited use, primarily due to a lack of available ecological information. Records of habitats need to be kept for verified oligochaete taxa in order to build a better understanding of specific requirements and distributions.

The results sheet for RT19 required laboratories to list any items of literature that were consulted for identification of each specimen. Several sources of oligochaete literature were noted in the data received. These were Brinkhurst (1971, 1982 & 1985), Brinkhurst and Jamieson (1971), Erséus (1975) and the 1994 Oligochaete workshop notes (which contained several Tubificidae papers and a Tubificidae features table). Some laboratories utilised just a single text which, in most instances, greatly reduced their capability to identify specimens correctly. The majority of questionnaire respondents commented upon the inadequacy of oligochaete literature. Several laboratories stated that the literature was too subjective. The comments can be summarised as a majority desire for a single Oligochaeta text containing marine, estuarine and freshwater taxa, which includes whole animal diagrams and / or images, comparative diagrams of chaetae, detailed descriptions, ecological notes and less reliance upon internal anatomy for identification.

The use of reference material to aid identification is universally understood by participants of the NMBAQC Scheme to be best practice. However, many laboratories have either no or very limited reference collections of oligochaete taxa. A positive correlation between the amount of reference material available and each laboratory's performance was evident in RT19. Those laboratories with little or no reference specimens invariably achieved the lowest number of correct identifications. It must

also be noted that laboratories with larger oligochaete reference specimens are likely to be more familiar with identifying oligochaetes and are consequently capable of relatively high ring test scores.

The majority of laboratories identify their oligochaetes using gross morphological features and temporary slide preparations for chaetal examination. Several laboratories stated that they do not find the clearing of oligochaetes to be an efficient use of time and the use of Ammans Lactophenol also raises health and safety (COSHH) issues. Four laboratories use permanent cleared mounts for the examination of internal oligochaete anatomy. The method is rarely performed upon all specimens encountered and usually a 10% subsample is selected for identification to species by this method. One laboratory stated that the expert opinion was that oligochaetes could not be identified reliably to species without the internal anatomical examination of adult specimens, which influenced oligochaete identification policy significantly. Laboratories may identify their oligochaetes to higher taxonomic levels because they believe that without clearing oligochaetes species identification is unachievable and / or the process of clearing all oligochaetes is not economically viable. The net result is reduction in oligochaete data and a dismissive attitude towards uncleared oligochaetes identified to species.

The ring test has proven that, with experience, several common species, including most sexually immature specimens, can be identified consistently without resorting to internal examination. The clearing of oligochaetes, aside from COSHH concerns, is not conducive to full sample audits. Secondary biomass calculations cannot be conducted and initial biomass records, as well as abundance records, are commonly estimated from proportions attained from an examined subsample. Random subsampling of oligochaetes prior to detailed examination is not recommended, as less abundant taxa are often overlooked and bias towards larger specimens and hence species often occurs. All RT19 oligochaete specimens were identifiable without examination of internal anatomy. Hence, only 1% of the RT19 specimens were cleared for identification by the participating laboratories. Clearing is often used as a final identification tool in instances where other external features are inconclusive. Intertidal estuarine macrobenthic samples often contain a large proportion of juvenile (sexually immature) oligochaete individuals. Clearing techniques would not classify such specimens to species. However, with experience and an understanding of growth series and gross morphological features, many such individuals can be identified to species and a far greater quality of ecological data acquired.

When asked to give their opinions of the importance of oligochaete identification, several laboratories gave surprising questionnaire responses. Many laboratories directly related oligochaete identification importance to relative oligochaete abundance. One laboratory rated oligochaete species identification of little importance because of its limited interpretative use. The interpretative use of oligochaetes would undoubtedly improve if more comprehensive literature and records were available. Greater levels of identification expertise would, in turn, lead to better ecological knowledge. One laboratory, with a relatively high degree of oligochaete identification experience in comparison with most laboratories, described oligochaete identification as extremely important. They added that Oligochaeta are dominant fauna at several of their stations and estimates of species diversity can be seriously skewed by failure to include diversity within the Oligochaeta. Oligochaeta show species partitioning on

salinity, sediment, habitat, depth and organic enrichment (pollution) characteristics. Some laboratories persist in suggesting the short-sighted 'horses for courses' approach of only processing according to perceived immediate objectives. Such an approach has been dismissed for NMMP data (Worsfold & Hall, 2001). The knowledge and understanding of oligochaetes will improve with time unless ill-conceived 'horses for courses' policies are allowed to prevail. The cost and damage caused by environmental surveys necessitates that the resultant data be transferable, used to their full potential, and not processed according to imagined short-term objectives.

The RT19 scores achieved by participating laboratories were very good considering that only single specimens were available for examination and many laboratories had limited experience. Two laboratories achieved very high scores with only two taxonomic differences recorded. The poorest results were achieved by laboratories that encounter few oligochaetes of limited diversity, which they do not routinely identify beyond class or family. Hopefully, such laboratories, given training and better literature, will be capable of raising the standard of their oligochaete knowledge to meet the proposed NMMP oligochaete identification requirements, discussed later.

Differences in the taxonomic levels to which animals are identified reduce the comparability of data. Current quality control procedures (NMBAQC Scheme Own Sample audits) do not highlight the problems as identifications to higher taxonomic levels are taken to be correct. Reduction of data to the lowest common denominator (i.e. highest taxonomic level) is a poor short-term solution to the use of the data that will not ensure maximum benefit (Worsfold & Hall, 2001). Therefore a SOP for NMMP oligochaetes is proposed (Appendix III), to be posted on the Scheme web site (www.nmbaqcs.org). Comments are invited. The SOP has been devised using ring test and macrobenthic data studied over the duration of the NMBAQC Scheme coupled with the questionnaire data. Essentially, the SOP advocates the best identification possible for oligochaete taxa without resorting to clearing and internal examination. It is the first version and is subject to change should subsequent studies enable greater taxonomic detail using gross morphological features. A laboratory adopting the NMMP oligochaete SOP (Ver.1.1) can qualify their data as such and greatly improve the comparative value of their data. For example, 'Tubificidae' recorded by such a laboratory (due to poor condition or recognition of an unfamiliar taxon) should not cause all tubificid species to be combined to family.

Implementation of the oligochaete SOP must be accompanied by sufficient training opportunities to enable all NMMP laboratories to achieve the required standard of expertise. Scheme participants may use the Laboratory Reference (LR) exercise to verify their NMMP oligochaetes, if necessary.

5. Conclusion

Three proposals are given for the improvement of Oligochaeta records for the NMMP. These are the development of an Oligochaeta SOP, additional training and improved literature. Initiatives for these proposals are detailed.

1. Development of an Oligochaeta SOP.

- Adoption of an NMMP standard policy for oligochaete identification.

  - **NMMP Oligochaeta SOP Version 1.1 (provisional) – Appendix III.**

2. Additional Training.

- Use of NMBAQC Scheme taxonomic workshop and Laboratory Reference (LR) exercise to improve and disseminate knowledge of oligochaetes.

  - **NMBAQC Scheme workshop (provisionally March 2003, MBA Plymouth) to include Oligochaeta. NMBAQC Scheme LR exercise is now free form to allow submission of any UK taxa.**

3. Improved Literature.

- Improved oligochaete literature covering marine, estuarine and freshwater taxa, including diagrams / images of whole specimens and details of ecological preferences. Ongoing literature search on taxonomy regularly submitted to NMBAQC (required for all taxonomic groups – NMBAQC funding required).

  - **Literature updates and ecological notes to be distributed at NMBAQC Scheme workshop (provisionally March 2003, MBA Plymouth).**

Oligochaetes, like many faunal groups, first all appear alike (probably none more so than oligochaetes). However, with experience and training, differences in gross morphological features can be observed and habitat details recorded to improve our understanding. In truth, the economics of clearing has long been a convenient excuse for many laboratories not attempting to identify the oligochaetes encountered. Methods in pure taxonomy require great attention to detail but it is essential that practical (e.g. ecological) outlets for taxonomic research be considered. The logical progression from the anatomically verifiable definition of a species is to find pragmatic means of quickly recognising it to provide ecological information. The present report and provisional SOP represent progress to that end.

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Tables 1A - 1H. Data from section 1 of the oligochaeta questionnaire.

1A.) How often do you encounter oligochaetes in your macrobenthic samples?

	No. Labs.	LabCodes
1. Always	3	10,15&20
2. Often	10	03,06,08,12,13, 14,16,18,19&21
3. Occasionally	4	04,05,09&11
4. Rarely	2	02&07
5. Never	0	-

1B.) At what taxonomic level do you normally identify oligochaetes? Give qualifying comments (e.g. species but Enchytraeids to family)

	No. Labs.	LabCodes	Comments
Class	2	02&03	-
Family	3	06,07&19	Depends upon customer requirements and existing data(06); Except for easily identifiable species such as T.benedii and H.costata(19).
Species, wherever possible.	14	04,05,08,09,10, 11,12,13,14,15, 16, 18,20&21	But Enchytraeids to family(08,12,16,18);Family generally for Tubificids and Enchytraeids(09);Enchytraeids to genus(14);Enchytraeids and naids to family(20).

1C.) How important do you consider oligochaete identification? Add comments

LabCode	Comments
LB0802	If they were to form a large proportion of the samples we identify we would probably consider identification more important, particularly with estuarine samples, but as most samples we encounter are fully marine, and we come across very few oligochaetes it is not currently considered important
LB0803	Oligochaete ID is as important as any other infaunal taxon wrt the type of studies we are involved in. However, the majority of the literature suggests you need sexually mature adults for correct ID and this involves mounting and clearin each specimen. We have analysed data where oligochaetes have been ID'd to species, then lumped them at class level an reanalysed the data set. For the majority of our studies this has not affected the results wrt the objectives.
LB0804	When they are abundant, as important as any other taxa.
LB0805	Important. Don't have any sites dominated by them and appear to have a limited species list (so far)
LB0806	Low priority because of the limited use made of it in interpretation of most data sets.
LB0807	For our samples the time taken to identify oligochaetes to species and the few animals, the time is not justified.
LB0808	No more or no less important than other groups. However, as with other groups, when faced with high numbers of individuals a pragmatic approach is usually adopted and a representative sub-sample of animals (@100) would be identified to the lowest taxonomic level possible and the resulting proportions of species identified applied to the whole sample.
LB0809	Oligochaetes are not often major components in our samples, and when they are, it is mostly*Tubificoides benedii* . However, the more components of a sample that can be identified to species the more information obtained.Therefore, I would like to be able to identifiy more of the Oligochaetes to the species level.
LB0810	Extremely. They are the dominant fauna at several sites, and estimates of species diversity can be seriously skewed by not including diversity within the oligochaeta. They show species partitioning on salinity and sediment/habitat characteristics which m...
LB0811	In the estuarine situation it is considered very important as it forms the main community structure. In transitional/coastal it is less important but they are not the main taxa in this area
LB0812	-
LB0813	Important, but more information on ecological requirements of individual species/groups needed in order to faciliate interpretation of community structure.
LB0814	Important in estuarine waters where they predominate. Ideally they should be treated as most other macrofauna and identified to species to provide best asssessment of composition and diversity of fauna.
LB0815	Depends on the origin of the sample, from an estuary with mud, depositing, and particularly when upper estuary, it is vital as Oligochaeta may be the only group represented.
LB0816	Just as important as identifying everything else.
LB0818	Having now acquired the experience and recently obtained the 1994 workshop keys/tables/descriptions, I consider oligochaete identification to be of significant importance in certain systems (Estuaries, rivers etc.)
LB0819	Not important, and more to the point, not practical to do routinely. Family level I.d. is quite sufficient as far as I'm concerned. There are also health and safety implications with processing specimens in chemicals such as Amman's Lactophenol
LB0820	Commercially clients have never insisted on higher levels of id.
LB0821	-

1D.) Place the following identification aids in rank order of importance for oligochaete identification at your laboratory
(1: most important; 5: least important). Exclude any aids not used; add comments

	LB0802	LB0803	LB0804	LB0805	LB0806	LB0807	LB0808
Keys/tables	3	5	1	1	1	1	2
Publications/descriptions	2	5	5	4	3	4	5
Reference material	1	2	3	2	4	2	4
Experience/memory	5	3	2	2	2	3	1
Habitat information	4	1	4	5	5	-	3

	LB0809	LB0810	LB0811	LB0812	LB0813	LB0814	LB0815
Keys/tables	2	2	1	2	1	1	2
Publications/descriptions	1	3	3	3	5	3	2
Reference material	1	1	5	4	2	2	1
Experience/memory	1	4	4	1	3	4	2
Habitat information	-	5	2	5	4	5	2

	LB0816	LB0818	LB0819	LB0820	LB0821		AVERAGE
Keys/tables	1	1	1	1	1		1.6
Publications/descriptions	3	3	3	3	2		3.3
Reference material	4	4	5	2	5		2.8
Experience/memory	2	2	2	4	3		2.6
Habitat information	-	3	4	5	4		3.8

1E.) Do you find your oligochaete literature adequate? Add comments

LabCode	Comments
LB0802	No, although I think we have most literature that is available but still feel that it is inadequate and sparse compared with polychaete family keys
LB0803	No, A lot of the literature we have is from the USA which proves confusing wrt name changes etc
LB0804	We have Brinkhurst and Unico's table of features. Also have access to Brinkhurst (freshwater) and Brinkhurst & Jamieson (1971). We are lacking many descriptions.
LB0805	no. Still very subjective
LB0806	No. Something like the Lin.Soc. book would be ideal but this is very limited. Beyond this we use the workshop [notes]. Need better keys, full descriptions and diagrams of all common species collected together in one publication.
LB0807	At the level we are interested in- yes
LB0808	No. The Tubificid table provided by Unico is generally good. However, other groups are poorly covered and on the whole the information we have is generally poor.
LB0809	Yes, for the level to which the Oligochaeta are normally identified.
LB0810	The Unicomarine tabular key is useful, certainly more so than trawling all the literature, but I had some problems with the Tub pseudogaster complex, and some of the commonly encountered (freshwater) species that extend to brackish water are not well cov...
LB0811	It surfices for the amount we do but certainly after the RT I felt it would have been better to have more publications - especially with drawings of chaete etc.
LB0812	Yes, combination of Brinkhurst 1982, publications, workshop notes and own notes an sketches. A comprehensive key & descriptions, replacing Brinkhurst 1982 is overdue.
LB0813	Its ok, the Unicomarine Workshop notes are best, but a lot of oligo features are a bit subjective.
LB0814	NO! Although I have a good selection of literature, both old and new, it is difficult to find good descriptions and figures of some taxa - for example Monopylephorus rubroniveus/parvus, Clitellio arenarius, Aktedrilus spp.
LB0815	No, we used what we had, but some of the species that were previously had not been seen, and we had no reference material, the literature was inadequate.
LB0816	Yes for the majority of work we do, but not that comprehensive.
LB0818	Having acquired the 1994 workshop keys/tables/descriptions I am incearsingly more confident about the identification o oligochaetes, however, new descriptions species are appearing all the time, the table v.3 gives excellent indications.
LB0819	No. for the most part (and necessarily I assume) it concentrates on internal anatomy which is impractical to deal with on a routine basis (and doesn't work - unless you happen to be the internationally recognized expert writing the paper of course)
LB0820	No -not at all.
LB0821	No - It would be better to have more pictures of the whole animal and external features rather than the internal features

1F.) Did you attend the 1994 Oligochaete workshop hosted by Unicomarine Ltd.? Add comments

LabCode	Comments
LB0802	None of the current benthic ecologists attended the workshop although the literature supplied for the workshop was used for this ring test
LB0803	One of our ex-employees did.
LB0804	No
LB0805	yes
LB0806	Yes. Only covered a limited range of species, we are not able to supply a large amount or wide range of oligs ours … a supply of reference material. Very dependent on being able to clear material (COSHH problem) also access to high …
LB0807	Yes
LB0808	Yes
LB0809	No.
LB0810	No -but I have the literature from it - Essential: makes you aware of the large variation in some of the penis sheaths of some species, which if you only have chaetae and penis sheaths visible can be troublesome.
LB0811	Yes - and the folder and papers from that meeting was my main source for the RT.
LB0812	Yes, it was very useful.
LB0813	yep, it was good
LB0814	Yes. I found it boosted my confidence considerably - the most useful side was actually seeing what certain species actualy looked like in the flesh rather than the poor line drawings from publications.
LB0815	One member of staff did attend, we have the paperwork, which we still use.
LB0816	No
LB0818	No, I hate to say it but perhaps it was about time we had an update (possible theme for next w/shop)
LB0819	No, but I've got the literature from it, which unfortunately I don't find useful.
LB0820	No I didn't get the chance
LB0821	No

1G.) How would you rank your experience with oligochaete identification?

	No. Labs.	LabCodes
1. Very experienced	0	-
2.	0	-
3. Reasonably experienced	9	05,07,08,10,12, 14,16,18&19
4.	10	02,03,04,06,09, 11,13,15,20&21
5. No experience	0	-

1H.) What methods do you normally use for oligochaete identification?

	No. Labs.	LabCodes	Comments
Stereo-examination of gross morphology	17	02,03,04,05,06, 08,09,10,11,12, 14,15,16,18,19, 20& 21	T.benedii & Grania spp.
Temporary mounts for chaetal examination	19	02,03,04,05, 06,07,08,09,10, 11,12,13,14,15, 16,18,19,20&21	Most Tubificoides, most Naididae; Temporary cleared mounts(14).
Permanent cleared mounts for examination of internal anatomy	4	05,07,10&18	Depending on specimen, size, condition and features, also abundance(05);Never done due to time(08);Where difficult specimens are present(18);Used to clear specimens with Ammans Lactophenol and mount them but found that the process did not improve my ability to identify specimens and wasted an awful lot of time(19).

Tables 2A - 2H. Data from section 2 of the oligochaeta questionnaire.

2A.) Did you find the habitat notes supplied with the ring test useful? Give comments

LabCode	Comments
LB0802	yes very useful as they helped to rule out species when identification using traditional keys was difficult
LB0803	A small amount. They were used to eliminate which species it definitely could not be during the ID process.
LB0804	Yes, as reinforcement of possible species designation.
LB0805	Yes. Unico '94 notes mainly marine, head to Brinkhurst for the freshwater ones!
LB0809	Yes, in that I was able to check whether or not my identification matched the known habitat for a given species.
LB0811	Yes - but I mainly used them as a check where I had doublers. Occasionally they were useful when the oli descriptions had habitat info with them.
LB0814	Only used to confirm a few ids. - eg for low salinity taxa such as Tubifex
LB0815	Yes, could not have have even guessed at the id. without this information.
LB0816	No
LB0821	Yes. Salinity and habitat was useful

2B.) Did you clear any of the ring test specimens? Give numbers, examples and reasons

LabCode	Comments
LB0802	No
LB0803	Yes, one, but we didn't note down which one it was.
LB0804	None.
LB0805	#8 A lot of broken chaetae, looking for some feature to aid id!
LB0809	No. All identifications were based on gross morphology and chaetal shape and arrangement. Given that there was only one specimen and my lack of experience and knowledge regarding internal morphology (e.g. male reproductive organs) it was not worthwhile for me to examine any of the specimens in this way.
LB0811	No.
LB0814	Yes - number 15 to get better view of penes.
LB0815	No
LB0816	No
LB0821	No

2C.) Did you use reference material to assist your identifications? Give examples

LabCode	Comments
LB0802	We would have if we had reference material. But as we hardly ever come across oligochaetes in our samples we have very few. Most if not all are Grania species and they did not feature in the ring test - I hope!
LB0803	Yes we used our own lab reference collection material although we do not have many marine oligochaetes within this.
LB0804	Some Psammoryctides from a previous ... survey.
LB0805	No. Ref. material limited and mainly obvious taxa
LB0809	Yes, although reference material for the Oligochaeta is available for only a few species. Ring test specimens were compared with reference specimens for Nais elinguis and Paranais litoralis. Reference materail was also used for Tharyx sp.
LB0811	No.
LB0814	Yes - checked our ref. material of T.swirencoides, T.scoticus , T.brownae
LB0815	Yes, we have a small collection of worms from ..., all of which have been verified -*Tubificoides benedii, T.heterochaetus, Heterochaeta costatus* , etc.
LB0816	No, as our reference specimens are far from complete.
LB0821	Don't have any reference material as of yet.

2D.) How long did the ring test take to complete?

LabCode	Time (hours)	Comments
LB0802	15	
LB0803	12	
LB0804	7	
LB0805	7	
LB0809	27	Including literature compilation
LB0811	20	
LB0814	7	
LB0815	6	
LB0816	21	
LB0821	-	

2E.) How many people were involved in the ring test identifications?

LabCode	No. People
LB0802	5
LB0803	3
LB0804	3
LB0805	1
LB0809	1
LB0811	1
LB0814	1
LB0815	1
LB0816	3
LB0821	1

2F.) How difficult did you find the ring test?

	No. Labs.	LabCodes
1. Very easy	0	-
2.	0	-
3.	2	14&15
4.	5	05,09,11,16&21
5. Very hard	3	02,03&04

2G.) How many of the 25 RT specimens do you think you identified correctly to species?

LabCode	Predicted **No. correct**	Actual **No. correct**	Oligochaetes Only **No. correct (22max)**
LB0802	3	*4*	*3*
LB0803	10	*14*	*11*
LB0804	12	*20*	*18*
LB0805	16	*16*	*14*
LB0809	12	*19*	*16*
LB0811	15	*16*	*13*
LB0814	20	*20*	*18*
LB0815	15	*23*	*20*
LB0816	15	*23*	*20*
LB0821	15	*18*	*18*

2H.) Please use the space below if you have any further comments regarding the ring test.

LabCode	Comments
LB0802	The majority of the participants feel that oligochaetes are inherently difficult and that we don't come across them often enough to warrant spending vast amounts of time searching through the literature. This is undoubtedly reflected in our identifications. However, there is every chance that we will be taking on estuarine samples in the near future so some expertise will be necessary.
LB0803	As we do not routinely identify oligochaetes to species and we have a poor selection of reference material we found this ring test difficult.We are hoping to use the ring test as a training exercise more than anything else. We would be interested to hear of key 'tips' for IDing these to species as we have been advised by other taxonomists that sexually mature adults are required for accurate identification to species as specimens need to be cleared in lactophenol to enable the penis sheath to be examined. This is very time consuming for one specimen, never mind for multiple individuals depending on the number you encounter in you samples.The majority of the specimens included in the ring test were not thought to be sexually mature so following the key with respect to using features of the penis sheath could not be done. However, we are not discounting that our lack of expertise may have led us to believe they were immature specimens!
LB0804	-
LB0805	-
LB0809	I found the Ring Test difficult, but a good opportunity to amass literature on the Oligochaeta and to try and improve my taxonomic knowledge of this group. However, what would be most beneficial would be to include the Oligochaeta in a taxonomic workshop, such as that held last autumn in Portaferry.
LB0811	Although initially terrified by the prospect of the RT I actually enjoyed it. I might not get many right but at least when I checked the habitat data against the specimens I had doublers of and they agreed that was a revelation!
LB0814	Several species appear to be repeated in this ring test - although this may be an error on my part. I had hoped to see more new taxa (only Psammoryctides and T.heterochaetus? Were new to me) and have the opportunity to save some digital images of their penes etc. I reckon a series of good digital images of diagnostic features of real oligochaetes would get round the present problems of poor illustrations in taxonomic papers.
LB0815	Hopefully your feedback will be as full as usual, as this will help greatly when undertaking further Oli id. Can we keep some of the specimens????????? We need to improve our reference collection.
LB0816	Although we usually find oligochaetes in our samples, they consist of a small no. of species. We don't find the diversity of oligochaetes that were included in this ring-test.
LB0821	-

Appendix I.

The National Marine Biological Analytical Quality Control Scheme

Ring Test Bulletin – RTB#19

Unicomarine Ltd.
May 2002

RING TEST DETAILS

Ring Test #19
Type/Contents – Targeted Oligochaeta and similar fauna
Circulated – 17/01/2002
Completion Date – 29/03/2002
Number of Participating Laboratories - 18
Number of Results Received – 10

Summary of differences

Specimen	Genus	Species	Total differences for (10) laboratories	
			Genus	Species
RT1901	Tubificoides	benedii	1	1
RT1902	Tubifex	tubifex	3	4
RT1903	Paranais	litoralis	2	2
RT1904	Tubificoides	benedii	0	0
RT1905	Nais	elinguis	1	4
RT1906	Psammoryctides	barbatus	4	4
RT1907	Heterochaeta	costata	1	1
RT1908	Tubificoides	swirencoides	1	4
RT1909	Tubificoides	heterochaetus	3	5
RT1910	Paranais	litoralis	2	3
RT1911	Tubificoides	amplivasatus	1	2
RT1912	Tubifex	tubifex	6	6
RT1913	Tubificoides	insularis	0	0
RT1914	Tubificoides	amplivasatus	1	3
RT1915	Psammoryctides	barbatus	4	4
RT1916	Paranais	litoralis	1	1
RT1917	Heterochaeta	costata	1	1
RT1918	Tubificoides	swirencoides	1	7
RT1919	Tubificoides	cf. galiciensis	0	7
RT1920	Tharyx	sp. A	2	4
RT1921	Mediomastus	fragilis	2	2
RT1922	Capitella	capitata	2	2
RT1923	Nais	elinguis	2	3
RT1924	Tubificoides	cf. galiciensis	0	6
RT1925	Heterochaeta	costata	1	1
		Total differences	42	77
		Average differences /lab.	4.2	7.7

Detailed Breakdown of Identifications

RT1901 – *Tubificoides benedii*
Sediment: Mud. Salinity: High. Depth: Mid Shore. Geography: Blackwater Estuary. Condition: Good, Large.
One generic and one specific difference; Lab 02 identified as Tubificidae.

RT1902 – *Tubifex tubifex*
Sediment: Mud. Salinity: Low. Depth: Mid Shore. Geography: Thames Estuary. Condition: Good, Small.
Three generic and four specific differences; Lab 02 identified as *Paranais sp.*, Lab 03 identified as *Tubificoides insularis* (both lack pectinate chaetae), Lab 05 identified as *Tubificoides aculeatus?* (which is an abyssal species), and Lab 11 identified as *Tubifex nerthus* (which has ventral anterior chaetae with increasingly reduced lower teeth).

RT1903 – *Paranais litoralis*
Sediment: Mud. Salinity: Medium. Depth: Mid Shore. Geography: Blackwater Estuary. Condition: Average.
Two generic and two specific differences; Lab 02 identified as *Tubificoides sp.* and Lab 15 identified as *Tubificoides pseudogaster* (both have dorsal chaetae present from the first chaetiger).

RT1904 – *Tubificoides benedii*
Sediment: Mud. Salinity: High. Depth: Mid Shore. Geography: Suffolk. Condition: Average-Poor.
No differences recorded.

RT1905 – *Nais elinguis*
Sediment: Mixed. Salinity: Low. Depth: Low Water Mark. Geography: Thames Estuary. Condition: Good, Faint Eyes.
One generic and four specific differences; Labs 02, 11 and 14 identified as *Nais variabilis* (which lacks dorsal chaetae with long parallel teeth), and Lab 03 identified as *Tubificoides sp.* (which has dorsal chaetae on the first chaetiger).

RT1906 – *Psammoryctides barbatus*
Sediment: Mixed. Salinity: Low. Depth: Mid Shore. Geography: Thames Estuary. Condition: Very Good, Large.
Four generic and four specific differences; Labs 02, 03, 09 and 11 identified as *Tubifex tubifex* (which lacks palmate chaetae).

RT1907 – *Heterochaeta costata*
Sediment: Muddy Sand. Salinity: Medium. Depth: Low Water Mark. Geography: North Lincolnshire. Condition: Very Good, Large.
One generic and one specific difference; Lab 02 did not identify this specimen.

RT1908 – *Tubificoides swirencoides*
Sediment: Mixed. Salinity: High. Depth: Shallow Subtidal. Geography: Strangford Lough. Condition: Very Poor, Incomplete.
One generic and four specific differences; Lab 02 identified as *Tubifex tubifex* (which lacks papillations and has pectinate chaetae), Lab 03 identified as *Tubificoides sp.*, Lab 05 identified as *Tubificoides amplivasatus* (which lacks posterior papillations), and Lab 09 identified as *Tubificoides scoticus* (which lacks anterior bifid chaetae with closely applied 'clothes peg' teeth).

RT1909 – *Tubificoides heterochaetus*
Sediment: Mud. Salinity: Medium. Depth: Shallow Subtidal. Geography: Thames Estuary. Condition: Average.
Three generic and five specific differences; Lab 04 identified as *Tubificoides pseudogaster*, Lab 09 identified as *Limnodrilus hoffmeisteri* (both of which lack simple pointed dorsal chaetae), Lab 03 identified as Tubificinae sp., Lab 05 identified as *Tubificoides spp?* (spp. indicates more than one species present, the vial should have contained just one specimen), and Lab 02 did not identify this specimen.

RT1910 – *Paranais litoralis*
Sediment: Mixed Gravel. Salinity: Medium. Depth: Mid Shore. Geography: Severn Estuary. Condition: Good, Asexual Evidence.
Two generic and three specific differences; Lab 02 identified as *Paranais sp.*, Lab 05 identified as *Chaetogaster spp.* (which has no dorsal chaetae; spp. indicates more than one species present, the vial should have contained just one specimen), and Lab 11 identified as *Tubificoides pseudogaster* (which has dorsal chaetae present from the first chaetiger).

RT1911 – *Tubificoides amplivasatus*
Sediment: Mixed. Salinity: High. Depth: Shallow Subtidal. Geography: Milford Haven. Condition: Average.
One generic and two specific differences; Lab 02 identified as Naididae (which have characteristic chaetae and body-forms), and Lab 21 identified as *Tubificoides insularis* (which has papillations).

RT1912 – *Tubifex tubifex*
Sediment: Mixed. Salinity: Low. Depth: Mid Shore. Geography: Thames Estuary. Condition: Poor.
Six generic and six specific differences; Lab 02 identified as Naididae (which have characteristic chaetae and body-forms), Lab 03 identified as *Tubificoides amplivasatus*, Lab 04 identified as *Tubificoides indet.*, Lab 05 identified as *Monopylephorus irroratus* (which has twisted hair chaetae and lacks pectinate chaetae), Lab 11 identified as *Tubificoides aculeatus* (which is an abyssal species), and Lab 21 identified as *Eiseniella tetraedra* (which has lacks hair and pectinate chaetae).

RT1913 – *Tubificoides insularis*
Sediment: Mixed. Salinity: High. Depth: Shallow Subtidal. Geography: Stour Estuary. Condition: Average. Notes: Co-habitant with specimen RT1914.
No differences recorded.

RT1914 – *Tubificoides amplivasatus*
Sediment: Mixed. Salinity: High. Depth: Shallow Subtidal. Geography: Stour Estuary. Condition: Good. Notes: Co-habitant with specimen RT1913.
One generic and three specific differences; Lab 02 identified as Tubificidae, Lab 03 identified as *Tubificoides sp.*, and Lab 16 identified as *Tubificoides scoticus* (which lacks posterior banding and has broad lance shaped anterior dorsal chaetae).

RT1915 – *Psammoryctides barbatus*
Sediment: Mixed. Salinity: Low. Depth: Shallow Subtidal. Geography: Thames Estuary. Condition: Good.
Four generic and four specific differences; Labs 02, 03, 09 and 11 identified as *Tubifex tubifex* (which lacks palmate chaetae).

RT1916 – *Paranais litoralis*
Sediment: Mud. Salinity: Medium. Depth: Mid Shore. Geography: Thames Estuary. Condition: Poor. Notes: Exact specimen for each laboratory as circulated in RT17.
One generic and one specific difference; Lab 02 identified as *Psammoryctides barbatus* (which has hair and palmate chaetae – possible vial mix up).

RT1917 – *Heterochaeta costata*
Sediment: Mud. Salinity: Medium. Depth: Mid Shore. Geography: Essex. Condition: Good.
Notes: Exact specimen for each laboratory as circulated in RT17.
One generic and one specific difference; Lab 03 identified as *Tubificoides amplivasatus* (which has hair chaetae and lacks pectinate chaetae).

RT1918 – *Tubificoides swirencoides*
Sediment: Mud. Salinity: High. Depth: Shallow Subtidal. Geography: Tees Estuary. Condition: Good.
One generic and seven specific differences; Labs 04, 05, 15 and 21 identified as *Tubificoides cf. galiciensis* (which has bifid chaetae accompanying the posterior hair chaetae), Lab 02 identified as *Clitellio arenarius?* (which has no hair chaetae), Lab 03 identified as *Tubificoides sp.*, and Lab 11 identified as *Tubificoides scoticus* (which lacks anterior bifid chaetae with closely applied 'clothes peg' teeth).

RT1919 – *Tubificoides cf. galiciensis*
Sediment: Mud. Salinity: High. Depth: Shallow Subtidal. Geography: Tees Estuary. Condition: Good.
Seven specific differences; Labs 03, 04, 11 and 14 identified as *Tubificoides swirencoides* (which has simple pointed chaetae accompanying the posterior hair chaetae), Lab 02 identified as *Tubificoides benedii* (which lacks hair chaetae), Lab 09 identified as *Tubificoides insularis* (which has anterior papillations), and Lab 16. Identifies as *Tubificoides scoticus* (which lacks bifid chaetae accompanying the posterior hair chaetae).

RT1920 – *Tharyx sp. A*
Sediment: Mud. Salinity: High. Depth: Mid Shore. Geography: North Wales. Condition: Good.
Two generic and four specific differences; Labs 04 and 14 identified as *Tharyx killariensis* (which has a longer thinner body and is subtidal), Lab 05 identified as *Chaetozone setosa agg.*, and Lab 21 identified as *Chaetozone sp. B* (both of which have posterior simple pointed acicular chaetae in both rami).

RT1921 – *Mediomastus fragilis*
Sediment: Mixed. Salinity: Full. Depth: Subtidal. Geography: Orkney. Condition: Good.
Two generic and two specific differences; Labs 02 identified as *Capitomastus minimus* (which has three anterior segments with capillary chaetae and no achaetus segment), and Lab 21 did not identify this specimen.

RT1922 – *Capitella capitata*
Sediment: Mud. Salinity: Medium. Depth: Mid Shore. Geography: Suffolk. Condition: Average.
Two generic and two specific differences; Lab 02 identified as *Tubificoides amplivasatus* (which lacks hooded hooks and has dorsal hair chaetae throughout its body), and Lab 21 did not identify this specimen.

RT1923 – *Nais elinguis*
Sediment: Mixed. Salinity: Low. Depth: Shallow Subtidal. Geography: Thames Estuary. Condition: Good, No Eyes.
Two generic and three specific differences; Labs 02 and 05 identified as *Paranais litoralis* (which lacks dorsal hair chaetae), and Lab 14 identified as *Nais variabilis* (which lacks dorsal chaetae with long parallel teeth).

RT1924 – *Tubificoides cf. galiciensis*
Sediment: Mud. Salinity: High. Depth: Shallow Subtidal. Geography: Tees Estuary. Condition: Good.
Six specific differences; Labs 05, 09 and 14 identified as *Tubificoides swirencoides*, Lab 11 identified as *Tubificoides amplivasatus* (both have simple pointed chaetae accompanying the posterior hair chaetae), Lab 21 identified as *Tubificoides benedii* (which lacks dorsal hair chaetae), and Lab 03 identified as *Tubificoides sp.*.

RT1925 – *Heterochaeta costata*
Sediment: Mud. Salinity: Medium. Depth: Mid Shore. Geography: Blackwater Estuary. Condition: Good.
One generic and one specific difference; Lab 02 identified as *Tubificoides pseudogaster agg.* (which lacks palmate chaetae).

PLEASE RETURN ALL RING TEST SPECIMENS BY 24TH MAY 2002. THESE ARE REFERENCE COLLECTION SPECIMENS AND MUST BE RETURNED TO OUR MUSEUM. YOUR LABORATORY WILL BE INELEGIBLE FOR FUTURE RING TESTS IF SPECIMENS ARE NOT RETURNED.

Appendix II. NMBAQCS RT19 'Oligochaeta' Questionnaire.

LabCode: _____

Please take a few moments to complete this questionnaire so that your ring test results can be qualified correctly.
If you did not participate in the ring test, please complete Section 1 only.

SECTION 1 - GENERAL

1A.) How often do you encounter oligochaetes in your macrobenthic samples?
Mark the appropriate box:

- ☐ 1. Always
- ☐ 2. Often
- ☐ 3. Occasionally
- ☐ 4. Rarely
- ☐ 5. Never

1B.) At what taxonomic level do you normally identify oligochaetes? Give qualifying comments (e.g. species but Enchytraeids to family)
Mark the appropriate box:

- ☐ Class
- ☐ Family
- ☐ Species, wherever possible.

1C.) How important do you consider oligochaete identification? Add comments

1D.) Place the following identification aids in rank order of importance for oligochaete identification at your laboratory
(1: most important; 5: least important). Exclude any aids not used; add comments

…….. Keys/tables
…….. Publications/descriptions
…….. Reference material
…….. Experience/memory
…….. Habitat information

1E.) Do you find your oligochaete literature adequate? Add comments

1F.) Did you attend the 1994 Oligochaete workshop hosted by Unicomarine Ltd.? Add comments

1G.) How would you rank your experience with oligochaete identification?
Mark the appropriate box:

- ☐ 1. Very experienced
- ☐ 2.
- ☐ 3. Reasonably experienced
- ☐ 4.
- ☐ 5. No experience

1H.) What methods do you normally use for oligochaete identification?
Give examples of taxa and proportions of specimens identified by each method
Mark the appropriate boxes:

- ☐ Stereo-examination of gross morphology
- ☐ Temporary mounts for chaetal examination
- ☐ Permanent cleared mounts for examination of internal anatomy

SECTION 2 - RT19 (to be completed by RT19 participants only)

2A.) Did you find the habitat notes supplied with the ring test useful? Give comments

2B.) Did you clear any of the ring test specimens? Give numbers, examples and reasons

2C.) Did you use reference material to assist your identifications? Give examples

2D.) How long did the ring test take to complete?

…….. Hours (total working hours, i.e. 2 persons for 2 hrs = 4 hrs)

2E.) How many people were involved in the ring test identifications?

2F.) How difficult did you find the ring test?
Mark the appropriate box:

- ☐ 1. Very easy
- ☐ 2.
- ☐ 3.
- ☐ 4.
- ☐ 5. Very hard

2G.) How many of the 25 RT specimens do you think you identified correctly to species?

…… out of 25.

2H.) Please use the space below if you have any further comments regarding the ring test, or suggestions for future target ring tests

Thank you for completing this questionnaire. Please either email or post your completed form to:
davidhall@unicomarine.com; David Hall, Unicomarine Ltd., Works Road, Letchworth, Hertfordshire SG6 1LW.

Appendix III. Unicomarine Ltd. Extraction/Recording/Biomass SOP for Macrobenthic Samples
NMMP Version 1.1 Oligochaeta

			Extracted*		Preservation		Recorded/Identification				Biomass			Key literature (not comprehensive)
Class	Family	Genus	All	In part	Alcohol	Dried	Enumeration	Present/absent	Tax. level**	Juv. separated	Weighed	Fragments incl.	Tubes/shells incl.	
Oligochaeta			☑		☑		☑		Varied	☑☒	☑	☑	n/a	Brinkhurst, 1971 & 1982; 1994 Oligochaete workhop notes; In-house tables & notes.
	Naididae		☑		☑		☑		Varied		☑	☑	n/a	
		Amphichaeta	☑		☑		☑		Species		☑	☑	n/a	
		Chaetogaster	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
		Nais	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971, 1982
		Paranais	☑		☑		☑		Species		☑	☑	n/a	
		Stylaria	☑		☑		☑		Species		☑	☑	n/a	
		Uncinais	☑		☑		☑		Species		☑	☑	n/a	
	Tubificidae		☑		☑		☑		Varied (Family, except where stated below)		☑	☑	n/a	Brinkhurst 1971, 1982; In-house notes.
		Monopylephorus	☑		☑		☑		Family (except M.irroratus to species)		☑	☑	n/a	
		Limnodriloides	☑		☑		☑		Genus		☑	☑	n/a	
		Clitellio	☑		☑		☑		Species		☑	☑	n/a	
		Heterochaeta	☑		☑		☑		Species		☑	☑	n/a	
		Limnodrilus	☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
		Tubifex	☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
		Tubificoides	☑		☑		☑		Species (except T.brownae, T.crenacoleus, T.diazi and T.pseudogaster, all as T.pseudogaster agg.)		☑	☑	n/a	
		Psammoryctides	☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Enchytraeidae		☑		☑		☑		Family (except Grania spp. to genus)		☑	☑	n/a	Brinkhurst 1982
		Grania	☑		☑		☑		Genus		☑	☑	n/a	
	Branchiobdellidae		☑		☑		☑		Genus		☑	☑	n/a	Brinkhurst 1971
	Aeolosomatidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Haplotaxidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Lumbriculidae		☑		☑		☑		Family		☑	☑	n/a	Brinkhurst 1971
	Dorydrilidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Glossoscolecidae		☑		☑		☑		Species		☑	☑	n/a	Brinkhurst 1971
	Lumbricidae		☑		☑		☑		Family (except Eiseniella tetraedra to species)		☑	☑	n/a	Brinkhurst 1982

*=some taxa will be counted in situ/subsampled if present in high numbers

**=minimum level required (good condition given)

National Marine Biological Analytical Quality Control Scheme

Guidelines for processing marine macrobenthic invertebrate samples: a Processing Requirements Protocol

Version 1.0, June 2010

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unicomarine

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SEPA
Scottish Environment Protection Agency

National Marine Biological AQC Coordinating Committee

CONTENTS

APPENDICES

SUMMARY

Processing requirements are described for marine macrobenthic samples. They are divided into guidelines for sample management, sample processing, blotted dry biomass assessment, and subsampling. Of these, the basic management/processing guideline forms the basis of best practice for all marine macrobenthic samples. It is reduced to a Processing Requirements Protocol (PRP), detailing those aspects that are required, without recommending specific methods. It also describes and discusses some of the issues inherent to sample processing.

Also included is a summary overview of a taxonomic discrimination protocol (TDP). The final TDP, which will detail treatment required for all taxa, will be in database format. An example for Oligochaeta is included here.

INTRODUCTION

This report introduces **standard guidelines for marine macrobenthic sample management and processing.** The purpose is to assist fieldworkers, commissioning organisations, and laboratory operatives with the management, tracking and processing of samples from the point of collection through delivery to the laboratory, sample analysis, quality assurance and the production and archiving of data products with the aim of producing comparable data.

There is currently no publication that provides processing requirements for macrobenthic invertebrate samples in sufficient detail for confident data comparability between laboratories. Monitoring handbooks (Holme & McIntyre, 1984, Baker & Wolff, 1987 Davies *et al*., 2001) give only very broad specifications for macrobenthic surveys including short notes on laboratory methods within guidelines for sampling. More guidance for processing macrobenthic samples is available in Rees *et al*. (1990) and Rumohr (1990). The Proceedings of the Humber Benthic Field Methods Workshop (Proudfoot *et al*., 2003) includes a review of laboratory subsampling and biomass measurement but little on laboratory processing. The UK Clean Seas Environment Monitoring Programme (CSEMP - formerly the National Marine Monitoring Programme or NMMP) presents advice for macrobenthic samples in the CSEMP Green Book, Appendix 10 (Cefas, 2009), but includes only a single paragraph on sample processing and a few paragraphs on biomass measurement. The International Standard 16665:2005 (EN ISO, 2005) offers the most comprehensive overview to date of the requirements for processing macrobenthic samples.

However, the specifications found in these documents can still be interpreted differently by different laboratories to the point of compromising direct comparison between data from different sources. Reviews of laboratory methods for the NMBAQC Scheme (Worsfold & Hall, 2001; Hall & Worsfold, 2002, Cooper & Rees, 2002) have shown significant differences in basic practices between laboratories. Working methods and skills vary widely between laboratories and they identify taxa to varying levels of accuracy. There may also be variation between staff at one laboratory, though some standardise through constant communication or in-house protocols.

Macrobenthic sample analysis is subject to many errors. The most significant relate to inadequate extraction of biological material from the sediment. Extraction errors are also impossible to correct where there has been discard of residues. Identification and enumeration discrepancies are also important sources of error and differences in extraction and recording policy may compound all errors

Data comparability is currently best achieved by use of a single analyst (impractical for national projects), through continuous comparison between analysts / laboratories, or through extensive data truncation (subject to inaccuracies and resulting in loss of information).

The aim here is to produce a Processing Requirements Protocol (PRP): a detailed standard document that outlines requirements for macrobenthic sample management and processing, from the point of collection to the final storage of data and sample material. The PRP is intended to augment the International Standard with the provision of more clarity on the detail of processing specifications; the TDP will supersede the International Standard in terms of taxon recording policy. Throughout the document a distinction has been made between actions that that are **imperative** and **must** be undertaken and those less stringent

requirements that are **recommended** as good practice and **should** be undertaken. The purpose of the PRP is to provide clear, unambiguous, and comprehensive instructions to facilitate the efficient management and processing of samples and the consistent production of good quality data which are comparable between different laboratories at a national level. The processes can be divided into different tasks which might potentially be completed by different organisations or laboratories. It is essential that the whole protocol is effectively managed to ensure the integrity of sampling and analytical information and the PRP includes guidelines on management aspects along with detailed laboratory procedural requirements. **For each task the key procedural requirements are outlined within text boxes; imperative actions that must be undertaken appear in red text**.

Although the PRP is intended as a standard document, it is likely that some details of the guidelines will be subject to review by the NMBAQC committee. The committee would be grateful for notice of any text requiring further specification or clarification. Each laboratory will have its own detailed Standard Operating Procedure (SOP) outlining exactly how procedures are carried at that specific lab. These SOPs may vary from lab to lab but provided that the different SOPs include the key sample processing requirements from this PRP then they should produce comparable results.

The implementation of appropriate health and safety requirements (*e.g.* CoSHH assessments for preservatives and other reagents) is an essential part of laboratory management. However, health and safety issues are not included in this PRP as they do not constitute processing requirements.

A Taxonomic Discrimination Protocol (TDP) is under development, alongside the PRP. It will detail how different taxa should be quantified and recorded and the taxonomic level at which they should be identified. The aim is to standardise and improve taxonomic resolution wherever possible. Taxonomic workshops and improved taxonomic literature may allow more precise identifications in future. An overview TDP and the TDP for Oligochaeta are included with this document (Appendices 3 and 4).

Abbreviations:

CMA	Competent Monitoring Authority
CoSHH	Control of Substances Hazardous to Health
CSEMP	Clean Seas Environmental Monitoring Programme
DGN	Dangerous Goods Note
H & S	Health and Safety
IDA	Industrial Denatured Alcohol, formerly Industrial Methylated Spirit (IMS)
LPM	Laboratory Project Manager
NMBAQC	National Marine Biological Analytical Quality Control
PCM	Primary Contract Manager
PRP	Processing Requirements Protocol
PSA	Particle Size Analysis
QA	Quality Assurance
QC	Quality Control
SDF	Sample Data Form
SPF	Sample Progress Form
SOP	Standard Operating Procedure
SPF	Sample Progress Form
TDP	Taxonomic Discrimination Protocol
TREM	Transport Emergency

PROCEDURAL GUIDELINE A: Management and Processing of Marine Macrobenthic Samples

A.1 Logistics

The manager of the project, Primary Contract Manager (PCM), must oversee the transfer of samples from the field to the analysing laboratory and provide clear instructions to all involved. They are then responsible for the ultimate fate of both data and samples and external quality control.

Sample analysis is typically conducted at a laboratory distant from the survey location, often by a different organisation from that which completed the survey.

A.2 Equipment

An efficient office system is necessary for maintenance of both paper and electronic records. Robust packaging is required for sample transport, particularly for postal dispatch. Vented premises are required for storage.

The sample analyst must have access to a laboratory equipped with washroom facilities and fume cupboard, along with desk space and microscopes of both compound and stereo types, with a range of magnifications e.g. x 10 to x 1000. Other equipment required includes:

- A range of certified standard mesh sieves: *e.g.* 0.5mm (1φ), 1mm (0φ), 2mm (-1φ), 4mm (-2φ), 32mm (-5φ) to separate sample fractions.
- Trays and dishes for sorting.
- Scraping knives and forceps of different sizes and coarseness.
- A range of watertight containers of different sizes for containment of samples and extracted fauna and appropriate alcohol resistant labels.
- Supplies of fixatives and preservatives (formaldehyde solution and Industrial Denatured Alcohol, IDA) must be available.

The premises must be equipped with comprehensive collections of both identification literature and reference specimens.

A.3 Personnel

The staff should include experienced personnel trained in sample management, sample processing and specimen identification, to cover all taxonomic groups encountered in the samples processed. There should be enough fully trained staff to provide adequate supervision for less experienced staff.

A.4 Sample collection

Detailed guidelines for sample collection are not provided here. Some guidelines are available in the CSEMP Green Book (Cefas, 2009). A review of best practice for field procedures for collecting macrofaunal samples was undertaken by Proudfoot *et al*. (2003). However an outline of some of the issues relating to sample collection is presented here as sample treatment during fieldwork may affect subsequent sample processing and quality.

Samples are commonly commissioned, collected and processed by different organisations. It is essential that a clear line of communication and responsibility is maintained throughout.

A single Primary Contract Manager (PCM) from the commissioning organisation should know who is responsible for each stage of the process.

The commissioning organisation PCM must give clear instructions to surveyors regarding procedures for sample collection including collation of field notes and field processing (e.g. sieving and preserving). **The entire sample is important.** It is not uncommon for surveyors to assume that only sediment is important and to discard stones or large animals. Many sources of confusion come from past traditions and terminology. Macrobenthic samples may be described as 'macrofaunal' or even 'infaunal' samples. The terms carry an implication that plants and 'epifauna' can be ignored and there may have been justifications raised for ignoring these components. One reason that all biota should be considered is that all are relevant to the nature of the habitat and biotope definitions. Another is that there are no firm distinctions between concepts such as 'infauna' and 'epifauna'. **Some surveyors are unaware that many animals move to the surface of water collected with the sample and that they will be lost if water is spilt over the side of containers.**

Preservation methods vary and should be clearly specified. Surveyors should also be aware that samples must be preserved quickly, especially in hot weather and that preservative must be thoroughly mixed into each sample. Surveyors must also remember that a 4% solution added to a container over half full with sediment and trapped seawater will no longer be 4%. **Inadequately preserved samples will impact on the physical quality of the preserved fauna and may render it difficult, or impossible, to identify.**

Many organisations routinely add a stain, such as Rose Bengal, to samples during preservation. Alternatively stain may be added later in laboratory prior to sample sorting (extraction). The PCM should specify whether this is necessary or acceptable and consider the requirements of the analysing laboratory, if possible. Some laboratories consider staining to be useful as an aid to extraction. This may be especially so if large volumes of residue require to be sorted. However others see stain as an impediment to identification as it may obscure diagnostic pigmentation patterns which are retained in some fauna. **Excess Rose Bengal leaches into alcohol during identification and obscures visibility; it cannot be removed from specimens reducing their value as reference material.**

Sample collection (PCM responsibilities)
A single Primary Contract Manager (PCM) from the commissioning organisation should know who is responsible for each stage of the process.
Clear instructions must be provided to surveyors to ensure that sample treatment during fieldwork is appropriate and that all required field notes are recorded.
The PCM must ensure that instructions to the fieldwork team are consistent with the requirements of laboratory analysis (*e.g.* with respect to sieving, retention of all material, preservative and staining).
The PCM must take responsibility for ensuring that all subcontractors receive the samples and all relevant information (*e.g.* details from field log) and are aware of the protocols to follow.
Each sample must be in a clearly labelled watertight container (or group of containers clearly identified as representing a single sample). It should be complete (with no loss of material coarser than the required mesh prior to containment) and adequately preserved.

A.5 Transport of samples

Samples are often inadequately packaged and leak chemicals en route. In many instances the legal requirements for labelling are not followed.

Transport of samples
The PCM should ensure that all samples arrive at the analysing laboratory in good condition.
Samples must be transported in fully watertight containers, with at least one other watertight layer surrounding each or all samples.
Containers must be robust and well insulated against damage.
All hazardous substances must be clearly labelled in accordance with the law and with the regulations of the carrier and requirements of all personnel who handle the package.
The PCM should also ensure that the analysing laboratory confirms receipt of the samples, with details of their condition.

A.6 Sample tracking

Samples often arrive at analysing laboratories without documentation or clear instructions. It is important that the origins of samples are clear and that all parties know basic details such as the number of samples to be processed and where they are or should be at any point in time.

Clear labelling is an obvious issue but links to other survey information (*e.g.* PSA data or field photos) are equally important. They are usually not all passed on to the analysing laboratory, either for reasons of confidentiality or difficulty of compilation. It may be considered that only the commissioning organisation needs this information but samples are generally retained at the analysing laboratory and their value may be lost to the future if information links are broken, so it is recommended that all data from field logs is passed on, where possible.

Sample tracking
The PCM must ensure that they obtain a comprehensive list of samples and sampling details from the organisation responsible for fieldwork.
They should produce an electronic document (*e.g.* a spreadsheet) with links to the following information for each sample and provide as much of this as possible (without breach of confidentiality) to the analysing laboratory: • station and sample code, • visual description of sample, • sampling position (with coordinate type and projection specified), • sampling depth (corrected to chart datum), • sampling date and time, • organisation, individuals and vessel involved in sampling (as appropriate), • sampling equipment (including surface area sampled), • details of all treatment of the sample post-collection (*e.g.* field sieving, with mesh, any material removed before preservation, preservative and any other additives used), • details of all other samples or data collected at the same sites or during the same survey (*e.g.* PSA, chemistry, photography, sonar, bathymetry).

Further to the information above the data guidelines for "Sediment sampling by grab or core for benthos" provided by the Marine Environmental Data and Information Network (MEDIN, 2009) should be adhered to by surveyors and laboratory analysts to ensure that all necessary information is collected.

A.7 Instructions for the analysing laboratory

For many years, commissioning organisations have believed that reference to a short line on processing requirements stating, for example 'identify to species where possible' will produce comparable data. In fact, every laboratory interprets such instructions differently and effectively follows its own standard practice. Many routinely ignore certain taxa by tradition without comment, or discard material without note. **Prescriptive instructions are essential and those included here should help, alongside the TDP.**

Instructions to the analysing laboratory
The PCM is responsible for ensuring that a suitable analysing laboratory is chosen and for providing them with all processing requirements. The PCM must communicate all relevant information to the Laboratory Project Manager (LPM).
Details of basic requirement options and basic survey information required by an analysing laboratory are summarised in the Sample PRP checklist in Appendix 1. It is recommended that the PCM complete a form of basic details (such as the Sample PRP checklist) and send it to the analysing laboratory along with the sample list and copies of the relevant processing guidelines.
The PCM must ensure that the analysing laboratory has an appropriate SOP in place, including Internal QA methods. The lab's SOP must be available for inspection and the laboratory must adhere to it.
The PCM must confirm that the analysing laboratory participates in an appropriate external QA scheme and must coordinate submission of relevant samples and data for any external QC exercises.
Samples, including extracted fauna and sorted residues must be retained at least until all internal and external QC is completed.
Disposal of samples and specimens is not recommended; if deemed necessary, they should first be offered to other agencies/organisations with an interest in marine biodiversity (*e.g.* universities or museums.)

A.8 Sample Processing

Processing time for macrobenthic samples may vary widely, depending upon mesh size required, sample type/size, sediment type and location of sampling point. All of these factors ultimately affect the richness of the sample, which, in turn affects time required for processing. Both quantity and diversity of benthos affect processing times, as does the difficulty of extraction from certain substratum types. Processing times vary from 30 minutes to five days per sample. Biomass assessment at species level usually adds about 10% to time costs for sample analysis.

The actual time for completion of a group of samples will depend upon the laboratory's existing workload. A backlog of several months for non-urgent samples is common. Laboratories should assess a subset of samples to gauge their difficulty in order to estimate the completion time for sample sets.

Sample Processing (Laboratory Project Manager responsibilities)
The analysing laboratory should appoint a Laboratory Project Manager (LPM) to assume responsibility for the conduct of the macrobenthic analysis.
The contact details of the LPM should be provided to the PCM.
The LPM should appoint a team to conduct sample analysis, in-house quality control and data management for the project.
The LPM must ensure that all procedures are documented.
All personnel involved in the process should be named and their work detailed by initials.
All documentation should be retained indefinitely and made available to the PCM, as necessary.
The analysing laboratory may work to its own standard operating procedure (SOP) but this must be compliant with the current NMBAQC PRP, be approved (by the PCM) and be made available on request for consultation by other organisations and for reference in reports.
Any procedures that differ significantly from the NMBAQC PRP must be agreed with the PCM before proceeding and documented.
The LPM should prioritise samples to meet deadlines for external quality assurance schemes and data submissions to national databases.

A.9 Sample logging

Sample logging
The analysing laboratory should check all sample containers for signs of external damage or leaks and report any to the PCM.
They should check the external labels against the sample list sent by the client laboratory, report any discrepancies and return an annotated list to the PCM for confirmation prior to sample analysis.
The analysing laboratory should use the list as the basis for a Sample Progress Form (SPF), which should be available in hard copy, retained indefinitely, and contain a log of all processes carried out on each sample.
Each sample must also have its own Sample Data Form (SDF), which should be available in hard copy, retained indefinitely, and include all information from the SPF.

A.10 Sample washing and sieving

The basic requirements for sieving samples in the laboratory are to wash the sample on a standard mesh to remove fixative and ensure that no material is lost over the sides of sieves. Sample washing should take place in a ventilated area. Some suggestions are made on how to divide a sample for extraction of biota but the details would belong to an SOP, rather than the PRP. An example SOP flow diagram for washing and sieving and extraction is provided in Appendix 2.

Some laboratories routinely treat samples with a stain, such as Rose Bengal, as an aid to sorting. There is no evidence to suggest stained samples are more accurately picked than unstained ones but it may increase efficiency (*i.e.* reduce sorting time) if large volumes of residue are to be processed. However analysts should be aware that stain may give a false sense of security that only stained material need be searched for and extracted, whereas many animals, such as mollusc and crustacean shells, do not readily stain and may be easily missed by an analyst in a stain mindset. Stain may also make identification of same taxa more difficult as it obscures pigment patterns. **Hence the use of staining should be regarded as optional, rather than a necessary requirement of sample processing, provided that each laboratory ensures all other measures for accurate extraction are in place.**

The gauge of sieve mesh used for marine macrobenthic surveys varies between sampling programmes. Both 0.5mm and 1mm are widely used. The 0.5 mm sieves are most frequently used in estuarine (transitional) waters and also for offshore oilfield samples, while 1 mm has generally been used for coastal waters. Conservation Agencies tend to use a 0.5 mm mesh for mapping and monitoring coastal waters under the Habitats Directive. For CSEMP and WFD there are specific sieve size requirements which differ between transitional and coastal waters (0.5mm and 1.0mm respectively).
The result of different mesh usage has been poor comparability between data from certain areas and artificial distinctions between sites that have been treated differently in different areas. One solution has been to record data at both mesh sizes but this is the most time-consuming option. This could involve stacking 0.5mm and 1 mm sieves for processing live samples in the field or field collection at 0.5mm and subsequent separation of the 1mm fraction of a fixed sample in the lab. These alternatives may produce different data as some live fauna may actively pass through the 1mm mesh whereas the same fauna, fixed and immobile, may be retained on the same 1mm sieve. Also, field sieving may not be complete and more may pass through with more rigorous sieving in the lab.

It would be useful in the long term, and for new initiatives, if only one mesh were standard but that would always cause problems for comparing with past data at a different mesh.

Sample washing and sieving
For each sample, the individual who carried out the initial sieving should record their name on the SPF.
Appropriate health and safety procedures should be in place for processing samples.
All sieves used for laboratory processing must be certified by the manufacturer and calibrated. Sieves with damaged or distorted mesh must not be used.
For each sample, sieves must be cleaned thoroughly before use to avoid contamination from previous samples.
Note should be made of the appearance or composition of the sample prior to washing/sieving, as features may be seen that would be missed by particle size analysis.
Inform PCM if the sample appears to have been poorly preserved (*e.g.* decomposing fauna and odours).
Decant preservative/fixative over a 250um sieve for recycling/disposal and return retained residue to sample.
Each sample must be sieved over an appropriate square mesh as specified in the initial instructions; the mesh size must be quoted in all documentation that relate to the sample.
Where samples have been pre-sieved in the field, they must be re-sieved in the laboratory at the appropriate mesh size (*i.e.* equal to or larger than mesh size used in field).
If sediment samples arrive from field unsieved and unfixed then they should be washed or sieved with isotonic water as delicate unfixed marine fauna will be damaged (bloated) if exposed to freshwater (tap water).
All material contained within the sample container must be retained until completion of processing unless it passes through the sieve. Notes or photos should be made on the composition and volume of residue after washing.
Samples can be divided into a light and a heavy fraction during sieving. The light fraction ('float') will comprise material that can be poured off the sample after moderate agitation in water.
If coarser sieves are used to subdivide a sample into manageable fractions, they should be placed above either a watertight container or a sieve of the specified mesh size or finer.

All fractions must be clearly labelled at all times.
Samples must be sieved gently at the specified mesh until no particulate material passes through the sieve.
Once washing/sieving is complete the sample should be gently washed into a sorting tray. The sieve mesh must be checked to ensure no fauna is left behind.
Containers that may contain biological material must not be left without adequate preservation for more than 24 hours.

A.11 Sample sorting (extraction)

Sample residues, or portions of residues, should be evenly spread in water in a shallow, flat vessel (*e.g.* white sorting tray for coarse fractions; Petri dish for fine), with good illumination. The residue depth should be sufficient to allow any contained fauna to be visible upon sifting with a spatula or forceps or following gentle agitation of the sample. The residue should be sorted/searched systematically (*e.g.* left to right, in concentric rings) with the aid of forceps or pipettes to extract the fauna. Fine fractions (*e.g.* <2mm) should be sorted with the aid of magnification (*e.g.* illuminated magnifier or using a stereo microscope).

It is best practice for <u>all</u> biological material retained by the sieve that would have been alive at the time of sample collection to be extracted from the sample. This is contrary to the practice of many laboratories, where certain taxa are ignored. The reasons for ignoring taxa usually stem from the idea that only 'infauna' are to be recorded. It is not possible to define 'infauna'. In a mixed substratum sample there will be taxa that live within sediment, some that live on the surface, some that nestle amongst stones, some attached to stones (fixed or motile), some clinging to epibiota and others that move between microhabitats. It makes no sense to ignore any taxon; they are all part of the same community. Similarly, taxa are sometimes ignored because they are considered meiofaunal. The meiofauna/macrofauna distinction is based on size of animals and, during the extraction phase, should be made by the sieve used, not based on taxonomic groups. Proper washing should pass most meiofaunal taxa through the sieve. (Any residual meiofauna should be recorded at the identification stage and, if required, can be removed at a subsequent data truncation stage). Plants and non-countable animals should also be extracted. If any taxon is ignored (not recommended) then this should be clearly stated in all documentation that refers to the sample.

It may be time-consuming to extract everything from samples with large amounts of material, so subsampling and in-situ counts are acceptable, in certain prescribed circumstances. A separate procedural guideline is provided for subsampling.

Sample sorting (extraction)
For each sample, the individual who carried out the sample sorting should record their name on the SPF.
The laboratory SOP must detail quality assurance methods for sorting.
All in-house QC procedures must be documented and the form of documentation approved by the PCM.
All biological material that would have been alive at the time of sample collection should be extracted from the sample, as should all items for which there is doubt as to whether it was alive at the time of sample collection. "If in doubt – pick it out!"
Abundant and easily identifiable taxa are best counted during extraction.
Taxa may be identified more efficiently if first separated into major taxonomic groups.

It will be necessary to break tubes, bored shells and soft rock to extract cryptic fauna.
All biological material must be preserved in industrial denatured alcohol (IDA) (>70%). Glycerol (10%) can be added to the preservative mix to prevent desiccation.
Note should be made of the fixation state of the extracted biota, if inadequate, and passed on to the PCM.
Residues from which all biological material has been removed must be re-preserved and retained until completion of all QC procedures.
Exceptions to the requirements of the above are listed below; **they must be agreed with the PCM** and details documented: • Taxa occurring in very high numbers may be sub-sampled or counted *in situ* (see below), • large volumes of 'float' may be sub-sampled, • residues of fibrous or entangled material (*e.g.* algae, fibrous tubes) containing large numbers of very small organisms may be re-sieved after loosening of the material, • large volumes of coarse substrata may be sub-sampled (see below), • sessile organisms considered to have been small enough to pass through the specified mesh had they been loose may be ignored, • small portions of large or very abundant organisms may be ignored if it is certain that they will have no significant impact on biomass measures, (*e.g.* small fragments of brittle-star legs, or detached tentacles from cirratulid worms), • certain sessile calcareous organisms, such as coralline algae, encrusting bryozoa or barnacles, may be preserved in a dried state, • organisms that clearly represent contamination (*e.g.* insects in offshore samples) may be ignored but should be expressly agreed with the PCM.

A.12 Macrofaunal identification

The requirement for a Taxonomic Discrimination Protocol (TDP) has been born out of varying levels of identification noted between laboratories within the NMBAQC Scheme. This PRP states that the standard requirement for identifying taxa (including 'epibiota') should be to the most accurate taxonomic level practicable, usually species. The aim of the TDP is to standardise identification levels, taxon by taxon. The use of stains or clearing agents is useful for the identification of some taxon groups. This PRP does not include methods for clearing, these can be found in specialist literature. However, where clearing is considered necessary, to improve taxonomic resolution it is recommended that worms are first separated into groups based on gross features before selecting the largest specimens for clearing. Where large abundances of mixed taxa are present that cannot be distinguished without clearing then it is acceptable to mount only a subsample of the specimens (*e.g.* 10% or 100 specimens, whichever greater).

The use of stains and clearing agent is recommended as follows:

- Methyl green stain may be used to aid resolution of certain features, particularly in capitellid, maldanid, or ampharetid polychaetes. It should be used sparingly and cleared before specimens are returned to storage.
- Oligochaetes may be cleared using Poly-vinyl lactophenol to allow a better view of chaetae and reproductive anatomy. The process is time-consuming and permanently alters specimens, such that they must be maintained on slides.

Macrofaunal identification
For each sample, all individuals involved in identification of the biota should record their names on the SPF and details should be included on the sample data sheets.
The laboratory SOP must include details of quality assurance for identification.
All procedures must be documented and the form of documentation approved by the PCM.
All organisms removed from each sample must be identified to the most accurate taxonomic level practicable (follow TDP), usually species. Identifications should be recorded in pencil on the SDF. Any subsequent changes should be initialled and dated.
Biota must be identified using appropriate keys and taxonomic literature and using current nomenclature (see following section for details).
The identifier should divide the identified material into separate vials per recorded taxon, including a reference collection (see below).
If biomass is required at the recorded taxonomic level, all non-countable portions of animals must be identified and added to separate taxon containers as far as is practicable. Where fragments cannot be identified, then they can be apportioned according to the head count.
If a stain such as methyl green is added to aid recognition of features it should be cleared for the long term storage of specimens. Any animals cleared with polyvinyl lactophenol should be retained on clearly labelled slides.
A note should be added to the alcohol preserved specimen vials detailing the number removed and mounted on slides.
The analysing laboratory is responsible for sourcing and obtaining the literature required for identification at the level specified in the TDP (for a summary overview see Appendix 3). They may use the NMBAQC standard identification literature list to source references but should not regard it as comprehensive. They should submit additional literature citations to the list as they find them; in this way, all laboratories will be informed of new literature as soon as possible.
The NMBAQC Scheme will provide unpublished workshop guides as they become available.
The analysing laboratory must follow a specified and transparent in-house quality control procedure for identifications. External QC is detailed elsewhere.

A.13 Taxonomic literature and nomenclature

The NMBAQC Scheme has three methods of relaying literature to participating laboratories:

- Through the development of the NMBAQC Taxonomic Literature Database (v107) listing published literature which can be searched taxonomically.
- Through the organisation of taxonomic workshops which may highlight recent new literature or produce new draft keys for particular taxonomic groups.
- Through notes added to the Ring Test bulletins.

The Scheme resources should not be considered definitive in terms of required literature.

Taxonomic literature and nomenclature
Each laboratory should take responsibility for developing its own resources and should maintain an inventory of their literature collection.
Labs should undertake literature searches on relevant taxonomic groups on a regular basis (*e.g.* annually - using internet sites such as British Library Direct: http://direct.bl.uk/bld/Home.do).

Older literature should not be ignored as it may provide valuable keys or illustrations. Many older taxonomic works are now available on the internet (*e.g.* via the Biodiversity Heritage Library – www.biodiversitylibrary.org)
Information on useful taxonomic works should be shared. Constant feedback between laboratories within the Scheme will help to improve access to taxonomic resources.
Laboratories should use and maintain checklists of marine species employing current nomenclature and correct spellings. Nomenclature must be taken from the most recent published sources. Published species directories (*e.g.* Howson & Picton, 1997, Costello *et al*. 2001), may be outdated and may contain errors. Species lists should be compliant with the World Register of Marine Species (WoRMS - see www.marinespecies.org), except where there is good evidence that WoRMS is outdated or erroneous.

A.14 Enumeration

Some taxa are easily counted, as they exist as whole, discrete individuals. Most, however, are subject to damage and fragmentation and standard counting protocols are needed. Heads are the usual unit; exceptions are discussed below and would be included in the TDP.

There remain many problems with the recording of sessile taxa. The extreme cases are that they have been ignored by some laboratories (which significantly reduces the value of data), while attempts have been made, at other labs, to quantify by biomass (which is extremely time-consuming for encrusting taxa). Records of non-countable taxa as 'present' can currently be taken as standard but it may be possible to develop a more quantitative method in the future. Details of which taxa are to be considered to exist as discrete individuals or as encrusting or erect colonies will be provided in the TDP. Empty shells or tests or cast skins of crustaceans should not be counted although it may be useful to note the occurrence of unusual or abundant taxa. **Some shells (*e.g. Turritella*) may need to be carefully searched for preserved soft parts.**

Enumeration
Enumeration would normally be carried out during identification, by the identifier.
All taxa that occur as discrete individuals must be counted by heads, or by hinge lines for bivalves, or mouths for echinoderms / Anthozoa.
Fauna should be removed from tubes. Where fauna is tightly bound in tubes and removal would cause excessive damage or time loss (*e.g.* for *Phoronis* or *Galathowenia*) then the empty tube portions should be "topped and tailed" to confirm that a head/anterior portion is present.
Taxa that occur as discrete individuals but for which only non-countable portions are present in a sample should be recorded as 'Fragments' (fr.) (*e.g.* if a single *Chaetopterus* tail occurs but with no head region then the presence of the taxon should be recorded).
Non-countable taxa (e.g. sessile taxa, encrusting taxa, plants) must be recorded (at least as 'present') for each sample in which they were found.
Counts from sub-samples must be detailed on the SDF but calculated as values for whole samples prior to data entry. All identifications and enumerations and calculations must be recorded in full in pencil on the SDF. If tally marks are used the final count should be shown in brackets. Any subsequent data changes or alterations should be initialled and dated.

A.15 Sample storage

The processed sample will comprise three parts – Residues, Extracted fauna and Reference collection. The residues from which all biological material has been removed and the extracted fauna must be retained until all QC procedures are complete. If external QC is required, they will need to be transported to the auditing laboratory.

Analysing laboratories must establish and maintain a reference collection which at least combines representative specimens of all taxa they have recorded from various surveys. In addition reference collections may be specified for all individual surveys (*i.e.* one collection per survey). In some instances duplicate collections may be required per survey with one collection retained by the analytical laboratory and one provided for the survey commissioner.

PCM storage responsibilities
The PCM must specify what should happen to residues, extracted fauna and reference specimens and coordinate any transfer of material between laboratories.
Residues The PCM must provide clear instructions as to whether or when residues may be discarded or returned.
Extracted fauna The extracted fauna must be retained until completion of QC and, should be archived for a number of years thereafter to allow ad hoc taxonomic reviews. The PCM should specify whether the extracted fauna should be retained by the analysing laboratory, returned, or sent elsewhere for archiving. If due for disposal, samples and specimens should be offered to other agencies/organisations with an interest in marine biodiversity (*e.g.* universities or museums). They should also specify any requirements regarding container types or subdivision of fauna (*i.e.* whether stored by recorded taxa, major taxonomic groups or as a single pot per sample).
Reference collections The PCM should specify whether any additional collection should be returned or sent elsewhere.

LPM Storage responsibilities
The LPM must ensure all residues, extracted fauna, or reference specimens are stored properly at the analysing laboratory any subsequent disposal, transfer, or archiving is as agreed with the PCM.
All stored material must include internal labels clearly written or printed with an alcohol-resistant ink and with enough information to identify the sample and its treatment.
The analysing laboratory must store residues from which all biological material has been removed in clearly labelled, watertight containers until completion of QC.
Sediment containing animals counted *in situ* or sub-samples with non-extracted animals must be retained in 70% IDA or formaldehyde solution.
All residue containers to be retained should have external labels detailing the nature and concentration of the preservatives contained, as well as sample/sub-sampling details.
The sample/sub-sampling detail should also be on the internal labels.
Subsample residues must be stored in a separate container to the main sample.
The analysing laboratory must retain all extracted fauna until completion of QC.
Samples should be stored in watertight containers, clearly labelled with sample and survey details and separated by recorded taxon; sub-sampled material should be stored separately.

With the exception of certain encrusting organisms, which may be dried (see above), fauna must be stored in 70% IDA.
An example of each of the taxa recorded by the analysing laboratory must be retained in a separate container, as a reference collection and retained indefinitely. Separate reference collections may be established for each survey.
A record must be kept (*e.g.* on the SDF) of which specimens have been removed from the sample for reference.
Each reference container should include all of the specimens and identifiable portions of that taxon from its sample.
Each reference container must be clearly labelled with the species name, sampling location, sampling date, initials of the identifier and a second confirming analyst, as well as a sample code to link to any information not on the label.
A reasonable effort should be made to ensure that those specimens selected for reference are among the most suitable for that purpose (in terms of condition, size range and numbers of individuals in the reference pot).
Multiple reference lots should be made for rare or taxonomically difficult taxa. Reference lots must be clearly labelled and preserved as for the extracted fauna.
Reference collections must be maintained indefinitely by the analysing laboratory. Laboratories should arrange for reference material to be validated externally by other analysts or recognised experts where possible.
Inventories of all reference collection material held should be maintained.

A.16 Data management

It is important that all data associated with a project are stored at a location from which they can be retrieved at any time and are accessible to appropriate personnel. The information should be passed on in full to any successor.

Data management
The PCM or LPM should ensure that they are always in a position to access the original data in their original form, along with all sample details and associated data.
The commissioning organisation is responsible for ensuring that all data are accessible and that none are lost. Information should be available in full to any successor (or temporary replacement).
All information documented during processing must be written by hand on a series of laboratory forms and retained for later inspection, if necessary.
The nature of the forms would follow the analysing laboratory's SOP but should include, as a minimum: • Sample Progress Forms (SPF) with analysis details and QC. • Sample Data Forms (SDF) with taxa, counts, biomass figures and reference collection selections.
The information from the forms should be transcribed electronically and supplied to the PCM (in spreadsheet or database format), on completion of the project.
The name of the person entering data into an electronic form for each sample should be recorded in the SPF.
The laboratory SOP must specify how quality control is ensured during data entry.
All in-house QC procedures must be documented and approved by the PCM.
There must always be an accessible resource in which the original data are retained in their original form. Later data truncation or data analysis methods will depend upon the objectives of the project and are beyond the scope of this guideline.

A.17 Data products

The basic product of macrobenthic sample analysis is a matrix of taxa recorded and enumerated in each sample. It is best stored in a database and presented in a spreadsheet format (*e.g.* Microsoft Excel). **There should always be an accessible resource in which the original data are retained in their original form.**

Data products
The sample codes must link clearly with sample information obtained from the survey: • name of organisation that owns data, • name of PCM, • organisation, individuals and vessel involved in sampling (as appropriate), • station and sample code, • visual description of sample, • sampling position (with coordinate type and projection specified), • sampling depth (corrected to chart datum), • sampling date and time, • sampling equipment (including surface area sampled), • details of all treatment of the sample post-collection (*e.g.* field sieving, with mesh, any material removed before preservation, preservative and any other additives used), • details of all other samples or data collected at the same sites or during the same survey (*e.g.* PSA, chemistry, photography, sonar, bathymetry).
They should also link clearly with processing details: • names of individuals involved in the different stages of processing the samples (including LCM), • details of any sub-sampling carried out, • details of specimens removed for reference collections, • location of sample components.
The data guideline and templates for "sediment sampling by grab or core for benthos" provided by the Marine Environmental Data and Information Network (MEDIN, 2009) should be followed as far as is possible.

A.18 Quality assurance and quality control

Quality Assurance (QA) is the adoption of practices and procedures aimed at ensuring the products from a laboratory consistently achieve acceptable standards. Quality Control (QC) is the systematic testing of products or samples to determine whether the quality targets are being achieved. QA involves training records and competency assessment, documenting and validating procedures, sample tracking and traceability, calibrating equipment, provision of reference material (voucher collections) and taxonomic literature and implementing a quality management system. QC involves setting appropriate analytical targets for testing via the re-analysis of a randomly selected proportion of samples. **Where samples fail to meet required quality the cause of the failure should be investigated and a suite of remedial actions should be implemented to improve the quality and prevent or minimise re-occurrence of errors.**

Internal QA/QC
Each stage of the laboratory analysis process should be subject to internal Quality Control (QC).
The analysing laboratory must produce or adopt Standard Operating Procedure(s) (SOP) that are fit for purpose and should demonstrate that these have been validated through production of acceptable data.
The analysing laboratory must ensure that all staff adhere to methods described in its SOP and all records relating to the SOP are available for inspection.
The competency (education, training, work experience and/or other demonstrated skills) of staff involved in analysis should be checked and recorded within the laboratory. For less experienced staff undergoing training, appropriate supervision of work should be provided until the required competency in the method is achieved. Competency should be improved / maintained through participation in internal or external training exercise or workshops in all relevant aspects of laboratory analysis.
A voucher/reference collection must be compiled containing examples of all taxa encountered. The samples must be fully labelled stating at least the taxon name, sampling location, and the identifier. Ideally determinations should be confirmed by a second analyst.
The laboratory must maintain a comprehensive and regularly updated library of taxonomic literature.
There must be an internal system of double checking (quality control) for at least 10% of samples for extraction, identification and enumeration.
There should be an internal system of double checking (quality control) for a proportion (*e.g.* 10%) of electronic records (in spreadsheets or databases) of biological data against original handwritten datasheets.
Appropriate quality criteria must be detailed in the SOP indicating acceptable targets for sorting, enumeration, identification, and biomass (if required) and relevant remedial actions where targets are not achieved.
The analysing laboratory should maintain an appropriate quality management system to document its audit trail of checked laboratory samples and spreadsheets/databases. This should include details the re-checked samples, comments on the differences from the original sample and details of any remedial action taken.
All samples (biota and residues) associated with samples which are subject to external QC must be retained until samples are deemed to have passed (or remedial action of failed samples has be completed satisfactorily).
All laboratory equipment should be maintained and calibrated, with remedial action in place to ensure normal functioning. This internal auditing system should also be documented.

External QA/QC
External Quality Assurance (QA) is mandatory for laboratories involved in the analysis of samples collected by Competent Monitoring Agencies for statutory monitoring programmes (*e.g.* WFD and CSEMP) or for projects funded by Government Departments or Agencies.
The analysing laboratory must demonstrate its participation in an external quality assurance scheme *e.g.* the National Marine Biological Analytical Quality Control (NMBAQC) scheme or equivalent. Minimum participation must involve exercises where a random selection of the participant's own samples is audited. The laboratory must achieve the scheme's quality standards and complete any required remedial actions.

All reports and Statement of Performance certificates provided by the external QA scheme must be available for inspection.
The analysing laboratory should participate in training exercises and workshops arranged by the QA scheme (*e.g.* the NMBAQC or equivalent) or other institutions to demonstrate staff member's knowledge of current analytical or taxonomic issues.
The analysing laboratory should seek laboratory certification or accreditation of their operations against recognised national / international guidelines such as Good Laboratory Practice (GLP), International Organisation of Standardisation (ISO), or United Kingdom Accreditation Service (UKAS).

PROCEDURAL GUIDELINE B: Biomass of macrobenthic samples

Biomass data are required for CSEMP macrobenthic samples but is not a requirement for WFD macrobenthic samples. Biomass from samples is also measured for other reasons such as estimating available food resources for populations of fish or birds. Sometimes, biomass may be considered an important attribute of the benthos itself. Biomass data could also potentially be used to measure changes in reproductive cycles or average size of particular taxa.

Advantages

- provides a measure of biological material that may be more relevant than numbers of organisms, which will be of varying sizes.

Disadvantages

- additional time and cost per sample,
- some damage to material, making quality control of data difficult,
- difficult to apply biomass to taxon groups that are permanently mounted on slides (*e.g.* oligochaetes).

Biomass measures must always be considered subject to considerable error, unless ash free dry weight is used. Ash free biomass destroys the specimens and any possibility of QC, therefore it should be considered only where there is a very specific need for highly accurate biomass measures.

The methods presented here allow for a basic wet weight biomass estimate. Biomass estimates will always be subject to variability due to differing effectiveness of drying methods. There is currently no precise methodology that will provide consistent results for blotting fauna of differing sizes, shapes, or physical consistency ranging from hard shelled molluscs to soft fragile worms. There is little point in adding highly time-consuming methods to standardise preservation time or rinsing, prior to wet biomass measures.

The choice of ‘species’ versus ‘family’ or ‘phylum’ level biomass will be specified by the monitoring programme. It is important to remember, however, that not every taxon can be recorded to species level and that small phyla may be combined and larger ones may be divided. Reference should instead be made to biomass at levels of ‘recorded taxon or ‘major taxonomic group’. Subdivision between taxonomic groups and taxa excluded from biomass currently vary between laboratories. Standard groups are provided here, more detail will be given in the TDP. Treatment of tubes and shells also currently varies between laboratories, so a standard is provided.

Conversion factors exist for transforming wet weight biomass to ash-free dry weight biomass (see Ricciardi & Bourget, 1998). They are not part of the laboratory procedure. However, conversion values are available only for a limited selection of species and those for major groups must be inaccurate due to the range of animals involved (especially for ‘others’ and molluscs). At some time, a revised list of factors should be produced.

Where biomass is to be carried out at the ‘species’ level, it must, in practice be conducted separately for the majority of taxa recorded during sample processing. **There will always be some taxa recorded at higher taxonomic levels.** In addition, many taxa are commonly

excluded from biomass. A standard list of taxa to exclude should be followed. This will be found in the TDP (for a summary overview see Appendix 3).

B.1 Logistics

Biomass is typically conducted at the laboratory that carried out basic sample analysis. These guidelines are for the analysing laboratory;

B.2 Equipment

The sample analyst must have access to a laboratory equipped with a recently calibrated, annually serviced balance, accurate to 0.0001 g. They will need trays and dishes for sorting, forceps and a range of watertight containers of different sizes for containment of samples. Supplies of preservatives (IDA) must be available.

B.3 Biomass by major taxonomic group

Biomass by major taxonomic group

Where biomass is required by phylum, it will, in practice be conducted by major taxonomic groups, with some large phyla divided, certain small phyla combined and others excluded from biomass. Traditionally biomass estimates are focussed on infaunal communities. (Epifaunal communities are assessed by percentage coverage estimates). The distinction between infaunal and epifaunal (or between solitary and colonial) taxa is not always clear cut. Nevertheless, a convention for dividing major infaunal groups for biomass assessment is presented, below:

- Cnidaria (infaunal forms only: Pennatulacea, Ceriantharia, some Actiniaria)
- Polychaeta
- Oligochaeta
- Crustacea (excluding Cirripedia (barnacles) and sessile parasites)
- Mollusca
- Echinodermata
- Other minor phyla (*e.g.* Nemertea, Platyhelminthes, Priapulida, Sipunculida, Phoronida, Chelicerata, Insecta, Hemichordata, Chordata)

Sessile taxa physically attached to the substratum are not weighed. A full list of taxa considered sessile and to be excluded from biomass is included in the TDP but a condensed list is included below.

- Protozoa
- Porifera
- Cnidaria (sessile colonial forms: Hydrozoa, Zoantharia, Alcyonaria)
- Entoprocta
- Cirripedia
- Sessile parasites
- Bryozoa
- Ascidiacea
- Plants and algae,
- Deposited eggs of invertebrates or vertebrates

B.4 Blotted wet weight biomass

Blotted wet weight biomass is very susceptible to recorder variability. Different operators apply varying degrees of pressure when blotting, rolling or puncturing specimens and wait for different periods of evaporation before recording the biomass. While a standard wait time can be adopted, it is difficult to standardise manipulation of specimens during blotting. Large numbers of animals weighed en masse produce different results from single animals weighed individually due to differing relative surface areas exposed.

There may also be differences caused by different chemical (preservative) treatments of samples and the time each sample was left in each substance. Though the findings of different biomass studies have varied a recent investigation by Wetzel, Leuchs, and Koop (2005) suggests that there is no difference between ethanol and formalin preservatives and that biomass loss of preserved specimens is minimal after a storage period of three weeks.

Blotted wet weight biomass
The name of the person weighing each sample should be recorded, along with a unique code for the analytical balance used.
Fragments of organisms must be extracted from the residue, as well as countable parts, as they will constitute a significant proportion of the biomass.
Fauna extracted from the samples must be sorted into individual taxa or the taxonomic groups required for biomass. Faunal fragments should be assigned to respective counted taxa as far as is possible.
Fauna from each biomass group should be removed from IDA with forceps (or sieved out, if necessary).
Fauna must then be placed on absorbent paper and gently dried (blotting with tissue paper is recommended) until no free surface moisture is apparent. Larger fauna should be gently rolled over to ensure moisture is absorbed from all surfaces.
Blotted fauna should be carefully transferred to a plastic or foil boat and placed on an analytical balance (tared with respect to the weighing boat).
Fauna must then be weighed in grams to an accuracy of 4 decimal places. Fauna weighing less than 0.0001 g should be assigned a nominal mass of 0.0001 g. The weight should be recorded once stability of the reading has been reached. It is recommended that a standard wait time is used to achieve stability (*e.g.* 30 seconds) to avoid progressive water loss by evaporation.
Care must be taken to avoid damage to the specimens; particular care must be taken with reference collection material, which would be treated separately from the main part of the sample.
All animals must be weighed intact, including the shells of molluscs and tests of echinoderms. Large specimens of taxa which might retain significant fluid (*e.g.* bivalves, echinoids, ascidians) should be punctured and drained prior to weighing.
Tube dwelling taxa should be removed from their tubes prior to weighing. Where fauna is tightly bound in tubes and removal would cause excessive damage or time loss (*e.g.* for *Phoronis* or *Galathowenia*) then the specimens can be weighed *in situ*. A tubed to un-tubed conversion factor can be created for specific taxa by weighing a subsample comprising a small number of specimens before and after careful removal of the tube. This factor can them be applied to other samples with the same taxon. Where a conversion factor has been applied it should be clearly indicated on the SDF.
Attached fauna (*e.g.* parasites and commensals) should be left attached and weighed with hosts.

B.5 Storage – biomass considerations

Storage – biomass considerations
Biomassed material should be returned as soon as possible to its preservative for storage to avoid excessive drying and damage to the specimens.

B.6 Data management – biomass considerations

Biomass data management
All information documented during biomass must be written by hand on the SDF and retained for later inspection, if necessary.
The information from the form should be transcribed electronically and supplied to the PCM (in spreadsheet or database format), on completion of the project.

B.7 Data products – biomass considerations

Biomass data products
The basic product of biomass analysis is a matrix of taxa recorded and weighed in each sample. It is best stored in a database and presented as a spreadsheet format (*e.g.* Microsoft Excel).
The sample codes must link clearly with other sample information obtained from the survey. Where biomass is recorded per taxon it must be possible to match up abundances and biomasses for each taxon.

B.8 Quality assurance and quality control

Biomass QA/QC
The analysing laboratory must ensure that it adheres to internal QA methods described in its SOP and that these are available for inspection.
Each stage of the process should be subject to QA.
External QC can provide a second estimate of biomass as a measure of recorder variability.

PROCEDURAL GUIDELINE C: Sub-sampling and *in situ* counts for macrobenthic samples

C.1 Introduction

Sub-sampling would be carried out at the laboratory responsible for basic sample analysis. These guidelines are for the analysing laboratory. The purpose of sub-sampling is to reduce the time and costs required for sample processing (which it may do by over 50% per sample) by fully analysing only a proportion of the sample. **The sub-sampling process aims to produce results that are not significantly different from those that would have been achieved had the entire sample been fully analysed.** The time and cost are directly related and affected by the same factors. **It should, be remembered that, although sub-sampling reduces total sample processing time, it will not do so by a factor directly related to the subsample fraction.** The sub-sampling process itself can become quite complicated and will also take some considerable time. Moreover numerical calculations required to convert sub-sample counts from fractions of samples to achieve full sample estimates are potentially prone to errors.

C.2 Equipment

Several techniques were tested at the Humber Benthic Field Methods Workshop (Proudfoot *et al*., 2003) including; marked tray, riffle box, quarteriser, aerated column, fulsom splitter, and magnetic stirrer. **Of these, the quarteriser proved most effective with sub-sample abundance estimates within 10% of the actual full sample value.** This is the method recommended here. Use of other methods must be documented and agreed with the PCM.

The quarteriser comprises a large perspex cylinder sectioned internally for about a third of its length into four equal compartments. The sample is poured in the top and the cylinder is filled with water to about 2cm above the height of the compartment dividers before being inverted to mix the sample and then stood upright to allow the sample material to settle into the four compartments. The sub-sample is obtained by draining one of the four compartments. The quarteriser method works best with light fractions or fine sediment fractions which can be temporarily suspended in water. For heavier coarser fractions the drained material should be tipped into two or four equal sized containers to achieve a similar "depth" and hence volume (this should only be necessary for dry material e.g. Bryozoa).

C.3 When and how to sub-sample

Sub-sampling and *in situ* counts should only be considered where processing times/costs would otherwise be prohibitive, where there would be no significant loss of information through sub-sampling and where agreed by the PCM. The recommendations here apply to sub-sampling of macrobiota samples.

Fractionation of the sample residues is advised, especially with more heterogeneous samples. Residues should be separated into heavy and light (float) fractions which can be further split into different sieve fractions (see Appendix 2). The different fractions may be treated differently from a sub-sampling point of view. Sub-sampling may then be considered where one of these fractions exceeds a particular volume or where a particular taxon group is excessively abundant. In practice most or all of the non-attached fauna will be floated / washed off the larger heavy fractions so sub-sampling of the latter fractions may effectively be estimating the abundance/occurrence of attached fauna only.

It is recommended that the minimum volume of a sub-sample sediment residue (*i.e.* total heavy fraction) should be 0.5 litre and that at least 10% of the total sample sediment residue volume should be processed in full. The minimum volume of a sub-sample of the fine fraction (<4>0.5mm) of the light/float material should be 0.05 litre. Sub-sampling aims to minimise sorting time by reducing picking effort on selected abundant taxa only. Other less abundant taxa should be sorted from the whole sample to gain a proper estimate of diversity.

All of the selected abundant taxa (or taxon group) must be picked from the sub-sample and should comprise a minimum of 100 specimens (or 10% or the total sample estimate, if greater). **Hence sub-sampling should not be considered unless the estimated total count for a taxon exceeds 200, 400, or 800 for 1/2, 1/4, 1/8 sub-sampling respectively. In practice if a taxon count does not exceed 100 in the subsample then that taxon does not qualify as "abundant" and should be picked/counted in the whole sample.** Where abundant taxa in a sub-sample can confidently assigned to particular species *in-situ (e.g. Mytilus edulis* juvs. or *Hydrobia ulvae*) then counting can be undertaken *in-situ*. Where the abundant taxon group is likely to include one than one similar species (*e.g.* for Oligochaeta sp.) then all specimens must be removed for microscopical examination.

When and how to subsample
If the total sample residue volume exceeds 1 litre and estimated counts of some abundant taxa are liable to exceed 200 for the whole sample then sub-sampling can be considered. Less abundant taxa must be counted from the whole sample.
Heterogeneous samples should be separated into light/float and heavy fractions and each of these split into sieve fractions (*e.g.* >31.5mm, <31.5>4mm, <4>2mm, <2>0.5mm).
If the settled volume of the fine fraction (<4>0.5mm) of light/float material in water exceeds 0.2 litre, and estimated counts of some abundant taxa are liable to exceed 200 for the whole sample then sub-sampling can be considered. Light fine fraction sub-samples should be at least 0.05 litre (50ml) and selected abundant taxa should have a minimum of 100 specimens in the sub-sample. Coarser fractions (>4mm) of light /float material should be sorted in full.
If the settled volume of the coarse fraction (<31.5>4 mm) of heavy material exceeds 1 litre, and encrusting biota are present on the majority of stones/shells then sub-sampling can be considered. Heavy coarse fraction sub-samples should be at least 0.5 litre (500ml). Countable fauna must be sorted in full. Coarser fractions (>31.5mm) and finer fractions (<4>2mm, and <2>0.5mm) of heavy material should be sorted in full.
Coarse heavy material retained at 4 mm but passing through 31.5 mm should be: a) sorted in full, if less than 1 litre in volume; b 1/2 sub-sampled if between 1 and 2 litres, b) 1/4 sub-sampled if between 2 and 4 litres, c) 1/8 sub-sampled if over 4 litres.
The procedure to be used for sub-sampling must be agreed with the PCM. Smaller sub-samples may be used with the express agreement of the PCM. Details of sub-sampling must be summarised in the SPF and detailed in the SOP.
Details of any sub-sampling undertaken must be provided on the SDF and all calculations to achieve final whole sample count estimates must be shown on the SDF.
Subsample residues should be stored in a separate container to other parts of the sample and clearly labelled.

C.4 The 'quarteriser' method

The 'quarteriser' method
The 'quarteriser' may be used only for sub-sampling the light fraction of samples.
After extraction of taxa not requiring sub-sampling, the light fraction should be washed into the 'quarteriser' and water added to approximately half the depth of the device.
A bung should be placed into the top and the 'quarteriser' inverted several times to ensure equal division of sediment between the four compartments.
After shaking, any residue left on the bung and the sides of the "quarteriser" should be gently rinsed into the compartments.
The device should then be left to stand undisturbed for several minutes, until all sediment in the sample has settled.
One of the quarter compartments should then be emptied slowly, to prevent disturbance that might cause material to flow between compartments, and rinsed into a watertight container or 0.5 mm sieve.
The fraction may be sub-sampled again, to generate a smaller fraction.

C.5 Subsample storage

Subsample storage
All sub-sampled biota must be retained in a separate container to those collected from the sample as a whole.
The duplicate subsample residues, which contain biota that have not been extracted, should also be preserved and retained.
All subsample components must be clearly labelled.

C.6 Data management

Data management
The sample analyst must enter details of samples that have been sub-sampled, the sub-sampling method and the fraction sorted onto all forms relating to the sample.

C.7 Data analysis

Data analysis
There must always be an accessible resource in which the original data are retained in their original form.
The final data matrix output, however, may record only the calculated estimates of each taxon for the whole sample.

C.8 Quality assurance and quality control

QA/QC
The sub-sampling process should be supervised by an experienced staff member. Calculations should be checked by a second staff member. All other processes must be subject to quality control.

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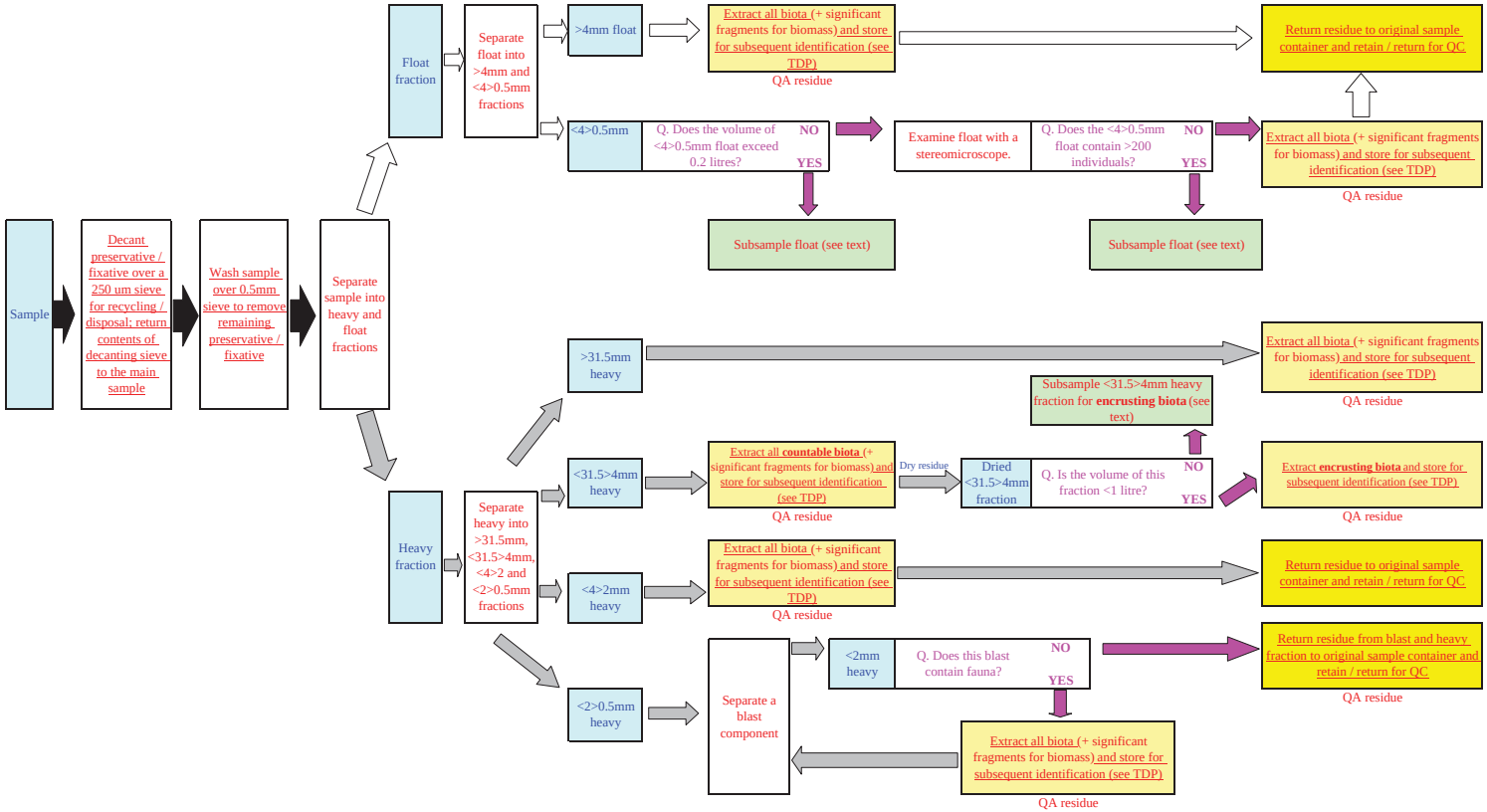
APPENDIX 1 - Macrobenthic Sample Analysis Checklist

Process	Best Practice: NMBAQC Processing Requirements
Survey Design	Not covered in this document.
Sample Collection	An adequate sample is collected using the specified equipment.
	Retain all material collected above 0.5mm (or 1mm) sieve mesh for subsequent processing.
Sample Preservation	All material preserved/fixed adequately with chemical content noted for subsequent handling/processing.
Sample Storage	Storage in air and watertight robust containers.
Sample Logging/Tracking	Unique external and internal reference labels; list all samples on the SPF (sample progress form).
Sample Transportation	Packaging, preparation and transportation to be conducted only by appropriately accredited couriers and/or trained staff.
	Complete/provide TREM card, DGN, TEI documentation and HazChem labels, where applicable.
	Package to minimise impact of damage & potential spills in transportation.
Sample Processing	Provide processing laboratory with SPF, PRP & TDP with samples.
	Any deviation from NMBAQC Guidelines (PRP and TDP) must be approved prior to laboratory sample processing.
Sieving / Faunal Extraction (See sieving and extraction flowchart for an example SOP, Appendix 2)	Conduct Sieving in a ventilated washroom and observe all H&S considerations including CoSHH.
	Decant liquid over a 250µm certified sieve for recycling/appropriate disposal. Rinse retained material over 0.5mm sieve mesh.
	Wash sample over 0.5mm certified sieve mesh (cleaned and checked for debris/defects prior to commencing each sample analysis).
	Separate sample into 0.5-1mm and >1mm fractions and extract biota; use a range of certified sieves, where applicable.
	Extract biota according to PRP and store for subsequent identification. It will be necessary to break tubes, bored shells and soft rock to extract cryptic fauna.
	Return residue to original sample container, with adequate preservative/fixative, and retain/return for QA/QC.
Identification & Enumeration	Identify and enumerate biota according to PRP/TDP and record on the SDF (sample data form).
	Create a survey reference collection including individuals of all taxa recorded. Make multiple reference lots for rare or taxonomically difficult taxa. Maintain reference collections indefinitely.
Biomass	Biomass according to PRP and record on the SDF (sample data form).
	Blotted dry biomass to 0.0001g using certified equipment.
Sample Storage (Post-analysis)	Residue - unique external and internal reference labels; biota stored as specified in PRP with unique reference labels.
	Store samples (residue & extracted biota) until all QC checks are completed.
Data Entry / Storage / Submission	Data from each SDF should be entered (separate 0.5-1mm & >1mm fractions) and stored electronically using a standard taxon list.
	Data should always be accessible in their original form, along with all sample details and associated data.
	Supply abundance and biomass data following PRP.
	Data submitted must detail any deviation from PRP and TDP.
Quality Control	Participate in all necessary AQC checks and undertake fully any prescribed remedial action.
Data Analysis	Not covered in this document.

APPENDIX 2 NMBAQC Scheme Sample Processing: Sieving and Extraction - an example SOP (processing requirements underlined).



Key

Sample = biota and residue material preserved / fixed adequately and stored in a water / air tight container with unique internal and external reference labels.
Sieve = certified mesh sieve; cleaned and checked for debris / defects prior to sample processing.
Float fraction = material poured off the sample after light agitation in water.
Heavy fraction = material remaining after removal of float material.
Blast component = material decanted from heavy fraction during high agitation with a jet of water.
Underlined text denotes that this is a processing requirement.

APPENDIX 3
Summary Overview of Taxonomic Discrimination Protocol (TDP)
Exclusive meiofaunal, freshwater & planktonic groups not shown.

		Extraction*	Preservation	Recording/Identification			Biomass (significant fragments always included)			
Major Taxonomic Group/Items	**Forms/Subgroups**			Enumeration/Presence	Criteria	Tax. level**	Weighed	Major group	Tubes/shells incl.	**Notes**
Protozoa	conspicuous only (*e.g. Lagotia, Astrorhiza*)	In part	Dry or Alcohol	Varies	Complete	Varies	☒	n/a	n/a	
Porifera		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	
	easily detachible	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	small encrusting patches	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	boring (*e.g. Cliona*)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Cnidaria		Varies	Varies	Varies	n/a	Varies	Varies	Cnidaria	☒	
Hydrozoa	erect	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Hydrozoa	stolonal or encrusting	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Octocorallia	erect (*e.g. Alcyonium*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Octocorallia	encrusting (*e.g. Sarcodictyon*)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Ceriantharia	*e.g . Cerianthus*	All	Alcohol	Counted	Mouth	Varies	☑	Cnidaria	☒	
Zoantharia	*e.g. Epizoanthus*	All	Dry or Alcohol	Counted (polyps)	Complete	Varies	☒	n/a	n/a	
Actiniaria	inc. Edwardsiidae	All	Alcohol	Counted	Mouth	Varies	☑	Cnidaria	☒	
Platyhelminthes		All	Alcohol	Counted	Head	Class	☑	Others	n/a	Freshwater taxa to genus/species
Nemertea		All	Alcohol	Counted	Head	Phylum	☑	Others	n/a	Distinctive taxa taken further
Nematoda		All	Alcohol	Counted	Head	Phylum	☑	Others	n/a	Mainly meiofaunal
Priapulida		All	Alcohol	Counted	Head	Species	☑	Others	n/a	
Entoprocta		In part	Alcohol	Presence	n/a	Genus	☒	n/a	n/a	
Chaetognatha		All	Alcohol	Counted	Head	Genus	☑	Others	n/a	Mainly planktonic; benthic sp. to spp.
Sipuncula		All	Alcohol	Counted	Trunk	Species	☑	Others	n/a	
Echiura		All	Alcohol	Counted	Trunk	Species	☑	Others	n/a	
Annelida		All	Alcohol	Counted	Head	Varies	☑	Varies	Varies	See Oligochaeta TDP
Chelicerata		All	Alcohol	Counted	Head	Varies	☑	Others	n/a	
Crustacea		Varies	Varies	Counted	Varies	Varies	Varies	Crustacea	n/a	
	free living (most)	All	Alcohol	Counted	Head	Varies	☑	Crustacea	n/a	
	attached parasites	All	Alcohol, with host	Counted	Head/Attachment	Varies	☒	n/a	n/a	Biomassed with host
	sessile (barnacles)	Varies	Dry or Alcohol	Counted	Head/Cirri	Varies	☒	n/a	n/a	
Myriapoda		All	Alcohol	Counted	Head	Class	☑	Others	n/a	
Hexapoda	*e.g.* insects	All	Alcohol	Counted	Head	Varies	Varies	Others	n/a	
Mollusca		All	Alcohol	Counted	Varies	Varies	☑	Mollusca	☑	
Brachiopoda		All	Alcohol	Counted	Lophophore	Species	☑	Others	☑	
Bryozoa		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	
	erect (*e.g. Flustra, Bugul* a)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	stolonal (*e.g. Nolella, Aetea*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	encrusting (most)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Phoronida		All	Alcohol	Counted	Head	Genus	☑	Others	☑	
Echinodermata		All	Alcohol	Counted	Mouth	Varies	☑	Echinodermata	☑	
Hemichordata		All	Alcohol	Counted	Head/collar	Class	☑	Others	n/a	
Chordata		Varies	Varies	Varies	Varies	Varies	Varies	Varies	n/a	
Tunicata	solitary	All	Alcohol	Counted	Branchial sac	Varies	☒	n/a	n/a	
Tunicata	stolonal (*e.g. Perophora*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Tunicata	detachible colonies (*e.g. Botryllus*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Tunicata	encrusting (*e.g.* Didemnidae)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Fish and Cephalochordata	-	All	Alcohol	Counted	Head	Varies	☑	Others or Fish	n/a	Biomass requirements project related
Cyanophyta		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Rhodophycota		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Chromophycota		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Chlorophycota		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Fungi		☒	n/a	☒	n/a	n/a	☒	n/a	n/a	
Tracheophycota	flowering plants	In part	Alcohol	Presence	n/a	Species	☒	n/a	n/a	Angiospermae
Animalia 'eggs'		Varies	Alcohol	Varies	Varies	Varies	☒	n/a	n/a	
Eggs	egg masses	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Eggs	discrete eggs (*e.g.* fish)	All	Alcohol	Counted	Complete	Varies	☒	n/a	n/a	
Anthropogenic material	including seeds	☒	n/a	☒	n/a	n/a	☒	n/a	n/a	

* = some may be counted *in situ* / subsampled if present in high numbers
** = minimum level required (good condition given); there may be some exceptions to be detailed in the fully expanded TDP

APPENDIX 4

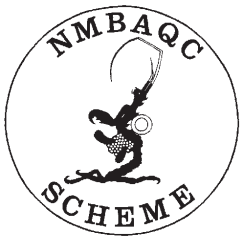
Taxonomic Discrimination Protocol (TDP) for Oligochaeta

Some meiofaunal, freshwater & planktonic groups not shown.

					Recorded/Identification			Biomass			
Class	**Family**	**Genus**	**Extraction***	**Preservation**	Enumeration/Presence	Tax. level**	Juv. separated	Weighed	Fragments incl.	Tubes/shells incl.	**Notes**
Oligochaeta			All	Alcohol	Counted	Varies	☒	☑	☑	n/a	
	Naididae		All	Alcohol	Counted	Varies	☒	☑	☑	n/a	
		Amphichaeta	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Chaetogaster	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Dero	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Nais	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Paranais	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Stylaria	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Uncinais	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Tubificidae		All	Alcohol	Counted	Varies (Family, except where stated below)	☒	☑	☑	n/a	
		Monopylephorus	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Limnodriloides	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Clitellio	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Heterochaeta	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Limnodrilus	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Tubifex	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Tubificoides	All	Alcohol	Counted	Species (except T.brownae, T.crenacoleus, T.diazi and T.pseudogaster, all as T.pseudogaster agg.)	☒	☑	☑	n/a	
		Potamothrix	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Psammoryctides	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Quistadrilus	All	Alcohol	Counted	Q. multisetosus to Species	☒	☑	☑	n/a	
		Branchiura	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Enchytraeidae		All	Alcohol	Counted	Family (except Grania spp. to genus)	☒	☑	☑	n/a	
		Grania	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
	Branchiobdellidae		All	Alcohol	Counted	Family	☒	☑	☑	n/a	
	Aeolosomatidae		All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
	Haplotaxidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Lumbriculidae		All	Alcohol	Counted	Family	☒	☑	☑	n/a	
	Dorydrilidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Glossoscolecidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Lumbricidae		All	Alcohol	Counted	Family (except Eisenella tetraedra to species)	☒	☑	☑	n/a	

* = some may be counted *in situ* / subsampled if present in high numbers

** = minimum level required; occasional specimens may be left at higher taxa if damaged, small or with unusual combinations of features



The National Marine Biological Analytical Quality Control Scheme

Macrobenthic Exercise Results – MB19

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EXERCISE DETAILS

Macrobenthos #19

Type/Contents – Natural marine sample from southern North Sea; approx. 0.5 litres of shell debris; 1 mm sieve mesh processing.

Circulated – 05/09/2011

Completion Date – 02/12/2011

Number of Participating Laboratories – 9

Number of Results Received – 7

Contents

NMBAQC Scheme Interim Results

LabCode	LB1802
SampleCode	MB19
Sample Received	16/01/2012
Notes	No biomass

Summary Data

Diff. In No. Taxa	**-6**
Diff. In No. Individuals	**-11**
Missed Taxa (in residue)	**5**
Missed Individuals (in residue)	**8**
Taxonomic Errors	**3**
Count Variance	**-3**
Biomass %diff.	-
Bray-Curtis Similarity index	**92.65**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Owenia fusiformis	129	-	Owenia fusiformis	**127**	-	Mixture (see below)
2	Sigalion mathildae	11	-	Sigalion mathildae	11	-	
3	Scoloplos armiger	6	-	Scoloplos armiger	6	-	
4	Spiophanes bombyx	56	-	Spiophanes bombyx	**60**	-	Mixture (see below)
5	Spio filicornis	4	-	Spio filicornis	4	-	
6	Scolelepis (bonnieri?)	1	-	Scolelepis bonnieri	1	-	
7	Poecilochaetus serpens	2	-	Poecilochaetus serpens	2	-	
8	Nephtys (kersivalensis?)	5	-	Nephtys sp. juv.	**4**	-	
9	Eteone longa	3	-	Eteone longa agg.	3	-	
10	Anaitides sp.	5	-	**Phyllodoce rosea**	5	-	Name change
11	Eumida sp.	1	-	Eumida bahusiensis	1	-	
12	Lagis koreni	1	-	Lagis koreni	1	-	
13	Ampharaete lindstroemi	1	-	**Ampharete lindstroemi**	1	-	Spelling error
14	Euclumene sp.	1	-	**Clymenura sp.**	1	-	Taxonomic error
15	Magelona alleni	1	-	Magelona alleni	1	-	
16	Magelona filiformis	7	-	Magelona filiformis	**1**	-	Taxonomic error (see below)
17	Glycinde nordmanni	1	-	Glycinde nordmanni	1	-	
18	Nemertea sp.	8	-	Nemertea	**6**	-	
19	Tubulanus polymorphus	3	-	Nemertea	3	-	Repeat taxon; TUM identification policy
20	Tubularia sp.	P	-	Tubularia sp.	P	-	
21	Phoronis sp.	4	-	Phoronis sp.	**3**	-	
22	Fabulina fabula	18	-	**Angulus fabula**	18	-	Name change
23	Thracia sp. juv.	2	-	Thracia sp. juv.	2	-	
24	Tellimya ferruginosa	1	-	Tellimya ferruginosa	1	-	
25	Chamellea striatula	1	-	**Chamelea striatula**	1	-	Spelling error
26	Gari fervensis	1	-	Gari fervensis	1	-	
27	Bathyporeia elegans	11	-	Bathyporeia elegans	**4**	-	Taxonomic error (see below)
28	Bathyporeia sp.	4	-	Bathyporeia sp.	4	-	
29	Siphonoecetes kroyeranus	8	-	Siphonoecetes kroyeranus	8	-	
30	Leucothoe incisa	1	-	Leucothoe incisa	1	-	
31	Megaluropus agilis	1	-	Megaluropus agilis	1	-	
32	Urothoe piseidonis	1	-	**Urothoe poseidonis**	1	-	Spelling error
33	Iphinoe trispinosa	2	-	Iphinoe trispinosa	2	-	
34	Diastylis sp. (bradyi?)	1	-	Diastylis bradyi	1	-	
35	Liocarcinus sp. juv.	1	-	Liocarcinus sp. juv.	1	-	
36	Amphiuroidea sp. juv.	1	-	Amphiuridae juv.	1	-	
37	Asteroidea sp. juv.	1	-	Asteroidea juv.	1	-	
38	Branchiostomma lanceolatus	1	-	**Branchiostoma lanceolatum**	1	-	Spelling error
39	Poly Bits	-	-	Poly Bits	-	-	Mixture (see below)
40	Emptied tubes	-	-	Emptied tubes	-	-	Mixture (see below)
Specimens from within taxon pots							
1				Spiophanes bombyx	1	-	
4				Spio filicornis	1	-	
16				**Magelona johnstoni**	5	-	Additional taxon
27				**Bathyporeia guilliamsoniana**	7	-	Additional taxon
39				Owenia fusiformis	2	-	
39				Phoronis sp.	1	-	
40				Spiophanes bombyx	1	-	
Specimens not picked from residue							
				Owenia fusiformis	1	-	
				Nematoda	1	-	New taxon
				Siphonoecetes kroyeranus	1	-	
				Perioculodes longimanus	1	-	New taxon
				Acidostoma sp.	2	-	New taxon
				Kurtiella bidentata	1	-	New taxon
				Thracia sp. juv.	1	-	
				Lovenella clausa	P	-	New taxon
		306	0		317	0	

NMBAQC Scheme Interim Results

LabCode	LB1804
SampleCode	MB19
Sample Received	05/12/2011
Notes	

Summary Data

Diff. In No. Taxa	**-4**
Diff. In No. Individuals	**-8**
Missed Taxa (in residue)	**0**
Missed Individuals (in residue)	**2**
Taxonomic Errors	**9**
Count Variance	**-6**
Biomass %diff.	**4.27**
Bray-Curtis Similarity index	**89.59**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	NEPHTYS HOMBERGII	1	1.4943	Nephtys hombergii	1	1.3622	
2	PHYLLODOCE indet	4	0.0039	Phyllodoce rosea	4	0.0022	Taxonomic error (see below)
3	NEPHTYS juv	3	0.0033	Nephtys sp. juv.	3	0.0022	
4	SPIOPHANES BOMBYX	88	0.0498	Spiophanes bombyx	**81**	0.0334	Mixture (see below)
5	OWENIA FUSIFORMIS	59	0.1935	Owenia fusiformis	**53**	0.1689	
6	PECTINARIA KORENI	4	0.0288	**Lagis koreni**	4	0.027	Name change
7	MAGELONA MIRABILIS	14	0.0455	**Magelona johnstoni**	14	0.0342	Taxonomic error
8	POLYCHAETA BITS	P	0.0869	Polychaeta frags	P	0.0902	Mixture (see below)
9	SCOLOPLOS ARMIGER	4	0.0104	Scoloplos armiger	4	0.0073	
10	POECILOCHAETUS SERPENS	1	0.0002	Poecilochaetus serpens	1	0.0002	
11	CRUSTACEAN BITS	P	0.0055	Crustacean frags.	P	0.0037	
12	CHAETOZONE CHRISTIEI	2	0.0017	Chaetozone christiei	2	0.001	
13	SPIO FILICORNIS	2	0.0006	Spio filicornis	2	0.0005	
14	SCOLELEPIS SQUAMATA	1	0.0021	**Scolelepis bonnieri**	1	0.0011	Taxonomic error
15	PHORONIS MUELLERI	3	0.0014	Phoronis sp.	3	0.0012	
16	AMPHIURA Juv	2	0.0059	**Amphipholis squamata**	2	0.0049	Taxonomic error
17	OPHIURIDAE arms	P	0.0017	**Amphiuridae frags**	P	0.0013	(taxonomic error)
18	DECAPODA JUV	4	0.0089	Liocarcinus sp. juv.	4	0.0064	
19	ABRA PRISMATICA	1	0.0063	Abra prismatica	1	0.0058	
20	THRACIA PHASEOLINA	7	0.0085	Thracia sp. juv.	7	0.0082	
21	CIRCOMPHALUS CASINA	1	0.0011	**Chamelea striatula juv.**	1	0.0011	Taxonomic error
22	SPISULA JUV	2	0.0015	Spisula sp. juv	2	0.0011	
23	POLINICES PULCHELLUS	1	0.0388	**Euspira pulchella**	1	0.0388	Name change
24	FABULINA FABULA	25	0.101	**Angulus fabula**	**24**	0.0922	Taxonomic error (see below); name change
25	EPITONIUM CLATHRUS	1	0.7735	Epitonium clathrus	1	0.8085	
26	TELLIMYA FERRUGINOSA	1	0.0069	Tellimya ferruginosa	1	0.0075	
27	DIASTYLIS BRADYI	1	0.0033	Diastylis bradyi	1	0.0024	
28	CRANGON CRANGON	1	0.0072	Crangon crangon	1	0.0044	
29	UROTHOE POSEIDONIS	1	0.0024	Urothoe poseidonis	1	0.002	
30	BATHYPOREIA	2	0.0007	Bathyporeia sp.	2	0.0007	
31	LEUCOTHOE INCISA	2	0.0027	Leucothoe incisa	2	0.0025	
32	BATHYPOREIA GUILLIAMSONIAN	5	0.0035	Bathyporeia guilliamsoniana	**4**	0.003	Taxonomic error (see below)
33	GAMMARIDAE INDET	1	0.0002	**Bathyporeia sp.**	1	0.0002	Taxonomic error
34	MELITA OBTUSATA	3	0.0025	**Abludomelita obtusata**	3	0.0027	Name change
35	SIPHONOECETES Spp	1	0.0001	Siphonoecetes kroyeranus	1	0.0001	
36	AMPHIPOD BITS	P	0.0042	Amphipoda frags.	P	0.004	
37	ECHINOCARDIUM CORDATUM	1	4.418	Echinocardium cordatum	1	4.4104	
38	SIGALION MATHILDAE	7	0.1168	Sigalion mathildae	7	0.1215	
39	ACTINIARIA Spp	2	2.775	Actiniaria	2	2.519	
40	TUBULARIA BELLIS	P	(0.004)	Tubularia sp.	P	-	
41	LOVENELLA CLAUSA	P	(0.0003)	Lovenella clausa	P	-	
42	LANICE CONCHILEGA	1	0.0044	Lanice conchilega	1	0.0032	
43	MAGELONA ALLENI	2	0.0055	Magelona alleni	2	0.0043	
44	MURICIDAE JUV	1	0.0009	**Bela brachystoma**	1	0.0009	Taxonomic error
45	EBALIA CRANCHII	1	0.0017	Ebalia sp. juv.	1	0.0014	
Specimens from within taxon pots							
2				**Eumida sanguinea**	2	-	Additional taxon
2				**Eteone longa agg.**	1	-	Additional taxon
4				Spio filicornis	1	-	
8				Spiophanes bombyx	9	-	
8				Eumida sanguinea	1	-	
8				Owenia fusiformis	2	-	
8				**Nemertea**	3	-	Additional taxon
24				Tellimya ferruginosa	1	-	
32				**Bathyporeia elegans**	1	-	Additional taxon
Specimens not picked from residue							
				Angulus fabula	1	-	
				Owenia fusiformis	1	-	
		263	10.2311		271	9.7938	

NMBAQC Scheme Interim Results

LabCode	LB1806
SampleCode	MB19
Sample Received	25/11/2011
Notes	No biomass

Summary Data

Diff. In No. Taxa	**0**
Diff. In No. Individuals	**0**
Missed Taxa (in residue)	**1**
Missed Individuals (in residue)	**1**
Taxonomic Errors	**1**
Count Variance	**1**
Biomass %diff.	-
Bray-Curtis Similarity index	**99.06**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Melita hergensis	1	-	**Abludomelita obtusata**	1	-	Taxonomic error
2	Siphonocetes sp.	9	-	**Siphonoecetes kroyeranus**	9	-	Spelling error
3	Portunidae sp juv	3	-	Liocarcinus sp. juv.	3	-	
4	Fabulina fabula	17	-	**Angulus fabula**	17	-	Name change
5	Thracia sp juv	2	-	Thracia sp. juv.	2	-	
6	Thracia phaseolina	2	-	Thracia sp. juv.	2	-	Combine with taxon 5 for stats.
7	Euspira pulchella	3	-	Euspira pulchella	3	-	
8	Spisula sp juv	2	-	Spisula sp. juv.	2	-	
9	Solenacea sp indet	2	-	Solenidae	2	-	
10	Bivalve sp indet	1	-	Lutraria sp. juv?	1	-	Not Abra
11	Spiophanes bombyx	85	-	Spiophanes bombyx	**84**	-	
12	Owenia fusiformis	77	-	Owenia fusiformis	77	-	
13	Lagis koreni	9	-	Lagis koreni	9	-	
14	Maldanidae sp juv	2	-	Clymenura sp.	2	-	
15	Phoronis sp	6	-	Phoronis sp.	6	-	
16	Magelona johnstoni	9	-	Magelona johnstoni	9	-	
17	Nematoda	1	-	Nematoda	1	-	
18	Scoloplos armiger	5	-	Scoloplos armiger	5	-	
19	Asteroidea sp juv	1	-	Asteroidea juv.	1	-	
20	Tubulanus polymorphus	4	-	Nemertea	4	-	TUM id. policy
21	Nephtys sp juv	2	-	Nephtys sp. juv	2	-	
22	Poecilochaetus serpens	1	-	Poecilochaetus serpens	1	-	
23	Sigalion mathildae	6	-	Sigalion mathildae	6	-	
24	n/a	-	-	n/a	-	-	
25	Glycinde nordmanni	1	-	Glycinde nordmanni	1	-	
26	Phyllodoce sp indet	4	-	Phyllodoce rosea	4	-	
27	Spisula subtruncata	1	-	Spisula subtruncata	1	-	
28	n/a	-	-	n/a	-	-	
29	Lanice conchilega	4	-	Lanice conchilega	4	-	
30	n/a	-	-	n/a	-	-	
31	Fragments	-	-	Fragments	-	-	
32	Hydrozoa sp	P	-	Tubularia sp.	P	-	Mixture (see below)
33	Mesacmaea mitchelli	2	-	Actiniaria	2	-	TUM id. policy
34	Anthozoa sp	1	-	Actiniaria	1	-	
35	Gari sp juv	2	-	Gari sp. juv	2	-	
Specimens from within taxon pots							
32				**Lovenella clausa**	P	-	Additional taxon
Specimens not picked from residue							
				Kurtiella bidentata	1	-	New taxon
				(Polychaete frags.)	(P)	-	
		265	0		265	0	

NMBAQC Scheme Interim Results

LabCode	LB1807
SampleCode	MB19
Sample Received	02/12/2011
Notes	No electronic data supplied

Summary Data

Diff. In No. Taxa	**-1**
Diff. In No. Individuals	**-7**
Missed Taxa (in residue)	**1**
Missed Individuals (in residue)	**3**
Taxonomic Errors	**0**
Count Variance	**-4**
Biomass %diff.	**-0.86**
Bray-Curtis Similarity index	**98.24**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Nephtys juv.	3	0.0036	Nephtys sp. juv.	3	0.0045	
2	Nephtys assimilis	1	0.0268	Nephtys assimilis	1	0.0267	
3	Scoloplos armiger	8	0.0193	Scoloplos armiger	8	0.0176	
4	Scololepis bonnieri	2	0.0088	**Scolelepis bonnieri**	2	0.0067	Spelling error
5	Spiophanes bombyx	73	0.0935	Spiophanes bombyx	**80**	0.0945	
6	Lagis koreni	7	0.0574	Lagis koreni	7	0.0408	
7	Euspira pulchella	1	0.0366	Euspira pulchella	1	0.036	
8	Phyllodoce rosea	4	0.0028	Phyllodoce rosea	4	0.0028	
9	Eteone longa agg.	2	0.0007	Eteone longa agg.	2	0.0008	
10	Sigalion mathildae	4	0.1753	Sigalion mathildae	**5**	0.156	
11	Magelona johnstoni	21	0.0617	Magelona johnstoni	21	0.0613	
12	Magelona filiformis	1	0.0008	Magelona filiformis	1	0.0008	
13	Magelona alleni	2	0.0076	Magelona alleni	2	0.0084	
14	Phyllodoce maculata	1	0.0008	Phyllodoce maculata	1	0.0007	
15	Chaetozone christiei	1	0.0007	Chaetozone christiei	1	0.0007	
16	Owenia fusiformis	122	1.2943	Owenia fusiformis	122	1.3583	
17	Nemertea	13	0.0057	Nemertea	**12**	0.0044	
18	Sigalionidae juv.	1	0.0004	Sigalion mathildae	1	0.0004	
19	Thracioidea juv.	1	0.0013	Thracia sp. juv.	1	0.0013	
20	Fabulina fabula	38	0.3727	**Angulus fabula**	**36**	0.3508	Name change
21	Ensis juv.	1	0.0073	Ensis sp. juv.	1	0.0074	
22	Thraciodea dam.	2	0.0138	Thracia sp. juv.	2	0.0134	
23	Pelecypoda dam.	2	0.0052	Pelecypoda	**1**	0.0049	
24	Spisula juv.	1	0.0003	Spisula sp. juv.	1	0.0003	
25	Bathyporeia gulliamsoniana	5	0.0063	**Bathyporeia guilliamsoniana**	5	0.0039	Spelling error
26	Bathyporeia sp.	3	0.0043	Bathyporeia sp.	3	0.0042	
27	Bathypareia elegans	1	0.0006	Bathyporeia elegans	1	0.0006	
28	Leucothoe incisa	3	0.0035	Leucothoe incisa	3	0.0035	
29	Melitidae dam.	P	0.0011	Abludomelita obtusata	P	0.0012	
30	Megaluropus agilis	1	0.0001	Megaluropus agilis	1	0.0001	
31	Processa modica	1	0.0007	Processa modica	1	0.0007	
32	Actinaria	1	1.3616	**Actiniaria**	1	1.3927	Spelling error
33	Glycinde nordmanni	1	0.0103	Glycinde nordmanni	1	0.0112	
34	Poecilochaetus serpens	1	0.001	Poecilochaetus serpens	1	0.001	
35	Phoronis	3	0.0033	Phoronis sp.	3	0.0027	
36	Spio filicornis	1	0.0003	Spio filicornis	1	0.0002	
37	Lanice conchelega	1	0.0003	**Lanice conchilega**	1	0.0002	Spelling error
38	Turbonilla dam.	1	0.0006	Turbonilla acuta	1	0.0006	
39	Ophiuroidea juv.	1	0.0007	Amphipholis squamata	1	0.0007	
Specimens from within taxon pots							
-				-	-	-	
Specimens not picked from residue							
				Lovenella clausa	P	-	New taxon
				Thracia sp. juv.	1	-	
				Angulus fabula	2	-	
		336	3.5921		343	3.623	

NMBAQC Scheme Interim Results

LabCode	LB1808
SampleCode	MB19
Sample Received	26/03/2012
Notes	No biomass

Summary Data

Diff. In No. Taxa	**0**
Diff. In No. Individuals	**-3**
Missed Taxa (in residue)	**0**
Missed Individuals (in residue)	**7**
Taxonomic Errors	**2**
Count Variance	**4**
Biomass %diff.	-
Bray-Curtis Similarity index	**96.85**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Owenia fusiformis	45	-	Owenia fusiformis	**44**	-	
2	Phoronis	11	-	Phoronis sp.	**10**	-	Mixture (see below)
3	Lovenella clausa	P	-	Lovenella clausa	P	-	
4	Electra pilosa	P	-	Electra pilosa	P	-	
5	Leuckatiara octona	P	-	**Leuckartiara octona**	P	-	Spelling error
6	Lagis koreni	2	-	Lagis koreni	2	-	
7	Portunidae	2	-	Liocarcinus sp. juv.	2	-	
8	Pariambus typicus	2	-	Pariambus typicus	2	-	
9	AMPHIPODA	5	-	Amphipoda	**6**	-	
10	Ampeliscidae	1	-	Ampelisca brevicornis	1	-	
11	Bathyporeia	1	-	Bathyporeia sp.	1	-	
12	Bathyporeia guilliamsoniana	7	-	Bathyporeia guilliamsoniana	7	-	
13	Leucothoe incisa	2	-	Leucothoe incisa	2	-	
14	ACTINIARIA	2	-	Actiniaria	2	-	
15	Angulus fabula	31	-	Angulus fabula	31	-	
16	Amphiura squamata	3	-	**Amphipholis squamata**	3	-	Name change
17	Tubularia	P	-	Tubularia sp.	P	-	
18	Magelona johnstoni	25	-	Magelona johnstoni	25	-	
19	Spiophanes bombyx	82	-	Spiophanes bombyx	**78**	-	
20	Magelona alleni	1	-	Magelona alleni	1	-	
21	Mactra stultorum	1	-	Mactra stultorum	1	-	
22	Spisula subtruncata	2	-	Spisula subtruncata	2	-	
23	Thracia	2	-	Thracia sp. juv.	2	-	
24	Gari	1	-	Gari sp. juv.	1	-	
25	Euspira pulchella	1	-	Euspira pulchella	1	-	
26	Nephtys	4	-	Nephtys sp. juv.	4	-	
27	Galathowenia oculata	1	-	Galathowenia oculata	1	-	
28	Poecilochaetus serpens	1	-	Poecilochaetus serpens	1	-	
29	Clymenura	1	-	Clymenura sp.	1	-	
30	Scoloplos (Scoloplos) arminger	3	-	**Scoloplos armiger**	3	-	Spelling error
31	NEMERTEA	11	-	Nemertea	11	-	
32	Eteone longa	2	-	Eteone longa agg.	2	-	
33	Nephtys assimilis	1	-	Nephtys assimilis	1	-	
34	Chaetozone christei	1	-	**Chaetozone christiei**	1	-	Spelling error
35	Sigalion squamosus	3	-	**Sigalion mathildae**	3	-	Taxonomic error
36	Eumida sanguinea	1	-	Eumida sanguinea	1	-	
37	Phyllodoce	1	-	Phyllodoce rosea	1	-	
38	Spio filicornis	2	-	Spio filicornis	2	-	
39	Scolelepis bonnieri	1	-	Scolelepis bonnieri	1	-	
40	Scolelepis tridentata	1	-	**Scolelepis cantabra**	1	-	Taxonomic error
41	Arctica islandica	1	-	Arctica islandica juv.	1	-	
Specimens from within taxon pots							
2				Spiophanes bombyx	1	-	
Specimens not picked from residue							
				Owenia fusiformis	4	-	
				Lagis koreni	1	-	
				Clymenura sp.	1	-	
				Spiophanes bombyx	1	-	
		264	0		267	0	

NMBAQC Scheme Interim Results

LabCode	LB1810
SampleCode	MB19
Sample Received	02/11/2011
Notes	

Summary Data

Diff. In No. Taxa	**0**
Diff. In No. Individuals	**-28**
Missed Taxa (in residue)	**0**
Missed Individuals (in residue)	**8**
Taxonomic Errors	**7**
Count Variance	**-20**
Biomass %diff.	**31.47**
Bray-Curtis Similarity index	**91.53**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Sigalion mathildae	4	0.1268	Sigalion mathildae	4	0.0705	
2	Spiophanes bombyx	48	0.0618	Spiophanes bombyx	**50**	0.0338	Mixture (see below)
3	Ampharete sp.	1	0.0066	Ampharete lindstroemi	1	0.0038	
4	Eteone longa	3	0.0034	Eteone longa agg.	**2**	0.0016	
5	Eteone foliosa	1	0.0033	Eteone foliosa	1	0.0017	
6	Scoloplos armiger	9	0.0279	Scoloplos armiger	9	0.0194	
7	Chaetozone christei	2	0.0026	**Chaetozone christiei**	2	0.0013	Spelling error
8	Hydrozoa	P	-	Tubularia sp.	P	-	Mixture (see below)
9	Spio armata	3	0.003	**Spio filicornis**	3	0.0022	Taxonomic error
10	Poecilochaetus serpens	1	0.0005	Poecilochaetus serpens	1	0.0004	
11	Nephtys hombergi	1	0.0224	**Nephtys assimilis**	1	0.0174	Taxonomic error
12	Nephys sp. Juvenile	2	0.0029	Nephys sp. juv.	2	0.0017	
13	Phyllodoce cf. rosea	4	0.0038	Phyllodoce rosea	4	0.0023	
14	Eumida sp.	1	0.0001	Eumida bahusiensis	1	0.0002	
15	Unidentified sp.	P	-	Tentacles	P	-	
16	Iphinoe trispinosa	1	0.0001	Iphinoe trispinosa	1	0.0003	
17	Megaluropis agilis	1	0.0001	**Perioculodes longimanus**	1	0.0001	Taxonomic error
18	Siphonocetes kroyeranus	4	0.0025	**Siphonoecetes kroyeranus**	4	0.0016	Spelling error
19	Bathyporeia guilliamsoniana	1	0.0011	Bathyporeia guilliamsoniana	1	0.0007	
20	Bathyporeia tenuipes	2	0.0009	Bathyporeia sp.	2	0.0005	
21	Bathyporeia elegans	7	0.0102	**Bathyporeia guilliamsoniana**	7	0.0078	Taxonomic error; mixture (see below); Repeat taxon
22	Spirobranchus lamarcki	1	0.0049	Spirobranchus lamarcki	1	0.0047	
23	Laevicardium crassum	1	0.0005	Laevicardium crassum	1	0.0004	
24	Cribrilina punctata	2	-	-	-	-	Dead
25	Magelona johnstoni	57	0.4037	Magelona johnstoni	57	0.2175	
26	Magelona cf. mirabilis	3	0.0153	**Magelona johnstoni**	3	0.0071	Taxonomic error; Repeat taxon
27	Magelona alleni	1	0.0033	Magelona alleni	1	0.0019	
28	Magelona filiformis	8	0.0076	Magelona filiformis	8	0.0039	
29	Spio filicornis	1	0.0001	Spio filicornis	1	0.0001	
30	Euspira nitida	1	0.0421	**Euspira pulchella**	1	0.042	Taxonomic error
31	Chamelea striatula	1	0.0505	Chamelea striatula juv.	1	0.048	
32	Tellina fabula	11	0.1781	**Angulus fabula**	11	0.1534	Name change
33	Ensis sp.	1	0.0146	Ensis sp. juv.	1	0.0084	
34	Mollusca unidentif.	2	0.0159	Thracia sp. juv.	2	0.014	
35	Autolytus prolifer	1	0.0001	Autolytus sp.	1	0.0001	TUM id. policy
36	-	-	-	**Bathyporeia sp.**	1	-	
37	Pectinaria sp.	3	0.0035	Lagis koreni	3	0.0014	
38	Unidentified polychaeta	P	0.0004	Lanice conchilega	1	0.0001	
39	Owenia fusiformis	193	0.776	Owenia fusiformis	**204**	0.6142	Mixture (see below)
40	Liocarcinus holsatus	1	0.5179	Liocarcinus holsatus	1	0.4696	
41	Amphiura sp.	1	0.0106	Amphiura sp.	1	0.0089	
42	Leucothoe incisa	1	0.0021	Leucothoe incisa	1	0.0017	
43	Isopoda sp.	1	0.0035	Isopoda sp.	1	0.0027	
44	Amphipoda unidentified	1	0.0027	Iphimedia sp.	1	0.0022	
45	Nemertea sp.	4	0.0196	Nemertea	4	0.0091	
46	Photis longicaudata	2	0.002	**Jassa sp.**	2	0.0012	Taxonomic error
47	Anthozoa sp.	1	1.1132	Actiniaria	1	0.6942	
48	Echinocardium cordatum	2	43.1023	Echinocardium cordatum	2	29.4424	
Specimens from within taxon pots							
2				Spio filicornis	2	-	
2				Chaetozone christiei	1	-	
8				**Lovenella clausa**	P	-	Additional taxon
21				**Megaluropus agilis**	1	-	Additional taxon
39				Spiophanes bombyx	1	-	
39				Nemertea	2	-	
39				Chaetozone christiei	1	-	
Specimens not picked from residue							
				Owenia fusiformis	4	-	
				Angulus fabula	3	-	
				Phoronis sp.	1	-	
				(Polychaete frags)	(P)	-	
		397	46.5705		425	31.9165	

NMBAQC Scheme Interim Results

LabCode	LB1822
SampleCode	MB19
Sample Received	13/12/2011
Notes	

Summary Data

Diff. In No. Taxa	**11**
Diff. In No. Individuals	**-49**
Missed Taxa (in residue)	**0**
Missed Individuals (in residue)	**16**
Taxonomic Errors	**23**
Count Variance	**-33**
Biomass %diff.	**12.67**
Bray-Curtis Similarity index	**76.02**

	Participating Laboratory			**Thomson Unicomarine Ltd.**			
Taxon Number	Taxon Name	Number	Biomass	Taxon Name	Number	Biomass	Comments
1	Nematoda	1	0.0001	Nematoda	1	0.0001	
2	Campanulariidae colonies	P	-	**Tubularia sp.**	P	-	Taxonomic error; mixture (see below)
3	Copepoda	P	-	Copepoda	1	0.0004	
4	Iphinoe trispinosa	1	0.0019	Iphinoe trispinosa	1	0.001	
5	Ampelisca brevicornis	1	0.0051	Ampelisca brevicornis	1	0.0039	
6	Megaluropus agilis	1	0.0011	Megaluropus agilis	1	0.0004	
7	Phtisica marina	1	0.0019	Phtisica marina	1	0.0007	
8	Pariambus typicus	2	0.0009	Pariambus typicus	2	0.0001	
9	Leocarcinus holsatus	1	2.7073	**Liocarcinus holsatus**	1	2.4242	Spelling error
10	Fabulina fabula	19	0.3987	**Angulus fabula**	19	0.3777	Name change
11	Tanaidae (a)	1	0.0019	**Siphonoecetes kroyeranus**	1	0.0002	Taxonomic error
12	Lunatia alderi	4	0.1438	**Euspira pulchella**	4	0.1451	Taxonomic error
13	Thracea phaseolina	3	0.0164	Thracia sp. juv.	3	0.0147	Spelling error
14	Sigalion mathildae	4	0.1498	Sigalion mathildae	4	0.1019	
15	Sigalion squamosus	1	0.0015	**Sigalion mathildae**	1	0.0006	Taxonomic error; Repeat taxon
16	Phloe sp.	1	0.0023	Pholoe baltica	1	0.0003	Spelling error
17	Nephtys cirrosa	2	0.0376	Nephtys cirrosa	**1**	0.0248	Taxonomic error (see below)
18	Nephtys caeca	1	0.0384	**Nephtys assimilis**	1	0.0255	Taxonomic error
19	Nephtys juv.	1	0.0024	Nephtys sp. juv.	1	0.0004	
20	Magelona mirabilis	14	0.0369	**Magelona johnstoni**	14	0.0298	Taxonomic error
21	Magelona minuta	3	0.0016	**Magelona filiformis**	3	0.0006	Taxonomic error
22	Magelona wilsoni	1	0.003	**Magelona alleni**	1	0.0015	Taxonimic error
23	Eumida sp.	1	0.0018	Eumida bahusiensis	1	0.0002	
24	Mystides sp.	3	0.0012	**Phyllodoce rosea**	3	0.0006	Taxonomic error
25	Pectinaria sp.	6	0.0603	Lagis koreni	6	0.0327	Taxonomic error (see below)
26	Oligochaeta	3	0.0058	**Nemertea**	3	0.0046	Taxonomic error
27	Scoloplos armiger	8	0.0371	Scoloplos armiger	**7**	0.0283	Taxonomic error (see below)
28	Monticellina dorsobranchialis	1	0.0025	**Chaetozone christiei**	1	0.0006	Taxonomic error
29	Cirratulidae	1	0.0035	Chaetozone christiei	1	0.0014	Repeat taxon
30	Scalibregmatidae	3	0.0008	**Spiophanes bombyx frags**	P	0.0002	Taxonomic error
31	Phoronis sp.	1	0.0005	Phoronis sp.	1	0.0005	
32	Owenia fusiformis	113	0.671	Owenia fusiformis	**114**	0.6105	Mixture (see below)
33	Autolytinae	1	0.0007	Autolytus sp.	1	0.0003	
34	Maldanidae (a)	2	0.0181	Clymenura sp.	2	0.0106	
35	Maldanidae (b)	1	0.0091	Clymenura sp.	P	0.0073	Repeat taxon
36	Maldanidae (c)	1	0.0229	Clymenura sp.	P	0.0172	Repeat taxon
37	Bathyporeia juv.	1	0.0009	Bathyporeia sp.	1	0.0003	
38	Bathyporeia sp.	1	0.0029	Bathyporeia sp.	1	0.0015	Repeat taxon
39	Corophiidae (a)	1	0.0017	Siphonoecetes kroyeranus	1	0.0007	
40	Leucothoe incisa	1	0.0018	Leucothoe incisa	1	0.0005	
41	Leucothoe lilljeborgi	1	0.0017	**Leucothoe incisa**	1	0.0007	Taxonomic error; Repeat taxon
42	Urothoe sp.	1	0.0031	Urothoe poseidonis	1	0.001	
43	Solenidae (no valves)	2	0.0117	Solenidae	2	0.0068	
44	Ganthiidae	1	0.0027	**Urothoe poseidonis**	1	0.0017	Taxonomic error; Repeat taxon
45	Isopoda (a)	1	0.0032	**Urothoe poseidonis**	1	0.0015	Taxonomic error; Repeat taxon
46	Malacoceros vulgaris ?	6	0.0044	**Spiophanes bombyx**	6	0.0017	Taxonomic error
47	Spionidae	77	0.0602	Spiophanes bombyx	**74**	0.0363	Mixture (see below); Repeat taxon
48	Dispio uncinata	1	0.0013	**Spio filicornis**	1	0.0004	Taxonomic error
49	Malacoceros sp,	8	0.0059	**Spiophanes bombyx**	8	0.0035	Taxonomic error; Repeat taxon
50	Pygospio sp,	1	0.0026	**Spiophanes bombyx**	1	0.0014	Taxonomic error; Repeat taxon
51	Scolelepis sp.	3	0.0036	Scolelepis bonnieri	**2**	0.0014	Taxonomic error (see below)
52	Spiophanes bombyx	15	0.0104	Spiophanes bombyx	15	0.0081	Repeat taxon
53	Golfingiidae	1	0.0018	Faunal frag	P	0.0002	
54	Polychaete fragments	P	-	Polychaete fragments	P	-	Mixture (see below)
55	Amphipod fragments	P	-	Amphipod fragments	P	-	
56	Unsorted invertebrate fragments	P	-	Unsorted invertebrate fragments	P	-	
Specimens from within taxon pots							
2				**Lovenella clausa**	P	-	Additional taxon
2				Spiophanes bombyx	1	-	
17				Nephtys assimilis	1	-	
25				**Lanice conchilega**	2	-	Additional taxon
27				Spiophanes bombyx	1	-	
32				Spiophanes bombyx	1	-	
32				Nemertea	1	-	
47				Spio filicornis	1	-	
51				Spio filicornis	1	-	
54				**Poecilochaetus serpens**	2	-	Additional taxon
54				Phoronis sp.	1	-	
54				Nemertea	5	-	
54				Nephtys sp. juv.	2	-	
54				Spiophanes bombyx	23	-	
55				Bathyporeia sp.	1	-	
Specimens not picked from residue							
				Spiophanes bombyx	6	-	
				Owenia fusiformis	5	-	
				Nemertea	1	-	
				Phoronis sp.	1	-	
				Angulus fabula	2	-	
				Thracia sp. juv.	1		
		330	4.5078		379	3.9366	

Table 1. Results from the analysis of Macrobenthic sample MB19 by the participating laboratories.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Number of Taxa				Number of Individuals				Not extracted			Individuals	Similarity	Taxonomic
LabCode	PL	TUM	Diff (n)	%max	PL	TUM	Diff (n)	%max	New Taxa	Ind	%ind	Count Error	index	errors
LB1802	38	44	-6	13.6	306	317	-11	3.5	5	8	2.5	-3	92.65	3
LB1803	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LB1804	41	45	-4	8.9	263	271	-8	3.0	0	2	0.7	-6	89.59	9
LB1806	31	31	0	0.0	265	265	0	0.0	1	1	0.4	1	99.06	1
LB1807	39	40	-1	2.5	336	343	-7	2.0	1	3	0.9	-4	98.24	0
LB1808	41	41	0	0.0	264	267	-3	1.1	0	7	2.6	4	96.85	2
LB1809	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LB1810	46	46	0	0.0	397	425	-28	6.6	0	8	1.9	-20	91.53	7
LB1822	53	42	11	20.8	330	379	-49	12.9	0	16	4.2	-33	76.02	23

Key: PL - participating laboratory.
TUM - Thomson Unicomarine Ltd.
"-" - No data. See forthcoming Annual Report, for details.

Table 2. Comparison of the efficiency of extraction of fauna by the participating laboratories for the major taxonomic groups present in sample MB19.

LabCode		Nemertea	Polychaeta	Oligochaeta	Chelicerata	Crustacea	Echinodermata	Mollusca	Other	Overall
LB1802	TUM count	9	241	-	-	34	2	25	6	317
	PL missed	0	1	-	-	4	0	2	1	8
	%missed	0.0	0.4	-	-	11.8	0.0	8.0	16.7	2.5
LB1803	TUM count	-	-	-	-	-	-	-	-	0
	PL missed	-	-	-	-	-	-	-	-	0
	%missed	-	-	-	-	-	-	-	-	-
LB1804	TUM count	3	197	-	-	22	3	41	5	271
	PL missed	0	1	-	-	0	0	1	0	2
	%missed	0.0	0.5	-	-	0.0	0.0	2.4	0.0	0.7
LB1806	TUM count	4	204	-	-	13	1	33	10	265
	PL missed	0	0	-	-	0	0	1	0	1
	%missed	0.0	0.0	-	-	0.0	0.0	3.0	0.0	0.4
LB1807	TUM count	12	265	-	-	14	1	47	4	343
	PL missed	0	0	-	-	0	0	3	0	3
	%missed	0.0	0.0	-	-	0.0	0.0	6.4	0.0	0.9
LB1808	TUM count	11	183	-	-	19	3	39	12	267
	PL missed	0	7	-	-	0	0	0	0	7
	%missed	0.0	3.8	-	-	0.0	0.0	0.0	0.0	2.6
LB1809	TUM count	-	-	-	-	-	-	-	-	0
	PL missed	-	-	-	-	-	-	-	-	0
	%missed	-	-	-	-	-	-	-	-	-
LB1810	TUM count	6	370	-	-	24	3	20	2	425
	PL missed	0	4	-	-	0	0	3	1	8
	%missed	0.0	1.1	-	-	0.0	0.0	15.0	50.0	1.9
LB1822	TUM count	10	316	-	-	18	-	31	4	379
	PL missed	1	11	-	-	0	-	3	1	16
	%missed	10.0	3.5	-	-	0.0	-	9.7	25.0	4.2

Key: PL - participating laboratory.
TUM - Thomson Unicomarine Ltd.
"-" - No data. See forthcoming Annual Report, for details.

Table 3. Comparison of the estimates of biomass made by the participating laboratories with those made by Unicomarine Ltd. for the major taxonomic groups present in sample MB19. Values are in grams (g).

LabCode		Nemertea	Polychaeta	Oligochaeta	Chelicerata	Crustacea	Echinodermata	Mollusca	Other	Overall
LB1802	PL	-	-	-	-	-	-	-	-	0
	TUM	-		-	-	-	-	-	-	0
	%diff.	-	-	-	-	-	-	-	-	-
LB1803	PL	-	-	-	-	-	-	-	-	0
	TUM	-	-	-	-	-	-	-	-	0
	%diff.	-	-	-	-	-	-	-	-	-
LB1804	PL	-	2.0477	-	-	0.0429	4.4256	0.9385	2.7764	10.2311
	TUM	-	1.8594	-	-	0.0335	4.4166	0.9641	2.5202	9.7938
	%diff.	-	9.2	-	-	21.9	0.2	-2.7	9.2	4.274223
LB1806	PL	-	-	-	-	-	-	-	-	0
	TUM	-	-	-	-	-	-	-	-	0
	%diff.	-	-	-	-	-	-	-	-	-
LB1807	PL	0.0057	1.7664	-	-	0.0166	0.0007	0.4378	1.3649	3.5921
	TUM	0.0044	1.7936	-	-	0.0142	0.0007	0.4147	1.3954	3.623
	%diff.	22.8	-1.5	-	-	14.5	0.0	5.3	-2.2	-0.9
LB1808	PL	-	-	-	-	-	-	-	-	0
	TUM	-	-	-	-	-	-	-	-	0
	%diff.	-	-	-	-	-	-	-	-	-
LB1809	PL	-	-	-	-	-	-	-	-	0
	TUM	-	-	-	-	-	-	-	-	0
	%diff.	-	-	-	-	-	-	-	-	-
LB1810	PL	0.0196	1.48	-	-	0.5431	43.1129	0.3017	1.1132	46.5705
	TUM	0.0091	1.0073	-	-	0.4884	29.4513	0.2662	0.6942	31.9165
	%diff.	53.6	31.9	-	-	10.1	31.7	11.8	37.6	31.5
LB1822	PL	0.0058	1.1927	-	-	2.7381	-	0.5706	0.0006	4.5078
	TUM	0.0046	0.9483	-	-	2.4388	-	0.5443	0.0006	3.9366
	%diff.	20.7	20.5	-	-	10.9	-	4.6	0.0	12.7

Key: PL - participating laboratory
TUM - Thomson Unicomarine Ltd.
"-" - No data. See forthcoming Annual Report, for details.

Table 4. Variation in faunal content of samples distributed as MB19.

Taxa*

LabCode	Nemertea	Polychaeta	Oligochaeta	Chelicerata	Crustacea	Echinodermata	Mollusca	Other	Total taxa
LB1802	1	18	-	-	12	2	6	5	44
LB1803	-	-	-	-	-	-	-	-	-
LB1804	1	17	-	-	12	2	9	4	45
LB1806	1	12	-	-	3	1	9	5	31
LB1807	1	20	-	-	7	1	8	3	40
LB1808	1	20	-	-	6	1	7	6	41
LB1809	-	-	-	-	-	-	-	-	-
LB1810	1	22	-	-	12	2	6	3	46
LB1822	1	19	-	-	14	0	4	4	42
Mean	1	18	-	-	9	1	7	4	41
Max	1	22	-	-	14	2	9	6	46
Min	1	12	-	-	3	0	4	3	31

Individuals*

LabCode	Nemertea	Polychaeta	Oligochaeta	Chelicerata	Crustacea	Echinodermata	Mollusca	Other	Total Ind.
LB1802	9	241	-	-	34	2	25	6	317
LB1803	-	-	-	-	-	-	-	-	-
LB1804	3	197	-	-	22	3	41	5	271
LB1806	4	204	-	-	13	1	33	10	265
LB1807	12	265	-	-	14	1	47	4	343
LB1808	11	183	-	-	19	3	39	12	267
LB1809	-	-	-	-	-	-	-	-	-
LB1810	6	370	-	-	24	3	20	2	425
LB1822	10	316	-	-	18	0	31	4	379
Mean	8	254	-	-	21	2	34	6	324
Max	12	370	-	-	34	3	47	12	425
Min	3	183	-	-	13	0	20	2	265

*TUM data used for all faunal groups (includes all faunal groups).

Figure 1: MB19 data from particpiating laboratories (raw-untransformed)

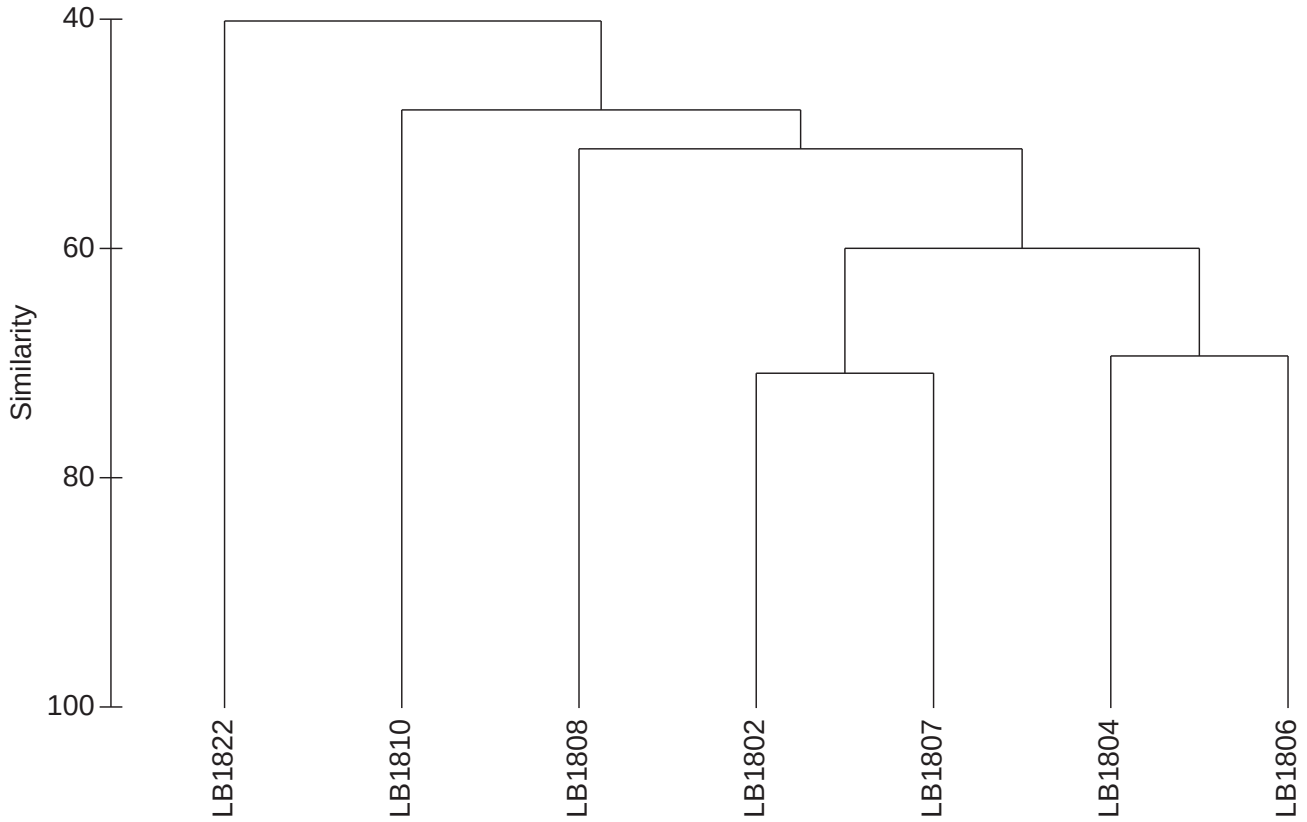
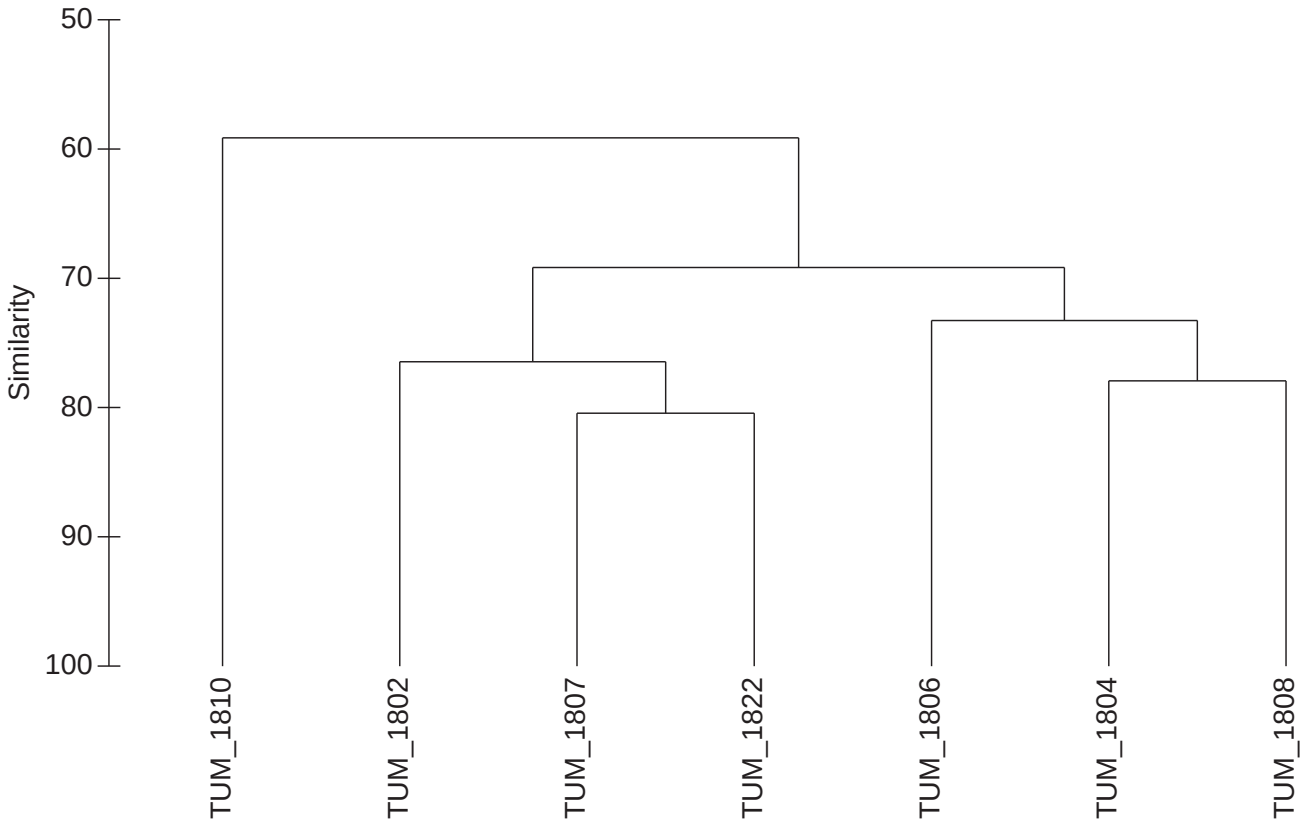


Figure 2: MB19 data reanalysed by Thomson Unicomarine Ltd. (untransformed)



Appendices

National Marine Biological Analytical Quality Control Scheme

Benthic Invertebrate Component - Macrobenthic sample exercise (MB)

Objective:

- To examine the consistency of extraction and identification of taxa from similar samples

The macrobenthic sample is a training exercise; results are not used to assess the performance of a laboratory.

Protocol:

Each participating laboratory receives a prepared, labelled macrobenthic sample in a sealed pot with minimal alcohol as a temporary preservative. Samples may be either 'natural' ($0.1m^2$ grabs) or artificially created uniform samples. 'Natural' samples are collected on the same day and from the same location at anchor. A single unsorted sample is distributed per Scheme year. Participating laboratories are required to sort and extract all biota, identify to the most accurate taxonomic level practicable, usually species, and enumerate according to the Scheme's processing requirements protocol (PRP) and taxonomic discrimination protocol (TDP). Biomass (blotted wet-weight) values are required for all taxa.

Reporting compares extraction efficiency, identification accuracy, enumeration accuracy and biomass estimates. Participating laboratory *vs.* Thomson Unicomarine Ltd. data set for each sample are compared using the Bray-Curtis similarity index.

Preparation:

Samples should be sieved (1.0 mm) and preserved (if not processed immediately) by the participating laboratory on receipt. Sorted residue and specimens should be returned to Thomson Unicomarine Ltd., where natural samples are re-processed.

Timescale:

Please send results, specimens and sample residues to Thomson Unicomarine Ltd. by **2nd December 2011.**

APPENDIX 3
Summary Overview of Taxonomic Discrimination Protocol (TDP)
Exclusive meiofaunal, freshwater & planktonic groups not shown.

		Extraction*	Preservation	Recording/Identification			Biomass (significant fragments always included)			
Major Taxonomic Group/Items	**Forms/Subgroups**			Enumeration/Presence	Criteria	Tax. level**	Weighed	Major group	Tubes/shells incl.	**Notes**
Protozoa	conspicuous only (*e.g. Lagotia, Astrorhiza*)	In part	Dry or Alcohol	Varies	Complete	Varies	☒	n/a	n/a	
Porifera		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	
	easily detachible	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	small encrusting patches	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	boring (*e.g. Cliona*)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Cnidaria		Varies	Varies	Varies	n/a	Varies	Varies	Cnidaria	☒	
Hydrozoa	erect	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Hydrozoa	stolonal or encrusting	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Octocorallia	erect (*e.g. Alcyonium*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Octocorallia	encrusting (*e.g. Sarcodictyon*)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Ceriantharia	*e.g . Cerianthus*	All	Alcohol	Counted	Mouth	Varies	☑	Cnidaria	☒	
Zoantharia	*e.g. Epizoanthus*	All	Dry or Alcohol	Counted (polyps)	Complete	Varies	☒	n/a	n/a	
Actiniaria	inc. Edwardsiidae	All	Alcohol	Counted	Mouth	Varies	☑	Cnidaria	☒	
Platyhelminthes		All	Alcohol	Counted	Head	Class	☑	Others	n/a	Freshwater taxa to genus/species
Nemertea		All	Alcohol	Counted	Head	Phylum	☑	Others	n/a	Distinctive taxa taken further
Nematoda		All	Alcohol	Counted	Head	Phylum	☑	Others	n/a	Mainly meiofaunal
Priapulida		All	Alcohol	Counted	Head	Species	☑	Others	n/a	
Entoprocta		In part	Alcohol	Presence	n/a	Genus	☒	n/a	n/a	
Chaetognatha		All	Alcohol	Counted	Head	Genus	☑	Others	n/a	Mainly planktonic; benthic sp. to spp.
Sipuncula		All	Alcohol	Counted	Trunk	Species	☑	Others	n/a	
Echiura		All	Alcohol	Counted	Trunk	Species	☑	Others	n/a	
Annelida		All	Alcohol	Counted	Head	Varies	☑	Varies	Varies	See Oligochaeta TDP
Chelicerata		All	Alcohol	Counted	Head	Varies	☑	Others	n/a	
Crustacea		Varies	Varies	Counted	Varies	Varies	Varies	Crustacea	n/a	
	free living (most)	All	Alcohol	Counted	Head	Varies	☑	Crustacea	n/a	
	attached parasites	All	Alcohol, with host	Counted	Head/Attachment	Varies	☒	n/a	n/a	Biomassed with host
	sessile (barnacles)	Varies	Dry or Alcohol	Counted	Head/Cirri	Varies	☒	n/a	n/a	
Myriapoda		All	Alcohol	Counted	Head	Class	☑	Others	n/a	
Hexapoda	*e.g.* insects	All	Alcohol	Counted	Head	Varies	Varies	Others	n/a	
Mollusca		All	Alcohol	Counted	Varies	Varies	☑	Mollusca	☑	
Brachiopoda		All	Alcohol	Counted	Lophophore	Species	☑	Others	☑	
Bryozoa		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	
	erect (*e.g. Flustra, Bugul* a)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	stolonal (*e.g. Nolella, Aetea*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
	encrusting (most)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Phoronida		All	Alcohol	Counted	Head	Genus	☑	Others	☑	
Echinodermata		All	Alcohol	Counted	Mouth	Varies	☑	Echinodermata	☑	
Hemichordata		All	Alcohol	Counted	Head/collar	Class	☑	Others	n/a	
Chordata		Varies	Varies	Varies	Varies	Varies	Varies	Varies	n/a	
Tunicata	solitary	All	Alcohol	Counted	Branchial sac	Varies	☒	n/a	n/a	
Tunicata	stolonal (*e.g. Perophora*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Tunicata	detachible colonies (*e.g. Botryllus*)	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Tunicata	encrusting (*e.g.* Didemnidae)	In part	Dry or Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Fish and Cephalochordata	-	All	Alcohol	Counted	Head	Varies	☑	Others or Fish	n/a	Biomass requirements project related
Cyanophyta		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Rhodophycota		In part	Varies	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Chromophycota		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Chlorophycota		In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	Record only if attached
Fungi		☒	n/a	☒	n/a	n/a	☒	n/a	n/a	
Tracheophycota	flowering plants	In part	Alcohol	Presence	n/a	Species	☒	n/a	n/a	Angiospermae
Animalia 'eggs'		Varies	Alcohol	Varies	Varies	Varies	☒	n/a	n/a	
Eggs	egg masses	In part	Alcohol	Presence	n/a	Varies	☒	n/a	n/a	
Eggs	discrete eggs (*e.g.* fish)	All	Alcohol	Counted	Complete	Varies	☒	n/a	n/a	
Anthropogenic material	including seeds	☒	n/a	☒	n/a	n/a	☒	n/a	n/a	

* = some may be counted *in situ* / subsampled if present in high numbers
** = minimum level required (good condition given); there may be some exceptions to be detailed in the fully expanded TDP

APPENDIX 4

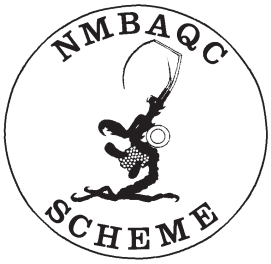
Taxonomic Discrimination Protocol (TDP) for Oligochaeta

Some meiofaunal, freshwater & planktonic groups not shown.

					Recorded/Identification			Biomass			
Class	**Family**	**Genus**	**Extraction***	**Preservation**	Enumeration/Presence	Tax. level**	Juv. separated	Weighed	Fragments incl.	Tubes/shells incl.	**Notes**
Oligochaeta			All	Alcohol	Counted	Varies	☒	☑	☑	n/a	
	Naididae		All	Alcohol	Counted	Varies	☒	☑	☑	n/a	
		Amphichaeta	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Chaetogaster	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Dero	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Nais	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Paranais	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Stylaria	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Uncinais	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Tubificidae		All	Alcohol	Counted	Varies (Family, except where stated below)	☒	☑	☑	n/a	
		Monopylephorus	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Limnodriloides	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Clitellio	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Heterochaeta	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Limnodrilus	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
		Tubifex	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Tubificoides	All	Alcohol	Counted	Species (except T.brownae, T.crenacoleus, T.diazi and T.pseudogaster, all as T.pseudogaster agg.)	☒	☑	☑	n/a	
		Potamothrix	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Psammoryctides	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
		Quistadrilus	All	Alcohol	Counted	Q. multisetosus to Species	☒	☑	☑	n/a	
		Branchiura	All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Enchytraeidae		All	Alcohol	Counted	Family (except Grania spp. to genus)	☒	☑	☑	n/a	
		Grania	All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
	Branchiobdellidae		All	Alcohol	Counted	Family	☒	☑	☑	n/a	
	Aeolosomatidae		All	Alcohol	Counted	Genus	☒	☑	☑	n/a	
	Haplotaxidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Lumbriculidae		All	Alcohol	Counted	Family	☒	☑	☑	n/a	
	Dorydrilidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Glossoscolecidae		All	Alcohol	Counted	Species	☒	☑	☑	n/a	
	Lumbricidae		All	Alcohol	Counted	Family (except Eisenella tetraedra to species)	☒	☑	☑	n/a	

* = some may be counted *in situ* / subsampled if present in high numbers

** = minimum level required; occasional specimens may be left at higher taxa if damaged, small or with unusual combinations of features



The National Marine Biological Analytical Quality Control Scheme
www.nmbaqcs.org

Ring Test Bulletin – RTB#42

Authors: **Jessica Taylor, David Hall, Tim Worsfold & Morena Aloisi**
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Thomson Unicomarine Ltd.
Date of Issue: 9th April 2013

RING TEST DETAILS
Ring Test #42
Type/Contents – Targeted, Scottish Fauna
Circulated – 22/02/2012
Completion Date – 27/04/2012
Number of Subscribing Laboratories – 23
Number of Participating Laboratories – 20
Number of Results Received – 24*
***multiple data entries per laboratory permitted**

Summary of differences

Specimen	Genus	Species	Total differences for 24 returns	
			Genus	Species
RT4201	*Crenella*	*decussata*	1	1
RT4202	*Parvicardium*	*minimum*	0	2
RT4203	*Pholoe*	*assimilis*	0	3
RT4204	*Ampelisca*	*tenuicornis*	0	4
RT4205	*Polyphysia*	*crassa*	19	19
RT4206	*Testudinalia*	*testudinalis*	1	1
RT4207	*Fabricia*	*stellaris*	0	0
RT4208	*Iphinoe*	*serrata*	1	2
RT4209	*Malacoceros*	*fuliginosus*	0	0
RT4210	*Protodorvillea*	*kefersteini*	0	0
RT4211	*Ditrupa*	*arietina*	0	0
RT4212	*Pterolysippe*	*vanelli*	2	2
RT4213	*Paramphinome*	*jeffreysii*	2	2
RT4214	*Omalogyra*	*atomus*	0	0
RT4215	*Lacuna*	*vincta*	1	3
RT4216	*Gammarus*	*locusta*	1	1
RT4217	*Skeneopsis*	*planorbis*	0	0
RT4218	*Ecrobia*	*ventrosa*	15	14
RT4219	*Onoba*	*aculeus*	0	2
RT4220	*Timoclea*	*ovata*	0	0
RT4221	*Onoba*	*aculeus*	10	12
RT4222	*Bittium*	*reticulatum*	0	0
RT4223	*Turtonia*	*minuta*	9	9
RT4224	*Ampharete*	*falcata*	3	6
RT4225	*Maxmuelleria*	*lankesteri*	7	7
		Total differences	72	90
		Average diff. / data return	2.9	3.6

Table 1. The identification of fauna made by participating laboratories for RT42 (arranged by specimen). Names are given only where different from the AQC identification.

	RT4201	RT4202	RT4203	RT4204	RT4205	RT4206
Taxon	*Crenella decussata*	*Parvicardium minimum*	*Pholoe assimilis*	*Ampelisca tenuicornis*	*Polyphysia crassa*	*Testudinalia testudinalis*
LB1802	- -	- -	- -	- -	Scalibregma inflatum	Acmaea virginea
LB1803	- -	- -	- -	- diadema	Scalibregma inflatum	- -
LB1806	- -	- -	- -	- -	Lipobranchus jeffreysii	- -
LB1807	- -	- -	- -	- -	Lipobranchus jeffreysii	- -
LB1808	- -	[Paravicardium] -	- -	- -	Scalibregma inflatum	[Collisella] [tessulata]
LB1809a	- -	- -	- -	- -	- -	- -
LB1809b	- -	- -	- baltica	- -	- -	- -
LB1810	- -	- -	- inornata	- -	Sclerocheilus minutus	- -
LB1811	- -	- -	- -	- -	Lipobranchus jeffreysi	- -
LB1812	- -	- scabrum	- -	- diadema	Lipobranchus jeffreysii	- -
LB1813	- [decusata]	- -	- -	- typica	- -	[tectura] -
LB1814	- -	- -	- -	- -	Lipobranchius jeffreysii	- -
LB1815	- -	- scabrum	- inornata	- eschrichtii	Lipobranchus jeffreysii	- -
LB1816	- -	- -	- -	- -	Lipobranchius jeffreysii	- -
LB1817	- -	- -	- -	- -	Lipobranchius jeffreysii	- -
LB1819	- -	- -	- -	- -	Asclerocheilus intermedius	- -
LB1820	- -	- -	- -	- -	Scalibregma inflatum	- -
LB1821	- -	- -	- -	- -	- -	- -
LB1823a	- -	- -	- -	- -	Scalibregma inflatum	- -
LB1823b	- -	- -	- -	- -	Scalibregma inflatum	- -
LB1824	- -	- -	- -	- -	Asclerocheilus intermedius	- -
LB1825a	- -	- -	- -	- -	Asclerocheilus intermedius	- -
LB1825b	- -	- -	- -	- -	- -	- -
LB1825c	Glycymeris glycymeris	- -	- -	- -	Asclerocheilus intermedius	- -

Table 1. The identification of fauna made by participating laboratories for RT42 (arranged by specimen). Names are given only where different from the AQC identification.

	RT4207	RT4208	RT4209	RT4210	RT4211	RT4212
Taxon	*Fabricia stellaris*	*Iphinoe serrata*	*Malacoceros fuliginosus*	*Protodorvillea kefersteini*	*Ditrupa arietina*	*Pterolysippe vanelli*
LB1802	- [sabella]	- -	- [fuliginosa]	- -	- -	Anobothrus gracilis
LB1803	- -	- -	- -	- [kefesteini]	- -	- -
LB1806	- -	- -	- -	- -	- -	- -
LB1807	- -	- trispinosa	- -	- -	- -	- -
LB1808	- -	- -	- -	- -	- -	- -
LB1809a	- -	- -	- -	- -	- -	- -
LB1809b	- -	- -	- -	- -	- -	[Eclysippe] -
LB1810	- -	- -	- -	- -	- -	- -
LB1811	- -	- -	- -	- -	- -	- -
LB1812	- [sabella]	Leucon (Leucon) acutirostris	- -	- -	- -	Amythasides macroglossus
LB1813	- [sabella]	- -	- [fuliginosis]	- -	- -	- -
LB1814	- -	- -	- -	- -	- -	[Eclysippe] -
LB1815	- [stellaris stellaris]	- -	- -	- -	- -	- -
LB1816	- -	- -	- -	- -	- -	- -
LB1817	- -	- -	- -	- -	- -	- -
LB1819	- -	- -	- -	- -	- -	[Auchenoplax] -
LB1820	- -	- -	- -	- -	- -	- -
LB1821	- -	- -	- -	- -	- -	- -
LB1823a	- -	- -	- -	- -	- -	- -
LB1823b	- -	- -	- -	- -	- -	- -
LB1824	- -	- -	- -	- -	- -	- -
LB1825a	- [sabella]	- -	- -	- -	- -	- -
LB1825b	- [sabella]	- -	- -	- -	- -	- -
LB1825c	- [sabella]	- -	- -	- -	- -	- -

Table 1. The identification of fauna made by participating laboratories for RT42 (arranged by specimen). Names are given only where different from the AQC identification.

	RT4213	RT4214	RT4215	RT4216	RT4217	RT4218
Taxon	*Paramphinome jeffreysii*	*Omalogyra atomus*	*Lacuna vincta*	*Gammarus locusta*	*Skeneopsis planorbis*	*Ecrobia ventrosa*
LB1802	- -	- -	Cingulopsis fulgida	- -	- -	Hydrobia ulvae
LB1803	- -	- -	- -	- -	- -	[Hydrobia] -
LB1806	- -	- -	- -	- -	- -	- -
LB1807	- -	- -	- -	- -	- -	- -
LB1808	- -	- -	- -	- -	- -	Hydrobia ulvae
LB1809a	- -	- -	- -	- -	- -	Hydrobia acuta
LB1809b	- -	- -	- -	- -	- -	- -
LB1810	- -	- -	- parva	- -	- -	0 0
LB1811	- -	- -	- -	- -	- -	Hydrobia acuta neglecta
LB1812	- -	- -	- parva	- -	- -	Potamopyrgus antipodarum
LB1813	- -	[Omalogyra atomus] -	[Lacuna vincta] -	Echinogammarus pirloti	- -	Odostomia scalaris
LB1814	- -	- -	- -	- -	- -	[Ventrosia] -
LB1815	- -	- -	- -	- -	- -	- -
LB1816	- -	- -	- -	- -	- -	- -
LB1817	- -	- -	- -	- -	- -	- -
LB1819	- -	- -	- -	- -	- -	- -
LB1820	- -	- -	- -	- -	- -	- truncata
LB1821	- -	- -	- -	- -	- -	- -
LB1823a	- -	- -	- -	- -	- -	Peringia ulvae
LB1823b	- -	- -	- -	- -	- -	Mercuria confusa
LB1824	- -	- -	- -	- -	- -	Marstoniopsis scholtzi
LB1825a	- -	- -	- -	- -	- -	Pusillina sarsii
LB1825b	Linopherus hemuli	- -	- -	- -	- -	Hydrobia ulvae
LB1825c	Linophorus hemuli	- -	- -	- -	- -	Mercuria confusa

Table 1. The identification of fauna made by participating laboratories for RT42 (arranged by specimen). Names are given only where different from the AQC identification.

	RT4219	RT4220	RT4221	RT4222	RT4223	RT4224	RT4225
Taxon	*Onoba aculeus*	*Timoclea ovata*	*Onoba aculeus*	*Bittium reticulatum*	*Turtonia minuta*	*Ampharete falcata*	*Maxmuellleria lankesteri*
LB1802	- -	- -	Cingulopsis fulgida	- -	Mysella bidentata	- lindstroemi	- -
LB1803	- -	- -	- [aculeatus]	- -	- -	- -	- -
LB1806	- -	- -	Obtusella intersecta	- -	Kurtiella bidentata	- -	- -
LB1807	- -	- -	Obtusella intersecta	- -	- -	- -	Thalassema thalassemum
LB1808	- -	- -	- -	- -	Kurtiella bidentata	- -	- [lankestrei]
LB1809a	- -	- -	- -	- -	- -	- -	Thalassema thalassemum
LB1809b	- -	- -	- -	- -	- -	- -	Thalassema thalassemum
LB1810	- -	- -	- -	- -	- -	- -	- -
LB1811	- semicostata	- -	Obtusella intersecta	- -	- -	- -	- -
LB1812	- -	- -	- -	- -	Tellimya ferruginosa	Amythasides macroglossus	Thalassema thalassemum
LB1813	- -	- -	Obtusella intersecta	- -	Kurtiella bidentata	[Ampharate] grubei	Echiurus echiurus
LB1814	- -	- -	- -	- -	- -	- -	- -
LB1815	- -	- -	- -	- -	- -	Pterolysippe vanelli	Falcidens crossotus
LB1816	- -	- -	- -	- -	Lasaea adansoni	- -	- -
LB1817	- -	- -	Obtusella intersecta	- -	- -	- -	- -
LB1819	- -	- -	Obtusella intersecta	- -	- -	- -	- -
LB1820	- -	- -	- -	- -	- -	- -	- -
LB1821	- -	- -	- -	- -	Lasaea adansoni	- sp.	- -
LB1823a	- semicostata	- -	- -	- -	Tellimya ferruginosa	- -	- -
LB1823b	- -	- -	- semicostata	- -	- -	- -	- -
LB1824	- -	- -	- semicostata	- -	- -	- -	Thalassema thalassemum
LB1825a	- -	- -	Rissoella diaphana	- -	- -	- -	- -
LB1825b	- -	- -	Obtusella intersecta	- -	Kellia suborbicularis	Amage adspersa	- -
LB1825c	- -	- -	Rissoella diaphana	- -	- -	- -	- -

Table 2. The identification of fauna made by participating laboratories for RT42 (arranged by participant). Names are given only where different from the AQC identifcation.

	Taxon	LB1802	LB1803	LB1806	LB1807	LB1808
RT4201	*Crenella decussata*	- -	- -	- -	- -	- -
RT4202	*Parvicardium minimum*	- -	- -	- -	- -	[Paravicardium] -
RT4203	*Pholoe assimilis*	- -	- -	- -	- -	- -
RT4204	*Ampelisca tenuicornis*	- -	- diadema	- -	- -	- -
RT4205	*Polyphysia crassa*	Scalibregma inflatum	Scalibregma inflatum	Lipobranchus jeffreysii	Lipobranchus jeffreysii	Scalibregma inflatum
RT4206	*Testudinalia testudinalis*	Acmaea virginea	- -	- -	- -	[Collisella] [tessulata]
RT4207	*Fabricia stellaris*	- [sabella]	- -	- -	- -	- -
RT4208	*Iphinoe serrata*	- -	- -	- -	- trispinosa	- -
RT4209	*Malacoceros fuliginosus*	- [fuliginosa]	- -	- -	- -	- -
RT4210	*Protodorvillea kefersteini*	- -	- [kefesteini]	- -	- -	- -
RT4211	*Ditrupa arietina*	- -	- -	- -	- -	- -
RT4212	*Pterolysippe vanelli*	Anobothrus gracilis	- -	- -	- -	- -
RT4213	*Paramphinome jeffreysii*	- -	- -	- -	- -	- -
RT4214	*Omalogyra atomus*	- -	- -	- -	- -	- -
RT4215	*Lacuna vincta*	Cingulopsis fulgida	- -	- -	- -	- -
RT4216	*Gammarus locusta*	- -	- -	- -	- -	- -
RT4217	*Skeneopsis planorbis*	- -	- -	- -	- -	- -
RT4218	*Ecrobia ventrosa*	Hydrobia ulvae	[Hydrobia] -	- -	- -	Hydrobia ulvae
RT4219	*Onoba aculeus*	- -	- -	- -	- -	- -
RT4220	*Timoclea ovata*	- -	- -	- -	- -	- -
RT4221	*Onoba aculeus*	Cingulopsis fulgida	- [aculeatus]	Obtusella intersecta	Obtusella intersecta	- -
RT4222	*Bittium reticulatum*	- -	- -	- -	- -	- -
RT4223	*Turtonia minuta*	Mysella bidentata	- -	Kurtiella bidentata	- -	Kurtiella bidentata
RT4224	*Ampharete falcata*	- lindstroemi	- -	- -	- -	- -
RT4225	*Maxmuelleria lankesteri*	- -	- -	- -	Thalassema thalassemum	- [lankestrei]

Table 2. The identification of fauna made by participating laboratories for RT42 (arranged by participant). Names are given only where different from the AQC identifcation.

	Taxon	LB1809a	LB1809b	LB1810	LB1811	LB1812
RT4201	*Crenella decussata*	- -	- -	- -	- -	- -
RT4202	*Parvicardium minimum*	- -	- -	- -	- -	- scabrum
RT4203	*Pholoe assimilis*	- -	- baltica	- inornata	- -	- -
RT4204	*Ampelisca tenuicornis*	- -	- -	- -	- -	- diadema
RT4205	*Polyphysia crassa*	- -	- -	Sclerocheilus minutus	Lipobranchus jeffreysi	Lipobranchus jeffreysii
RT4206	*Testudinalia testudinalis*	- -	- -	- -	- -	- -
RT4207	*Fabricia stellaris*	- -	- -	- -	- -	- [sabella]
RT4208	*Iphinoe serrata*	- -	- -	- -	- -	Leucon (Leucon) acutirostris
RT4209	*Malacoceros fuliginosus*	- -	- -	- -	- -	- -
RT4210	*Protodorvillea kefersteini*	- -	- -	- -	- -	- -
RT4211	*Ditrupa arietina*	- -	- -	- -	- -	- -
RT4212	*Pterolysippe vanelli*	- -	[Eclysippe] -	- -	- -	Amythasides macroglossus
RT4213	*Paramphinome jeffreysii*	- -	- -	- -	- -	- -
RT4214	*Omalogyra atomus*	- -	- -	- -	- -	- -
RT4215	*Lacuna vincta*	- -	- -	- parva	- -	- parva
RT4216	*Gammarus locusta*	- -	- -	- -	- -	- -
RT4217	*Skeneopsis planorbis*	- -	- -	- -	- -	- -
RT4218	*Ecrobia ventrosa*	Hydrobia acuta	- -	0 0	Hydrobia acuta neglecta	Potamopyrgus antipodarum
RT4219	*Onoba aculeus*	- -	- -	- -	- semicostata	- -
RT4220	*Timoclea ovata*	- -	- -	- -	- -	- -
RT4221	*Onoba aculeus*	- -	- -	- -	Obtusella intersecta	- -
RT4222	*Bittium reticulatum*	- -	- -	- -	- -	- -
RT4223	*Turtonia minuta*	- -	- -	- -	- -	Tellimya ferruginosa
RT4224	*Ampharete falcata*	- -	- -	- -	- -	Amythasides macroglossus
RT4225	*Maxmuelleria lankesteri*	Thalassema thalassemum	Thalassema thalassemum	- -	- -	Thalassema thalassemum

Table 2. The identification of fauna made by participating laboratories for RT42 (arranged by participant). Names are given only where different from the AQC identifcation.

	Taxon	LB1813	LB1814	LB1815	LB1816	LB1817
RT4201	*Crenella decussata*	- [decusata]	- -	- -	- -	- -
RT4202	*Parvicardium minimum*	- -	- -	- scabrum	- -	- -
RT4203	*Pholoe assimilis*	- -	- -	- inornata	- -	- -
RT4204	*Ampelisca tenuicornis*	- typica	- -	- eschrichtii	- -	- -
RT4205	*Polyphysia crassa*	- -	Lipobranchius jeffreysii	Lipobranchus jeffreysii	Lipobranchius jeffreysii	Lipobranchius jeffreysii
RT4206	*Testudinalia testudinalis*	[tectura] -	- -	- -	- -	- -
RT4207	*Fabricia stellaris*	- [sabella]	- -	- [stellaris stellaris]	- -	- -
RT4208	*Iphinoe serrata*	- -	- -	- -	- -	- -
RT4209	*Malacoceros fuliginosus*	- [fuliginosis]	- -	- -	- -	- -
RT4210	*Protodorvillea kefersteini*	- -	- -	- -	- -	- -
RT4211	*Ditrupa arietina*	- -	- -	- -	- -	- -
RT4212	*Pterolysippe vanelli*	- -	[Eclysippe] -	- -	- -	- -
RT4213	*Paramphinome jeffreysii*	- -	- -	- -	- -	- -
RT4214	*Omalogyra atomus*	[Omalogyra atomus] -	- -	- -	- -	- -
RT4215	*Lacuna vincta*	[Lacuna vincta] -	- -	- -	- -	- -
RT4216	*Gammarus locusta*	Echinogammarus pirloti	- -	- -	- -	- -
RT4217	*Skeneopsis planorbis*	- -	- -	- -	- -	- -
RT4218	*Ecrobia ventrosa*	Odostomia scalaris	[Ventrosia] -	- -	- -	- -
RT4219	*Onoba aculeus*	- -	- -	- -	- -	- -
RT4220	*Timoclea ovata*	- -	- -	- -	- -	- -
RT4221	*Onoba aculeus*	Obtusella intersecta	- -	- -	- -	Obtusella intersecta
RT4222	*Bittium reticulatum*	- -	- -	- -	- -	- -
RT4223	*Turtonia minuta*	Kurtiella bidentata	- -	- -	Lasaea adansoni	- -
RT4224	*Ampharete falcata*	[Ampharate] grubei	- -	Pterolysippe vanelli	- -	- -
RT4225	*Maxmuelleria lankesteri*	Echiurus echiurus	- -	Falcidens crossotus	- -	- -

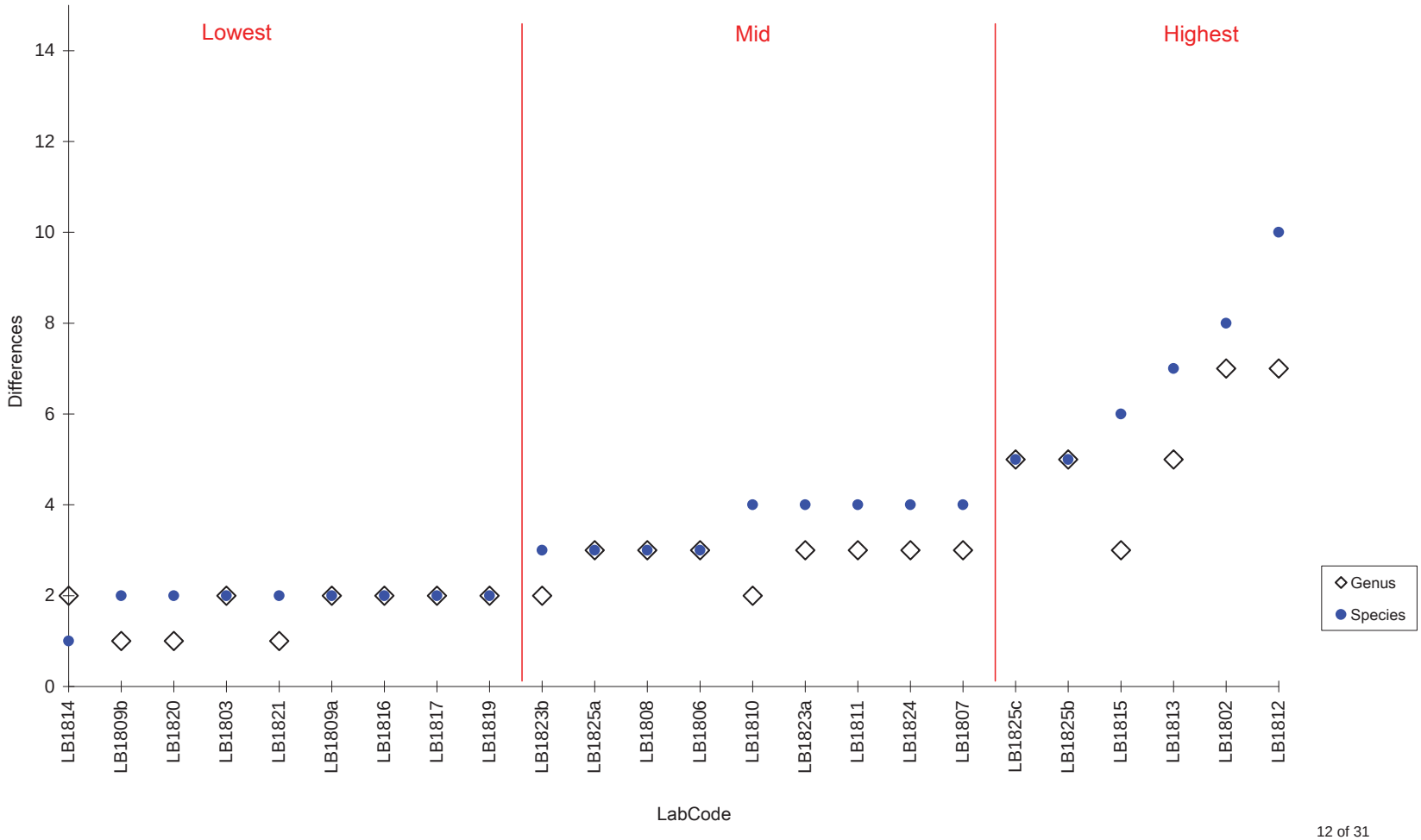
Table 2. The identification of fauna made by participating laboratories for RT42 (arranged by participant). Names are given only where different from the AQC identifcation.

	Taxon	LB1819	LB1820	LB1821	LB1823a	LB1823b
RT4201	*Crenella decussata*	- -	- -	- -	- -	- -
RT4202	*Parvicardium minimum*	- -	- -	- -	- -	- -
RT4203	*Pholoe assimilis*	- -	- -	- -	- -	- -
RT4204	*Ampelisca tenuicornis*	- -	- -	- -	- -	- -
RT4205	*Polyphysia crassa*	Asclerocheilus intermedius	Scalibregma inflatum	- -	Scalibregma inflatum	Scalibregma inflatum
RT4206	*Testudinalia testudinalis*	- -	- -	- -	- -	- -
RT4207	*Fabricia stellaris*	- -	- -	- -	- -	- -
RT4208	*Iphinoe serrata*	- -	- -	- -	- -	- -
RT4209	*Malacoceros fuliginosus*	- -	- -	- -	- -	- -
RT4210	*Protodorvillea kefersteini*	- -	- -	- -	- -	- -
RT4211	*Ditrupa arietina*	- -	- -	- -	- -	- -
RT4212	*Pterolysippe vanelli*	[Auchenoplax] -	- -	- -	- -	- -
RT4213	*Paramphinome jeffreysii*	- -	- -	- -	- -	- -
RT4214	*Omalogyra atomus*	- -	- -	- -	- -	- -
RT4215	*Lacuna vincta*	- -	- -	- -	- -	- -
RT4216	*Gammarus locusta*	- -	- -	- -	- -	- -
RT4217	*Skeneopsis planorbis*	- -	- -	- -	- -	- -
RT4218	*Ecrobia ventrosa*	- -	- truncata	- -	Peringia ulvae	Mercuria confusa
RT4219	*Onoba aculeus*	- -	- -	- -	- semicostata	- -
RT4220	*Timoclea ovata*	- -	- -	- -	- -	- -
RT4221	*Onoba aculeus*	Obtusella intersecta	- -	- -	- -	- semicostata
RT4222	*Bittium reticulatum*	- -	- -	- -	- -	- -
RT4223	*Turtonia minuta*	- -	- -	Lasaea adansoni	Tellimya ferruginosa	- -
RT4224	*Ampharete falcata*	- -	- -	- sp.	- -	- -
RT4225	*Maxmuelleria lankesteri*	- -	- -	- -	- -	- -

Table 2. The identification of fauna made by participating laboratories for RT42 (arranged by participant). Names are given only where different from the AQC identifcation.

	Taxon	LB1824	LB1825a	LB1825b	LB1825c
RT4201	*Crenella decussata*	- -	- -	- -	Glycymeris glycymeris
RT4202	*Parvicardium minimum*	- -	- -	- -	- -
RT4203	*Pholoe assimilis*	- -	- -	- -	- -
RT4204	*Ampelisca tenuicornis*	- -	- -	- -	- -
RT4205	*Polyphysia crassa*	Asclerocheilus intermedius	Asclerocheilus intermedius	- -	Asclerocheilus intermedius
RT4206	*Testudinalia testudinalis*	- -	- -	- -	- -
RT4207	*Fabricia stellaris*	- -	- [sabella]	- [sabella]	- [sabella]
RT4208	*Iphinoe serrata*	- -	- -	- -	- -
RT4209	*Malacoceros fuliginosus*	- -	- -	- -	- -
RT4210	*Protodorvillea kefersteini*	- -	- -	- -	- -
RT4211	*Ditrupa arietina*	- -	- -	- -	- -
RT4212	*Pterolysippe vanelli*	- -	- -	- -	- -
RT4213	*Paramphinome jeffreysii*	- -	- -	Linopherus hemuli	Linophorus hemuli
RT4214	*Omalogyra atomus*	- -	- -	- -	- -
RT4215	*Lacuna vincta*	- -	- -	- -	- -
RT4216	*Gammarus locusta*	- -	- -	- -	- -
RT4217	*Skeneopsis planorbis*	- -	- -	- -	- -
RT4218	*Ecrobia ventrosa*	Marstoniopsis scholtzi	Pusillina sarsii	Hydrobia ulvae	Mercuria confusa
RT4219	*Onoba aculeus*	- -	- -	- -	- -
RT4220	*Timoclea ovata*	- -	- -	- -	- -
RT4221	*Onoba aculeus*	- semicostata	Rissoella diaphana	Obtusella intersecta	Rissoella diaphana
RT4222	*Bittium reticulatum*	- -	- -	- -	- -
RT4223	*Turtonia minuta*	- -	- -	Kellia suborbicularis	- -
RT4224	*Ampharete falcata*	- -	- -	Amage adspersa	- -
RT4225	*Maxmuelleria lankesteri*	Thalassema thalassemum	- -	- -	- -

Figure 1. The number of differences from the AQC identification of specimens distributed in RT42 for each of the participating laboratories. Arranged in order of increasing number of differences.



Specimen Images and Detailed Breakdown of Identifications

LabCodes are abbreviated in this report to exclude the Scheme year, *i.e.* LB1801a = Lab 01a. An optional terminal character has been added to the LabCode (small case sequential letters) tin cases where we have received multiple data entries from a laboratory, *i.e.* two participants from laboratory 01 would be coded as Lab 01a & Lab 01b. For details of your LabCode please contact your Scheme representative or Thomson Unicomarine Ltd.

(Figure codes: A=anterior; P=posterior; L=lateral; D=dorsal; V=ventral)

RT4201 – *Crenella decussata* (Figure 1a).

Substratum: Mixed. Salinity: Full. Depth: Circalittoral. Geography: W. Scotland. Condition: Good, Small, Juvenile (1.0-1.5 mm).

Fig. 1a. *Crenella decussata* (RT4201) – L

One generic and one specific difference:
Lab 25c identified as *Glycymeris glycymeris* (Figure 1b) (which has a taxodont hinge and weaker radial sculpture).

Lab 13 incorrectly spelt the species.

Fig. 1b. *Glycymeris glycymeris* – L

RT4202 – *Parvicardium minimum* (Figure 2a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower shelf). Geography: N. North Sea. Condition: Good, Medium (2-3 mm).

Fig. 2a. *Parvicardium minimum* (RT4202) – L

No generic and two specific differences:
Labs 12 and 15 identified as *Parvicardium scabrum* (Figure 2b) (which has fewer ribs, more acute spines and a more angular shell outline).

Lab 08 incorrectly spelt the genus.

Fig. 2b. *Parvicardium scabrum* – L

RT4203 – *Pholoe assimilis* (Figure 3a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral. Geography: E. Scotland. Condition: Fair/Poor, Small (2 mm).

Fig. 3a. *Pholoe assimilis* (RT4203) – D

No generic and three specific differences:
Lab 09b identified as *Pholoe baltica* (Figure 3b) (which has a prominent facial tubercle);
Labs 10 and 15 identified as *Pholoe inornata* (Figure 3c) (which has papillated tentacular cirri, more irregular eyes and submarginal elytral papillae).

Fig. 3b. *Pholoe baltica* – D

Fig. 3c. *Pholoe inornata* – D

RT4204 – Ampelisca tenuicornis (Figure 4a).

Substratum: Mixed. Salinity: Full. Depth: Infralittoral. Geography: Shetland. Condition: Good, Med/Large.

Fig. 4a. *Ampelisca tenuicornis* (RT4204) – L

No generic and four specific differences:
Labs 03 and 12 identified as *Ampelisca diadema* (Figure 4b) (which has longer first antennae and a transverse row of setae on the inner surface of coxal plate 1);
Lab 13 identified as *Ampelisca typica* (Figure 4c) (which has a larger and more angular urosomal keel);
Lab 15 identified as *Ampelisca eschrichtii* (no photograph available) (which has a shorter ischium than merus on pereopod 7).

Fig. 4b. *Ampelisca diadema* – L

Fig. 4c. *Ampelisca typica* - L

RT4205 – *Polyphysia crassa* (Figure 5a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral. Geography: N. Scotland. Condition: Fair, Small (2-3 mm).

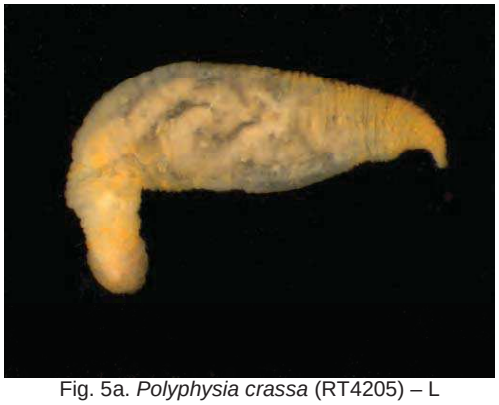


Fig. 5a. *Polyphysia crassa* (RT4205) – L

Nineteen generic and nineteen specific differences:
Labs 02, 03, 08, 20, 23a and 23b identified as *Scalibregma inflatum* (Figure 5b) (which has has a T-shaped prostomium);
Labs 06, 07, 11, 12, 14, 15, 16, and 17 identified as *Lipobranch(i)us jeffreysii* (Figure 5c) (which lacks branchiae);
Labs 19, 24, 25a, and 25c identified as *Asclerocheilus intermedius* (Figure 5d) (which has more distinct prostomial projections);
Lab 10 identified as *Sclerocheilus minutus*, a synonym of *Asclerocheilus intermedius*.

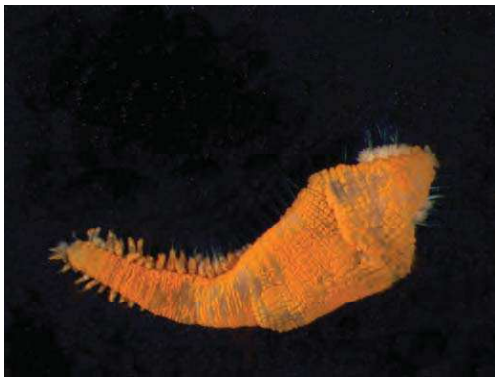


Fig. 5b. *Scalibregma inflatum* – L

Fig. 5c. *Lipobranchius jeffreysii* – L

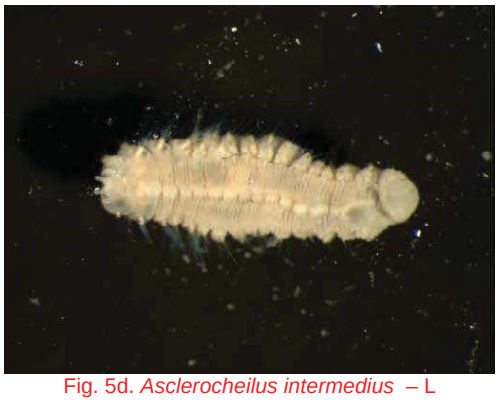


Fig. 5d. *Asclerocheilus intermedius* – L

RT4206 – *Testudinalia testudinalis* (Figure 6a).
Substratum: Rock. Salinity: Full. Depth: Intertidal. Geography: Orkney. Condition: Good, Medium (13 mm).

Fig. 6a. *Testudinalia testudinalis* (RT4206) – D

One generic and one specific difference:
Lab 02 identified as *Acmaea virginea* a synonym of *Tectura virginea* (Figure 6b) (which lacks dark pigment).

Lab 08 identified the synonym *Collisella tessulata*; Lab 13 identified the synonym *Tectura testudinalis*.

Fig. 6b. *Tectura virginea* – D

RT4207 – *Fabricia stellaris* (Figure 7a).
Substratum: Mixed. Salinity: High. Depth: Infralittoral. Geography: Orkney. Condition: Good, Medium (2-3 mm).

Fig. 7a. *Fabricia stellaris* (RT4207) – L

No generic or specific differences.

Labs 02, 12, 13, 25a, 25b, and 25c identified the synonym *Fabricia sabella*; Lab 15 identified the subspecies *Fabricia stellaris stellaris*.

RT4208 – *Iphinoe serrata* (Figure 8a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower shelf). Geography: S.E. England. Condition: Good, Medium (6-7 mm).

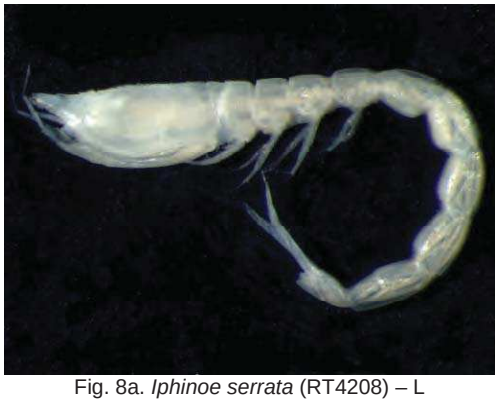


Fig. 8a. *Iphinoe serrata* (RT4208) – L

One generic and two specific differences:
Lab 07 identified as *Iphinoe trispinosa* (Figure 8b) (which has fewer dorsal spines);
Lab 12 identified as *Leucon (Leucon) acutirostris* (no photograph available) (which lacks eyes).

Fig. 8b. *Iphinoe trispinosa* – L

RT4209 – *Malacoceros fuliginosus* (Figure 9a).

Substratum: Mud. Salinity: Full. Depth: Infralittoral. Geography: Shetland. Condition: Fair, Medium (Variable).

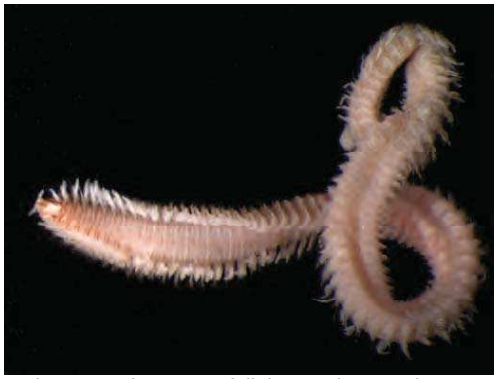


Fig. 9a. *Malacoceros fuliginosus* (RT4209) – AD

No generic or specific differences.

The current policy is to use the suggested species name of *Malacoceros fuliginosus*; however, the nomenclature is currently under review (V. Radashevsky, pers comm.).

Labs 02 and 13 incorrectly spelt the species.

RT4210 – *Protodorvillea kefersteini* (Figure 10a).
Substratum: Mixed. Salinity: Full. Depth: Infralittoral. Geography: Shetland. Condition: Fair, Medium (Variable).

Fig. 10a. *Protodorvillea kefersteini* (RT4210) – AD

No generic or specific differences.

Lab 03 incorrectly spelt the species.

RT4211 – *Ditrupa arietina* (Figure 11a).
Substratum: Muddy Sand. Salinity: Full. Depth: Circalittoral. Geography: N. North Sea. Condition: Good, Large (2.5-3.5 cm).

Fig. 11a. *Ditrupa arietina* (RT4211) – L

No generic or specific differences.

RT4212 – *Pterolysippe vanelli* (Figure 12a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower Shelf). Geography: N. North Sea. Condition: Fair, Medium.

Fig. 12a. *Pterolysippe vanelli* (RT4212) – D

Two generic and two specific differences:
Lab 02 identified as *Anobothrus gracilis* (Figure 12b);
Lab 12 identified as *Amythasides macroglossus* (Figure 12c) (both of which lack elongated mid body segments).

Lab 09b and 14 identified the synonym *Eclysippe vanelli*;
Lab 19 identified the synonym *Auchenoplax vanelli*.

Fig. 12b. *Anobothrus gracilis* - DL

Fig. 12c. *Amythasides macroglossus* – D

RT4213 – *Paramphinome jeffreysii* (Figure 13a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower Shelf). Geography: N. North Sea. Condition: Good, Medium.

Fig. 13a. *Paramphinome jeffreysii* (RT4213) – L

Two generic and two specific differences:
Labs 25b and 25c identified as *Linopherus hemuli* (no photograph available) (which lacks large anteriorly directed hooks on chaetiger 1).

RT4214 – *Omalogyra atomus* (Figure 14a).

Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Small (1mm).

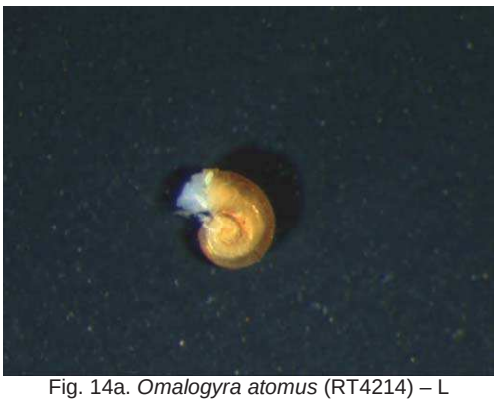


Fig. 14a. *Omalogyra atomus* (RT4214) – L

No generic or specific differences.

RT4215 – *Lacuna vincta* (Figure 15a).

Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Medium.

Fig. 15a. *Lacuna vincta* (RT4215) – L

One generic and three specific differences:
Lab 02 identified as *Cingulopsis fulgida*, a synonym of *Eatonina fulgida* (Figure 15b) (which has more tumid whorls and lacks an umbilical chink);
Labs 10 and 12 identified as *Lacuna parva* (Figure 15c) (which has a shorter spire).

Fig. 15b. *Eatonina fulgida* – L

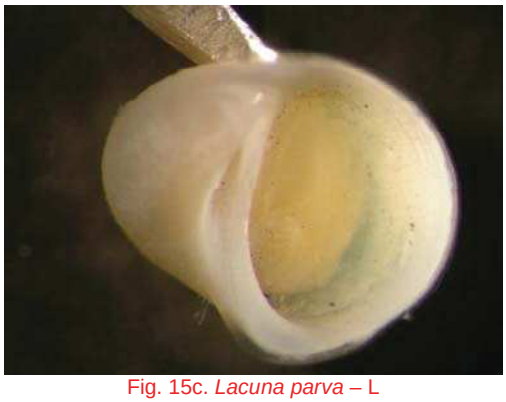


Fig. 15c. *Lacuna parva* – L

RT4216 – *Gammarus locusta* (Figure 16a).

Substratum: Mixed. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Fair/ No Uropod 3, Medium/Large.

Fig. 16a. *Gammarus locusta* (RT4216) – L

One generic and one specific difference:
Lab 13 identified as *Echinogammarus pirloti* (no photograph available) (which has uropod 3 with a very small inner ramus, whereas in *Gammarus locusta* the inner ramus is at least one third of the outer ramus length).

RT4217 – *Skeneopsis planorbis* (Figure 17a).

Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good/Fair, Medium.

Fig. 17a. *Skeneopsis planorbis* (RT4217) – L

No generic or specific differences.

RT4218 – *Ecrobia ventrosa* (Figure 18a).

Substratum: Mud. Salinity: Reduced. Depth: Intertidal. Geography: N. Scotland. Condition: Fair, Medium.

Fig. 18a. *Ecrobia ventrosa* (RT4218) – L

Fifteen generic and fourteen specific differences:
Lab 23a identified as *Peringia ulvae* (Figure 18b) (which has less tumid whorls);
Labs 02, 08, and 25b identified as *Hydrobia ulvae*, a synonym of *P. ulvae*;
Lab 09a identified as *Hydrobia acuta* and Lab 11 identified as *Hydrobia acuta neglecta*, a subspecies of *Hydrobia acuta* (no photograph available) (which lacks a filiform tip to the penis);
Lab 12 identified as *Potamopyrgus antipodarum* (Figure 18c) (which is larger for the same number of whorls);
Lab 13 identified as *Odostomia scalaris* (no photograph available) (which has a columellar tooth);
Lab 20 identified as *Ecrobia truncata* (no photograph available) (which is not known from European waters);
Labs 23b and 25c identified as *Mercuria confusa* (Figure 18d) (which has stronger axial sculpture and a broader shell);
Lab 24 identified as *Marstoniopsis scholtzi* (no photograph available) (which is found only in fully fresh water and has a less tapering spire);
Lab 25a identified as *Pusillina sarsii* (Figure 18e) (which has some apical pigment).

Lab 03 identified the synonym *Hydrobia ventrosa*;
Lab 14 identified the synonym *Ventrosia ventrosa*;
Lab 10 did not submit data for this specimen (identification is required to species for RT exercises).

Fig. 18b. *Peringia ulvae* – L

Fig. 18c. *Potamopyrgus antipodarum* – L

Fig. 18d. *Mercuria confusa* – L

Fig. 18e. *Pusillina sarsii* – L

RT4219 – *Onoba aculeus* (Figure 19a).

Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Medium/Large.

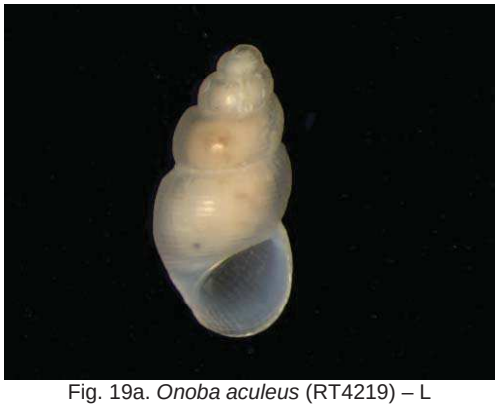


Fig. 19a. *Onoba aculeus* (RT4219) – L

No generic and two specific differences: Labs 11 and 23a identified as *Onoba semicostata* (Figure 19b) (which has a smaller protoconch).

Fig. 19b. *Onoba semicostata* – L

RT4220 – *Timoclea ovata* (Figure 20a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower Shelf). Geography: N. North Sea. Condition: Good, Small.

Fig. 20a. *Timoclea ovata* (RT4220) – L

No generic or specific differences.

RT4221 – *Onoba aculeus* (Figure 21a).

Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Small (1 mm).

Fig. 21a. *Onoba aculeus* (RT4221) – L

Ten generic and twelve specific differences:
Lab 02 identified as *Cingulopsis fulgida*, a synonym of *Eatonina fulgida* (Figure 15b) (which lacks spiral sculpture);
Labs 06, 07, 11, 13, 17, 19, and 25b identified as *Obtusella intersecta* (Figure 21b) (which has weaker sculpture and a broader shell);
Labs 23b and 24 identified as *Onoba semicostata* (Figure 19b) (which has a smaller protoconch);
Labs 25a and 25c identified as *Rissoella diaphana* (Figure 21c) (which lacks spiral sculpture).

Lab 03 incorrectly spelt the species.

Fig. 21b. *Obtusella intersecta* – L

Fig. 21c. *Rissoella diaphana* – L

RT4222 – *Bittium reticulatum* (Figure 22a).
Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Medium (4-5 mm).


Fig. 22a. *Bittium reticulatum* (RT4222) – L

No generic or specific differences.

RT4223 – *Turtonia minuta* (Figure 23a).
Substratum: Algae. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Good, Small (1 mm).


Fig. 23a. *Turtonia minuta* (RT4223) – L

Nine generic and nine specific differences:
Labs 06, 08, and 13 identified as *Kurtiella bidentata* (Figure 23c);
Lab 02 identified as *Mysella bidentata*, a synonym of *K. bidentata* (Figure 23b) (which has a more oblong shell);
Labs 12 and 23a identified as *Tellimya ferruginosa* (Figure 23d) (which has a more elongate shell);
Labs 16 and 21 identified as *Lasaea adansoni* (Figure 23e);
Lab 25b identified as *Kellia suborbicularis* (Figure 23f) (both of which have larger larval shells).


Fig. 23b. *Kurtiella bidentata* – L


Fig. 23d. *Tellimya ferruginosa* – L

Fig. 23e. *Lasaea adansoni* – L

Fig. 23f. *Kellia suborbicularis* – L

RT4224 – *Ampharete falcata* (Figure 24a).

Substratum: Mud. Salinity: Full. Depth: Circalittoral (Lower Shelf). Geography: N. North Sea. Condition: Fair, Small (6 mm).

Fig. 24a. *Ampharete falcata* (RT4224) – AD

Three generic and six specific differences:
Lab 02 identified as *Ampharete lindstroemi* (Figure 24b);
Lab 13 identified as *Ampharate grubei*, which is a misspelling (Figure 24c) (both of which have longer palae);
Lab 15 identified as *Pterolysippe vanelli* (Figure 12a) (which has elongate posterior thoracic segments);
Lab 25b identified as *Amage adspersa* (no photograph available) (which has dorsal bristles on seventeen segments);
Lab 12 identified as *Amythasides macroglossus* (Figure 24d) (which has three pairs of branchiae).

Lab 21 identified as *Ampharete* sp. (identification is required to species for RT exercises).

Fig. 24b. *Ampharete lindstroemi* – L

Fig. 24c. *Ampharete grubei* – AD

Fig. 24d. *Amythasides macroglossus* – AD

RT4225 – *Maxmuelleria lankesteri* (Figure 25a).

Substratum: Mud. Salinity: Full. Depth: Infralittoral. Geography: W. Scotland. Condition: Fair, Small (up to 25 mm).

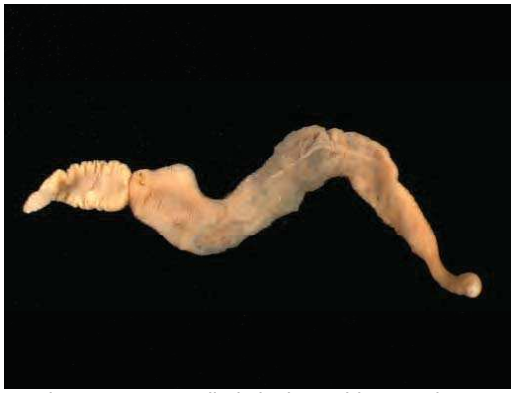


Fig. 25a. *Maxmuelleria lankesteri* (RT4225) – L

Seven generic and seven specific differences:
Labs 07, 09a, 09b, 12, and 24 identified as *Thalassema thalassemum* (no photograph available) (which is found in rock crevices, has a more southerly distribution and a pointed proboscis);
Lab 13 identified as *Echiurus echiurus* (Figure 25b) (which has posterior chaetae);
Lab 15 identified as *Falcidens crossotus* (Figure 25c) (which has spicules).

Lab 08 incorrectly spelt the species.

Fig. 25b. *Echiurus echiurus* – L

Fig. 25c. *Falcidens crossotus* – L

Acknowledgements

We would like to thank Inga Williamson (Biotikos) for donating Specimens 06 & 09, and Naveed Bhatti (SEPA) for donating Specimens 05, 18 & 25.

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Ring Test Specimen Return Instructions

Please return all ring test specimens as soon as possible.
These are reference specimens and must be returned to our collection. Your laboratory will be ineligible for future ring tests if specimens are not returned.

Return address: **Ruth Barnich, Thomson Unicomarine Ltd., Units 6 - 9 Business Centre East, Fifth Avenue, Letchworth, Hertfordshire SG6 2TS, UK**

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

SDC	Phylum	TaxonName
	Cyanobacteria	Gloeotrichia
		PLANTAE
	Bacillariophyceae	BACILLARIOPHYCEAE
		Noctiluca
		Vaucheria
ZM0001	Rhodophyta	RHODOPHYTA
ZM0002	Rhodophyta	RHODOPHYCEAE
ZM0053	Rhodophyta	Porphyra
ZM0170	Rhodophyta	Palmaria palmata
ZM0194	Rhodophyta	Corallinaceae
ZM0304	Rhodophyta	Catenella caespitosa (?)
ZM0332	Rhodophyta	Dumontia contorta
ZM0332	Rhodophyta	Dumontia contorta (?)
ZM0345	Rhodophyta	Chondrus crispus
ZM0368	Rhodophyta	Callophyllis
ZM0417	Rhodophyta	Polyides rotundus
ZM0431	Rhodophyta	Gracilaria
ZM0433	Rhodophyta	Gracilaria gracilis
ZM0443	Rhodophyta	Plocamium cartilagineum
ZM0454	Rhodophyta	Lomentaria
ZM0455	Rhodophyta	Lomentaria articulata (?)
ZM0456	Rhodophyta	Lomentaria clavellosa
ZM0471	Rhodophyta	Aglaothamnion
ZM0489	Rhodophyta	Antithamnion
ZM0507	Rhodophyta	Ceramium
ZM0539	Rhodophyta	Halurus flosculosus
ZM0551	Rhodophyta	Plumaria plumosa
ZM0554	Rhodophyta	Pterothamnion plumula
ZM0591	Rhodophyta	Cryptopleura
ZM0592	Rhodophyta	Cryptopleura ramosa
ZM0629	Rhodophyta	Chondria
ZM0629	Rhodophyta	Chondria (?)
ZM0655	Rhodophyta	Polysiphonia
ZM0690	Rhodophyta	Rhodomela confervoides
ZR0002	Phaeophyta	PHAEOPHYCEAE
ZR0002	Phaeophyta	PHAEOPHYCEAE (?)
ZR0313	Phaeophyta	Dictyota dichotoma
ZR0015	Phaeophyta	Ectocarpus
ZR0288	Phaeophyta	Sphacelaria
ZR0354	Phaeophyta	Saccharina latissima
ZR0372	Phaeophyta	Halidrys siliquosa
ZR0375	Phaeophyta	Ascophyllum nodosum
ZR0376	Phaeophyta	Fucus
ZR0377	Phaeophyta	Fucus ceranoides
ZR0382	Phaeophyta	Fucus serratus
ZR0383	Phaeophyta	Fucus spiralis
ZR0384	Phaeophyta	Fucus vesiculosus
ZS0001	Chlorophyta	CHLOROPHYTA
ZS0001	Chlorophyta	CHLOROPHYTA (?)
ZS0232	Chlorophyta	Bryopsis plumosa
ZS0002	Chlorophyta	CHLOROPHYCEAE
ZS0039	Chlorophyta	Spongomorpha
ZS0142	Chlorophyta	Blidingia
ZS0149	Chlorophyta	Enteromorpha
ZS0174	Chlorophyta	Ulva
ZS0189	Chlorophyta	Chaetomorpha
ZS0195	Chlorophyta	Cladophora
ZS0217	Chlorophyta	Rhizoclonium
	Bryophyta	BRYOPHYTA
	Spermatophyta	Lemnaceae
	Spermatophyta	Lemna
		ANIMALIA
		ANIMALIA (?)
		ANIMALIA (Type A)
		ANIMALIA (eggs)
		ANIMALIA (juv)
A0001		PROTOZOA
A0001		PROTOZOA (?)
		FORAMINIFERIDA
		Lagotia viridis
C0001	Porifera	PORIFERA
C0053	Porifera	Leucosolenia
C0133	Porifera	Scypha ciliata
C0133	Porifera	Scypha ciliata (?)
C0423	Porifera	Suberites massa
C0475	Porifera	Cliona
C0632	Porifera	Halichondria
C0638	Porifera	Halichondria bowerbanki
C0638	Porifera	Halichondria bowerbanki (?)

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

C0651	Porifera	Halichondria panicea
C0758	Porifera	Esperiopsis fucorum (?)
C1427	Porifera	Haliclona oculata
C1670	Porifera	Dysidea fragilis
C1686	Porifera	Halisarca dujardini
D0002	Cnidaria	STAUROZOA
D0002	Cnidaria	STAUROZOA (Type A)
D0002	Cnidaria	STAUROZOA (Type A, larva)
D0002	Cnidaria	STAUROZOA (Type B)
D0002	Cnidaria	STAUROZOA (juv)
D0002	Cnidaria	STAUROZOA (larva)
D0041	Cnidaria	Chrysaora hysoscella
D0048	Cnidaria	Aurelia aurita
D0138	Cnidaria	LEPTOLIDA
D0138	Cnidaria	LEPTOLIDA (Type A)
D0138	Cnidaria	LEPTOLIDA (larva)
	Cnidaria	Hydra
D0158	Cnidaria	Tubulariidae
D0163	Cnidaria	Tubularia
D0166	Cnidaria	Tubularia indivisa
D0172	Cnidaria	Coryne
D0180	Cnidaria	Sarsia
D0216	Cnidaria	FILIFERA
D0216	Cnidaria	FILIFERA (?)
D0217	Cnidaria	Eudendriidae
D0218	Cnidaria	Eudendrium
D0246	Cnidaria	Bougainvilliidae
D0251	Cnidaria	Bougainvillia
D0273	Cnidaria	Hydractinia echinata
D0285	Cnidaria	Cordylophora caspia
D0296	Cnidaria	CONICA (Type A)
D0336	Cnidaria	Lovenella clausa
D0341	Cnidaria	Opercularella lacerata
D0343	Cnidaria	Phialella quadrata
D0343	Cnidaria	Phialella quadrata (?)
D0348	Cnidaria	Calycella syringa
D0351	Cnidaria	Campanulina pumila
D0351	Cnidaria	Campanulina pumila (?)
D0380	Cnidaria	Lafoeidae
D0390	Cnidaria	Halecium
D0392	Cnidaria	Halecium halecinum
D0398	Cnidaria	Halecium sessile
D0409	Cnidaria	Abietinaria abietina
D0413	Cnidaria	Diphasia
D0424	Cnidaria	Hydrallmania falcata
D0427	Cnidaria	Sertularella
D0433	Cnidaria	Sertularia
D0435	Cnidaria	Sertularia cupressina
D0440	Cnidaria	Tamarisca tamarisca
D0445	Cnidaria	Tridentata distans
D0447	Cnidaria	Plumulariidae
D0455	Cnidaria	Kirchenpaueria pinnata
D0456	Cnidaria	Kirchenpaueria similis
D0462	Cnidaria	Nemertesia
D0463	Cnidaria	Nemertesia antennina
D0469	Cnidaria	Plumularia setacea
D0491	Cnidaria	Campanulariidae
D0493	Cnidaria	Campanularia
D0494	Cnidaria	Campanularia hincksii
D0502	Cnidaria	Clytia gracilis
D0503	Cnidaria	Clytia hemisphaerica
D0505	Cnidaria	Clytia paulensis
D0515	Cnidaria	Laomedea flexuosa
D0517	Cnidaria	Obelia
D0597	Cnidaria	Alcyonium digitatum
D0627	Cnidaria	HEXACORALLIA
D0632	Cnidaria	Cerianthus lloydii
D0662	Cnidaria	ACTINIARIA
D0662	Cnidaria	ACTINIARIA (Type A)
D0673	Cnidaria	Actiniidae
D0684	Cnidaria	Urticina felina
D0745	Cnidaria	Amphianthus dohrnii
D0710	Cnidaria	Metridium senile
D0715	Cnidaria	Sagartia troglodytes
D0717	Cnidaria	Cereus pedunculatus
D0722	Cnidaria	Sagartiogeton undatus
D0759	Cnidaria	Edwardsiidae
D0761	Cnidaria	Nematostella vectensis
D0761	Cnidaria	Nematostella vectensis (?)
D0766	Cnidaria	Edwardsia claparedii

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

E0001	Ctenophora	CTENOPHORA
E0006	Ctenophora	Pleurobrachia pileus
E0015	Ctenophora	Beroe cucumis
E0015	Ctenophora	Beroe cucumis (?)
F0001	Platyhelminthes	PLATYHELMINTHES
F0001	Platyhelminthes	PLATYHELMINTHES (?)
F0002	Platyhelminthes	TURBELLARIA
	Platyhelminthes	Fecampia erythrocephala (eggs)
	Platyhelminthes	CESTODA
	Platyhelminthes	DIGENEA (?)
G0001	Nemertea	NEMERTEA
HD0001	Nemertea	NEMATODA
HD0001	Nematoda	NEMATODA (Type A)
HD0001	Nematoda	NEMATODA (Type B)
HD0387	Nematoda	Paradraconema spinosum
J0007	Priapulida	Priapulus caudatus
K0044	Entoprocta	Pedicellinidae
K0045	Entoprocta	Pedicellina
K0050	Entoprocta	Barentsia
L0001	Chaetognatha	CHAETOGNATHA
L0012	Chaetognatha	Parasagitta elegans
L0026	Chaetognatha	Parasagitta setosa
L0009	Chaetognatha	Sagitta
L0009	Chaetognatha	Sagitta (juv)
N0001	Sipuncula	SIPUNCULA
N0009	Sipuncula	Sipunculus nudus
N0009	Sipuncula	Sipunculus nudus (?)
N0012	Sipuncula	Golfingia (juv)
N0014	Sipuncula	Golfingia elongata
N0016	Sipuncula	Golfingia margaritacea
N0017	Sipuncula	Golfingia vulgaris
N0025	Sipuncula	Nephasoma minutum
N0028	Sipuncula	Thysanocardia procera
N0034	Sipuncula	Phascolion strombus
N0037	Sipuncula	Onchnesoma steenstrupi
O0006	Echiura	Echiurus echiurus
O0018	Echiura	Maxmuelleria lankesteri
O0018	Echiura	Maxmuelleria lankesteri (?)
P0002	Annelida	POLYCHAETA
P0002	Annelida	POLYCHAETA (juv)
P0002	Annelida	POLYCHAETA (larva)
P0003	Annelida	PHYLLODOCIDA
P0015	Annelida	Pisione remota
P0017	Annelida	Aphroditidae (juv)
P0019	Annelida	Aphrodita aculeata
P0019	Annelida	Aphrodita aculeata (juv)
P0025	Annelida	Polynoidae
P0025	Annelida	Polynoidae (juv)
P0039	Annelida	Antinoella finmarchica
P0044	Annelida	Enipo kinbergi
P0049	Annelida	Gattyana cirrhosa
P0049	Annelida	Gattyana cirrhosa (?)
P0050	Annelida	Harmothoe
P0050	Annelida	Harmothoe (juv)
P0052	Annelida	Harmothoe antilopes
	Annelida	Harmothoe clavigera
P0058	Annelida	Harmothoe extenuata
P0062	Annelida	Harmothoe glabra
P0064	Annelida	Harmothoe imbricata
P0065	Annelida	Harmothoe impar
P0065	Annelida	Harmothoe impar (agg)
P0074	Annelida	Harmothoe spinifera
P0082	Annelida	Lepidonotus squamatus
P0051	Annelida	Malmgrenia andreapolis
P0067	Annelida	Malmgrenia arenicolae
P0067	Annelida	Malmgrenia arenicolae (agg)
P0066	Annelida	Malmgrenia ljungmani (?)
P0091	Annelida	Pholoe
P0092	Annelida	Pholoe baltica (sensu Petersen)
P0094	Annelida	Pholoe inornata (sensu Petersen)
P0096	Annelida	Sigalionidae (juv)
P0106	Annelida	Sthenelais
P0106	Annelida	Sthenelais (juv)
P0107	Annelida	Sthenelais boa
P0114	Annelida	Phyllodocidae
P0114	Annelida	Phyllodocidae (juv)
P0116	Annelida	Eteone
P0118	Annelida	Eteone longa
P0118	Annelida	Eteone longa (Type A)
P0118	Annelida	Eteone longa (agg)

P0118	Annelida	Eteone longa (agg, epitoke)
P0122	Annelida	Hesionura elongata
P0124	Annelida	Hypereteone foliosa
P0126	Annelida	Mysta barbata
P0127	Annelida	Mysta picta
P0139	Annelida	Anaitides
P0141	Annelida	Anaitides groenlandica
P0143	Annelida	Anaitides longipes
P0144	Annelida	Anaitides maculata
P0145	Annelida	Anaitides mucosa
P0146	Annelida	Anaitides rosea
P0150	Annelida	Eulalia (?)
P0152	Annelida	Eulalia bilineata
P0153	Annelida	Eulalia expusilla
P0155	Annelida	Eulalia mustela
P0156	Annelida	Eulalia ornata
P0161	Annelida	Eulalia viridis
P0163	Annelida	Eumida
P0163	Annelida	Eumida (juv)
P0164	Annelida	Eumida bahusiensis
P0167	Annelida	Eumida sanguinea
P0178	Annelida	Phyllodoce
P0185	Annelida	Pirakia punctifera
P0241	Annelida	Tomopteridae (juv)
P0244	Annelida	Tomopteris (juv)
P0248	Annelida	Tomopteris helgolandica
P0255	Annelida	Glycera
P0255	Annelida	Glycera (juv)
P0256	Annelida	Glycera alba
P0258	Annelida	Glycera dayi
P0260	Annelida	Glycera lapidum
P0260	Annelida	Glycera lapidum (agg)
P0260	Annelida	Glycera lapidum (juv)
P0262	Annelida	Glycera oxycephala
P0265	Annelida	Glycera tridactyla
P0268	Annelida	Glycinde nordmanni
P0271	Annelida	Goniada maculata
P0271	Annelida	Goniada maculata (?)
P0274	Annelida	Goniadella
P0279	Annelida	Commensodorum (Type A)
P0282	Annelida	Ephesiella peripatus
P0284	Annelida	Sphaerodoridium claparedii
P0288	Annelida	Sphaerodoropsis minuta
P0291	Annelida	Sphaerodorum gracilis
P0293	Annelida	Hesionidae
P0293	Annelida	Hesionidae (?)
P0305	Annelida	Psamathe fusca
P0311	Annelida	Nereimyra punctata
P0313	Annelida	Ophiodromus flexuosus
P0317	Annelida	Ophiodromus pallidus
P0319	Annelida	Podarkeopsis capensis
P0321	Annelida	Syllidia armata
P0321	Annelida	Syllidia armata (juv)
P0326	Annelida	Microphthalmus
P0346	Annelida	Syllidae
P0346	Annelida	Syllidae (Type A)
P0346	Annelida	Syllidae (juv)
P0346	Annelida	Syllidae (epitoke)
P0358	Annelida	Syllis
P0358	Annelida	Syllis (?)
P0358	Annelida	Syllis (juv)
	Annelida	Syllis "species A"
	Annelida	Syllis "species D"
	Annelida	Syllis "species G"
	Annelida	Syllis "species H"
P0365	Annelida	Syllis armillaris
P0349	Annelida	Syllis cornuta
P0349	Annelida	Syllis cornuta (agg)
P0360	Annelida	Syllis gracilis
P0360	Annelida	Syllis gracilis (?)
P0368	Annelida	Syllis hyalina
P0368	Annelida	Syllis hyalina (?)
P0371	Annelida	Syllis variegata
P0380	Annelida	Eusyllis blomstrandi
P0403	Annelida	Streptosyllis bidentata
P0405	Annelida	Streptosyllis websteri
P0406	Annelida	Syllides
P0407	Annelida	Syllides benedicti
P0411	Annelida	Brania
P0412	Annelida	Brania clavata

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

P0413	Annelida	Brania limbata
P0413	Annelida	Brania limbata (?)
P0413	Annelida	Brania limbata (?, epitoke)
P0414	Annelida	Brania pusilla
P0421	Annelida	Exogone hebes
P0421	Annelida	Exogone hebes (epitoke)
P0422	Annelida	Exogone naidina
P0422	Annelida	Exogone naidina (epitoke)
P0423	Annelida	Exogone verugera
P0424	Annelida	Sphaerosyllis
P0425	Annelida	Sphaerosyllis bulbosa
P0426	Annelida	Sphaerosyllis erinaceus
P0427	Annelida	Sphaerosyllis hystrix
P0430	Annelida	Sphaerosyllis taylori
P0430	Annelida	Sphaerosyllis taylori (agg)
P0430	Annelida	Sphaerosyllis taylori (epitoke)
	Annelida	Sphaerosyllis thomasi
P0431	Annelida	Sphaerosyllis tetralix
P0431	Annelida	Sphaerosyllis tetralix (epitoke)
P0434	Annelida	Autolytus
P0434	Annelida	Autolytus (Type B)
P0434	Annelida	Autolytus (epitoke)
P0437	Annelida	Autolytus brachycephalus
P0440	Annelida	Autolytus langerhansi
P0440	Annelida	Autolytus langerhansi (?)
P0440	Annelida	Autolytus langerhansi (agg)
P0444	Annelida	Autolytus prolifera
P0451	Annelida	Proceraea
P0451	Annelida	Proceraea (epitoke)
P0452	Annelida	Proceraea cornuta
P0453	Annelida	Proceraea picta
P0455	Annelida	Procerastea
P0456	Annelida	Procerastea halleziana
P0458	Annelida	Nereididae
P0458	Annelida	Nereididae (juv)
P0471	Annelida	Alitta succinea
P0472	Annelida	Alitta virens
P0475	Annelida	Eunereis longissima
P0475	Annelida	Eunereis longissima (epitoke)
P0462	Annelida	Hediste diversicolor
P0470	Annelida	Neanthes irrorata
P0473	Annelida	Nereis
P0473	Annelida	Nereis (juv)
P0476	Annelida	Nereis pelagica
P0478	Annelida	Nereis zonata
P0480	Annelida	Perinereis cultrifera
P0484	Annelida	Platynereis dumerilii
P0490	Annelida	Nephtyidae
P0490	Annelida	Nephtyidae (juv)
P0494	Annelida	Nephtys
P0494	Annelida	Nephtys (juv)
P0495	Annelida	Nephtys assimilis
P0496	Annelida	Nephtys caeca
P0498	Annelida	Nephtys cirrosa
P0499	Annelida	Nephtys hombergii
P0499	Annelida	Nephtys hombergii (?)
P0499	Annelida	Nephtys hombergii (Type A)
P0499	Annelida	Nephtys hombergii (Type B)
P0499	Annelida	Nephtys hombergii (agg)
P0499	Annelida	Nephtys hombergii (juv)
P0502	Annelida	Nephtys kersivalensis
P0502	Annelida	Nephtys kersivalensis (juv)
P0545	Annelida	Nothria conchylega
P0553	Annelida	Eunicidae (juv)
P0563	Annelida	Marphysa
P0564	Annelida	Marphysa bellii
P0564	Annelida	Marphysa bellii (juv)
P0565	Annelida	Marphysa fallax
P0566	Annelida	Marphysa sanguinea
P0568	Annelida	Nematonereis unicornis
	Annelida	Hilbigneris pleijeli
P0582	Annelida	Lumbrineris latreilli
P0579	Annelida	Lumbrineris gracilis
P0589	Annelida	Drilonereis
P0591	Annelida	Drilonereis filum
P0598	Annelida	Dorvilleidae
P0613	Annelida	Ophryotrocha
P0619	Annelida	Ophryotrocha hartmanni
P0633	Annelida	Parougia caeca
P0638	Annelida	Protodorvillea kefersteini

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

P0642	Annelida	Schistomeringos neglecta
P0643	Annelida	Schistomeringos rudolphi
P0665	Annelida	Orbinia sertulata (juv)
P0672	Annelida	Scoloplos armiger
P0672	Annelida	Scoloplos armiger (juv)
P0675	Annelida	Aricidea
P0677	Annelida	Aricidea minuta
P0684	Annelida	Aricidea catherinae
P0690	Annelida	Cirrophorus branchiatus
P0693	Annelida	Levinsenia gracilis
P0695	Annelida	Paradoneis (Type A)
P0699	Annelida	Paradoneis lyra
P0718	Annelida	Poecilochaetus serpens
P0720	Annelida	Spionidae
P0720	Annelida	Spionidae (Type A)
P0720	Annelida	Spionidae (juv)
P0720	Annelida	Spionidae (larva)
P0722	Annelida	Aonides oxycephala
P0723	Annelida	Aonides paucibranchiata
	Annelida	Atherospio guillei
P0727	Annelida	Boccardia polybranchia
P0750	Annelida	Dipolydora coeca
P0750	Annelida	Dipolydora coeca (agg)
P0751	Annelida	Dipolydora caulleryi
P0751	Annelida	Dipolydora caulleryi (?)
P0754	Annelida	Dipolydora flava
P0760	Annelida	Dipolydora quadrilobata
P0731	Annelida	Laonice
P0733	Annelida	Laonice bahusiensis
P0737	Annelida	Malacoceros fuliginosus
P0738	Annelida	Malacoceros tetracerus
P0746	Annelida	Minuspio multibranchiata
P0748	Annelida	Polydora
P0748	Annelida	Polydora (?)
P0748	Annelida	Polydora (Type A)
P0748	Annelida	Polydora (juv)
	Annelida	Polydora ligni
P0752	Annelida	Polydora ciliata
P0752	Annelida	Polydora ciliata (agg)
P0753	Annelida	Polydora cornuta
P0753	Annelida	Polydora cornuta (agg)
P0771	Annelida	Pseudopolydora
P0772	Annelida	Pseudopolydora antennata
P0774	Annelida	Pseudopolydora pulchra
P0775	Annelida	Pygospio
P0776	Annelida	Pygospio elegans
P0776	Annelida	Pygospio elegans (Type A)
P0776	Annelida	Pygospio elegans (larva)
P0777	Annelida	Scolelepis (juv)
P0779	Annelida	Scolelepis bonnieri
P0781	Annelida	Scolelepis foliosa
	Annelida	Scolelepis korsuni
P0783	Annelida	Scolelepis squamata
P0785	Annelida	Scolelepis tridentata
P0787	Annelida	Spio
P0788	Annelida	Spio armata
P0788	Annelida	Spio armata (agg)
P0789	Annelida	Spio decorata
P0790	Annelida	Spio filicornis
P0791	Annelida	Spio martinensis
P0794	Annelida	Spiophanes bombyx
P0796	Annelida	Spiophanes kroyeri
P0797	Annelida	Streblospio
P0799	Annelida	Streblospio shrubsolii
P0804	Annelida	Magelona alleni
P0805	Annelida	Magelona filiformis
	Annelida	Magelona johnstoni
P0806	Annelida	Magelona minuta
P0807	Annelida	Magelona mirabilis
P0822	Annelida	Cirratulidae
P0822	Annelida	Cirratulidae (Type A)
P0823	Annelida	Aphelochaeta (?)
	Annelida	Aphelochaeta "species A"
P0824	Annelida	Aphelochaeta marioni
	Annelida	Protocirrineris
P0829	Annelida	Caulleriella alata
	Annelida	Caulleriella viridis
P0832	Annelida	Chaetozone
	Annelida	Chaetozone caputesocis (?)
	Annelida	Chaetozone christiei

P0833	Annelida	Chaetozone gibber
P0834	Annelida	Chaetozone setosa
P0834	Annelida	Chaetozone setosa (agg)
P0831	Annelida	Chaetozone zetlandica
P0835	Annelida	Cirratulus (juv)
P0838	Annelida	Cirriformia
P0838	Annelida	Cirriformia (juv)
P0839	Annelida	Cirriformia tentaculata
P0839	Annelida	Cirriformia tentaculata (juv)
P0840	Annelida	Dodecaceria
P0842	Annelida	Dodecaceria concharum (sensu Petersen)
P0844	Annelida	Monticellina dorsobranchialis
P0845	Annelida	Tharyx
P0847	Annelida	Tharyx "species A"
P0846	Annelida	Tharyx killariensis
P0853	Annelida	Ctenodrilus serratus
P0868	Annelida	Cossura
P0869	Annelida	Cossura longocirrata
P0871	Annelida	Cossura pygodactyla
P0878	Annelida	Diplocirrus glaucus
P0881	Annelida	Flabelligera affinis
P0884	Annelida	Pherusa flabellata
P0885	Annelida	Pherusa plumosa
P0889	Annelida	Macrochaeta
P0903	Annelida	Capitellidae
P0906	Annelida	Capitella
P0906	Annelida	Capitella (juv)
P0907	Annelida	Capitella capitata
P0917	Annelida	Heteromastus filiformis
P0919	Annelida	Mediomastus fragilis
P0920	Annelida	Notomastus
P0921	Annelida	Notomastus latericeus
P0927	Annelida	Pseudonotomastus southerni
P0928	Annelida	Arenicolidae
P0928	Annelida	Arenicolidae (juv)
P0929	Annelida	Arenicola
P0929	Annelida	Arenicola (juv)
P0931	Annelida	Arenicola marina
P0938	Annelida	Maldanidae
P0938	Annelida	Maldanidae (juv)
P0955	Annelida	Clymenura
P0960	Annelida	Euclymene (?)
P0960	Annelida	Euclymene (Type B)
P0960	Annelida	Euclymene (juv)
P0964	Annelida	Euclymene oerstedii
P0964	Annelida	Euclymene oerstedii (?)
P0964	Annelida	Euclymene oerstedii (agg)
P0967	Annelida	Heteroclymene robusta
P0971	Annelida	Praxillella affinis
P0979	Annelida	Nicomache
P0983	Annelida	Notoproctus
P0993	Annelida	Opheliidae
P0993	Annelida	Opheliidae (juv)
P0999	Annelida	Ophelia borealis
P1003	Annelida	Ophelia rathkei
P1007	Annelida	Travisia forbesii
P1014	Annelida	Ophelina acuminata
P1022	Annelida	Asclerocheilus intermedius
P1025	Annelida	Scalibregma
P1026	Annelida	Scalibregma celticum
P1027	Annelida	Scalibregma inflatum
P1091	Annelida	Galathowenia
P1093	Annelida	Galathowenia oculata
P1098	Annelida	Owenia fusiformis
P1099	Annelida	TEREBELLIDA
P1099	Annelida	TEREBELLIDA (juv)
P1107	Annelida	Lagis koreni
P1115	Annelida	Sabellaria
P1117	Annelida	Sabellaria spinulosa
P1118	Annelida	Ampharetidae
P1118	Annelida	Ampharetidae (juv)
P1124	Annelida	Melinna palmata
P1133	Annelida	Ampharete
P1133	Annelida	Ampharete (juv)
P1134	Annelida	Ampharete baltica
P1134	Annelida	Ampharete baltica (?)
P1136	Annelida	Ampharete finmarchica
P1138	Annelida	Ampharete grubei
P1138	Annelida	Ampharete grubei (agg)
P1138	Annelida	Ampharete grubei (juv)

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P1139	Annelida	Ampharete lindstroemi
P1141	Annelida	Amphicteis (juv)
P1142	Annelida	Amphicteis gunneri
P1143	Annelida	Amphicteis midas
P1147	Annelida	Anobothrus gracilis
P1175	Annelida	Terebellides stroemi
P1179	Annelida	Terebellidae
P1179	Annelida	Terebellidae (juv)
P1185	Annelida	Amphitritides gracilis
P1185	Annelida	Amphitritides gracilis (?)
P1189	Annelida	Eupolymnia nebulosa
P1190	Annelida	Eupolymnia nesidensis
P1190	Annelida	Eupolymnia nesidensis (?)
P1195	Annelida	Lanice conchilega
P1195	Annelida	Lanice conchilega (juv)
P1203	Annelida	Neoamphitrite
P1204	Annelida	Neoamphitrite affinis
P1205	Annelida	Neoamphitrite edwardsi (?)
P1206	Annelida	Neoamphitrite figulus
P1210	Annelida	Nicolea venustula
P1211	Annelida	Nicolea zostericola
P1229	Annelida	Amaeana trilobata
P1233	Annelida	Lysilla loveni
P1235	Annelida	Polycirrus
P1242	Annelida	Polycirrus medusa
P1254	Annelida	Thelepus cincinnatus
P1255	Annelida	Thelepus setosus
P1256	Annelida	SABELLIDA (juv)
P1257	Annelida	Sabellidae
P1257	Annelida	Sabellidae (juv)
P1263	Annelida	Branchiomma bombyx
P1271	Annelida	Demonax
P1283	Annelida	Fabricia stellaris
P1294	Annelida	Manayunkia aestuarina
P1297	Annelida	Megalomma vesiculosum
P1316	Annelida	Pseudopotamilla reniformis
P1317	Annelida	Sabella (juv)
P1320	Annelida	Sabella pavonina
P1320	Annelida	Sabella pavonina (juv)
P1324	Annelida	Serpulidae
P1334	Annelida	Hydroides norvegica
P1339	Annelida	Pomatoceros
P1340	Annelida	Spirobranchus lamarcki
P1341	Annelida	Spirobranchus triqueter
P1402	Annelida	OLIGOCHAETA
P1402	Annelida	OLIGOCHAETA (eggs)
P1413	Annelida	Nais
P1420	Annelida	Paranais litoralis
P1422	Annelida	Stylaria lacustris
P1424	Annelida	Uncinais uncinata
P1425	Annelida	Tubificidae
P1425	Annelida	Tubificidae (Type A)
P1428	Annelida	Monopylephorus irroratus
P1479	Annelida	Heterochaeta costata
P1480	Annelida	Limnodrilus
P1486	Annelida	Tubifex tubifex
P1487	Annelida	Tubificoides
P1487	Annelida	Tubificoides (Type A)
P1487	Annelida	Tubificoides (Type B)
P1487	Annelida	Tubificoides (Type D)
P1489	Annelida	Tubificoides amplivasatus
P1490	Annelida	Tubificoides benedii
P1494	Annelida	Tubificoides diazi
P1496	Annelida	Tubificoides insularis
P1498	Annelida	Tubificoides pseudogaster
P1498	Annelida	Tubificoides pseudogaster (agg)
P1500	Annelida	Tubificoides swirencoides
	Annelida	Tubificoides galiciensis
	Annelida	Aulodrilus pluriseta
	Annelida	Psammoryctides barbatus
P1501	Annelida	Enchytraeidae
P1524	Annelida	Grania
P1527	Annelida	Grania postclitellochaeta
P1579	Annelida	HIRUDINEA
	Annelida	Theromyzon tessulatum
Q0002	Arthropoda	PYCNOGONIDA
Q0002	Arthropoda	PYCNOGONIDA (juv)
Q0004	Arthropoda	Nymphon (juv)
Q0005	Arthropoda	Nymphon brevirostre
Q0007	Arthropoda	Nymphon gracile

Appendix 3. Complete taxon list from the Harwich Haven Authority surveys

Q0009	Arthropoda	Nymphon hirtum
Q0015	Arthropoda	Achelia echinata
Q0015	Arthropoda	Achelia echinata (agg)
Q0018	Arthropoda	Achelia longipes
Q0018	Arthropoda	Achelia longipes (agg)
	Arthropoda	Ammothea hilgendorfi
Q0030	Arthropoda	Endeis spinosa
Q0032	Arthropoda	Callipallene
Q0032	Arthropoda	Callipallene (juv)
Q0033	Arthropoda	Callipallene brevirostris
Q0034	Arthropoda	Callipallene emaciata
Q0042	Arthropoda	Anoplodactylus (juv)
Q0043	Arthropoda	Anoplodactylus angulatus
Q0044	Arthropoda	Anoplodactylus petiolatus
Q0045	Arthropoda	Anoplodactylus pygmaeus
Q0048	Arthropoda	Phoxichilidium femoratum
Q0049	Arthropoda	Pycnogonidae (juv)
Q0051	Arthropoda	Pycnogonum littorale
Q0052	Arthropoda	ARACHNIDA
Q0054	Arthropoda	ACARINA
R0001	Arthropoda	CRUSTACEA (eggs)
R0001	Arthropoda	CRUSTACEA (larva)
	Arthropoda	CLADOCERA
R0013	Arthropoda	MAXILLOPODA
R0013	Arthropoda	MAXILLOPODA (Type A)
R0015	Arthropoda	THORACICA (Type A, larva)
R0015	Arthropoda	THORACICA (larva)
R0041	Arthropoda	Verruca stroemia
R0073	Arthropoda	Balanidae
R0073	Arthropoda	Balanidae (Type A)
R0073	Arthropoda	Balanidae (Type B)
R0073	Arthropoda	Balanidae (juv)
R0068	Arthropoda	Elminius modestus
R0077	Arthropoda	Balanus crenatus
R0078	Arthropoda	Balanus improvisus
R0092	Arthropoda	Peltogastridae
R0102	Arthropoda	Peltogaster paguri
	Arthropoda	Sacculina carcini
R0142	Arthropoda	COPEPODA
R0142	Arthropoda	COPEPODA (Type A)
R0617	Arthropoda	CYCLOPOIDA (?)
R0704	Arthropoda	Notodelphys
R0706	Arthropoda	Notodelphys allmani
R0732	Arthropoda	Ascidicola rosea
R0785	Arthropoda	HARPACTICOIDA
R1035	Arthropoda	Alteutha
R1911	Arthropoda	Clausidiidae
R1789	Arthropoda	Ergasilus
R1789	Arthropoda	Ergasilus (?)
R1789	Arthropoda	Ergasilus (juv)
R1968	Arthropoda	Selioides bocqueti
R1820	Arthropoda	Sabelliphilus elongatus
R2122	Arthropoda	Cancerilla tubulata
R2206	Arthropoda	Caligidae
R2207	Arthropoda	Caligus
R2224	Arthropoda	Lepeophtheirus pectoralis (?)
R2306	Arthropoda	Lernaeenicus sprattae
R2310	Arthropoda	Lernaeocera minuta
R2412	Arthropoda	OSTRACODA
R2413	Arthropoda	MYODOCOPIDA
R2432	Arthropoda	Eusarsiella zostericola
R2458	Arthropoda	PODOCOPIDA
S0018	Arthropoda	Rissoides desmaresti
S0025	Arthropoda	MYSIDACEA (juv)
S0031	Arthropoda	Mysidae
S0031	Arthropoda	Mysidae (juv)
S0033	Arthropoda	Siriella
S0033	Arthropoda	Siriella (?)
S0034	Arthropoda	Siriella armata
S0043	Arthropoda	Gastrosaccus sanctus
S0044	Arthropoda	Gastrosaccus spinifer
S0060	Arthropoda	Leptomysis lingvura
S0067	Arthropoda	Mysidopsis gibbosa
S0074	Arthropoda	Mesopodopsis slabberi
S0076	Arthropoda	Neomysis integer
S0076	Arthropoda	Neomysis integer (juv)
S0081	Arthropoda	Praunus
S0082	Arthropoda	Praunus flexuosus
S0086	Arthropoda	Schistomysis kervillei
S0089	Arthropoda	Schistomysis spiritus

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S0089	Arthropoda	Schistomysis spiritus (?)
S0097	Arthropoda	AMPHIPODA
	Arthropoda	Crangonyx pseudogracilis
S0102	Arthropoda	Apherusa bispinosa
S0106	Arthropoda	Apherusa jurinei
S0107	Arthropoda	Apherusa ovalipes
S0116	Arthropoda	Gammarellus homari
S0118	Arthropoda	Oedicerotidae
S0131	Arthropoda	Perioculodes longimanus
S0133	Arthropoda	Pontocrates altamarinus
S0135	Arthropoda	Pontocrates arenarius
S0138	Arthropoda	Synchelidium maculatum
S0146	Arthropoda	Parapleustes bicuspis
S0152	Arthropoda	Amphilochidae
S0158	Arthropoda	Amphilochus manudens
S0159	Arthropoda	Amphilochus neapolitanus
S0164	Arthropoda	Gitana sarsi
S0166	Arthropoda	Gitanopsis bispinosa
S0186	Arthropoda	Cressa dubia
S0187	Arthropoda	Stenothoidae
S0191	Arthropoda	Metopa alderi
S0193	Arthropoda	Metopa borealis
S0199	Arthropoda	Metopa pusilla
S0213	Arthropoda	Stenothoe marina
S0214	Arthropoda	Stenothoe monoculoides
S0217	Arthropoda	Stenothoe valida
S0219	Arthropoda	Stenula rubrovittata
S0224	Arthropoda	Hyale prevostii
S0228	Arthropoda	Talitridae
S0233	Arthropoda	Orchestia cavimana
S0234	Arthropoda	Orchestia gammarella
S0241	Arthropoda	Talitrus saltator
S0247	Arthropoda	Urothoe brevicornis
S0248	Arthropoda	Urothoe elegans
S0250	Arthropoda	Urothoe poseidonis
S0253	Arthropoda	Harpinia
S0254	Arthropoda	Harpinia antennaria
S0255	Arthropoda	Harpinia crenulata
S0257	Arthropoda	Harpinia pectinata
S0269	Arthropoda	Phoxocephalus holbolli
S0271	Arthropoda	Lysianassidae (juv)
S0275	Arthropoda	Acidostoma neglectum
S0274	Arthropoda	Acidostoma obesum (sensu Stoddart & Lowry)
S0303	Arthropoda	Lysianassa ceratina
S0321	Arthropoda	Orchomenella nana
S0330	Arthropoda	Socarnes erythrophthalmus
S0336	Arthropoda	Tmetonyx cicada
S0344	Arthropoda	Tryphosella sarsi
S0360	Arthropoda	Argissa hamatipes
S0380	Arthropoda	Iphimedia minuta
S0382	Arthropoda	Iphimedia obesa
S0409	Arthropoda	Atylus
S0409	Arthropoda	Atylus (juv)
S0410	Arthropoda	Atylus falcatus
S0411	Arthropoda	Atylus guttatus
S0412	Arthropoda	Atylus swammerdamei
S0413	Arthropoda	Atylus vedlomensis
S0415	Arthropoda	Dexamine spinosa
S0416	Arthropoda	Dexamine thea
S0420	Arthropoda	Tritaeta gibbosa
	Arthropoda	Atylidae
S0422	Arthropoda	Ampeliscidae
S0423	Arthropoda	Ampelisca
S0423	Arthropoda	Ampelisca (juv)
S0427	Arthropoda	Ampelisca brevicornis
S0429	Arthropoda	Ampelisca diadema
S0438	Arthropoda	Ampelisca spinipes
S0440	Arthropoda	Ampelisca tenuicornis
S0448	Arthropoda	Haploops tubicola
S0451	Arthropoda	Bathyporeia
S0452	Arthropoda	Bathyporeia elegans
S0454	Arthropoda	Bathyporeia guilliamsoniana
S0456	Arthropoda	Bathyporeia pelagica
S0457	Arthropoda	Bathyporeia pilosa
S0462	Arthropoda	Haustorius arenarius
S0464	Arthropoda	Gammaridae
S0464	Arthropoda	Gammaridae (juv)
S0466	Arthropoda	Echinogammarus olivii
S0471	Arthropoda	Gammarus
S0472	Arthropoda	Gammarus chevreuxi

S0473	Arthropoda	Gammarus crinicornis
S0474	Arthropoda	Gammarus duebeni
S0477	Arthropoda	Gammarus lacustris
S0478	Arthropoda	Gammarus locusta
S0478	Arthropoda	Gammarus locusta (?)
S0480	Arthropoda	Gammarus pulex
S0481	Arthropoda	Gammarus spooneri
S0483	Arthropoda	Gammarus zaddachi
S0489	Arthropoda	Megaluropus agilis
S0495	Arthropoda	Melitidae
S0495	Arthropoda	Melitidae (juv)
S0498	Arthropoda	Abludomelita obtusata
S0498	Arthropoda	Abludomelita obtusata (Type A)
S0503	Arthropoda	Cheirocratus
S0503	Arthropoda	Cheirocratus (female)
S0504	Arthropoda	Cheirocratus assimilis
S0505	Arthropoda	Cheirocratus intermedius
S0506	Arthropoda	Cheirocratus sundevallii
S0521	Arthropoda	Maerella tenuimana
S0522	Arthropoda	Melita (juv)
S0525	Arthropoda	Melita palmata
S0525	Arthropoda	Melita palmata (juv)
S0519	Arthropoda	Maera othonis
S0534	Arthropoda	Ampithoe rubricata
S0537	Arthropoda	Isaeidae
S0539	Arthropoda	Gammaropsis cornuta
S0541	Arthropoda	Gammaropsis maculata
S0542	Arthropoda	Gammaropsis nitida
S0550	Arthropoda	Microprotopus maculatus
S0552	Arthropoda	Photis longicaudata
S0553	Arthropoda	Photis pollex
S0558	Arthropoda	Ischyroceridae
S0561	Arthropoda	Ericthonius
S0561	Arthropoda	Ericthonius (female)
S0561	Arthropoda	Ericthonius (juv)
S0562	Arthropoda	Ericthonius difformis
S0564	Arthropoda	Ericthonius punctatus
S0568	Arthropoda	Jassa
S0568	Arthropoda	Jassa (female)
S0568	Arthropoda	Jassa (juv)
S0569	Arthropoda	Jassa falcata
S0570	Arthropoda	Jassa marmorata
S0576	Arthropoda	Parajassa pelagica
S0577	Arthropoda	Aoridae
S0577	Arthropoda	Aoridae (female)
S0579	Arthropoda	Aora gracilis
S0585	Arthropoda	Lembos websteri
S0585	Arthropoda	Lembos websteri (?)
S0588	Arthropoda	Leptocheirus hirsutimanus
S0590	Arthropoda	Leptocheirus pilosus
S0592	Arthropoda	Microdeutopus
S0592	Arthropoda	Microdeutopus (Type A)
S0593	Arthropoda	Microdeutopus anomalus
S0596	Arthropoda	Microdeutopus gryllotalpa
	Arthropoda	Grandidierella japonica
S0604	Arthropoda	Corophiidae
S0604	Arthropoda	Corophiidae (juv)
S0605	Arthropoda	Corophium
S0605	Arthropoda	Corophium (juv)
S0609	Arthropoda	Corophium arenarium
S0614	Arthropoda	Corophium multisetosum
S0616	Arthropoda	Corophium volutator
S0606	Arthropoda	Monocorophium acherusicum
S0612	Arthropoda	Monocorophium insidiosum
S0615	Arthropoda	Monocorophium sextonae
S0610	Arthropoda	Crassicorophium bonnellii
S0611	Arthropoda	Crassicorophium crassicorne
S0607	Arthropoda	Apocorophium acutum
S0618	Arthropoda	Siphonoecetes kroyeranus
S0621	Arthropoda	Unciola crenatipalma
S0623	Arthropoda	Podoceridae
S0628	Arthropoda	Dyopedos monacanthus
S0629	Arthropoda	Dyopedos porrectus
S0639	Arthropoda	Caprellidae
S0641	Arthropoda	Caprella acanthifera
S0643	Arthropoda	Caprella equilibra
S0646	Arthropoda	Caprella linearis
	Arthropoda	Caprella mutica
S0649	Arthropoda	Caprella tuberculata
S0651	Arthropoda	Pariambus typicus

S0728	Arthropoda	Hyperiidae
S0730	Arthropoda	Hyperia galba
S0790	Arthropoda	ISOPODA
S0790	Arthropoda	ISOPODA (Type A, male)
S0790	Arthropoda	ISOPODA (juv)
S0792	Arthropoda	Gnathiidae
S0792	Arthropoda	Gnathiidae (female)
S0792	Arthropoda	Gnathiidae (juv)
S0793	Arthropoda	Gnathia
S0796	Arthropoda	Gnathia oxyuraea
S0803	Arthropoda	Anthura gracilis
S0805	Arthropoda	Cyathura carinata
S0844	Arthropoda	Natatolana borealis
S0851	Arthropoda	Eurydice affinis
S0854	Arthropoda	Eurydice pulchra
S0869	Arthropoda	Lekanesphaera hookeri
	Arthropoda	Lekanesphaera levii
S0871	Arthropoda	Lekanesphaera rugicauda
S0868	Arthropoda	Sphaeroma
S0872	Arthropoda	Sphaeroma serratum
S0877	Arthropoda	Asellus aquaticus
S0885	Arthropoda	Jaera albifrons (agg)
S0892	Arthropoda	Janira maculosa
S0901	Arthropoda	Munna
S0907	Arthropoda	Munna minuta
S0934	Arthropoda	Idotea
S0934	Arthropoda	Idotea (juv)
S0935	Arthropoda	Idotea baltica
S0936	Arthropoda	Idotea chelipes
S0937	Arthropoda	Idotea emarginata
S0938	Arthropoda	Idotea granulosa
S0939	Arthropoda	Idotea linearis
S0941	Arthropoda	Idotea neglecta
S0942	Arthropoda	Idotea pelagica
S0947	Arthropoda	Zenobiana prismatica
S0952	Arthropoda	Astacilla
S0995	Arthropoda	Bopyridae
S0995	Arthropoda	Bopyridae (female)
S0995	Arthropoda	Bopyridae (male)
S1009	Arthropoda	Ione thoracica
S1112	Arthropoda	Heterotanais oerstedi
S1114	Arthropoda	Leptochelia dubia
S1140	Arthropoda	Pseudoparatanais batei
S1142	Arthropoda	Tanaopsis graciloides
S1169	Arthropoda	Tanaissus lilljeborgi
S1183	Arthropoda	CUMACEA
S1184	Arthropoda	Bodotriidae
S1188	Arthropoda	Cumopsis goodsiri
S1191	Arthropoda	Vaunthompsonia cristata
S1194	Arthropoda	Bodotria arenosa
S1197	Arthropoda	Bodotria scorpioides
S1208	Arthropoda	Eudorella truncatula
S1224	Arthropoda	Cumella pygmaea
S1228	Arthropoda	Nannastacus unguiculatus
S1231	Arthropoda	Pseudocumatidae
S1236	Arthropoda	Pseudocuma longicornis
S1244	Arthropoda	Diastylidae
S1247	Arthropoda	Diastylis
S1247	Arthropoda	Diastylis (juv)
S1248	Arthropoda	Diastylis bradyi
S1252	Arthropoda	Diastylis lucifera
S1253	Arthropoda	Diastylis rathkei
S1254	Arthropoda	Diastylis rugosa
S1263	Arthropoda	EUPHAUSIACEA (larva)
S1268	Arthropoda	Nyctiphanes couchi
S1276	Arthropoda	DECAPODA
S1276	Arthropoda	DECAPODA (Type A)
S1276	Arthropoda	DECAPODA (Type B)
S1276	Arthropoda	DECAPODA (Type D)
S1276	Arthropoda	DECAPODA (eggs)
S1276	Arthropoda	DECAPODA (juv)
S1276	Arthropoda	DECAPODA (zoea)
S1311	Arthropoda	Palaemonidae (Type A)
S1311	Arthropoda	Palaemonidae (zoea)
S1315	Arthropoda	Palaemon
S1317	Arthropoda	Palaemon elegans
	Arthropoda	Palaemon macrodactylus
	Arthropoda	Palaemon macrodactylus (zoea)
S1319	Arthropoda	Palaemon serratus
S1319	Arthropoda	Palaemon serratus (juv)

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S1321	Arthropoda	Palaemonetes varians
S1331	Arthropoda	Alpheus macrocheles (zoea)
S1333	Arthropoda	Athanas nitescens
S1334	Arthropoda	Hippolytidae
S1334	Arthropoda	Hippolytidae (Type A)
S1334	Arthropoda	Hippolytidae (juv)
S1334	Arthropoda	Hippolytidae (zoea)
S1345	Arthropoda	Eualus pusiolus
S1350	Arthropoda	Hippolyte varians
S1360	Arthropoda	Thoralus cranchii
S1362	Arthropoda	Processa (?)
S1362	Arthropoda	Processa (zoea)
S1363	Arthropoda	Processa canaliculata
S1366	Arthropoda	Processa modica
S1374	Arthropoda	Pandalina brevirostris
S1374	Arthropoda	Pandalina brevirostris (juv)
S1377	Arthropoda	Pandalus montagui
S1380	Arthropoda	Crangonidae
S1380	Arthropoda	Crangonidae (zoea)
S1386	Arthropoda	Philocheras (zoea)
S1388	Arthropoda	Philocheras fasciatus
S1390	Arthropoda	Philocheras trispinosus
S1383	Arthropoda	Crangon (Type A)
S1383	Arthropoda	Crangon (juv)
S1383	Arthropoda	Crangon (zoea)
S1384	Arthropoda	Crangon allmanni
S1384	Arthropoda	Crangon allmanni (?)
S1385	Arthropoda	Crangon crangon
S1400	Arthropoda	Homarus gammarus
S1407	Arthropoda	Axius stirhynchus
S1407	Arthropoda	Axius stirhynchus (juv)
S1409	Arthropoda	Calocaris macandreae
S1415	Arthropoda	Callianassa subterranea
S1415	Arthropoda	Callianassa subterranea (juv)
S1418	Arthropoda	Upogebia (juv)
S1419	Arthropoda	Upogebia deltaura
S1445	Arthropoda	Paguridae
S1445	Arthropoda	Paguridae (juv)
S1448	Arthropoda	Anapagurus hyndmanni
S1449	Arthropoda	Anapagurus laevis
S1449	Arthropoda	Anapagurus laevis (?)
S1457	Arthropoda	Pagurus bernhardus
S1457	Arthropoda	Pagurus bernhardus (Type A)
S1457	Arthropoda	Pagurus bernhardus (juv)
S1457	Arthropoda	Pagurus bernhardus (zoea)
S1463	Arthropoda	Pagurus pubescens
S1469	Arthropoda	Galatheidae (juv)
S1470	Arthropoda	Galathea (zoea)
S1472	Arthropoda	Galathea intermedia
S1472	Arthropoda	Galathea intermedia (juv)
S1475	Arthropoda	Galathea squamifera
S1482	Arthropoda	Pisidia longicornis
S1482	Arthropoda	Pisidia longicornis (Type A)
S1482	Arthropoda	Pisidia longicornis (Type B)
S1482	Arthropoda	Pisidia longicornis (juv)
S1482	Arthropoda	Pisidia longicornis (zoea)
S1504	Arthropoda	Ebalia
S1504	Arthropoda	Ebalia (megalopa)
S1504	Arthropoda	Ebalia (juv)
S1504	Arthropoda	Ebalia (zoea)
S1508	Arthropoda	Ebalia tuberosa
S1509	Arthropoda	Ebalia tumefacta
S1517	Arthropoda	Hyas (juv)
S1518	Arthropoda	Hyas araneus
S1519	Arthropoda	Hyas coarctatus
S1525	Arthropoda	Inachus (juv)
S1526	Arthropoda	Inachus dorsettensis (Type A)
S1526	Arthropoda	Inachus dorsettensis (Type B)
S1526	Arthropoda	Inachus dorsettensis (zoea)
S1528	Arthropoda	Inachus phalangium
S1529	Arthropoda	Macropodia
S1529	Arthropoda	Macropodia (megalopa)
S1529	Arthropoda	Macropodia (juv)
S1529	Arthropoda	Macropodia (zoea)
	Arthropoda	Macropodia parva
S1532	Arthropoda	Macropodia rostrata
S1552	Arthropoda	Corystes cassivelaunus
S1552	Arthropoda	Corystes cassivelaunus (juv)
S1555	Arthropoda	Atelecyclus rotundatus
S1555	Arthropoda	Atelecyclus rotundatus (juv)

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S1566	Arthropoda	Cancer pagurus
S1566	Arthropoda	Cancer pagurus (Type B)
S1566	Arthropoda	Cancer pagurus (juv)
S1569	Arthropoda	Portunidae (juv)
S1569	Arthropoda	Portunidae (zoea)
S1577	Arthropoda	Liocarcinus (juv)
	Arthropoda	Liocarcinus vernalis
S1578	Arthropoda	Liocarcinus navigator
S1580	Arthropoda	Liocarcinus depurator
S1581	Arthropoda	Liocarcinus holsatus
S1582	Arthropoda	Liocarcinus marmoreus
S1584	Arthropoda	Liocarcinus pusillus
S1589	Arthropoda	Necora puber
S1589	Arthropoda	Necora puber (Type A)
S1594	Arthropoda	Carcinus maenas
S1594	Arthropoda	Carcinus maenas (Type A)
S1594	Arthropoda	Carcinus maenas (Type B)
S1594	Arthropoda	Carcinus maenas (megalopa)
S1594	Arthropoda	Carcinus maenas (juv)
S1594	Arthropoda	Carcinus maenas (zoea)
S1614	Arthropoda	Pilumnus (juv)
S1615	Arthropoda	Pilumnus hirtellus
S1615	Arthropoda	Pilumnus hirtellus (juv)
S1638	Arthropoda	Pinnotheres pisum
S1638	Arthropoda	Pinnotheres pisum (?, megalopa)
S1638	Arthropoda	Pinnotheres pisum (zoea)
	Arthropoda	CHILOPODA (?)
	Arthropoda	ODONATA
	Arthropoda	Calopterygidae
	Arthropoda	Coenagriidae
	Arthropoda	EPHEMEROPTERA
	Arthropoda	Baetidae (?)
	Arthropoda	Caenidae
	Arthropoda	Ephemerellidae
	Arthropoda	Ephemeridae
	Arthropoda	HEMIPTERA
	Arthropoda	Corixidae
	Arthropoda	Corixidae (juv)
	Arthropoda	Notonectidae
	Arthropoda	Aphididae
	Arthropoda	THYSANOPTERA
	Arthropoda	TRICHOPTERA
	Arthropoda	Goeridae (?)
	Arthropoda	Leptoceridae
	Arthropoda	Limnephilidae
	Arthropoda	Polycentropodidae
	Arthropoda	Psychomyiidae
	Arthropoda	Sericostomatidae
	Arthropoda	DIPTERA
	Arthropoda	DIPTERA (Type A)
	Arthropoda	DIPTERA (larva)
	Arthropoda	DIPTERA (pupa)
	Arthropoda	Chironomidae
	Arthropoda	Chironomidae (juv)
	Arthropoda	Chironomidae (larva)
	Arthropoda	Chironomidae (pupa)
	Arthropoda	Tipulidae
	Arthropoda	Tipulidae (juv)
	Arthropoda	Tipulidae (larva)
	Arthropoda	Culicidae
	Arthropoda	Ceratopogonidae
	Arthropoda	Dolichopodidae
	Arthropoda	Dolichopodidae (larva)
	Arthropoda	Rhagionidae
	Arthropoda	COLEOPTERA
	Arthropoda	COLEOPTERA (larva)
	Arthropoda	Dytiscidae
	Arthropoda	Elmidae
	Arthropoda	Staphylinidae
	Arthropoda	Curculionidae
	Arthropoda	Chrysomelidae
	Arthropoda	HYMENOPTERA
	Arthropoda	COLLEMBOLA
W0053	Mollusca	Leptochiton asellus
W0079	Mollusca	Lepidochitona cinerea
W0088	Mollusca	GASTROPODA
W0088	Mollusca	GASTROPODA (juv)
W0157	Mollusca	Gibbula
W0157	Mollusca	Gibbula (juv)
W0161	Mollusca	Gibbula tumida

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W0161	Mollusca	Gibbula tumida (juv)
W0163	Mollusca	Gibbula cineraria
W0163	Mollusca	Gibbula cineraria (juv)
W0182	Mollusca	Calliostoma zizyphinum
W0182	Mollusca	Calliostoma zizyphinum (juv)
W0198	Mollusca	Skenea serpuloides
	Mollusca	Theodoxus fluviatilis
W0285	Mollusca	Lacuna (?)
W0287	Mollusca	Lacuna crassior
W0292	Mollusca	Lacuna vincta
W0283	Mollusca	Littorinidae (?)
W0294	Mollusca	Littorina (Type A)
W0294	Mollusca	Littorina (eggs)
W0294	Mollusca	Littorina (juv)
W0296	Mollusca	Littorina littorea
W0302	Mollusca	Littorina obtusata
W0305	Mollusca	Littorina saxatilis
W0324	Mollusca	Rissoidae
W0324	Mollusca	Rissoidae (juv)
W0328	Mollusca	Rissoa parva f. interrupta
W0348	Mollusca	Crisilla semistriata
W0371	Mollusca	Onoba semicostata
	Mollusca	Bithynia leachii
	Mollusca	Bithynia tentaculata
	Mollusca	Potamopyrgus antipodarum
W0387	Mollusca	Ventrosia ventrosa
W0385	Mollusca	Peringia ulvae
W0402	Mollusca	Assiminea grayana
W0421	Mollusca	Tornus subcarinatus
W0439	Mollusca	Crepidula fornicata
W0439	Mollusca	Crepidula fornicata (eggs)
W0439	Mollusca	Crepidula fornicata (juv)
W0773	Mollusca	Euspira catena
W0491	Mollusca	Euspira pulchella
W0549	Mollusca	Epitonium clathrus
W0556	Mollusca	Epitonium clathratulum
W0687	Mollusca	Nucella lapillus (juv)
W0685	Mollusca	Ocenebra erinacea
W0702	Mollusca	Buccinidae (juv)
W0708	Mollusca	Buccinum undatum
W0708	Mollusca	Buccinum undatum (eggs)
W0708	Mollusca	Buccinum undatum (juv)
W0743	Mollusca	Hinia (eggs)
W0743	Mollusca	Hinia (juv)
W0745	Mollusca	Hinia reticulata
W0819	Mollusca	Oenopota rufa
	Mollusca	Valvata cristata
	Mollusca	Valvata piscinalis
W0901	Mollusca	Omalogyra atomus
W0906	Mollusca	Pyramidellidae
W0971	Mollusca	Turbonilla lactea
W0965	Mollusca	Chrysallida pellucida
W0956	Mollusca	Noemiamea dolioliformis
W0908	Mollusca	Odostomia
W0909	Mollusca	Odostomia acuta
W0913	Mollusca	Odostomia plicata
W0915	Mollusca	Odostomia turrita
W0916	Mollusca	Odostomia unidentata
W0919	Mollusca	Brachystomia
W0919	Mollusca	Brachystomia (?)
W0920	Mollusca	Brachystomia carrozzai (?)
W0925	Mollusca	Brachystomia scalaris
W1059	Mollusca	Diaphana minuta
W1077	Mollusca	Retusa obtusa
W1036	Mollusca	Philine
W1038	Mollusca	Philine aperta
W1118	Mollusca	Elysia viridis
W1118	Mollusca	Elysia viridis (juv)
W1127	Mollusca	Alderia modesta
W1135	Mollusca	Limapontia capitata
W1136	Mollusca	Limapontia depressa
W1243	Mollusca	NUDIBRANCHIA
W1243	Mollusca	NUDIBRANCHIA (eggs)
W1243	Mollusca	NUDIBRANCHIA (juv)
W1301	Mollusca	Goniodoris castanea
W1315	Mollusca	Ancula gibbosa
W1333	Mollusca	Acanthodoris pilosa
W1320	Mollusca	Onchidoris
W1325	Mollusca	Onchidoris muricata
W1350	Mollusca	Polycera quadrilineata

W1359	Mollusca	Thecacera pennigera
W1267	Mollusca	Dendronotus frondosus
W1270	Mollusca	Doto
W1246	Mollusca	Tritonia
W1246	Mollusca	Tritonia (juv)
W1292	Mollusca	Embletonia pulchra
W1410	Mollusca	Proctonotus mucroniferus
W1482	Mollusca	Aeolidiidae
W1484	Mollusca	Aeolidia papillosa
W1445	Mollusca	Eubranchus
W1445	Mollusca	Eubranchus (?)
W1431	Mollusca	Cuthona
	Mollusca	Lymnaea peregra
	Mollusca	Lymnaea truncatula
W1511	Mollusca	Ovatella myosotis
	Mollusca	Acroloxus lacustris
	Mollusca	Gyraulus albus
W1560	Mollusca	PELECYPODA
W1560	Mollusca	PELECYPODA (juv)
W1563	Mollusca	Nuculidae (juv)
W1565	Mollusca	Nucula (juv)
W1568	Mollusca	Nucula hanleyi
W1569	Mollusca	Nucula nitidosa
W1570	Mollusca	Nucula nucleus
W1577	Mollusca	Nuculoma tenuis
W1691	Mollusca	Mytilidae
W1691	Mollusca	Mytilidae (juv)
W1693	Mollusca	Mytilus (juv)
W1695	Mollusca	Mytilus edulis
W1695	Mollusca	Mytilus edulis (juv)
W1721	Mollusca	Musculus discors
W1721	Mollusca	Musculus discors (juv)
W1698	Mollusca	Modiolus (juv)
W1702	Mollusca	Modiolus modiolus
W1702	Mollusca	Modiolus modiolus (juv)
W1768	Mollusca	Pectinidae (juv)
W1773	Mollusca	Aequipecten opercularis
W1773	Mollusca	Aequipecten opercularis (juv)
W1805	Mollusca	Anomiidae (juv)
W1761	Mollusca	Crassostrea gigas
W1758	Mollusca	Ostrea edulis
W1864	Mollusca	Diplodonta rotundata
W1882	Mollusca	Hemilepton nitidum
W1906	Mollusca	Kurtiella bidentata
W1902	Mollusca	Tellimya ferruginosa
	Mollusca	Carditidae (juv)
W1929	Mollusca	Goodallia triangularis
W1938	Mollusca	Cardiidae (juv)
W1949	Mollusca	Parvicardium exiguum
W1952	Mollusca	Parvicardium scabrum
W1960	Mollusca	Cerastoderma
W1961	Mollusca	Cerastoderma edule
W1961	Mollusca	Cerastoderma edule (juv)
W1962	Mollusca	Cerastoderma glaucum
W1972	Mollusca	Mactra stultorum
W1972	Mollusca	Mactra stultorum (juv)
W1973	Mollusca	Spisula (juv)
W1977	Mollusca	Spisula solida
W1977	Mollusca	Spisula solida (juv)
W1978	Mollusca	Spisula subtruncata (juv)
W1982	Mollusca	Lutraria (juv)
W1996	Mollusca	Ensis (juv)
W1998	Mollusca	Ensis arcuatus
W1998	Mollusca	Ensis arcuatus (juv)
W1997	Mollusca	Ensis directus
W1997	Mollusca	Ensis directus (juv)
W2006	Mollusca	Phaxas pellucidus
W2006	Mollusca	Phaxas pellucidus (juv)
W2019	Mollusca	Fabulina fabula
W2021	Mollusca	Moerella donacina
W2029	Mollusca	Macoma balthica
W2029	Mollusca	Macoma balthica (juv)
W2068	Mollusca	Scrobicularia plana
W2068	Mollusca	Scrobicularia plana (juv)
W2058	Mollusca	Abra
W2059	Mollusca	Abra alba
W2059	Mollusca	Abra alba (juv)
W2061	Mollusca	Abra nitida
W2062	Mollusca	Abra prismatica
W2064	Mollusca	Abra tenuis

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	Mollusca	Pisidium
W2086	Mollusca	Veneridae (juv)
W2110	Mollusca	Tapes (juv)
	Mollusca	Tapes philippinarum
	Mollusca	Tapes philippinarum (juv)
W2115	Mollusca	Tapes decussatus
W2113	Mollusca	Tapes rhomboides
W2124	Mollusca	Venerupis senegalensis
W2124	Mollusca	Venerupis senegalensis (juv)
W2104	Mollusca	Timoclea ovata
W2104	Mollusca	Timoclea ovata (juv)
W2137	Mollusca	Petricola pholadiformis
W2137	Mollusca	Petricola pholadiformis (juv)
W2144	Mollusca	Mya
W2147	Mollusca	Mya truncata
W2147	Mollusca	Mya truncata (juv)
W2149	Mollusca	Mya arenaria
W2149	Mollusca	Mya arenaria (juv)
W2152	Mollusca	Sphenia binghami
W2157	Mollusca	Corbula gibba
W2162	Mollusca	Gastrochaena dubia
W2166	Mollusca	Hiatella arctica
W2166	Mollusca	Hiatella arctica (?)
W2172	Mollusca	Saxicavella jeffreysi
W2174	Mollusca	Pholadidae
W2174	Mollusca	Pholadidae (juv)
W2181	Mollusca	Barnea candida
W2181	Mollusca	Barnea candida (agg)
W2181	Mollusca	Barnea candida (juv)
W2183	Mollusca	Barnea parva
W2201	Mollusca	Teredo navalis
W2217	Mollusca	Nototeredo norvegica
W2227	Mollusca	Thracia (juv)
W2307	Mollusca	Sepia officinalis
W2309	Mollusca	Sepiolidae (juv)
W2329	Mollusca	Sepiola atlantica
W2341	Mollusca	Alloteuthis subulata
W2341	Mollusca	Alloteuthis subulata (juv)
Y0001	Bryozoa	BRYOZOA
Y0004	Bryozoa	Crisiidae
Y0013	Bryozoa	Crisia
Y0027	Bryozoa	Tubulipora
Y0042	Bryozoa	Plagioecia sarniensis
Y0066	Bryozoa	Disporella hispida
Y0073	Bryozoa	Alcyonidium
Y0074	Bryozoa	Alcyonidium albidum
Y0075	Bryozoa	Alcyonidium cellarioides
Y0075	Bryozoa	Alcyonidium cellarioides (?)
Y0076	Bryozoa	Alcyonidium diaphanum
Y0077	Bryozoa	Alcyonidium gelatinosum
Y0080	Bryozoa	Alcyonidium mytili
Y0081	Bryozoa	Alcyonidium parasiticum
Y0084	Bryozoa	Flustrellidra hispida
Y0091	Bryozoa	Nolella
Y0092	Bryozoa	Nolella dilatata
Y0094	Bryozoa	Nolella stipata (?)
Y0096	Bryozoa	Anguinella palmata
Y0097	Bryozoa	Victorellidae
Y0098	Bryozoa	Victorella
Y0111	Bryozoa	Walkeria
Y0112	Bryozoa	Walkeria uva
Y0118	Bryozoa	Triticella
Y0119	Bryozoa	Triticella flava
Y0122	Bryozoa	Farrella repens
Y0131	Bryozoa	Vesicularia spinosa
Y0135	Bryozoa	Amathia lendigera
Y0137	Bryozoa	Bowerbankia
Y0139	Bryozoa	Bowerbankia gracilis
Y0154	Bryozoa	Aetea anguina
Y0165	Bryozoa	Eucratea loricata
Y0170	Bryozoa	Membranipora membranacea
Y0172	Bryozoa	Conopeum reticulum
Y0177	Bryozoa	Electra monostachys
Y0178	Bryozoa	Electra pilosa
Y0182	Bryozoa	Aspidelectra melolontha
Y0186	Bryozoa	Flustra
Y0187	Bryozoa	Flustra foliacea
Y0203	Bryozoa	Callopora discreta
Y0204	Bryozoa	Callopora dumerilli
Y0221	Bryozoa	Amphiblestrum

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Y0222	Bryozoa	Amphiblestrum auritum
Y0240	Bryozoa	Bugula
Y0245	Bryozoa	Bugula neritina
Y0246	Bryozoa	Bugula plumosa
Y0249	Bryozoa	Bugula stolonifera
Y0256	Bryozoa	Bicellariella ciliata
Y0261	Bryozoa	Beania mirabilis
Y0276	Bryozoa	Scrupocellaria reptans
Y0278	Bryozoa	Scrupocellaria scrupea
Y0279	Bryozoa	Scrupocellaria scruposa
Y0280	Bryozoa	Tricellaria (Type A)
Y0310	Bryozoa	Cribrilina punctata
Y0333	Bryozoa	Hippothoa flagellum
Y0337	Bryozoa	Celleporella hyalina
Y0350	Bryozoa	Umbonula ovicellata (?)
Y0364	Bryozoa	Escharella immersa
Y0369	Bryozoa	Escharella variolosa
Y0370	Bryozoa	Escharella ventricosa
Y0385	Bryozoa	Porella concinna
Y0401	Bryozoa	Reptadeonella violacea
Y0411	Bryozoa	Cryptosula pallasiana
Y0414	Bryozoa	Hippoporina pertusa
Y0418	Bryozoa	Pentapora fascialis
Y0423	Bryozoa	Schizoporella
Y0457	Bryozoa	Smittina cheilostoma
Y0461	Bryozoa	Smittoidea amplissima
Y0461	Bryozoa	Smittoidea amplissima (?)
Y0463	Bryozoa	Smittoidea reticulata
Y0467	Bryozoa	Schizomavella
Y0468	Bryozoa	Schizomavella auriculata
Y0474	Bryozoa	Schizomavella linearis
Y0480	Bryozoa	Microporella ciliata
Y0495	Bryozoa	Cellepora pumicosa
Y0504	Bryozoa	Turbicellepora avicularis
Y0520	Bryozoa	Hagiosynodos latus
ZA0003	Phoronida	Phoronis
ZA0003	Phoronida	Phoronis (larva)
ZA0005	Phoronida	Phoronis muelleri
ZA0006	Phoronida	Phoronis ovalis
ZB0018	Echinodermata	ASTEROIDEA (juv)
ZB0075	Echinodermata	Crossaster papposus
ZB0075	Echinodermata	Crossaster papposus (juv)
ZB0100	Echinodermata	Asterias rubens
ZB0100	Echinodermata	Asterias rubens (juv)
ZB0124	Echinodermata	Ophiothrix fragilis
ZB0124	Echinodermata	Ophiothrix fragilis (juv)
ZB0148	Echinodermata	Amphiuridae
ZB0148	Echinodermata	Amphiuridae (juv)
ZB0149	Echinodermata	Amphiura (juv)
ZB0152	Echinodermata	Amphiura chiajei
ZB0161	Echinodermata	Amphipholis squamata
ZB0161	Echinodermata	Amphipholis squamata (juv)
ZB0165	Echinodermata	Ophiuridae
ZB0165	Echinodermata	Ophiuridae (juv)
ZB0166	Echinodermata	Ophiura (juv)
ZB0168	Echinodermata	Ophiura albida
ZB0170	Echinodermata	Ophiura ophiura
ZB0181	Echinodermata	ECHINOIDEA (juv)
ZB0190	Echinodermata	ECHINOIDA (juv)
ZB0193	Echinodermata	Psammechinus miliaris
ZB0193	Echinodermata	Psammechinus miliaris (juv)
ZB0194	Echinodermata	Echinidae (juv)
ZB0198	Echinodermata	Echinus esculentus
ZB0212	Echinodermata	Echinocyamus pusillus
ZB0213	Echinodermata	SPATANGOIDA
ZB0213	Echinodermata	SPATANGOIDA (juv)
ZB0223	Echinodermata	Echinocardium cordatum
ZB0225	Echinodermata	Echinocardium pennatifidum
ZB0266	Echinodermata	Cucumariidae (juv)
ZB0262	Echinodermata	Thyone fusus
ZB0262	Echinodermata	Thyone fusus (juv)
ZC0012	Hemichordata	ENTEROPNEUSTA
ZC0018	Hemichordata	Saccoglossus
ZD0002	Chordata	ASCIDIACEA
ZD0002	Chordata	ASCIDIACEA (Type A)
ZD0002	Chordata	ASCIDIACEA (Type B)
ZD0002	Chordata	ASCIDIACEA (juv)
ZD0002	Chordata	ASCIDIACEA (larva)
ZD0007	Chordata	Clavelina lepadiformis
ZD0013	Chordata	Distaplia rosea

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ZD0020	Chordata	Polyclinidae
ZD0022	Chordata	Polyclinum aurantium
ZD0041	Chordata	Didemnidae
ZD0071	Chordata	Ciona intestinalis
ZD0078	Chordata	Perophora listeri
ZD0082	Chordata	Ascidiidae
ZD0083	Chordata	Ascidiella (juv)
ZD0084	Chordata	Ascidiella aspersa
ZD0085	Chordata	Ascidiella scabra
ZD0087	Chordata	Ascidia
ZD0087	Chordata	Ascidia (larva)
ZD0088	Chordata	Ascidia conchilega
ZD0100	Chordata	Styelidae
ZD0104	Chordata	Styela clava
ZD0112	Chordata	Polycarpa fibrosa
ZD0115	Chordata	Polycarpa pomaria
ZD0120	Chordata	Dendrodoa grossularia
ZD0124	Chordata	Stolonica socialis
ZD0125	Chordata	Botryllus
ZD0126	Chordata	Botryllus schlosseri
ZD0128	Chordata	Botrylloides leachi
ZD0138	Chordata	Pyura
ZD0140	Chordata	Pyura squamulosa
ZD0146	Chordata	Molgula
ZD0146	Chordata	Molgula (juv)
ZD0149	Chordata	Molgula complanata
ZD0151	Chordata	Molgula manhattensis
ZD0160	Chordata	APPENDICULARIA
ZF0028	Chordata	Scyliorhinus canicula
ZF0089	Chordata	Raja clavata
ZG0001	Chordata	OSTEICHTHYES
ZG0001	Chordata	OSTEICHTHYES (Type A)
ZG0001	Chordata	OSTEICHTHYES (Type B)
ZG0001	Chordata	OSTEICHTHYES (Type C)
ZG0001	Chordata	OSTEICHTHYES (Type D)
ZG0001	Chordata	OSTEICHTHYES (Type E)
ZG0001	Chordata	OSTEICHTHYES (Type E, eggs)
ZG0001	Chordata	OSTEICHTHYES (Type E, megalopa)
ZG0001	Chordata	OSTEICHTHYES (Type F)
ZG0001	Chordata	OSTEICHTHYES (Type F, eggs)
ZG0001	Chordata	OSTEICHTHYES (Type G)
ZG0001	Chordata	OSTEICHTHYES (Type H)
ZG0001	Chordata	OSTEICHTHYES (Type I, eggs)
ZG0001	Chordata	OSTEICHTHYES (eggs)
ZG0001	Chordata	OSTEICHTHYES (juv)
ZG0001	Chordata	OSTEICHTHYES (larva)
ZG0011	Chordata	Anguilla anguilla
ZG0029	Chordata	Clupeidae
ZG0029	Chordata	Clupeidae (juv)
ZG0036	Chordata	Sardina pilchardus (Type A)
ZG0034	Chordata	Clupea harengus
ZG0034	Chordata	Clupea harengus (eggs)
ZG0034	Chordata	Clupea harengus (juv)
ZG0038	Chordata	Sprattus sprattus
ZG0038	Chordata	Sprattus sprattus (?, eggs)
ZG0038	Chordata	Sprattus sprattus (Type A)
ZG0038	Chordata	Sprattus sprattus (eggs)
ZG0038	Chordata	Sprattus sprattus (juv)
ZG0041	Chordata	Engraulis encrasicolus (Type A)
ZG0041	Chordata	Engraulis encrasicolus (eggs)
ZG0041	Chordata	Engraulis encrasicolus (juv)
ZG0054	Chordata	Osmerus eperlanus
	Chordata	Cobitis taenia
ZG0086	Chordata	Diplecogaster bimaculata (?, juv)
ZG0105	Chordata	Gadidae
ZG0105	Chordata	Gadidae (eggs)
ZG0105	Chordata	Gadidae (juv)
ZG0111	Chordata	Ciliata mustela
ZG0116	Chordata	Gadus morhua
ZG0123	Chordata	Merlangius merlangus
ZG0134	Chordata	Pollachius
ZG0135	Chordata	Pollachius pollachius
ZG0143	Chordata	Trisopterus luscus
ZG0144	Chordata	Trisopterus minutus
ZG0185	Chordata	Belone belone (juv)
ZG0194	Chordata	Atherina presbyter
ZG0226	Chordata	Gasterosteus aculeatus
ZG0230	Chordata	Spinachia spinachia
ZG0235	Chordata	Syngnathidae (juv)
ZG0237	Chordata	Entelurus aequoreus

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ZG0242	Chordata	Nerophis lumbriciformis
ZG0244	Chordata	Syngnathus
ZG0245	Chordata	Syngnathus acus
ZG0245	Chordata	Syngnathus acus (?)
ZG0246	Chordata	Syngnathus rostellatus
ZG0246	Chordata	Syngnathus rostellatus (juv)
ZG0269	Chordata	Trigla lucerna
ZG0273	Chordata	Cottidae (juv)
ZG0281	Chordata	Myoxocephalus scorpius
ZG0283	Chordata	Taurulus bubalis
ZG0291	Chordata	Agonus cataphractus
ZG0294	Chordata	Cyclopterus lumpus
ZG0294	Chordata	Cyclopterus lumpus (juv)
ZG0295	Chordata	Liparis
ZG0296	Chordata	Liparis liparis
ZG0297	Chordata	Liparis montagui
ZG0312	Chordata	Dicentrarchus labrax
ZG0374	Chordata	Mullus surmuletus
ZG0395	Chordata	Crenilabrus melops
ZG0395	Chordata	Crenilabrus melops (?, juv)
ZG0399	Chordata	Labrus bergylta
ZG0405	Chordata	Echiichthys vipera (Type A)
ZG0412	Chordata	Lipophrys pholis
ZG0412	Chordata	Lipophrys pholis (juv)
ZG0437	Chordata	Zoarces viviparus
ZG0440	Chordata	Pholis gunnellus
ZG0441	Chordata	Ammodytidae (juv)
ZG0444	Chordata	Ammodytes tobianus (?)
ZG0451	Chordata	Callionymus (eggs)
ZG0451	Chordata	Callionymus (juv)
ZG0452	Chordata	Callionymus lyra
ZG0452	Chordata	Callionymus lyra (juv)
ZG0455	Chordata	Gobiidae
ZG0455	Chordata	Gobiidae (?, juv)
ZG0455	Chordata	Gobiidae (Type A)
ZG0455	Chordata	Gobiidae (juv)
ZG0457	Chordata	Aphia minuta
ZG0461	Chordata	Crystallogobius linearis (?)
ZG0462	Chordata	Gobius
ZG0462	Chordata	Gobius (juv)
ZG0467	Chordata	Gobius niger
ZG0468	Chordata	Gobius paganellus
ZG0470	Chordata	Gobiusculus flavescens
ZG0476	Chordata	Pomatoschistus
ZG0476	Chordata	Pomatoschistus (Type A)
ZG0476	Chordata	Pomatoschistus (juv)
ZG0481	Chordata	Pomatoschistus pictus
ZG0556	Chordata	Scophthalmus rhombus
ZG0564	Chordata	Pleuronectidae (juv)
ZG0572	Chordata	Limanda limanda
ZG0574	Chordata	Microstomus kitt
ZG0576	Chordata	Platichthys flesus
ZG0576	Chordata	Platichthys flesus (Type A)
ZG0576	Chordata	Platichthys flesus (Type A, juv)
ZG0576	Chordata	Platichthys flesus (Type B)
ZG0576	Chordata	Platichthys flesus (Type C)
ZG0576	Chordata	Platichthys flesus (juv)
ZG0578	Chordata	Pleuronectes platessa
ZG0578	Chordata	Pleuronectes platessa (juv)
ZG0581	Chordata	Soleidae (juv)
ZG0585	Chordata	Buglossidium luteum (?, eggs)
ZG0589	Chordata	Solea (juv)
ZG0591	Chordata	Solea solea
ZG0591	Chordata	Solea solea (?)
ZG0591	Chordata	Solea solea (Type A)
ZG0591	Chordata	Solea solea (eggs)
ZG0591	Chordata	Solea solea (juv)

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Aphelochaeta marioni	83981	822	Biotope characterising species; taxonomy unresolved; cryptogenic
Streblospio	49626	656	Biotope characterising species; taxonomy unresolved; includes non-native
Phoronis	38885	396	Taxonomy unresolved
Tubificoides benedii	38633	584	Biotope characterising species
Elminius modestus	21460	125	Biotope characterising species; non-native
Tharyx "species A"	21145	560	Taxonomy unresolved; cryptogenic
Tubificoides amplivasatus	11725	605	Biotope characterising species
Pariambus typicus	11359	454	
Peringia ulvae	9370	372	Biotope characterising species
Tubificoides pseudogaster (agg)	7167	494	Taxonomy unresolved
Scalibregma inflatum	6876	99	
Abra tenuis	6634	227	
Sabella pavonina	5753	133	Biotope characterising species; cryptogenic
Exogone naidina	5270	422	
Chaetozone zetlandica	4543	427	Newly recorded
Ampharete acutifrons	4532	556	Taxonomy unresolved
Sphaerosyllis taylori	4172	389	Taxonomy unresolved
Achelia	4079	325	
Hediste diversicolor	3968	341	Biotope characterising species
Melinna palmata	3723	553	
Syllidia armata	3705	339	
Crepidula fornicata	3586	290	Biotope characterising species; non-native
Capitella	3374	355	Taxonomy unresolved
Tritaeta gibbosa	3317	93	
Mediomastus fragilis	3193	332	Biotope characterising species
Scoloplos armiger	3001	135	
Nephtys hombergii	2979	693	Biotope characterising species
Corophium volutator	2910	83	Biotope characterising species
Sabelliphilus elongatus	2766	15	
Manayunkia aestuarina	2649	79	Biotope characterising species
Phyllodoce mucosa	2581	342	
Pygospio elegans	2485	280	Biotope characterising species
Cirriformia tentaculata	2474	284	
Macoma balthica	2334	373	Biotope characterising species
Polydora cornuta	2312	247	Cryptogenic
Cerastoderma edule	2185	333	Biotope characterising species
Galathowenia oculata	1935	184	
Cumella pygmaea	1679	249	
Mytilus edulis	1589	248	Biotope characterising species
Aricidea minuta	1558	229	
Dendrodoa grossularia	1437	35	
Cossura pygodactyla	1424	275	Cryptogenic
Mya arenaria	1413	112	Non-native
Harmothoe impar (agg)	1290	258	
Microprotopus maculatus	1264	238	
Heterochaeta costata	1209	55	Biotope characterising species
Balanus crenatus	1147	71	
Tubificoides galiciensis	1119	134	Taxonomy unresolved
Amphipholis squamata	1110	152	
Eusarsiella zostericola	979	142	Non-native
Anoplodactylus pygmaeus	900	177	
Ascidiella aspersa	874	147	
Exogone hebes	857	185	
Monocorophium sextonae	776	59	Cryptogenic
Monocorophium acherusicum	762	94	Cryptogenic
Crassicorophium bonnellii	762	53	Cryptogenic
Retusa obtusa	612	138	
Eumida sanguinea	584	181	
Harpinia pectinata	568	104	
Sabellaria spinulosa	567	80	Biotope characterising species
Prosphaerosyllis	562	159	Taxonomy unresolved
Abra alba	469	158	Biotope characterising species
Harmothoe imbricata	467	134	
Bodotria scorpioides	443	181	
Lanice conchilega	408	137	Biotope characterising species
Eteone longa (agg)	404	111	Biotope characterising species
Cyathura carinata	398	41	
Eudorella truncatula	396	147	
Nucula nucleus	394	115	Biotope characterising species
Notomastus	339	126	
Melita palmata	338	63	
Unciola crenatipalma	336	39	
Aora gracilis	319	73	
Eteone longa (Type A)	305	52	Taxonomy unresolved; non-native
Dipolydora quadrilobata	300	42	
Spiophanes bombyx	287	63	Biotope characterising species
Chironomidae (larva)	284	74	
Molgula manhattensis	284	32	
Tubificoides insularis	282	37	
Munna	281	75	
Parvicardium exiguum	281	138	
Nucula nitidosa	270	69	
Protodorvillea kefersteini	230	103	
Carcinus maenas	229	168	
Dipolydora coeca (agg)	227	67	Taxonomy unresolved
Tubificoides swirencoides	226	12	Taxonomy unresolved
Microdeutopus gryllotalpa	225	66	
Platynereis dumerilii	207	96	
Polydora ciliata (agg)	207	65	Taxonomy unresolved
Ampharete lindstroemi	180	52	
Eumida bahusiensis	179	89	

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Pholoe inornata (sensu Petersen)	178	94	
Pycnogonum littorale	177	80	
Scrobicularia plana	172	57	Biotope characterising species
Eunereis longissima	171	86	
Spirobranchus lamarcki	168	64	
Lepidonotus squamatus	167	97	
Abra nitida	166	64	
Gibbula cineraria	159	81	
Nymphon brevirostre	151	64	
Anoplodactylus petiolatus	151	66	
Paranais litoralis	147	3	
Jaera albifrons (agg)	147	23	
Alderia modesta	146	18	
Amphilochus neapolitanus	143	77	
Gitana sarsi	140	66	
Lekanesphaera levii	135	41	
Ophryotrocha	134	75	
Grania	127	13	
Sphaerosyllis thomasi	118	8	
Alitta virens	118	60	Cryptogenic
Erinaceusyllis erinaceus	116	64	
Stenothoe marina	114	29	
Eusyllis blomstrandi	113	51	
Phaxas pellucidus	113	59	
Jassa	105	62	
Ampelisca spinipes	102	26	
Ericthonius punctatus	101	23	
Scalibregma celticum	96	36	
Amphilochus manudens	96	37	
Polycarpa pomaria	92	31	
Euclymene oerstedii	91	19	
Ctenodrilus serratus	90	5	Cryptogenic
Ampelisca brevicornis	89	44	
Ericthonius difformis	88	5	
Caprella linearis	84	27	
Nematostella vectensis	81	17	Nationally scarce; protected; non-native
Photis pollex	76	30	Cryptogenic
Amphicteis midas	75	37	
Verruca stroemia	75	3	
Odostomia turrita	75	32	
Exogone verugera	72	17	
Lumbrineris gracilis	70	45	Taxonomy unresolved
Syllis gracilis	69	32	
Apherusa bispinosa	69	35	
Syllis variegata	65	28	
Callipallene	65	26	
Neoamphitrite figulus	64	46	
Lepidochitona cinerea	64	27	
Monocorophium insidiosum	63	18	Cryptogenic
Dyopedos monacanthus	63	24	
Styela clava	63	20	Non-native
Gattyana cirrhosa	62	46	
Ammothea hilgendorfi	59	11	Non-native
Barnea candida	55	9	
Limapontia depressa	53	14	
Glycera tridactyla	52	47	
Idotea baltica	52	10	
Pseudocuma longicornis	51	26	
Petricola pholadiformis	50	25	Non-native
Kurtiella bidentata	49	27	
Littorina saxatilis	46	7	Biotope characterising species
Nephtys kersivalensis	44	21	Taxonomy unresolved
Nephtys cirrosa	43	27	
Sthenelais boa	42	39	
Dipolydora caulleryi	42	20	
Caulleriella alata	41	21	
Lagis koreni	40	23	
Argissa hamatipes	38	26	
Crangon crangon	38	36	
Venerupis philippinarum	38	19	Non-native
Idotea chelipes	36	18	
Pisidia longicornis	36	17	
Salvatoria clavata	35	20	
Abludomelita obtusata	35	17	
Salvatoria limbata	34	4	
Alitta succinea	33	6	Cryptogenic
Saxicavella jeffreysi	33	5	
Ensis directus	32	25	Non-native
Spio martinensis	31	13	
Ammothella	31	13	
Ampelisca tenuicornis	31	10	
Iphimedia minuta	30	14	
Dexamine spinosa	30	20	
Sphenia binghami	30	12	
Heteroclymene robusta	29	5	
Bathyporeia elegans	29	9	
Ascidiella scabra	28	9	
Onchidoris muricata	27	19	
Syllis armillaris	26	5	
Littorina littorea	25	8	
Ascidicola rosea	24	13	

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Praxillella affinis	23	11	
Cheirocratus sundevallii	21	15	
Nephtys caeca	20	19	
Pomatoschistus	20	11	
Asclerocheilus intermedius	19	7	Taxonomy unresolved
Gammaropsis cornuta	19	9	
Grandidierella japonica	19	4	Non-native
Zenobiana prismatica	19	13	
Goniada maculata	18	17	
Aonides oxycephala	18	17	
Urothoe elegans	18	3	
Magelona johnstoni	17	8	
Protocirrineris	17	1	Taxonomy unresolved; cryptogenic
Crassicorophium crassicorne	17	5	
Glycera oxycephala	16	12	
Notodelphys	16	9	
Alteutha	16	12	
Hesionura elongata	15	2	
Sphaerosyllis bulbosa	15	5	
Hypereteone foliosa	14	7	
Glycera lapidum (agg)	14	8	
Mesopodopsis slabberi	14	14	
Metopa pusilla	14	8	
Rissoa parva	14	10	
Edwardsiidae	13	8	
Tanaissus lilljeborgi	13	7	
Liocarcinus depurator	13	2	
Spisula solida	13	6	
Pseudopolydora pulchra	12	10	
Macrochaeta	12	3	
Odostomia plicata	12	6	
Musculus discors	12	8	
Thyone fusus	12	11	
Syllides	11	9	
Perioculodes longimanus	11	10	
Parapleustes bicuspis	11	5	
Stenothoe monoculoides	11	5	
Diastylis bradyi	11	11	
Chironomidae (pupa)	11	4	
Edwardsia claparedii	10	1	
Flabelligera affinis	10	7	
Ophelia borealis	10	5	
Nannastacus unguiculatus	10	5	
Acanthodoris pilosa	10	9	
Golfingia elongata	9	7	
Sphaerodoropsis minuta	9	8	
Fabricia stellaris	9	3	
Bathyporeia pelagica	9	1	
Gibbula tumida	9	6	
Brachystomia	9	6	
Aphrodita aculeata	8	8	
Malmgrenia arenicolae	8	6	
Malacoceros tetracerus	8	6	
Spio filicornis	8	2	
Pherusa plumosa	8	5	
Cressa dubia	8	2	
Urothoe brevicornis	8	3	
Atylus falcatus	8	8	
Psammechinus miliaris	8	6	
Apherusa jurinei	7	2	
Iphimedia obesa	7	2	
Atylus guttatus	7	6	
Gammarus locusta	7	4	
Macropodia rostrata	7	7	
Ophiothrix fragilis	7	7	
Molgula complanata	7	6	
Mysta picta	6	6	
Psamathe fusca	6	5	
Brania	6	5	
Phoxichilidium femoratum	6	6	
Schistomysis kervillei	6	6	
Microdeutopus anomalus	6	4	
Diastylis rugosa	6	5	
Tellimya ferruginosa	6	1	
Ophiura albida	6	6	
Harmothoe antilopes	5	3	
Pholoe baltica (sensu Petersen)	5	4	
Phyllodoce rosea	5	4	
Streptosyllis websteri	5	4	
Spio armata	5	3	
Dodecaceria	5	5	Taxonomy unresolved
Travisia forbesii	5	2	
Endeis spinosa	5	3	
Schistomysis spiritus	5	4	
Harpinia crenulata	5	4	
Haploops tubicola	5	2	
Cumopsis goodsiri	5	5	
Pagurus bernhardus	5	5	
Eubranchus	5	5	
Polycarpa fibrosa	5	1	
Priapulus caudatus	4	3	

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Golfingia vulgaris	4	2	
Maxmuelleria lankesteri	4	4	
Podarkeopsis capensis	4	3	
Streptosyllis bidentata	4	2	
Psammoryctides barbatus	4	1	
Cancerilla tubulata	4	3	
Harpinia antennaria	4	3	
Gammarus zaddachi	4	2	
Janira maculosa	4	3	
Thoralus cranchii	4	3	
Elysia viridis	4	1	
Tritonia	4	2	
Parvicardium scabrum	4	4	
Venerupis corrugata	4	4	
Echinocardium cordatum	4	3	
Eulalia expusilla	3	3	
Eulalia ornata	3	1	
Marphysa sanguinea	3	3	
Aonides paucibranchiata	3	3	
Malacoceros fuliginosus	3	3	
Spio decorata	3	3	
Ophelina acuminata	3	2	
Atylus swammerdamei	3	2	
Ampelisca diadema	3	3	
Bathyporeia guilliamsoniana	3	2	
Cheirocratus intermedius	3	3	
Photis longicaudata	3	3	
Corophium arenarium	3	1	
Bodotria arenosa	3	3	
Hippolyte varians	3	3	
Pandalus montagui	3	3	
Cancer pagurus	3	3	
Pinnotheres pisum	3	3	
Leptochiton asellus	3	3	
Tornus subcarinatus	3	2	
Modiolus (juv)	3	2	
Microphthalmus	2	2	
Nereis zonata	2	2	
Perinereis cultrifera	2	2	
Parougia caeca	2	2	
Scolelepis bonnieri	2	2	
Ampharete baltica (?)	2	1	Taxonomy unresolved
Amphitritides gracilis	2	2	
Eupolymnia nesidensis (?)	2	1	
Branchiomma bombyx	2	1	
Spirobranchus triqueter	2	2	
Nymphon hirtum	2	1	
Urothoe poseidonis	2	1	
Orchomenella nana	2	1	
Tryphosella sarsi	2	2	
Gammaropsis maculata	2	2	
Apocorophium acutum	2	2	Cryptogenic
Siphonoecetes kroyeranus	2	2	
Diastylis rathkei	2	2	
Atelecyclus rotundatus	2	2	
Lacuna crassior	2	2	
Alvania semistriata	2	2	
Onoba semicostata	2	2	
Euspira pulchella	2	1	
Epitonium clathratulum	2	2	
Buccinum undatum (juv)	2	2	
Hinia reticulata	2	2	
Diaphana minuta	2	2	
Asterias rubens	2	2	
Ascidia conchilega	2	1	
Gobius niger	2	2	
Clavelina lepadiformis	1	1	
Cerianthus lloydii	1	1	
Thysanocardia procera	1	1	
Mysta barbata	1	1	
Pirakia punctifera	1	1	
Glycera dayi	1	1	
Glycinde nordmanni	1	1	
Goniadella gracilis	1	1	
Sphaerodorum gracilis	1	1	
Brania pusilla	1	1	
Procerastea	1	1	
Schistomeringos neglecta	1	1	
Paradoneis lyra	1	1	
Laonice bahusiensis	1	1	
Magelona filiformis	1	1	
Aphelochaeta "species A"	1	1	
Chaetozone gibber	1	1	Newly recorded
Diplocirrus glaucus	1	1	
Pherusa flabellata	1	1	
Notoproctus	1	1	
Neoamphitrite edwardsi (?)	1	1	
Nicolea zostericola	1	1	
Anoplodactylus angulatus	1	1	
Siriella armata	1	1	
Apherusa ovalipes	1	1	

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Gammarellus homari	1	1	
Gitanopsis bispinosa	1	1	
Phoxocephalus holbolli	1	1	
Acidostoma obesum (sensu Stoddart & Lowry)	1	1	
Dexamine thea	1	1	
Gammarus spooneri	1	1	
Parajassa pelagica	1	1	
Leptocheirus pilosus	1	1	
Eurydice pulchra	1	1	
Lekanesphaera hookeri	1	1	
Idotea granulosa	1	1	
Idotea linearis	1	1	
Heterotanais oerstedi	1	1	
Leptochelia dubia	1	1	
Athanas nitescens	1	1	
Crangon allmanni	1	1	
Liocarcinus vernalis	1	1	
Odostomia acuta	1	1	
Philine aperta	1	1	
Limapontia capitata	1	1	
Thecacera pennigera	1	1	Cryptogenic
Embletonia pulchra	1	1	
Proctonotus mucroniferus	1	1	
Crassostrea gigas	1	1	Non-native
Mactra stultorum	1	1	
Spisula subtruncata	1	1	
Fabulina fabula	1	1	
Abra prismatica	1	1	
Venerupis decussata	1	1	
Timoclea ovata	1	1	
Ciona intestinalis	1	1	
Stolonica socialis	1	1	
Pyura squamulosa	1	1	
Anguilla anguilla	1	1	
Conopeum reticulum		405	
Anguinella palmata		368	
Bicellariella ciliata		153	
Alcyonidium mytili		128	Taxonomy unresolved
Cryptosula pallasiana		106	
Nolella		96	
Electra monostachys		81	
Scypha ciliata		78	Taxonomy unresolved
Alcyonidium diaphanum		77	Taxonomy unresolved
Pedicellina		67	
Bugula plumosa		62	
Hydrallmania falcata		60	
Electra pilosa		58	
Halecium		57	
Sertularia		57	
Sertularella		54	
Barentsia		50	
Vesicularia spinosa		40	
Leucosolenia		39	
Cliona		34	
Eudendrium		34	
Diphasia		33	
Botrylloides leachi		28	
Flustra foliacea		24	
Calycella syringa		23	
Scrupocellaria scruposa		23	
Aspidelectra melolontha		22	
Escharella immersa		22	
Perophora listeri		21	
Tubulariidae		20	
Schizomavella linearis		20	
Walkeria uva		19	
Alcyonidium parasiticum		17	
Botryllus schlosseri		14	Cryptogenic
Clytia gracilis		13	
Alcyonidium cellarioides (?)		13	Taxonomy unresolved
Clytia hemisphaerica		10	
Amphiblestrum auritum		10	
Amathia lendigera		8	
Eucratea loricata		8	
Tridentata distans		7	
Kirchenpaueria pinnata		7	
Plumularia setacea		6	
Alcyonium digitatum		6	
Pentapora fascialis		6	
Cordylophora caspia		5	Non-native
Lovenella clausa		5	
Opercularella lacerata		3	
Phialella quadrata		3	
Crisia		3	
Suberites massa		2	
Dysidea fragilis		2	
Scrupocellaria reptans		2	
Tricellaria inopinata		2	
Escharella variolosa		2	
Schizoporella		2	
Smittoidea amplissima (?)		2	

Appendix 4. Species recorded from the standardised Shipek grab samples, in order of total abundance, with taxonomic notes.

TaxonName	Total	Count	Notes
Haliclona oculata		1	
Halisarca dujardini		1	
Campanulina pumila		1	
Tamarisca tamarisca		1	
Kirchenpaueria similis		1	
Nemertesia		1	
Clytia paulensis		1	
Balanus improvisus		1	Cryptogenic
Alcyonidium albidum		1	Taxonomy unresolved
Flustrellidra hispida		1	
Victorella		1	
Farrella repens		1	
Bugula stolonifera		1	
Beania mirabilis		1	
Umbonula ovicellata (?)		1	
Smittoidea reticulata		1	
Cellepora pumicosa		1	

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

			P0462	P0499	P0753	P0797	P1027	P1320	P1479	P1489	P1490	R0068	W0439		P0824		P0829	P0832	P0833	P0831	P0835	P0839	P0840	P0847	P0853	P0871		
	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
512	1997	ORW97#25-#A#114-7	0	0	2	5	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	13	0	4	0	0	0	0
513	1997	ORW97#25-#B#114-8	0	0	1	1	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	27	0	0	0	0	0	0
514	1997	ORW97#251#A#114-9	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
515	1997	ORW97#251#B#1141-	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
516	1997	ORW97#252#A#114-5	0	0	0	190	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0
517	1997	ORW97#252#B#114-6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0
518	1997	ORW97#253#A#11411	0	1	9	39	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	29	0	2	0	0
519	1997	ORW97#253#B#11412	3	0	34	79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	86	0	0	0	0
520	1997	ORW97#254#A#114-3	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
521	1997	ORW97#254#B#114-4	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
522	1997	ORW97#255#A#11415	5	1	16	50	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	31	0	0	0	0
523	1997	ORW97#255#B#11416	10	0	25	71	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	73	0	0	0	0
524	1997	ORW97#256#A#114-1	0	0	7	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
525	1997	ORW97#256#B#114-2	0	1	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
526	1997	ORW97#257#A#11413	4	0	11	108	0	0	0	4	0	0	0	0	19	0	0	0	0	0	0	0	0	52	0	1	0	0
527	1997	ORW97#257#B#11414	5	1	17	119	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	120	0	1	0	0
528	1997	ORW97#258#A#11419	8	0	84	57	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
529	1997	ORW97#258#B#1142-	1	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
530	1997	ORW97#259#A#11399	0	2	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
531	1997	ORW97#259#B#114--	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
532	1997	ORW97#26-#A#11417	0	0	0	1	0	0	0	0	28	0	0	0	3	0	0	0	0	0	0	0	0	8	0	0	0	0
533	1997	ORW97#26-#B#11418	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	76	0	0	0	0
534	1997	ORW97#261#A#11421	45	1	9	12	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0	0
535	1997	ORW97#261#B#11422	35	0	29	15	0	0	0	0	11	0	0	0	1	0	0	0	0	0	0	0	0	50	0	0	0	0
536	1997	ORW97#262#A#11397	0	0	3	7	0	2	0	0	1	0	1	0	28	0	0	0	0	0	0	0	0	29	0	1	0	0
537	1997	ORW97#262#B#11398	0	1	14	4	0	3	0	0	1	0	0	0	15	0	0	0	0	0	0	0	0	11	0	2	0	0
538	1997	ORW97#263#A#11423	2	0	0	2	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	60	0	0	0	0
539	1997	ORW97#263#B#11424	0	0	0	3	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	0
540	1997	ORW97#264#A#11427	69	0	24	0	0	0	0	0	19	0	0	0	3	0	0	0	0	0	0	0	0	27	0	0	0	0
541	1997	ORW97#264#B#11428	79	0	60	53	0	0	0	0	86	0	0	0	1	0	0	0	0	0	0	0	0	21	0	0	0	0
542	1997	ORW97#265#A#11395	0	4	6	11	0	65	0	0	65	0	0	0	32	0	0	0	0	0	0	19	0	0	0	0	0	0
543	1997	ORW97#265#B#11396	0	0	3	149	0	0	0	2	20	0	0	0	46	0	0	0	0	5	0	0	0	25	0	0	0	0
544	1997	ORW97#266#A#11425	15	1	0	0	0	0	0	0	27	0	0	0	1	0	0	0	0	0	0	14	0	56	0	0	0	0
545	1997	ORW97#266#B#11426	11	0	3	1	0	0	0	0	85	0	0	0	0	0	0	0	0	0	0	8	0	55	0	0	0	0
546	1997	ORW97#267#A#11429	7	1	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0
547	1997	ORW97#267#B#1143-	0	1	0	25	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	42	0	0	0	0
548	1997	ORW97#268#A#11393	0	0	0	0	0	0	0	0	1	0	0	0	201	0	0	0	0	6	0	0	0	1	0	0	0	0
549	1997	ORW97#268#B#11394	0	0	0	0	0	0	0	0	2	0	0	0	201	0	0	0	0	11	0	0	0	0	0	0	0	0
550	1997	ORW97#269#A#11431	3	3	2	1	0	0	0	0	364	0	0	0	0	0	0	0	0	0	0	25	0	1	0	0	0	0
551	1997	ORW97#269#B#11432	3	0	14	6	0	0	0	0	245	0	0	0	3	0	0	0	0	0	0	30	0	19	0	0	0	0
552	1997	ORW97#27-#A#11435	0	4	11	21	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
553	1997	ORW97#27-#B#11436	0	2	6	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
554	1997	ORW97#271#A#11391	0	2	0	16	0	5	0	0	43	0	3	0	71	0	0	0	0	4	0	0	0	9	0	0	0	0
555	1997	ORW97#271#B#11392	0	0	1	7	0	0	0	0	3	0	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	0
556	1997	ORW97#272#A#11433	10	3	45	167	0	0	0	1	19	0	0	0	15	0	0	0	0	0	0	0	0	4	0	0	0	0
557	1997	ORW97#272#B#11434	6	3	51	116	0	0	0	0	19	0	0	0	2	0	0	0	0	0	0	0	0	11	0	0	0	0
558	1997	ORW97#273#A#11437	3	1	4	0	0	0	0	0	4	0	0	0	4	0	0	0	0	9	0	0	0	124	0	0	0	0
559	1997	ORW97#273#B#11438	4	2	2	3	0	0	0	0	1	0	0	0	12	0	0	0	0	2	0	0	0	0	0	0	0	0
560	1997	ORW97#274#A#11389	0	0	0	1	0	0	0	0	0	0	2	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
561	1997	ORW97#274#B#1139-	0	0	0	3	0	42	0	0	6	0	3	0	337	0	0	0	0	10	0	2	0	9	0	0	0	0
562	1997	ORW97#275#A#11439	32	3	1	2	0	0	2	0	152	0	0	0	94	0	0	0	0	0	0	12	0	14	0	0	0	0
563	1997	ORW97#275#B#1144-	31	0	0	3	0	1	0	0	68	0	0	0	100	0	0	0	0	4	0	2	0	23	0	0	0	0
564	1997	ORW97#276#A#11373	28	1	2	1	0	0	0	0	39	0	0	0	174	0	0	0	0	3	0	0	0	6	0	0	0	0
565	1997	ORW97#276#B#11374	57	0	0	1	0	0	0	0	170	0	0	0	625	0	0	0	0	2	0	0	0	38	0	0	0	0
566	1997	ORW97#277#A#11379	0	5	0	0	0	0	0	0	0	0	0	0	160	0	0	0	0	3	0	0	0	0	0	0	0	0
567	1997	ORW97#277#B#1138-	0	2	0	3	0	92	0	4	12	0	0	0	489	0	0	0	0	4	0	0	0	2	0	4	0	0
568	1997	ORW97#278#A#11377	0	0	0	8	0	28	0	12	10	0	0	0	2152	0	0	0	0	10	0	8	0	6	0	13	0	0
569	1997	ORW97#278#B#11378	0	0	0	0	0	127	0	3	26	0	0	0	215	0	0	0	0	1	0	5	0	0	0	2	0	0
570	1997	ORW97#279#A#11375	12	0	2	1	0	0	0	0	86	0	0	0	73	0	0	0	0	1	0	82	0	3	0	0	0	0
571	1997	ORW97#279#B#11376	3	3	1	6	0	0	0	0	458	0	0	0	91	0	0	0	0	0	0	40	0	35	0	0	0	0
572	1997	ORW97#28-#A#11371	2	8	0	2	0	0	0	0	1	0	0	0	59	0	0	0	0	0	0	0	0	7	0	0	0	0
573	1997	ORW97#28-#B#11372	14	2	6	9	0	0	0	0	0	0	0	0	438	0	0	0	0	9	0	0	0	36	0	0	0	0
574	1997	ORW97#281#A#11383	0	0	0	0	0	0	0	0	1	0	11	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0
575	1997	ORW97#281#B#11384	0	0	0	0	0	0	0	0	1	0	8	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
576	1997	ORW97#282#A#11381	0	0	0	3	0	0	0	0	5	0	2	0	17	0	0	0	0	2	0	0	0	1	0	0	0	0
577	1997	ORW97#282#B#11382	0	0	0	2	0	2	0	0	0	0	0	0	18	0	0	0	0	1	0	0	0	0	0	0	0	0
578	1997	ORW97#283#A#11369	0	8	0	0	0	0	0	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
579	1997	ORW97#283#B#1137-	8	2	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
580	1997	ORW97#284#A#11349	3	0	2	0	0	0	0	0	11	0	1	0	9	0	0	0	0	2	0	0	0	4	0	0	0	0
581	1997	ORW97#284#B#1135-	15	0	15	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
582	1997	ORW97#285#A#11387	0	0	0	0	0	0	0	10	0	0	21	0	7	0	0	0	0	1	0	0	0	1	0	0	0	0
583	1997	ORW97#285#B#11388	0	0	0	0	0	0	0	1	8	0	3	0	6	0	0	0	0	13	0	0	0	0	0	0	0	0
584	1997	ORW97#286#A#11385	0	0	0	0	0	7	0	3	13	0	4	0	7	0	0	0	0	3	0	0	0	0	0	0	0	0
585	1997	ORW97#286#B#11386	0	0	0	0	0	1	0	6	2	0	1	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0
586	1997	ORW97#287#A#11367	11	9	0	0	0	1	0	0	6	0	0	0	101	0	0	0	0	3	0	0	0	6	0	0	0	0
587	1997	ORW97#287#B#11368	0	3	3	0	0	0	0	0	8	0	0	0	86	0	0	0	0	7	0	0	0	2	0	0	0	0
588	1997	ORW97#288#A#11351	1	3	0	0	0	0	0	0	20	0	0	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
589	1997	ORW97#288#B#11352	5	0	1	0	0	0	0	0	3	0	0	0	31	0	0	0	0	0	0	0	0	2	0	0	0	0
590	1997	ORW97#289#A#11345	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
591	1997	ORW97#289#B#11346	0	0	0	0	0	4	0	1	0	0	4	0	1	0	0	0	0	4	0	0	0	0	0	0	0	0
592	1997	ORW97#29-#A#11365	1	3	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
593	1997	ORW97#29-#B#11366	1	0	0	2	0	0	0	14	25	0	0	0	8	0	0	0	0	8	0	2	0	6	0	0	0	0
594	1997	ORW97#291#A#11353	2	7	0	4	0	0	0	0	231	0	0	0	467	0	0	0	0	0	0	0	0	4	0	0	0	0
595	1997	ORW97#291#B#11354	1	3	0	0	0	0	0	0	41	0	0	0	134	0	0	0	0	0	0	0	0	3	0	0	0	0
596	1997	ORW97#292#A#11337	0	0	8	0	0	0	0	0	0	0	0	0	83	0	0	0	0	5	0	0	0	0	0	0	0	0
597	1997	ORW97#292#B#11338	0	1	2	4	0	0	0	0	1	0	0	0	50	0	0	0	0	2	0	0	0	0	0	0	0	0
598	1997	ORW97#293#A#11363	15	0	1	15	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	6	0	0	0	0
599	1997	ORW97#293#B#11364	17	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
600	1997	ORW97#294#A#11357	7	0	0	1	0	0	0	0	13	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	0
601	1997	ORW97#294#B#11358	1	0	9	0	0	0	0	0	8	0	0	0	36	0	0	0	0	1	0	0	0	0	0	0	0	0
602	1997	ORW97#295#A#11333	0	5	0	15	0	0	0	0	0	0	0	0	32	0	0	0	0	1	0	0	0	1	0	0	0	0
603	1997	ORW97#295#B#11334	0	2	2	8	0	0	0	0	0	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0	0	0
604	1997	ORW97#296#A#11331	0	2	0	0	0	0	0	0	1	0	0	0	274	0	0	0	0	24	0	0	0	5	0	0	0	0
605	1997	ORW97#296#B#11332	0	5	2	1	0	0	0	1	0	0	0	0	37	0	0	0	0	5	0	0	0	14	0	1	0	0
606	1997	ORW97#297#A#11361	4	0	3	2	0	0	0	0	0	0	0	0	4	0	0	0	0	8	0	0	0	0	0	0	0	0
607	1997	ORW97#297#B#11362	4	0	6	1	0	0	0	0	0	0	0	0	2	0	0	0	0	16	0	0	0	0	0	1	0	0
608	1997	ORW97#298#A#11355	1	0	1	0	0	0	0	0	4	0	0	0	42	0	0	0	0	0	0	0	0	0	0	0	0	0
609	1997	ORW97#298#B#11356	3	0	1	0	0	0	0	0	6	0	0	0	57	0	0	0	0	0	0	0	0	0	0	0	0	0
610	1997	ORW97#299#A#11335	0	2	0	0	0	15	0	0	2	0	0	0	63	0	0	0	0	2	0	0	0	1	0	0	0	0
611	1997	ORW97#299#B#11336	0	0	0	0	0	94	0	0	3	0	0	0	39	0	0	0	0	1	0	0	0	1	0	0	0	0
612	1997	ORW97#3--#A#11359	2	0	1	0	0	0	0	0	1	0	0	0	12	0	0	0	0	3	0	0	0	0	0	0	0	0
613	1997	ORW97#3--#B#1136-	8	0	7	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
614	1997	ORW97#3-1#A#11329	0	0	0	0	0	16	0	1	2	0	29	0	3	0	0	0	0	1	0	1	0	0	0	1	0	0
615	1997	ORW97#3-1#B#1133-	0	2	0	0	0	25	0	1	3	0	0	0	6	0	0	0	0	0	0	0	0	0	0	3	0	0
616	1997	ORW97#3-2#A#11327	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0
617	1997	ORW97#3-2#B#11328	0	3	0	0	0	0	0	1	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	4	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
618	1997	ORW97#3-3#A#11339	0	0	0	0	0	1	1	1	2	0	4	0	10	0	0	0	0	17	0	0	0	0	0	1	0	0
619	1997	ORW97#3-3#B#1134-	0	0	0	0	0	0	0	1	0	0	11	0	13	0	0	0	0	12	0	0	0	0	0	0	0	0
620	1997	ORW97#3-4#A#11341	0	2	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	18	0	0	0	0	0	0	0	0
621	1997	ORW97#3-4#B#11342	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	18	0	0	0	0	0	0	0	0
622	1997	ORW97#3-5#A#11343	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
623	1997	ORW97#3-5#B#11344	0	1	1	0	0	0	0	9	1	0	0	0	8	0	0	0	0	3	1	0	0	0	0	1	0	0
624	1997	ORW97#3-6#A#11347	0	1	0	0	0	324	0	0	2	0	0	0	37	0	0	0	0	0	0	0	0	1	0	0	0	0
625	1997	ORW97#3-6#B#11348	0	4	0	1	0	209	0	2	0	0	0	0	137	0	0	0	0	4	0	0	0	3	0	0	0	0
632	1997	PYE97#31-#A#11788	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
633	1997	PYE97#31-#B#11789	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
634	1997	PYE97#311#A#1179-	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
635	1997	PYE97#311#B#11791	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
626	1997	PYE97#3-7#A#11782	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
627	1997	PYE97#3-7#B#11783	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
628	1997	PYE97#3-8#A#11784	0	1	0	17	0	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	10	0	4	0	0
629	1997	PYE97#3-8#B#11785	0	2	1	15	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	19	0	27	0	0
630	1997	PYE97#3-9#A#11786	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
631	1997	PYE97#3-9#B#11787	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
236	1997	STR97#150#A#11319	46	0	0	27	0	0	118	0	23	0	0	0	0	0	0	0	0	0	0	0	0	134	0	0	0	0
237	1997	STR97#150#B#11320	48	0	0	46	0	0	32	0	1	0	0	0	1	0	0	0	0	0	0	0	0	154	0	0	0	0
238	1997	STR97#151#A#11313	56	0	0	3	0	0	3	0	46	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
239	1997	STR97#151#B#11314	64	0	0	1	0	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
240	1997	STR97#152#A#11321	92	0	3	307	0	0	165	0	19	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0
241	1997	STR97#152#B#11322	49	0	2	109	0	0	62	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
242	1997	STR97#153#A#11315	139	0	0	4	0	0	9	0	128	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
243	1997	STR97#153#B#11316	92	0	0	2	0	0	4	0	85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
244	1997	STR97#154#A#11317	16	0	10	29	0	0	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
245	1997	STR97#154#B#11318	12	0	12	33	0	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0
246	1997	STR97#155#A#11323	0	0	0	1	0	0	1	0	291	0	0	0	0	0	0	0	0	0	0	0	0	22	0	0	0	0
247	1997	STR97#155#B#11324	0	0	0	3	0	0	0	0	454	0	0	0	0	0	0	0	0	0	0	0	0	154	0	0	0	0
248	1997	STR97#157#A#11311	0	0	7	23	0	0	0	0	247	0	0	0	0	0	0	0	0	0	0	0	0	11	0	0	0	0
249	1997	STR97#157#B#11312	0	0	4	9	0	0	0	0	124	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0
250	1997	STR97#158#A#11309	0	0	0	0	0	0	0	0	358	0	0	0	0	0	0	0	0	0	0	0	0	367	0	0	0	0
251	1997	STR97#158#B#11310	0	0	0	1	0	0	0	0	405	0	0	0	0	0	0	0	0	0	0	0	0	351	0	0	0	0
252	1997	STR97#159#A#11325	1	0	0	0	0	0	0	0	1	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
253	1997	STR97#159#B#11326	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254	1997	STR97#160#A#11305	7	0	1	0	0	0	0	0	206	0	0	0	0	0	0	0	0	0	0	0	0	228	0	0	0	0
255	1997	STR97#160#B#11306	13	0	1	0	0	0	0	0	269	0	0	0	0	0	0	0	0	0	0	0	0	243	0	0	0	0
256	1997	STR97#161#A#11303	0	0	0	15	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	13	0	0	0	0
257	1997	STR97#161#B#11304	0	0	0	7	0	0	0	0	1	0	0	0	4	0	0	0	0	0	0	0	0	34	0	1	0	0
258	1997	STR97#163#A#11307	0	0	0	0	0	0	0	0	482	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
259	1997	STR97#163#B#11308	0	0	0	0	0	0	0	0	265	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0
260	1997	STR97#164#A#11277	37	1	0	0	0	0	0	0	350	0	0	0	1	0	0	0	0	0	0	0	0	109	0	0	0	0
261	1997	STR97#164#B#11278	31	0	0	0	0	0	0	0	341	0	0	0	3	0	0	0	0	0	0	0	0	219	0	0	0	0
262	1997	STR97#165#A#11275	22	0	19	1	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
263	1997	STR97#165#B#11276	3	1	0	12	0	0	0	0	1	0	0	0	75	0	0	0	0	0	0	0	0	9	0	0	0	0
264	1997	STR97#166#A#11273	2	0	1	35	0	0	0	0	4	0	0	0	48	0	0	0	0	0	0	0	0	3	0	0	0	0
265	1997	STR97#166#B#11274	0	0	0	17	0	0	0	0	1	0	0	0	239	0	0	0	0	0	0	0	0	0	0	0	0	0
266	1997	STR97#168#A#11227	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
267	1997	STR97#168#B#11228	0	0	0	0	0	0	0	3	2	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
268	1997	STR97#169#A#11271	12	3	0	5	0	0	0	13	4	0	7	0	7	0	0	0	0	0	0	0	0	109	0	1	0	0
269	1997	STR97#169#B#11272	40	0	0	0	0	0	0	0	1	0	2	0	37	0	0	0	0	0	0	0	0	43	0	0	0	0
270	1997	STR97#170#A#11269	3	0	0	15	0	0	1	68	0	0	33	0	592	0	0	0	0	0	0	0	0	3	0	0	0	0
271	1997	STR97#170#B#11270	10	0	0	3	0	0	0	2	1	0	0	0	273	0	0	0	0	0	0	0	0	3	0	0	0	0
272	1997	STR97#171#A#11229	4	3	0	3	0	0	0	8	251	0	0	0	1	0	0	0	0	0	0	0	0	15	0	1	0	0
273	1997	STR97#171#B#11230	0	5	0	12	0	0	0	6	175	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
274	1997	STR97#172#A#11225	3	1	0	7	0	0	0	2	39	0	3	0	3	0	0	0	0	0	0	1	0	13	0	0	0	0
275	1997	STR97#172#B#11226	1	2	0	10	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
276	1997	STR97#173#A#11265	1	4	0	2	0	0	0	9	0	0	0	0	20	0	0	0	0	0	0	0	0	17	0	1	0	0
277	1997	STR97#173#B#11266	0	4	0	4	0	0	0	4	0	0	0	0	17	0	0	0	0	0	0	0	0	6	0	0	0	0
278	1997	STR97#174#A#11267	7	6	0	2	0	0	0	14	120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
279	1997	STR97#174#B#11268	2	3	0	1	0	0	0	25	110	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
280	1997	STR97#175#A#11231	1	2	0	0	0	0	0	1	91	0	0	0	1	0	0	0	0	0	0	0	0	126	0	0	0	0
281	1997	STR97#175#B#11232	0	3	0	1	0	0	0	0	85	0	0	0	0	0	0	0	0	0	0	0	0	267	0	0	0	0
282	1997	STR97#176#A#11233	2	2	0	0	0	0	0	5	0	0	0	0	306	0	0	0	0	0	0	2	0	8	0	1	0	0
283	1997	STR97#176#B#11234	0	1	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
284	1997	STR97#177#A#11221	1	1	0	0	0	0	0	0	25	0	0	0	3	0	0	0	0	0	0	7	0	4	0	0	0	0
285	1997	STR97#177#B#11222	4	0	0	3	0	0	0	0	93	0	0	0	15	0	0	0	0	0	0	3	0	16	0	0	0	0
286	1997	STR97#178#A#11223	0	2	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
287	1997	STR97#178#B#11224	22	0	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	0	16	0	0	0	0	0	0
288	1997	STR97#179#A#11261	0	4	0	5	0	0	0	0	0	0	0	0	180	0	0	0	0	0	0	0	0	1	0	9	0	0
289	1997	STR97#179#B#11262	0	3	0	1	0	0	0	0	0	0	0	0	973	0	0	0	0	2	0	0	0	4	0	1	0	0
290	1997	STR97#180#A#11235	1	5	0	0	0	0	0	0	173	0	2	0	2	0	0	0	0	0	0	8	0	0	0	0	0	0
291	1997	STR97#180#B#11236	3	5	0	0	0	0	0	0	166	0	0	0	1	0	0	0	0	0	0	46	0	0	0	0	0	0
292	1997	STR97#181#A#11237	0	3	0	0	0	0	0	0	1	0	0	0	91	0	0	0	0	0	0	0	0	0	0	0	0	0
293	1997	STR97#181#B#11238	0	3	0	1	0	0	0	0	2	0	1	0	51	0	0	0	0	1	0	0	0	0	0	0	0	0
294	1997	STR97#182#A#11279	0	5	0	2	0	0	0	1	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
295	1997	STR97#182#B#11280	0	4	0	5	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
296	1997	STR97#183#A#11217	3	5	0	0	0	0	0	1	141	0	0	0	10	0	0	0	0	0	0	0	0	1	0	0	0	0
297	1997	STR97#183#B#11218	2	5	0	0	0	0	0	0	230	0	0	0	1	0	0	0	0	0	0	0	0	117	0	0	0	0
298	1997	STR97#184#A#11219	0	3	0	1	0	0	0	6	1	0	0	0	14	0	0	0	0	0	0	2	0	0	0	0	0	0
299	1997	STR97#184#B#11220	0	5	0	7	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
300	1997	STR97#185#A#11215	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
301	1997	STR97#185#B#11216	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
302	1997	STR97#186#A#11211	2	4	0	0	0	0	0	1	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
303	1997	STR97#186#B#11212	3	2	0	0	0	0	0	2	21	0	2	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0
304	1997	STR97#187#A#11213	1	0	0	0	0	0	0	1	49	0	1	0	26	0	0	0	0	0	0	13	0	0	0	0	0	0
305	1997	STR97#187#B#11214	1	0	0	1	0	0	0	28	68	0	0	0	12	0	0	0	0	1	0	33	0	0	0	0	0	0
306	1997	STR97#188#A#11239	0	1	0	0	0	0	0	0	9	0	0	0	66	0	0	0	0	0	0	3	0	0	0	0	0	0
307	1997	STR97#188#B#11240	0	0	0	0	0	0	0	0	31	0	0	0	232	0	0	0	0	0	0	11	0	0	0	0	0	0
308	1997	STR97#189#A#11201	0	0	0	0	0	0	0	0	1	0	0	0	25	0	0	0	0	1	0	1	0	0	0	0	0	0
309	1997	STR97#189#B#11202	0	1	0	0	0	0	0	0	3	0	15	0	218	0	0	0	0	0	0	3	0	0	0	0	0	0
310	1997	STR97#190#A#11283	0	2	0	0	0	0	0	1	14	0	2	0	287	0	0	0	0	0	0	7	0	12	0	0	0	0
311	1997	STR97#190#B#11284	0	3	0	0	0	0	0	2	17	0	10	0	249	0	0	0	0	0	0	34	0	3	0	0	0	0
312	1997	STR97#191#A#11281	2	0	0	0	0	0	0	3	1	0	26	0	15	0	0	0	0	0	0	0	0	5	0	0	0	0
313	1997	STR97#191#B#11282	2	0	0	0	0	0	0	9	1	0	0	0	2	0	0	0	0	0	0	1	0	1	0	0	0	0
314	1997	STR97#192#A#11203	0	7	0	0	0	0	0	0	1	0	14	0	116	0	0	0	0	0	0	1	0	2	0	0	0	0
315	1997	STR97#192#B#11204	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
316	1997	STR97#193#A#11293	0	2	0	1	0	0	0	0	398	0	0	0	2	0	0	0	0	0	0	0	0	243	0	0	0	0
317	1997	STR97#193#B#11294	0	2	0	1	0	0	0	0	309	0	0	0	0	0	0	0	0	0	0	0	0	129	0	0	0	0
318	1997	STR97#194#A#11285	0	6	0	2	0	0	0	0	121	0	0	0	7	0	0	0	0	0	0	12	0	0	0	0	0	0
319	1997	STR97#194#B#11286	3	14	0	2	0	0	0	0	283	0	0	0	225	0	0	0	0	0	0	6	0	8	0	0	0	0
320	1997	STR97#195#A#11199	1	0	0	0	0	0	0	2	1	0	0	0	15	0	0	0	0	1	0	0	0	0	0	0	0	0
321	1997	STR97#195#B#11200	0	5	0	0	0	0	0	25	27	0	1	0	22	0	0	0	0	1	0	0	0	0	0	2	0	0
322	1997	STR97#196#A#11197	0	2	0	0	0	0	0	0	22	0	1	0	26	0	0	0	0	3	0	0	0	0	0	1	0	0
323	1997	STR97#196#B#11198	0	0	0	0	0	7	0	0	8	0	1	0	6	0	0	0	0	1	0	0	0	0	0	0	0	0
324	1997	STR97#197#A#11291	3	1	1	0	0	0	0	0	22	0	0	0	7	0	0	0	0	0	0	0	0	88	0	0	0	0
325	1997	STR97#197#B#11292	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
326	1997	STR97#198#A#11193	0	2	0	2	0	0	0	1	1	0	0	0	18	0	0	0	0	1	0	0	0	1	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
327	1997	STR97#198#B#11194	0	4	0	0	0	55	1	0	1	0	0	0	563	0	0	0	0	2	0	2	0	0	0	0	0	0
328	1997	STR97#199#A#11195	1	3	0	0	0	221	0	4	0	0	0	0	494	0	0	0	0	0	0	2	0	0	0	1	0	0
329	1997	STR97#199#B#11196	0	2	0	0	0	0	0	0	0	0	0	0	817	0	0	0	0	2	0	0	0	0	0	0	0	0
330	1997	STR97#200#A#11191	0	2	0	0	0	41	0	0	3	0	1	0	818	0	0	0	0	0	0	2	0	0	0	0	0	0
331	1997	STR97#200#B#11192	0	1	0	0	0	0	0	0	0	0	0	0	99	0	0	0	0	2	0	0	0	0	0	0	0	0
332	1997	STR97#201#A#11289	3	14	0	6	0	0	0	1	24	0	0	0	35	0	0	0	0	0	0	0	0	7	0	0	0	0
333	1997	STR97#201#B#11290	8	0	3	4	0	0	0	0	17	0	0	0	24	0	0	0	0	0	0	0	0	12	0	0	0	0
334	1997	STR97#202#A#11287	2	2	0	2	0	0	0	0	91	0	0	0	181	0	0	0	0	7	0	1	0	0	0	0	0	0
335	1997	STR97#202#B#11288	0	3	0	0	0	0	0	2	72	0	0	0	42	0	0	0	0	0	0	1	0	0	0	0	0	0
336	1997	STR97#203#A#11189	3	2	1	0	0	0	0	0	0	0	0	0	73	0	0	0	0	4	0	0	0	0	0	0	0	0
337	1997	STR97#203#B#11190	0	8	0	8	0	0	0	0	0	0	0	0	484	0	0	0	0	0	0	0	0	4	0	0	0	0
338	1997	STR97#204#A#11155	12	5	2	1	0	0	0	0	229	0	0	0	83	0	0	0	0	4	0	20	0	5	0	0	0	0
339	1997	STR97#204#B#11156	0	6	1	4	0	0	0	0	173	0	0	0	257	0	0	0	0	2	0	0	0	8	0	0	0	0
340	1997	STR97#205#A#11157	1	0	0	0	0	0	0	1	1	0	0	0	49	0	0	0	0	4	0	0	0	8	0	0	0	0
341	1997	STR97#205#B#11158	0	1	2	0	0	0	0	5	13	0	0	0	54	0	0	0	0	2	0	0	0	10	0	0	0	0
342	1997	STR97#206#A#11149	3	3	0	1	0	0	1	0	819	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
343	1997	STR97#206#B#11150	0	4	0	6	0	0	0	0	1170	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
344	1997	STR97#207#A#11151	7	0	0	0	0	0	0	0	142	0	0	0	131	0	0	0	0	1	0	11	0	6	0	0	0	0
345	1997	STR97#207#B#11152	5	6	0	2	0	0	0	0	869	0	0	0	182	0	0	0	0	0	0	23	0	0	0	0	0	0
346	1997	STR97#208#A#11153	1	5	0	16	0	0	0	0	0	0	0	0	881	0	0	0	0	33	0	0	0	0	0	0	0	0
347	1997	STR97#208#B#11154	0	3	2	72	1	0	0	0	0	0	0	0	76	0	0	0	0	1	0	0	0	0	0	0	0	0
348	1997	STR97#209#A#11147	0	2	0	4	0	0	0	1	520	0	0	0	76	0	0	0	0	0	0	15	0	26	0	0	0	0
349	1997	STR97#209#B#11148	1	0	0	1	0	0	0	0	629	0	0	0	12	0	0	0	0	0	0	31	0	0	0	0	0	0
350	1997	STR97#210#A#11145	16	6	0	48	0	0	0	0	16	0	0	0	560	0	0	0	0	17	0	0	0	16	0	0	0	0
351	1997	STR97#210#B#11146	0	6	0	0	0	0	0	0	32	0	0	0	144	0	0	0	0	1	0	0	0	16	0	0	0	0
352	1997	STR97#211#A#11143	0	1	1	0	2	0	0	5	7	0	0	0	367	0	0	0	0	15	0	0	0	35	0	0	0	0
353	1997	STR97#211#B#11144	0	3	0	0	1	0	0	1	0	0	0	0	743	0	0	0	0	44	0	0	0	4	0	1	0	0
354	1997	STR97#212#A#11161	0	1	1	0	0	0	0	1	1	0	0	0	4	0	0	0	0	12	0	0	0	0	0	0	0	0
355	1997	STR97#212#B#11162	0	0	0	1	0	1	0	0	0	0	0	0	5	0	0	0	0	1	0	0	0	1	0	0	0	0
356	1997	STR97#213#A#11163	0	0	0	0	1	0	0	9	1	0	0	0	15	0	0	0	0	7	0	0	0	0	0	0	0	0
357	1997	STR97#213#B#11164	0	0	0	0	0	0	0	0	0	0	0	0	13	0	0	0	0	6	0	0	0	0	0	0	0	0
358	1997	STR97#214#A#11165	3	2	0	4	0	0	0	3	38	0	0	0	666	0	0	0	0	13	0	0	0	44	0	0	0	0
359	1997	STR97#214#B#11166	5	1	0	5	0	0	0	0	47	0	0	0	685	0	0	0	0	7	0	0	0	28	0	0	0	0
360	1997	STR97#215#A#11169	0	0	0	0	1	0	0	3	0	0	0	0	6	0	0	0	0	24	0	0	0	0	0	0	0	0
361	1997	STR97#215#B#11170	0	0	0	0	1	0	0	3	1	0	1	0	15	0	0	0	0	65	0	0	0	8	0	0	0	0
362	1997	STR97#216#A#11167	1	0	0	0	1	0	0	2	2	0	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0	0
363	1997	STR97#216#B#11168	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0
364	1997	STR97#217#A#11171	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
365	1997	STR97#217#B#11172	0	1	0	0	5	0	0	0	2	0	0	0	0	0	0	0	0	11	0	0	0	3	0	0	0	0
366	1997	STR97#218#A#11173	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
367	1997	STR97#218#B#11174	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
368	1997	STR97#219#A#11175	0	1	0	2	1	0	0	0	0	0	0	0	184	0	0	0	0	10	0	0	0	0	0	0	0	0
369	1997	STR97#219#B#11176	0	1	11	14	3	0	1	6	4	0	0	0	526	0	0	0	0	21	0	0	0	11	0	0	0	0
370	1997	STR97#220#A#11241	0	1	0	5	6	0	0	4	0	0	0	0	155	0	0	0	0	49	0	0	0	0	0	0	0	0
371	1997	STR97#220#B#11242	0	0	0	1	7	0	0	0	0	0	0	0	58	0	0	0	0	9	0	1	0	3	0	0	0	0
372	1997	STR97#221#A#11243	0	5	0	6	0	0	0	17	1	0	0	0	48	0	0	0	0	5	0	0	0	1	0	0	0	0
373	1997	STR97#221#B#11244	0	0	0	2	0	0	0	5	1	0	0	0	18	0	0	0	0	3	0	0	0	23	0	0	0	0
374	1997	STR97#222#A#11295	0	10	0	15	0	0	0	0	18	0	0	0	47	0	0	0	0	0	0	0	0	0	0	0	0	0
375	1997	STR97#222#B#11296	2	3	0	25	0	0	0	0	113	0	0	0	227	0	0	0	0	1	0	0	0	5	0	0	0	0
376	1997	STR97#223#A#11141	0	0	0	0	0	1	1	4	7	0	0	0	26	0	0	0	0	2	0	2	0	1	0	0	0	0
377	1997	STR97#223#B#11142	0	0	0	0	0	1	0	1	16	0	0	0	15	0	0	0	0	2	0	0	0	3	0	0	0	0
378	1997	STR97#224#A#11183	0	1	0	0	0	0	0	1	2	0	1	0	1	0	0	0	0	10	0	0	0	0	0	0	0	0
379	1997	STR97#224#B#11184	0	0	0	0	0	0	0	0	2	0	0	0	2	0	0	0	0	2	0	0	0	12	0	0	0	0
380	1997	STR97#225#A#11185	0	0	0	0	1	0	0	20	2	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
381	1997	STR97#225#B#11186	0	2	0	2	0	0	0	62	2	0	0	0	44	0	0	0	0	0	0	0	0	8	0	0	0	0
382	1997	STR97#226#A#11187	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
383	1997	STR97#226#B#11188	0	3	0	4	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
384	1997	STR97#227#A#11299	2	9	0	12	0	0	0	0	208	0	0	0	54	0	0	0	0	0	0	0	0	2	0	0	0	0
385	1997	STR97#227#B#11300	3	9	0	5	0	0	0	0	182	0	0	0	36	0	0	0	0	1	0	0	0	24	0	0	0	0
386	1997	STR97#228#A#11301	0	5	0	0	0	0	0	0	678	0	0	0	8	0	0	0	0	0	0	9	0	3	0	0	0	0
387	1997	STR97#228#B#11302	0	2	0	0	0	0	0	0	1119	0	0	0	24	0	0	0	0	0	0	0	0	27	0	0	0	0
388	1997	STR97#229#A#11297	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0
389	1997	STR97#229#B#11298	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
390	1997	STR97#230#A#11177	0	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
391	1997	STR97#230#B#11178	0	3	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
392	1997	STR97#231#A#11179	0	1	0	4	2	0	0	8	0	0	0	0	24	0	0	0	0	10	0	0	0	0	0	0	0	0
393	1997	STR97#231#B#11180	0	2	0	3	2	0	0	27	2	0	0	0	33	0	0	0	0	4	0	0	0	9	0	0	0	0
394	1997	STR97#232#A#11181	0	0	0	0	2	0	0	3	0	0	0	0	17	0	0	0	0	16	0	0	0	0	0	0	0	0
395	1997	STR97#232#B#11182	0	0	0	1	1	0	0	0	4	0	0	0	10	0	0	0	0	5	0	0	0	9	0	0	0	0
396	1997	STR97#233#A#11137	0	0	16	0	0	0	0	0	0	0	0	0	1056	0	0	0	0	16	0	0	0	0	0	0	0	0
397	1997	STR97#233#B#11138	0	0	0	4	0	0	0	0	0	0	0	0	148	0	0	0	0	0	0	0	0	0	0	0	0	0
398	1997	STR97#234#A#11139	3	0	8	1	0	0	0	6	0	0	0	0	10	0	0	0	0	5	0	0	0	0	0	0	0	0
399	1997	STR97#234#B#11140	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
400	1997	STR97#235#A#11135	0	9	0	16	0	0	0	0	0	0	0	0	240	0	0	0	0	0	0	0	0	32	0	0	0	0
401	1997	STR97#235#B#11136	0	12	0	0	0	0	0	0	0	0	0	0	576	0	0	0	0	1	0	0	0	16	0	0	0	0
402	1997	STR97#236#A#11133	0	5	0	24	0	0	0	0	0	0	0	0	1700	0	0	0	0	1	0	0	0	20	0	10	0	0
403	1997	STR97#236#B#11134	0	10	0	16	0	0	0	0	0	0	0	0	872	0	0	0	0	0	0	0	0	24	0	0	0	0
404	1997	STR97#237#A#11259	2	1	0	0	0	0	0	37	14	0	1	0	161	0	0	0	0	1	0	2	0	5	0	3	0	0
405	1997	STR97#237#B#11260	1	6	0	0	0	0	0	0	3	0	1	0	219	0	0	0	0	1	0	0	0	0	0	0	0	0
406	1997	STR97#238#A#11257	1	0	0	0	0	0	0	0	1	0	0	0	40	0	0	0	0	3	0	13	0	1	0	0	0	0
407	1997	STR97#238#B#11258	0	1	0	0	0	0	0	0	12	0	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0
408	1997	STR97#239#A#11255	0	5	0	0	0	0	0	15	0	0	0	0	143	0	0	0	0	1	0	0	0	2	0	0	0	0
409	1997	STR97#239#B#11256	0	10	0	0	0	0	0	0	0	0	0	0	375	0	0	0	0	0	0	0	0	0	0	1	0	0
410	1997	STR97#240#A#11253	0	1	0	0	0	0	0	0	0	0	0	0	860	0	0	0	0	1	0	0	0	0	0	0	0	0
411	1997	STR97#240#B#11254	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
412	1997	STR97#241#A#11251	0	2	0	0	0	0	0	17	9	0	2	0	820	0	0	0	0	1	0	0	0	3	0	2	0	0
413	1997	STR97#241#B#11252	1	4	0	0	0	0	0	34	11	0	8	0	595	0	0	0	0	0	0	1	0	3	0	0	0	0
414	1997	STR97#242#A#11249	1	3	0	0	0	1	2	23	2	0	0	0	259	0	0	0	0	2	0	4	0	5	0	0	0	0
415	1997	STR97#242#B#11250	4	2	0	0	0	0	0	0	2	0	1	0	736	0	0	0	0	1	0	0	0	4	0	0	0	0
416	1997	STR97#243#A#11247	0	2	0	0	0	12	0	0	1	0	0	0	175	0	0	0	0	0	0	2	0	0	0	0	0	0
417	1997	STR97#243#B#11248	1	4	0	0	0	14	0	0	0	0	0	0	279	0	0	0	0	0	0	1	0	0	0	0	0	0
418	1997	STR97#244#A#11245	2	0	2	0	0	0	0	0	0	0	0	0	31	0	0	0	0	1	0	2	0	0	0	0	0	0
419	1997	STR97#244#B#11246	4	1	0	0	0	0	0	1	3	0	2	0	43	0	0	0	0	0	0	0	0	0	0	0	0	0
420	1997	STR97#245#A#11209	0	1	0	0	0	0	0	1	30	0	0	0	74	0	0	0	0	0	0	2	0	0	0	0	0	0
421	1997	STR97#245#B#11210	0	4	0	0	0	1	0	0	11	0	0	0	109	0	0	0	0	0	0	4	0	0	0	0	0	0
422	1997	STR97#246#A#11207	0	0	0	0	0	0	0	23	35	0	1	0	8	0	0	0	0	0	0	3	0	1	0	0	0	0
423	1997	STR97#246#B#11208	0	0	0	0	0	0	0	18	117	0	2	0	6	0	0	0	0	0	0	13	0	0	0	0	0	0
424	1997	STR97#247#A#11205	2	2	1	0	0	0	0	8	3	0	24	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0
425	1997	STR97#247#B#11206	11	2	1	0	0	0	0	0	0	0	8	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
426	1997	STR97#248#A#11159	0	1	0	0	0	0	0	1	1	0	0	0	508	0	0	0	0	2	0	0	0	0	0	0	0	0
427	1997	STR97#248#B#11160	0	0	1	1	0	3	0	2	2	0	0	0	129	0	0	0	0	17	0	1	0	4	0	1	0	0
428	1997	STR97#249#A#11263	4	5	0	0	0	0	26	3	7	0	0	0	206	0	0	0	0	1	0	26	0	1	0	1	0	0
429	1997	STR97#249#B#11264	1	0	0	0	0	0	0	0	0	0	1	0	306	0	0	0	0	1	0	5	0	7	0	0	0	0
430	1998	STR98DM#415#A#13667	0	0	0	0	0	0	0	9	1	0	4	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0
431	1998	STR98DM#415#B#13668	0	0	0	0	0	0	0	3	1	2	0	0	10	0	0	0	0	1	0	0	0	0	0	0	0	0
432	1998	STR98DM#416#A#13669	0	1	0	0	0	0	0	6	1	0	2	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0
433	1998	STR98DM#416#B#13670	0	2	0	0	0	1	0	47	0	0	5	0	19	0	0	0	0	0	0	0	0	0	0	5	0	0
434	1998	STR98DM#417#A#13671	0	0	0	0	0	1	1	121	44	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
435	1998	STR98DM#417#B#13672	0	1	0	0	0	0	0	17	33	0	3	0	13	0	0	0	0	0	0	6	0	0	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
436	1998	STR98DM#418#A#13673	0	0	0	0	0	0	0	10	53	0	0	0	32	0	0	0	0	0	0	11	0	0	0	2	0	0
437	1998	STR98DM#418#B#13674	0	0	0	0	0	0	0	21	35	0	10	0	18	0	0	0	0	0	0	11	0	0	0	0	0	0
438	1998	STR98DM#419#A#13675	0	0	0	0	0	0	0	16	44	0	11	0	284	0	0	0	0	0	0	4	0	1	0	2	0	0
439	1998	STR98DM#419#B#13676	0	1	0	0	0	0	0	1	0	0	5	0	58	0	0	0	0	3	0	2	0	0	0	0	0	0
440	1998	STR98DM#420#A#13677	0	4	0	1	0	6	0	2	5	0	0	0	41	0	0	0	0	1	0	1	0	1	0	2	0	0
441	1998	STR98DM#420#B#13678	0	10	0	0	0	3	0	1	0	0	1	0	85	0	0	0	0	1	0	0	0	0	0	0	0	0
442	1998	STR98DM#421#A#13679	0	1	0	0	0	0	0	13	2	0	18	0	101	0	0	0	0	3	0	6	0	0	0	1	0	0
443	1998	STR98DM#421#B#13680	0	0	0	0	0	0	0	5	3	0	9	0	24	0	0	0	0	0	0	0	0	1	0	0	0	0
444	1998	STR98DM#422#A#13681	0	3	0	0	0	0	0	4	5	0	11	0	166	0	0	0	0	2	0	2	0	3	0	0	0	0
125	1998	STR98DM#422#B#13682	0	0	0	0	0	0	0	4	3	0	22	0	169	0	0	0	0	2	0	4	0	0	0	0	0	0
126	1998	STR98DM#423#A#13683	0	5	0	0	0	0	0	4	0	0	2	0	105	0	0	0	0	5	0	0	0	0	0	0	0	0
127	1998	STR98DM#423#B#13684	0	4	0	0	0	1	0	0	0	0	17	0	68	0	0	0	0	5	0	6	0	0	0	1	0	0
128	1998	STR98DM#424#A#13711	0	2	0	5	0	0	1	53	20	0	4	0	153	0	0	0	0	1	0	0	0	4	0	0	0	0
129	1998	STR98DM#424#B#13712	0	0	0	0	0	0	1	28	13	523	118	0	62	0	0	0	0	1	0	16	0	0	0	0	0	0
130	1998	STR98DM#425#A#13709	0	4	0	0	0	0	0	77	45	0	39	0	157	0	0	0	0	1	0	1	0	0	0	1	0	0
131	1998	STR98DM#425#B#13710	0	4	0	0	0	0	0	64	76	0	32	0	104	0	0	0	0	0	0	1	0	8	0	0	0	0
445	1998	STR98DM#426#A#13657	0	0	0	0	0	0	0	3	1	0	8	0	124	0	0	0	0	2	0	0	0	0	0	0	0	0
446	1998	STR98DM#426#B#13658	0	1	0	0	0	0	0	4	0	0	1	0	139	0	0	0	0	2	0	1	0	2	0	0	0	0
132	1998	STR98DM#427#A#13707	0	1	0	0	0	2	0	14	6	0	1	0	23	0	0	0	0	1	0	11	0	0	0	0	0	0
133	1998	STR98DM#427#B#13708	0	0	0	0	0	0	0	22	0	0	3	0	4	0	0	0	0	0	0	9	0	0	0	0	0	0
134	1998	STR98DM#428#A#13705	0	3	0	1	0	0	0	0	0	0	0	0	53	0	0	0	0	5	0	0	0	0	0	0	0	0
135	1998	STR98DM#428#B#13706	0	1	0	0	0	1	0	1	0	0	25	0	71	0	0	0	0	0	0	3	0	0	0	0	0	0
136	1998	STR98DM#429#A#13701	0	3	0	0	0	0	0	1	0	12	10	0	99	0	0	0	0	2	0	0	0	1	0	0	0	0
137	1998	STR98DM#429#B#13702	0	11	0	0	0	0	1	7	0	16	33	0	40	0	0	0	0	1	0	0	0	0	0	2	0	0
138	1998	STR98DM#430#A#13703	0	1	0	1	0	0	0	1	3	0	2	0	37	0	0	0	0	0	0	3	0	0	0	0	0	0
139	1998	STR98DM#430#B#13704	0	0	0	0	0	0	1	19	37	0	51	0	135	0	0	0	0	1	0	2	0	0	0	1	0	0
140	1998	STR98DM#431#A#13699	0	0	0	4	0	1	0	98	8	4	10	0	139	0	0	0	0	0	0	3	0	9	0	13	0	0
141	1998	STR98DM#431#B#13700	0	3	0	0	0	0	0	6	2	53	79	0	111	0	0	0	0	1	0	0	0	0	0	0	0	0
447	1998	STR98DM#432#A#13653	0	0	0	1	0	0	0	23	0	0	10	0	95	0	0	0	0	0	0	1	0	1	0	1	0	0
448	1998	STR98DM#432#B#13654	0	1	0	1	0	0	0	15	4	0	12	0	34	0	0	0	0	0	0	7	0	0	0	0	0	0
449	1998	STR98DM#433#A#13637	0	1	3	0	0	0	0	3	0	0	10	0	16	0	0	0	0	0	0	8	0	0	0	0	0	0
450	1998	STR98DM#433#B#13638	0	2	1	0	0	0	0	5	0	0	2	0	12	0	0	0	0	0	0	3	0	0	0	1	0	0
451	1998	STR98DM#434#A#13641	0	4	0	4	0	0	0	4	0	0	3	0	11	0	0	0	0	0	0	0	0	4	0	0	0	0
452	1998	STR98DM#434#B#13642	0	15	0	0	0	0	0	1	0	0	1	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0
453	1998	STR98DM#435#A#13639	0	4	0	0	0	0	0	0	1	0	0	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0
454	1998	STR98DM#435#B#13640	0	3	0	0	0	0	0	1	0	0	0	0	44	0	0	0	0	3	0	0	0	0	0	0	0	0
455	1998	STR98DM#436#A#13643	0	5	0	1	0	0	0	1	0	0	5	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0
456	1998	STR98DM#436#B#13644	0	17	0	2	0	0	0	0	0	0	0	0	49	0	0	0	0	0	0	0	0	0	0	4	0	0
142	1998	STR98DM#437#A#13697	0	1	0	6	0	0	0	32	0	0	31	0	52	0	0	0	0	0	0	1	0	5	0	0	0	0
143	1998	STR98DM#437#B#13698	0	1	0	3	0	0	0	0	0	0	8	0	86	0	0	0	0	0	0	2	0	5	0	1	0	0
144	1998	STR98DM#438#A#13693	0	9	0	2	0	0	0	4	0	0	25	0	50	0	0	0	0	0	0	4	0	0	0	9	0	0
145	1998	STR98DM#438#B#13694	0	1	0	0	0	0	0	7	1	0	163	0	22	0	0	0	0	0	0	33	0	0	0	2	0	0
146	1998	STR98DM#439#A#13695	0	0	0	5	0	0	0	10	0	0	11	0	151	0	0	0	0	1	0	0	0	20	0	0	0	0
147	1998	STR98DM#439#B#13696	0	0	0	3	0	0	0	24	1	0	2	0	130	0	0	0	0	0	0	0	0	19	0	0	0	0
148	1998	STR98DM#440#A#13691	0	0	1	7	0	0	0	41	2	0	16	0	355	0	0	0	0	1	0	2	0	21	0	1	0	0
149	1998	STR98DM#440#B#13692	0	3	0	1	0	0	0	10	0	0	67	0	25	0	0	0	0	0	0	13	0	0	0	0	0	0
150	1998	STR98DM#441#A#13685	0	0	10	0	0	0	0	2	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
151	1998	STR98DM#441#B#13686	0	12	1	1	0	0	0	12	0	0	114	0	36	0	0	0	0	0	0	6	0	0	0	3	0	0
152	1998	STR98DM#442#A#13687	0	1	0	7	0	0	0	60	1	3	1	0	124	0	0	0	0	0	0	1	0	16	0	0	0	0
153	1998	STR98DM#442#B#13688	0	1	0	4	0	0	0	66	1	0	27	0	64	0	0	0	0	0	0	1	0	18	0	2	0	0
154	1998	STR98DM#443#A#13689	0	0	0	1	0	0	0	4	0	6	16	0	6	0	0	0	0	0	0	1	0	10	0	1	0	0
155	1998	STR98DM#443#B#13690	1	21	0	0	0	0	0	7	0	0	0	0	5	0	0	0	0	0	0	0	0	4	0	0	0	0
457	1998	STR98DM#444#A#13665	0	1	0	4	0	0	0	6	0	0	19	0	97	0	0	0	0	0	0	7	0	2	0	0	0	0
458	1998	STR98DM#444#B#13666	0	2	0	1	0	0	0	11	0	0	45	0	29	0	0	0	0	2	0	4	0	7	0	1	0	0
459	1998	STR98DM#445#A#13663	0	5	0	5	0	0	0	13	0	5	42	0	31	0	0	0	0	1	0	1	0	1	0	0	0	0
460	1998	STR98DM#445#B#13664	0	0	1	3	0	0	0	15	0	0	13	0	90	0	0	0	0	0	0	1	0	8	0	2	0	0
461	1998	STR98DM#446#A#13635	0	0	0	0	0	0	0	1	0	116	20	0	14	0	0	0	0	0	0	0	0	4	0	0	0	0
462	1998	STR98DM#446#B#13636	0	9	0	0	0	0	4	0	0	0	6	0	105	0	0	0	0	0	0	1	0	0	0	0	0	0
463	1998	STR98DM#447#A#13645	0	2	0	2	0	0	0	2	0	0	0	0	118	0	0	0	0	0	0	0	0	2	0	0	0	0
464	1998	STR98DM#447#B#13646	0	8	0	7	0	0	0	1	0	0	0	0	15	0	0	0	0	1	0	0	0	0	0	1	0	0
465	1998	STR98DM#448#A#13655	0	8	1	1	0	0	0	0	0	0	3	0	53	0	0	0	0	0	0	0	0	2	0	0	0	0
466	1998	STR98DM#448#B#13656	0	3	1	6	0	0	0	4	1	0	0	0	38	0	0	0	0	0	0	0	0	0	0	1	0	0
467	1998	STR98DM#449#A#13647	0	15	0	5	0	0	0	4	0	0	2	0	133	0	0	0	0	0	0	0	0	2	0	1	0	0
468	1998	STR98DM#449#B#13648	0	5	0	4	0	0	0	1	0	0	1	0	171	0	0	0	0	0	0	0	0	1	0	0	0	0
469	1998	STR98DM#450#A#13649	0	4	1	44	0	0	0	50	0	83	109	0	124	0	0	0	0	1	0	1	0	35	0	0	0	0
470	1998	STR98DM#450#B#13650	0	0	0	7	0	0	0	8	0	5	14	0	29	0	0	0	0	0	0	3	0	1	0	0	0	0
471	1998	STR98DM#451#A#13651	0	3	0	37	0	0	0	12	0	163	39	0	25	0	0	0	0	0	0	0	0	29	0	1	0	0
472	1998	STR98DM#451#B#13652	0	3	2	2	0	0	0	1	2	34	14	0	25	0	0	0	0	0	0	0	0	3	0	0	0	0
473	1998	STR98DM#452#A#13659	0	6	0	3	0	0	0	2	0	0	3	0	191	0	0	0	0	0	0	0	0	0	0	0	0	0
474	1998	STR98DM#452#B#13660	0	6	0	12	0	0	0	1	0	0	12	0	94	0	0	0	0	0	0	0	0	2	0	0	0	0
475	1998	STR98DM#453#A#13661	0	4	0	6	0	0	0	6	0	0	2	0	17	0	0	0	0	0	0	0	0	1	0	0	0	0
476	1998	STR98DM#453#B#13662	0	0	0	21	0	0	0	53	2	11	53	0	37	0	0	0	0	0	0	0	0	22	0	1	0	0
502	1999	NAZE99A#N1#B1#15294	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
503	1999	NAZE99A#N1#B2#15295	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
504	1999	NAZE99A#N2#B1#15296	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	0	0	0
505	1999	NAZE99A#N2#B2#15297	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
506	1999	NAZE99A#N3#B1#15298	0	0	0	0	0	0	0	0	0	23	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0
507	1999	NAZE99A#N3#B2#15299	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
508	1999	NAZE99A#N4#B1#153--	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
509	1999	NAZE99A#N4#B2#153-1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
510	1999	NAZE99A#N5#B1#153-2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
511	1999	NAZE99A#N5#B2#153-3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
156	1999	STR99DM#415#A#16696	0	0	0	0	0	0	0	9	10	1	0	0	19	0	0	0	0	0	0	10	0	0	0	0	0	0
157	1999	STR99DM#415#B#16697	0	0	0	0	0	0	0	6	10	0	0	0	26	0	0	0	0	0	0	1	0	0	0	0	0	0
158	1999	STR99DM#416#A#16698	0	3	0	0	0	37	0	0	0	0	0	0	59	0	0	0	0	0	0	3	0	0	0	0	0	0
159	1999	STR99DM#416#B#16699	0	10	0	0	0	9	0	18	5	0	0	0	48	0	0	0	0	0	0	0	0	0	0	2	0	0
160	1999	STR99DM#417#A#16700	0	0	0	0	0	1	0	33	10	0	0	0	17	0	0	0	0	1	0	4	0	0	0	0	0	0
161	1999	STR99DM#417#B#16701	0	0	0	0	0	0	0	34	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0
162	1999	STR99DM#418#A#16702	0	0	0	0	0	0	0	7	0	0	1	0	25	0	0	0	0	0	0	1	0	0	0	1	0	0
163	1999	STR99DM#418#B#16703	0	0	0	0	0	0	0	9	4	0	5	0	248	0	0	0	0	0	0	1	0	0	0	0	0	0
164	1999	STR99DM#419#A#16704	0	0	0	0	0	0	0	40	31	1	3	0	61	0	0	0	0	0	0	5	0	0	0	0	0	0
165	1999	STR99DM#419#B#16705	0	0	0	0	0	0	0	19	26	0	9	0	76	0	0	0	0	0	0	5	0	0	0	0	0	0
166	1999	STR99DM#420#A#16706	0	6	0	0	0	0	0	17	7	0	1	0	287	0	0	0	0	3	0	2	0	0	0	0	0	0
167	1999	STR99DM#420#B#16707	0	8	0	0	0	118	0	25	8	0	0	0	261	0	0	0	0	2	0	10	0	2	0	2	0	0
168	1999	STR99DM#421#A#16708	0	1	0	0	0	0	0	3	3	1	3	0	139	0	0	0	0	1	0	2	0	0	0	0	0	0
169	1999	STR99DM#421#B#16709	0	5	0	0	0	0	0	6	1	0	1	0	8	0	0	0	0	1	0	2	0	0	0	0	0	0
170	1999	STR99DM#422#A#16710	0	3	0	1	0	0	0	26	3	0	0	0	292	0	0	0	0	0	0	0	0	0	0	0	0	0
171	1999	STR99DM#422#B#16711	0	4	0	0	0	0	0	32	1	0	0	0	290	0	0	0	0	0	0	0	0	0	0	4	0	0
172	1999	STR99DM#423#A#16712	0	2	0	1	0	0	0	25	10	0	1	0	225	0	0	0	0	1	0	0	0	0	0	0	0	0
173	1999	STR99DM#423#B#16713	0	0	0	1	0	0	0	7	41	28	2	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
174	1999	STR99DM#424#A#16714	0	0	0	0	0	0	0	10	23	20	1	0	20	0	0	0	0	0	0	1	0	0	0	0	0	0
175	1999	STR99DM#424#B#16715	0	2	0	1	0	0	0	3	8	6	6	0	452	0	0	0	0	3	0	1	0	0	0	0	0	0
176	1999	STR99DM#425#A#16716	0	4	0	0	0	1	0	118	41	0	28	0	76	0	0	0	0	0	0	3	0	0	0	0	0	0
177	1999	STR99DM#425#B#16717	0	0	0	0	0	0	0	19	6	0	10	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0
178	1999	STR99DM#426#A#16718	0	2	0	0	0	0	0	24	1	0	5	0	157	0	0	0	0	1	0	0	0	0	0	0	0	0
179	1999	STR99DM#426#B#16719	0	0	0	0	0	0	0	9	4	0	2	0	181	0	0	0	0	1	0	2	0	0	0	0	0	0
180	1999	STR99DM#427#A#16720	0	0	0	0	0	0	0	85	54	0	3	0	59	0	0	0	0	1	0	12	0	0	0	0	0	0
181	1999	STR99DM#427#B#16721	0	0	0	0	0	0	0	14	100	0	0	0	10	0	0	0	0	1	0	13	0	0	0	0	0	0
182	1999	STR99DM#428#A#16722	0	1	0	0	0	0	0	25	11	0	4	0	141	0	0	0	0	1	0	2	0	0	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
183	1999	STR99DM#428#B#16723	0	2	0	0	0	0	0	31	8	0	59	0	219	0	0	0	0	0	0	0	0	0	0	0	0	0
184	1999	STR99DM#429#A#16724	0	3	0	0	0	0	0	28	3	0	5	0	423	0	0	0	0	4	0	0	0	0	0	0	0	0
185	1999	STR99DM#429#B#16725	0	9	0	0	0	0	0	4	0	0	17	0	201	0	0	0	0	0	0	0	0	0	0	0	0	0
186	1999	STR99DM#430#A#16726	0	0	0	0	0	0	0	16	2	0	0	0	77	0	0	0	0	0	0	4	0	0	0	0	0	0
187	1999	STR99DM#430#B#16727	0	2	0	0	0	0	0	0	1	0	3	0	151	0	0	0	0	0	0	5	1	0	0	0	0	0
188	1999	STR99DM#431#A#16728	0	1	0	1	0	0	0	13	0	1	6	0	66	0	0	0	0	0	0	2	0	0	0	0	0	0
189	1999	STR99DM#431#B#16729	0	2	0	0	0	0	0	11	1	5	21	0	219	0	0	0	0	0	0	4	0	1	0	0	0	0
190	1999	STR99DM#432#A#16730	0	3	0	0	0	0	0	51	2	0	15	0	80	0	0	0	0	2	0	6	0	0	0	0	0	0
191	1999	STR99DM#432#B#16731	0	2	0	0	0	0	0	15	26	0	14	0	87	0	0	0	0	0	0	28	0	0	0	0	0	0
192	1999	STR99DM#433#A#16732	0	1	0	0	0	0	0	17	3	0	0	0	39	0	0	0	0	0	0	13	0	0	0	0	0	0
193	1999	STR99DM#433#B#16733	0	2	0	0	0	1	0	0	0	0	1	0	33	0	0	0	0	0	0	20	0	1	0	0	0	0
194	1999	STR99DM#434#A#16734	0	1	0	0	0	0	0	0	0	0	0	0	74	0	0	0	0	2	0	0	0	0	0	0	0	0
195	1999	STR99DM#434#B#16735	0	2	0	0	0	0	0	4	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
196	1999	STR99DM#435#A#16736	0	3	0	0	0	0	0	1	0	0	0	0	140	0	0	0	0	2	0	0	0	0	0	0	0	0
197	1999	STR99DM#435#B#16737	0	6	0	0	0	0	0	1	0	0	0	0	111	0	0	0	0	1	0	0	0	0	0	0	0	0
198	1999	STR99DM#436#A#16738	0	6	0	1	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	1	0	0
199	1999	STR99DM#436#B#16739	0	4	0	1	0	0	0	11	0	0	0	0	88	0	0	0	0	0	0	0	0	0	0	0	0	0
200	1999	STR99DM#437#A#16740	0	1	0	0	0	0	0	0	0	6	11	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0
201	1999	STR99DM#437#B#16741	0	2	0	3	0	0	0	6	2	0	0	0	32	0	0	0	0	0	0	1	0	8	0	0	0	0
202	1999	STR99DM#438#A#16742	0	1	0	0	0	0	0	29	0	0	4	0	34	0	0	0	0	0	0	14	0	0	0	0	0	0
203	1999	STR99DM#438#B#16743	0	0	0	0	0	1	0	16	0	0	3	0	143	0	0	0	0	1	0	16	0	0	0	0	0	0
204	1999	STR99DM#439#A#16744	0	0	0	0	0	0	0	6	0	2	2	0	22	0	0	0	0	0	0	3	0	0	0	0	0	0
205	1999	STR99DM#439#B#16745	1	0	0	0	0	0	0	19	1	2	51	0	14	0	0	0	0	0	0	40	0	0	0	0	0	0
206	1999	STR99DM#440#A#16746	0	1	0	0	0	0	0	1	0	22	31	0	365	0	0	0	0	1	0	6	0	0	0	0	0	0
207	1999	STR99DM#440#B#16747	0	1	0	2	0	0	0	30	0	0	15	0	113	0	0	0	0	0	0	2	0	9	0	0	0	0
208	1999	STR99DM#441#A#16748	0	0	0	0	0	0	0	2	0	0	1	0	7	0	0	0	0	0	0	0	0	3	0	0	0	0
209	1999	STR99DM#441#B#16749	0	5	0	0	0	0	0	40	0	0	1	0	51	0	0	0	0	0	0	3	0	0	0	0	0	0
210	1999	STR99DM#442#A#16750	0	3	0	3	0	0	0	47	1	17	2	0	147	0	0	0	0	1	0	0	0	3	0	1	0	0
211	1999	STR99DM#442#B#16751	1	1	0	0	0	0	0	20	0	0	3	0	45	0	0	0	0	0	0	1	0	1	0	0	0	0
212	1999	STR99DM#443#A#16752	0	2	0	0	0	0	0	63	1	3	19	0	180	0	0	0	0	0	0	0	0	8	0	0	0	0
213	1999	STR99DM#443#B#16753	0	1	0	1	0	0	0	2	0	0	0	0	189	0	0	0	0	0	0	0	0	0	0	0	0	0
214	1999	STR99DM#444#A#16754	0	0	0	0	0	0	0	22	0	2	7	0	27	0	0	0	0	1	0	1	0	6	0	0	0	0
215	1999	STR99DM#444#B#16755	0	2	0	0	0	0	0	0	0	0	1	0	9	0	0	0	0	0	0	0	0	0	0	1	0	0
216	1999	STR99DM#445#A#16756	0	1	0	1	0	0	0	17	0	1	13	0	97	0	0	0	0	0	0	0	0	26	0	0	0	0
217	1999	STR99DM#445#B#16757	0	4	0	2	0	0	0	6	0	0	3	0	553	0	0	0	0	0	0	0	0	0	0	0	0	0
218	1999	STR99DM#446#A#16758	0	0	0	0	0	0	0	29	1	0	0	0	31	0	0	0	0	0	0	11	0	0	0	1	0	0
219	1999	STR99DM#446#B#16759	0	5	0	7	0	0	0	42	0	0	0	0	223	0	0	0	0	1	0	0	0	5	0	2	0	0
220	1999	STR99DM#447#A#16760	0	6	0	1	0	0	0	0	0	0	0	0	347	0	0	0	0	0	0	0	0	0	0	0	0	0
221	1999	STR99DM#447#B#16761	0	8	0	6	0	0	0	1	0	2	0	0	134	0	0	0	0	0	0	0	0	0	0	1	0	0
222	1999	STR99DM#448#A#16762	0	0	0	2	0	0	0	1	1	0	0	0	113	0	0	0	0	0	0	0	0	0	0	0	0	0
223	1999	STR99DM#448#B#16763	0	4	0	4	0	0	0	3	0	0	0	0	354	0	0	0	0	0	0	0	0	1	0	0	0	0
224	1999	STR99DM#449#A#16764	0	8	0	4	0	0	0	1	0	45	17	0	341	0	0	0	0	0	0	0	0	0	0	0	0	0
225	1999	STR99DM#449#B#16765	0	4	0	3	0	0	0	9	0	0	0	0	478	0	0	0	0	0	0	0	0	0	0	0	0	0
226	1999	STR99DM#450#A#16766	0	5	0	0	0	0	0	13	0	15	75	0	301	0	0	0	0	1	0	4	0	0	0	0	0	0
227	1999	STR99DM#450#B#16767	0	6	0	8	0	0	0	73	0	0	1	0	106	0	0	0	0	0	0	0	0	9	0	1	0	0
228	1999	STR99DM#451#A#16768	0	0	0	0	0	0	0	2	0	0	5	0	75	0	0	0	0	0	0	0	0	0	0	0	0	0
229	1999	STR99DM#451#B#16769	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	0	0	0	0	0	0	0	0	0	0
230	1999	STR99DM#452#A#16770	0	3	0	0	0	0	0	7	0	0	0	0	221	0	0	0	0	0	0	0	0	2	0	1	0	0
231	1999	STR99DM#452#B#16771	1	4	0	1	0	0	0	7	0	0	13	0	197	0	0	0	0	0	0	0	0	0	0	0	0	0
232	1999	STR99DM#453#A#16772	0	7	0	0	0	0	0	28	0	2	2	0	61	0	0	0	0	0	0	0	0	0	0	1	0	0
233	1999	STR99DM#453#B#16773	0	3	0	5	0	0	0	65	0	1	10	0	270	0	0	0	0	0	0	5	0	6	0	1	0	0
492	2000	NAZE2---#N1#767/--#1936-	0	0	0	0	0	6	0	0	11	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
493	2000	NAZE2---#N1#768/--#19361	0	0	0	0	0	2	0	1	20	0	0	0	0	0	0	0	0	1	0	3	0	1	0	0	0	0
494	2000	NAZE2---#N2#77-/--#19362	0	0	0	4	0	0	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
495	2000	NAZE2---#N2#771/--#19363	0	0	0	1	0	0	0	3	4	0	0	0	1	0	0	0	0	3	0	0	0	2	0	0	0	0
496	2000	NAZE2---#N3#773/--#19364	0	0	0	0	0	0	0	3	0	127	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
497	2000	NAZE2---#N3#774/--#19365	0	0	0	0	0	0	0	0	0	146	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
498	2000	NAZE2---#N4#776/--#19366	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
499	2000	NAZE2---#N4#777/--#19367	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
500	2000	NAZE2---#N5#779/--#19368	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
501	2000	NAZE2---#N5#78-/--#19369	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
234	2000	STR00DM#457#A#19048	1	4	0	0	0	0	0	31	4	0	8	0	9	0	0	0	0	1	0	1	0	0	0	0	0	0
235	2000	STR00DM#457#B#19052	3	1	0	0	0	0	0	43	0	0	0	0	25	0	0	0	0	0	0	3	0	0	0	1	0	0
636	2000	STR--DM#415#A#18999	0	0	0	0	2	13	0	24	13	0	0	0	16	0	0	0	0	0	0	2	1	1	0	0	0	0
637	2000	STR--DM#415#B#19---	0	2	0	0	1	25	0	136	4	0	0	0	187	0	0	0	0	0	0	2	0	0	0	7	0	0
638	2000	STR--DM#416#A#19--1	0	2	0	2	0	9	0	53	0	0	0	0	642	0	0	0	0	0	0	3	0	0	0	1	0	0
639	2000	STR--DM#416#B#19--2	0	3	0	1	0	171	0	81	10	0	0	0	197	0	0	0	0	0	0	34	0	0	0	5	0	0
640	2000	STR--DM#417#A#19--3	0	1	0	0	0	0	0	28	42	0	0	0	28	0	0	0	0	1	0	0	0	0	0	0	0	0
641	2000	STR--DM#417#B#19--4	0	1	0	0	0	5	0	23	15	0	3	0	32	0	0	0	0	0	0	0	0	1	0	0	0	0
642	2000	STR--DM#418#A#19--5	0	3	0	0	0	0	0	7	1	0	2	0	23	0	0	0	0	1	0	0	0	0	0	0	0	0
643	2000	STR--DM#418#B#19--6	0	0	0	0	0	0	0	11	0	0	0	0	202	0	0	0	0	0	0	3	0	0	0	0	0	0
644	2000	STR--DM#419#A#19--7	3	0	0	0	0	0	0	27	1	0	0	0	8	0	0	0	0	0	0	11	0	0	0	0	0	0
645	2000	STR--DM#419#B#19--8	0	0	0	0	0	10	0	33	27	0	0	0	50	17	0	0	0	0	0	4	0	0	0	0	0	0
646	2000	STR--DM#42-#A#19--9	0	1	0	0	0	0	0	17	12	0	4	0	96	0	0	0	0	0	0	11	0	0	0	0	0	0
647	2000	STR--DM#42-#B#19-1-	0	0	0	0	0	0	0	38	14	0	0	0	317	0	0	0	0	0	0	0	0	1	0	0	0	0
648	2000	STR--DM#421#A#19-11	0	0	0	1	0	0	0	17	1	0	0	0	112	0	0	0	0	0	0	0	0	0	0	0	0	0
649	2000	STR--DM#421#B#19-12	0	4	0	1	0	1	0	61	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	4	0	0
650	2000	STR--DM#422#A#19-13	0	3	0	0	0	0	0	13	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0
651	2000	STR--DM#422#B#19-14	0	2	0	2	0	0	0	46	1	0	0	0	207	0	0	0	0	0	0	0	0	1	0	2	0	0
652	2000	STR--DM#423#A#19-15	0	1	0	0	0	0	0	19	26	46	1	0	173	0	0	0	0	2	0	0	0	0	0	0	0	0
653	2000	STR--DM#423#B#19-16	1	3	0	0	0	0	0	56	4	31	2	0	203	0	0	0	0	3	0	2	0	0	0	2	0	0
654	2000	STR--DM#424#A#19-43	1	0	0	2	0	0	0	11	0	0	0	0	673	0	0	0	0	3	0	2	0	0	0	0	0	0
655	2000	STR--DM#424#B#19-44	0	0	0	0	0	0	0	31	3	0	0	0	124	0	0	0	0	3	0	0	0	0	0	0	0	0
656	2000	STR--DM#425#A#19-41	1	1	0	0	0	0	0	10	10	0	2	0	289	0	0	0	0	0	0	9	0	0	0	0	0	0
657	2000	STR--DM#425#B#19-42	2	0	0	0	3	0	0	58	39	0	2	0	250	0	0	0	0	2	0	1	0	0	0	0	0	0
658	2000	STR--DM#426#A#18989	0	2	0	0	0	1	0	7	5	0	1	0	137	0	0	0	0	0	0	1	0	0	0	0	0	0
659	2000	STR--DM#426#B#1899-	0	1	0	1	0	0	0	13	0	0	0	0	191	0	0	0	0	0	0	0	0	0	0	0	0	0
660	2000	STR--DM#427#A#19-39	3	0	0	0	0	7	0	10	5	3	7	0	164	0	0	0	0	0	0	2	0	0	0	0	0	0
661	2000	STR--DM#427#B#19-4-	0	1	0	0	0	1	0	8	3	0	2	0	33	0	0	0	0	1	0	3	0	0	0	0	0	0
662	2000	STR--DM#428#A#19-37	2	4	0	1	0	0	0	5	1	0	27	0	512	0	0	0	0	0	0	1	0	0	0	0	0	0
663	2000	STR--DM#428#B#19-38	5	2	0	0	0	2	0	1	0	1	9	0	285	0	0	0	0	0	0	1	0	0	0	0	0	0
664	2000	STR--DM#429#A#19-33	2	8	0	0	0	0	0	14	0	77	5	0	203	0	0	0	0	2	0	2	0	0	0	0	0	0
665	2000	STR--DM#429#B#19-34	1	3	0	1	0	0	0	1	0	5	0	0	268	0	0	0	0	0	0	0	0	0	0	0	0	0
666	2000	STR--DM#43-#A#19-35	0	0	0	0	0	0	0	3	2	0	7	0	118	0	0	0	0	0	0	3	0	0	0	0	0	0
667	2000	STR--DM#43-#B#19-36	6	0	0	1	0	0	0	6	4	0	1	0	387	0	0	0	0	1	0	16	0	0	0	0	0	0
668	2000	STR--DM#431#A#19-31	2	0	0	1	0	0	0	0	0	30	1	0	428	0	0	0	0	0	0	0	0	0	0	1	0	0
669	2000	STR--DM#431#B#19-32	4	0	0	0	0	0	0	22	5	58	3	0	208	0	1	0	0	0	0	0	0	1	0	0	0	0
670	2000	STR--DM#432#A#18985	6	0	0	0	1	0	0	1	0	2	14	0	130	0	0	0	0	0	0	23	0	0	0	0	0	0
671	2000	STR--DM#432#B#18986	2	2	0	0	0	0	0	11	0	0	18	0	192	0	0	0	0	0	0	15	0	13	0	2	0	0
672	2000	STR--DM#433#A#18969	2	0	0	0	0	0	0	0	0	0	0	0	148	0	0	0	0	2	0	0	0	0	0	0	0	0
673	2000	STR--DM#433#B#1897-	7	0	0	0	0	0	0	1	0	0	13	0	101	0	0	0	0	0	0	11	0	0	0	0	0	0
674	2000	STR--DM#434#A#18973	0	1	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0
675	2000	STR--DM#434#B#18974	0	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
676	2000	STR--DM#435#A#18971	4	1	0	1	0	0	0	1	0	0	0	0	272	0	0	0	0	3	0	0	0	0	0	0	0	0
677	2000	STR--DM#435#B#18972	4	4	0	3	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
678	2000	STR--DM#436#A#18975	2	11	0	0	0	0	0	4	3	4	13	0	158	0	0	0	0	0	0	0	0	0	0	0	0	0
679	2000	STR--DM#436#B#18976	0	4	0	2	0	0	0	1	0	0	0	0	182	0	0	0	0	0	0	0	0	0	0	0	0	0
680	2000	STR--DM#437#A#19-29	11	1	0	0	0	0	0	5	0	87	25	0	320	0	0	0	0	0	0	0	0	0	0	1	0	0
681	2000	STR--DM#437#B#19-3-	9	1	0	0	1	1	0	30	0	70	40	0	385	0	0	0	0	2	0	19	0	2	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
682	2000	STR--DM#438#A#19-25	15	0	0	3	0	2	0	5	0	64	4	0	249	0	0	0	0	0	0	8	0	0	0	0	0	0
683	2000	STR--DM#438#B#19-26	5	0	0	0	0	0	0	15	0	12	1	0	268	0	0	0	0	0	0	3	0	0	0	0	0	0
684	2000	STR--DM#439#A#19-27	1	1	0	0	0	0	0	2	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0
685	2000	STR--DM#439#B#19-28	2	1	0	0	0	0	0	5	0	0	0	0	168	0	0	0	0	0	0	0	0	0	0	0	0	0
686	2000	STR--DM#44-#A#19-23	3	0	0	2	0	0	0	24	1	104	7	0	9	0	0	0	0	1	0	0	0	320	0	0	0	0
687	2000	STR--DM#44-#B#19-24	1	0	0	0	0	0	0	23	0	125	10	0	119	0	0	0	0	0	0	0	0	0	0	0	0	0
688	2000	STR--DM#441#A#19-17	14	0	0	0	0	0	0	14	0	5	1	0	193	0	0	0	0	0	0	16	0	0	0	1	0	0
689	2000	STR--DM#441#B#19-18	22	1	0	1	0	0	0	9	0	28	0	0	251	0	0	0	0	1	0	5	0	0	0	0	0	0
690	2000	STR--DM#442#A#19-19	12	2	0	0	0	0	0	0	0	0	0	0	313	0	0	0	0	0	0	0	0	0	0	0	0	0
691	2000	STR--DM#442#B#19-2-	0	2	0	0	0	0	0	6	0	14	0	0	324	0	0	0	0	1	0	0	0	0	0	0	0	0
692	2000	STR--DM#443#A#19-21	7	1	0	7	0	0	0	28	1	15	3	0	96	0	0	0	0	0	0	0	0	0	0	0	0	0
693	2000	STR--DM#443#B#19-22	1	4	0	15	0	0	0	3	1	0	0	0	30	0	0	0	0	0	0	0	0	1	0	0	0	0
694	2000	STR--DM#444#A#18997	4	2	0	0	0	0	0	0	0	4	1	0	69	0	0	0	0	0	0	14	0	0	0	0	0	0
695	2000	STR--DM#444#B#18998	10	0	0	0	0	0	0	1	0	0	0	0	6	0	0	0	0	0	0	1	0	0	0	0	0	0
696	2000	STR--DM#445#A#18995	14	1	0	2	0	0	0	14	0	3	8	0	165	0	0	0	0	0	0	0	0	0	0	0	0	0
697	2000	STR--DM#445#B#18996	0	1	0	0	0	0	0	6	0	6	1	0	347	0	0	0	0	0	0	0	0	1	0	0	0	0
698	2000	STR--DM#446#A#18967	5	13	0	3	0	0	0	106	0	77	14	0	115	0	0	0	0	0	0	1	0	16	0	0	0	0
699	2000	STR--DM#446#B#18968	5	1	0	1	0	0	0	10	0	20	6	0	247	0	0	0	0	0	0	0	0	0	0	0	0	0
700	2000	STR--DM#447#A#18977	1	3	0	18	0	0	0	6	0	0	0	0	107	0	0	0	0	0	0	0	0	0	0	52	0	0
701	2000	STR--DM#447#B#18978	9	1	0	3	0	0	0	21	2	27	0	0	326	0	0	0	0	0	0	0	0	1	0	1	0	0
702	2000	STR--DM#448#A#18987	4	1	1	2	0	0	0	0	0	0	0	0	293	0	0	0	0	0	0	0	0	0	0	0	0	0
703	2000	STR--DM#448#B#18988	6	4	0	12	0	0	0	1	0	0	0	0	714	0	0	0	0	0	0	0	0	0	0	1	0	0
704	2000	STR--DM#449#A#18979	24	6	0	2	0	0	0	149	0	30	15	1	163	0	0	0	1	0	0	10	0	0	0	5	0	0
705	2000	STR--DM#449#B#1898-	15	0	0	3	0	0	0	55	0	64	5	0	89	0	0	0	0	0	0	3	0	0	0	0	0	0
706	2000	STR--DM#45-#A#18981	11	5	0	1	0	0	0	22	0	88	0	0	361	0	0	0	0	1	0	0	0	0	0	1	0	0
707	2000	STR--DM#45-#B#18982	10	0	0	2	0	0	0	4	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
708	2000	STR--DM#451#A#18983	10	5	0	3	0	0	0	7	0	22	2	0	54	0	0	0	0	0	0	0	0	0	0	0	0	0
709	2000	STR--DM#451#B#18984	3	2	0	20	0	0	0	1	0	0	0	0	16	0	0	0	0	0	0	0	0	0	0	10	0	0
710	2000	STR--DM#452#A#18991	6	0	0	0	0	0	0	0	0	0	0	0	130	0	0	0	0	0	0	0	0	0	0	0	0	0
711	2000	STR--DM#452#B#18992	23	8	0	10	0	0	0	10	0	0	0	0	465	0	0	0	0	0	0	0	0	0	0	0	0	0
712	2000	STR--DM#453#A#18993	7	0	0	2	0	0	0	8	0	26	1	0	89	0	0	0	0	0	0	0	0	0	0	0	0	0
713	2000	STR--DM#453#B#18994	11	0	0	3	0	0	0	7	0	21	2	0	198	0	0	0	0	0	0	0	0	1	0	1	0	0
714	2000	STR--DM#454#A#19-45	0	4	0	3	0	0	0	7	0	0	0	0	357	0	0	0	0	0	0	0	0	0	0	7	0	0
715	2000	STR--DM#454#B#19-49	0	4	0	9	0	0	0	7	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	6	0	0
716	2000	STR--DM#455#A#19-46	0	1	0	0	0	0	0	5	0	0	0	0	148	0	0	0	0	2	0	0	0	0	0	0	0	0
717	2000	STR--DM#455#B#19-5-	0	5	0	0	1	0	0	0	0	0	0	0	68	0	0	0	0	3	0	0	0	0	0	0	0	0
718	2000	STR--DM#456#A#19-47	4	7	0	0	0	0	0	5	1	0	9	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0
719	2000	STR--DM#456#B#19-51	1	8	0	0	1	0	0	101	1	0	13	0	51	0	0	0	0	0	0	3	0	0	0	2	0	0
1131	2001	HHA01#B1#B1-(A)#4843	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1132	2001	HHA01#B1#B1-(B)#4844	0	0	0	0	20	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1133	2001	HHA01#B1#B1-(C)#4845	0	1	0	0	52	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1134	2001	HHA01#B10#B10-(A)#4867	0	0	0	0	123	0	0	33	0	0	0	0	51	0	0	0	0	38	0	0	0	0	0	0	0	0
1135	2001	HHA01#B10#B10-(B)#4868	0	2	0	0	80	0	0	33	0	0	0	0	108	0	0	0	0	20	0	0	0	8	0	0	0	0
1136	2001	HHA01#B10#B10-(C)#4869	0	0	0	0	222	0	0	31	1	0	0	0	151	0	0	0	0	9	0	0	0	0	0	0	0	0
1137	2001	HHA01#B11#B11-(A)#4870	0	3	0	0	0	0	0	11	1	0	0	0	163	0	0	0	0	7	0	0	0	29	0	0	0	0
1138	2001	HHA01#B11#B11-(B)#4871	0	1	0	0	18	0	0	9	1	0	0	0	162	0	0	0	0	12	0	0	0	44	0	0	0	0
1139	2001	HHA01#B11#B11-(C)#4872	0	1	0	0	17	0	0	10	0	0	0	0	118	0	0	0	0	2	0	0	0	9	0	0	0	0
1140	2001	HHA01#B12#B12-(A)#4873	0	3	0	0	0	0	0	94	4	98	0	0	222	0	0	0	0	5	0	0	0	3	0	2	0	0
1141	2001	HHA01#B12#B12-(B)#4874	0	0	0	0	3	1	0	37	2	0	0	0	225	0	0	0	0	2	0	1	0	4	0	0	0	0
1142	2001	HHA01#B12#B12-(C)#4875	0	1	0	0	1	0	0	129	3	0	0	0	260	0	0	0	0	3	0	2	0	29	0	1	0	0
1143	2001	HHA01#B12A#B12A-(A)#4876	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1144	2001	HHA01#B12A#B12A-(B)#4877	0	2	0	0	5	0	0	21	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	1	0	0
1145	2001	HHA01#B12A#B12A-(C)#4878	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1146	2001	HHA01#B13#B13-(A)#4879	1	5	0	0	0	0	0	27	0	0	2	0	0	0	0	0	0	0	0	8	0	97	0	0	0	0
1147	2001	HHA01#B13#B13-(B)#4880	0	6	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	8	0	1	0	4	0	0
1148	2001	HHA01#B13#B13-(C)#4881	1	3	1	0	0	0	0	29	0	8	4	0	0	0	0	0	0	0	0	21	0	0	0	0	0	0
1149	2001	HHA01#B14#B14-(A)#4882	0	10	0	0	34	0	0	47	0	0	0	0	12	0	0	0	0	0	0	0	0	24	0	0	0	0
1150	2001	HHA01#B14#B14-(B)#4883	0	9	4	0	0	0	0	18	0	0	0	0	10	0	0	0	0	0	0	0	0	35	0	0	0	0
1151	2001	HHA01#B14#B14-(C)#4884	3	4	5	0	0	0	0	229	0	0	0	0	25	0	0	0	0	0	0	0	0	0	0	9	0	0
1152	2001	HHA01#B14A#B14A-(A)#4885	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	14	0	0	0	5	0	0	0	0
1153	2001	HHA01#B14A#B14A-(B)#4886	0	0	0	0	15	0	0	49	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1154	2001	HHA01#B14A#B14A-(C)#4887	0	0	0	0	15	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1155	2001	HHA01#B15#B15-(A)#4888	0	1	28	0	0	0	0	1	0	0	0	0	7	0	0	0	0	1	0	0	0	3	0	0	0	0
1156	2001	HHA01#B15#B15-(B)#4889	0	1	0	0	372	0	0	2	0	0	0	0	127	0	0	0	0	4	0	0	0	35	0	0	0	0
1157	2001	HHA01#B15#B15-(C)#4890	0	1	1	0	112	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1158	2001	HHA01#B15A#B15A-(A)#4891	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1159	2001	HHA01#B15A#B15A-(B)#4892	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1160	2001	HHA01#B15A#B15A-(C)#4893	0	0	0	0	2	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1161	2001	HHA01#B16#B16-(A)#4894	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1162	2001	HHA01#B16#B16-(C)#4896	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1163	2001	HHA01#B16A#B16A-(B)#4898	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1164	2001	HHA01#B16A#B16A-(C)#4899	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1165	2001	HHA01#B18A#B18A-(A)#4900	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1166	2001	HHA01#B18A#B18A-(C)#4902	0	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1167	2001	HHA01#B19A#B19A-(A)#4903	0	1	0	0	165	0	0	9	0	0	0	0	0	0	0	0	0	33	0	0	0	0	0	0	0	0
1168	2001	HHA01#B19A#B19A-(B)#4904	0	0	0	0	154	0	0	0	9	0	0	0	29	0	0	0	0	35	0	1	0	47	0	0	0	0
1169	2001	HHA01#B19A#B19A-(C)#4905	0	2	1	0	118	0	0	2	1	0	0	0	41	0	0	0	0	22	0	0	0	6	0	0	0	0
1170	2001	HHA01#B2#B2-(A)#4846	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1171	2001	HHA01#B2#B2-(B)#4847	0	0	0	0	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1172	2001	HHA01#B2#B2-(C)#4848	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1173	2001	HHA01#B3#B3-(C)#4851	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1174	2001	HHA01#B4#B4-(B)#4853	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1175	2001	HHA01#B4#B4-(C)#4854	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1176	2001	HHA01#B5#B5-(A)#4855	0	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1177	2001	HHA01#B5#B5-(B)#4856	0	1	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1178	2001	HHA01#B5#B5-(C)#4857	0	1	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1179	2001	HHA01#B6#B6-(A)#4858	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1180	2001	HHA01#B6#B6-(B)#4859	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1181	2001	HHA01#B6#B6-(C)#4860	0	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1182	2001	HHA01#B8#B8-(A)#4861	0	0	0	2	96	0	0	2	0	0	0	0	43	0	0	0	0	5	0	0	0	3	0	0	0	0
1183	2001	HHA01#B8#B8-(B)#4862	0	0	0	1	1295	0	0	7	2	0	0	0	35	0	0	0	0	9	0	0	0	15	0	0	0	0
1184	2001	HHA01#B8#B8-(C)#4863	0	1	0	1	185	0	0	5	0	0	0	0	18	0	0	0	0	0	0	0	0	0	0	0	0	0
1185	2001	HHA01#B9#B9-(A)#4864	0	0	0	0	12	0	0	0	0	0	0	0	29	0	0	0	0	5	0	0	0	1	0	0	0	0
1186	2001	HHA01#B9#B9-(B)#4865	0	0	0	0	0	0	0	0	0	0	0	0	123	0	0	0	0	16	0	0	0	0	0	0	0	0
1187	2001	HHA01#B9#B9-(C)#4866	0	2	0	0	1	0	0	1	1	0	0	0	100	0	0	0	0	9	0	0	0	9	0	0	0	0
1188	2002	HHA02#B10#B10-1#5049	0	0	7	0	127	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	25	0	0	0	0
1189	2002	HHA02#B10#B10-2#5050	0	0	0	0	85	0	0	0	1	0	0	0	0	0	0	0	0	5	0	0	0	7	0	0	0	0
1190	2002	HHA02#B10#B10-3#5051	0	0	3	0	39	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0
1191	2002	HHA02#B11#B11-1#5052	0	1	0	0	317	0	0	3	0	0	1	0	66	0	0	0	0	4	0	0	0	3	0	0	0	0
1192	2002	HHA02#B11#B11-2#5053	0	0	0	1	578	0	0	0	0	0	0	0	45	0	0	0	0	0	0	0	0	0	0	1	0	0
1193	2002	HHA02#B11#B11-3#5054	0	0	0	0	592	0	0	3	0	0	6	0	176	0	0	0	0	16	0	0	0	0	0	0	0	0
1194	2002	HHA02#B12#B12-1#5055	0	0	1	1	70	0	0	101	12	0	15	0	56	0	0	0	0	5	0	0	0	0	0	0	0	0
1195	2002	HHA02#B12#B12-2#5056	0	0	0	0	140	0	0	78	4	0	18	0	43	0	0	0	0	10	0	0	0	0	0	4	0	0
1196	2002	HHA02#B12#B12-3#5057	0	0	0	0	28	0	0	44	0	0	5	0	12	0	0	0	0	6	0	0	0	0	0	0	0	0
1197	2002	HHA02#B13#B13-1#5058	0	0	1	24	10	0	0	2	2	0	0	0	12	0	0	0	0	1	0	0	0	10	0	0	0	0
1198	2002	HHA02#B13#B13-2#5059	1	1	0	3	3	0	0	0	4	0	0	0	3	0	0	0	0	3	0	0	0	2	0	0	0	0
1199	2002	HHA02#B13#B13-3#5060	0	3	1	7	2	0	0	0	12	0	0	0	23	0	0	0	0	1	0	0	0	0	0	0	0	0
1200	2002	HHA02#B14#B14-1#5061	0	2	0	0	24	0	0	10	0	0	0	0	52	0	0	0	0	4	0	0	0	15	0	0	0	0
1201	2002	HHA02#B14#B14-2#5062	0	1	0	0	46	0	0	11	1	0	0	0	57	0	0	0	0	0	0	0	0	18	0	1	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
1202	2002	HHA02#B14#B14-3#5063	0	0	0	1	25	0	0	5	0	0	0	0	28	0	0	0	0	2	0	0	0	8	0	8	0	0
1203	2002	HHA02#B15#B15-1#5064	0	0	1	0	373	0	0	2	0	0	0	0	11	0	0	0	0	2	0	0	0	0	0	0	0	0
1204	2002	HHA02#B15#B15-2#5065	0	0	0	0	374	0	0	0	0	0	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	0
1205	2002	HHA02#B15#B15-3#5066	0	1	2	0	687	0	0	3	1	0	0	0	74	0	0	0	0	7	0	0	0	0	0	0	0	0
958	2003	HHA03#01#1#7728	0	10	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
959	2003	HHA03#01#2#7729	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
960	2003	HHA03#01#3#7730	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
961	2003	HHA03#02#1#7731	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
962	2003	HHA03#02#2#7732	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
963	2003	HHA03#02#3#7733	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
964	2003	HHA03#04#1#7734	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
965	2003	HHA03#04#2#7735	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
966	2003	HHA03#05#2#7738	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
967	2003	HHA03#05#3#7739	0	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
968	2003	HHA03#06#1#7740	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
969	2003	HHA03#06#3#7742	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
970	2003	HHA03#08#1#7743	0	11	1	0	0	0	0	0	0	0	0	0	13	0	0	0	0	1	0	0	0	6	0	0	0	0
971	2003	HHA03#08#2#7744	0	16	0	7	0	0	0	3	0	0	0	0	125	0	0	0	0	13	0	0	0	0	0	0	0	0
972	2003	HHA03#08#3#7745	0	0	0	14	0	0	0	9	0	0	0	0	50	0	0	0	0	1	0	0	0	24	0	1	0	0
973	2003	HHA03#09#1#7746	0	1	0	0	0	0	0	0	0	0	0	0	134	0	0	0	0	9	0	0	0	4	0	0	0	0
974	2003	HHA03#09#2#7747	0	1	0	0	0	2	0	0	0	0	0	0	28	0	0	0	0	0	0	0	0	0	0	0	0	0
975	2003	HHA03#09#3#7748	0	0	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	1	0	0	0	3	0	0	0	0
976	2003	HHA03#10#1#7749	0	0	0	0	0	0	0	0	1	0	0	0	105	0	0	0	0	43	0	0	0	10	0	1	0	0
977	2003	HHA03#10#2#7750	0	0	0	0	0	0	0	21	0	0	0	0	115	0	1	0	0	29	0	0	0	13	0	0	0	0
978	2003	HHA03#10#3#7751	0	0	0	1	0	0	0	2	10	0	0	0	112	0	0	0	0	14	0	0	0	7	0	0	0	0
979	2003	HHA03#11#1#7752	0	1	1	0	0	1	0	34	4	0	0	0	340	0	0	0	0	19	0	0	0	10	0	0	0	0
980	2003	HHA03#11#2#7753	0	0	0	0	0	0	0	0	0	0	0	0	187	0	0	0	0	1	0	0	0	5	0	7	0	0
981	2003	HHA03#11#3#7754	0	6	0	0	0	710	0	51	0	0	0	0	340	0	1	0	0	0	0	0	0	52	0	35	0	0
982	2003	HHA03#12#1#7755	0	0	1	0	0	2	0	289	0	0	0	0	63	0	0	0	0	0	0	4	0	3	0	10	0	0
983	2003	HHA03#12#2#7756	0	0	0	0	0	0	0	60	3	0	0	0	108	0	0	0	0	0	0	1	0	4	0	1	0	0
984	2003	HHA03#13#1#7758	2	5	0	1	0	0	0	299	2	0	0	0	1	0	2	0	0	0	0	16	0	243	0	1	0	0
985	2003	HHA03#13#2#7759	1	5	3	0	0	0	0	567	2	0	4	0	12	0	0	0	0	0	0	7	0	340	0	8	0	0
986	2003	HHA03#13#3#7760	1	3	0	0	0	0	0	172	6	0	0	0	22	0	0	0	0	0	0	18	0	214	0	2	0	0
987	2003	HHA03#14#1#7761	10	0	28	0	0	0	0	22	0	0	0	0	2	0	0	0	0	0	0	0	0	25	0	1	0	0
988	2003	HHA03#14#2#7762	4	3	2	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	12	0	0	0	0
989	2003	HHA03#14#3#7763	1	7	0	0	0	0	0	109	0	0	0	0	4	0	0	0	0	1	0	0	0	46	0	35	0	0
990	2003	HHA03#15#1#7764	0	2	0	0	0	0	0	0	0	0	0	0	65	0	0	0	0	11	0	0	0	10	0	0	0	0
991	2003	HHA03#15#2#7765	0	0	2	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
992	2003	HHA03#15#3#7766	0	6	1	0	0	0	0	0	0	0	0	0	24	0	0	0	0	1	0	0	0	4	0	0	0	0
993	2003	HHADWA03#DWA-001#a#31113	0	0	0	0	0	0	0	0	0	290	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
994	2003	HHADWA03#DWA-002#a#31209	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
995	2003	HHADWA03#DWA-003#a#31111	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
996	2003	HHADWA03#DWA-004#a#31221	0	1	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
997	2003	HHADWA03#DWA-005#a#30824	0	1	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
998	2003	HHADWA03#DWA-005A#a#31141	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0
999	2003	HHADWA03#DWA-006#a#30823	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1000	2003	HHADWA03#DWA-006A#a#31210	0	0	0	0	0	0	0	1	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1001	2003	HHADWA03#DWA-007#a#31213	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1002	2003	HHADWA03#DWA-010#a#31110	0	1	0	10	1	0	0	3	0	0	0	0	14	0	0	0	0	92	0	0	0	2	0	0	0	0
1003	2003	HHADWA03#DWA-012#a#31195	0	12	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1004	2003	HHADWA03#DWA-014#a#31226	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
1005	2003	HHADWA03#DWA-015#a#30820	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1006	2003	HHADWA03#DWA-015A#a#30825	0	3	0	9	3	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	0	0	0	0
1007	2003	HHADWA03#DWA-016#a#30818	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1008	2003	HHADWA03#DWA-016A#a#30822	0	1	0	5	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1009	2003	HHADWA03#DWA-017#a#30817	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1010	2003	HHADWA03#DWA-018#a#30815	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1011	2003	HHADWA03#DWA-019#a#30806	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1012	2003	HHADWA03#DWA-019A#a#30821	0	0	0	3	0	0	0	0	0	0	0	0	13	0	0	0	0	14	0	0	0	0	0	0	0	0
1013	2003	HHADWA03#DWA-020#a#30813	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1014	2003	HHADWA03#DWA-021#a#31260	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
1015	2003	HHADWA03#DWA-022#a#31261	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1016	2003	HHADWA03#DWA-023#a#31224	0	0	0	1	1	0	0	0	0	0	0	0	3	0	0	0	0	2	0	0	0	0	0	0	0	0
1017	2003	HHADWA03#DWA-024#a#31142	0	0	0	0	0	0	0	0	3	0	2	0	2	0	0	0	0	10	0	0	0	1	0	0	0	0
1018	2003	HHADWA03#DWA-025#a#31140	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1019	2003	HHADWA03#DWA-026#a#31138	0	0	0	0	0	0	0	1	0	104	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1020	2003	HHADWA03#DWA-027#a#31135	0	0	0	2	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1021	2003	HHADWA03#DWA-028#a#31115	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	0	0	0
1022	2003	HHADWA03#DWA-029#a#31112	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1023	2003	HHADWA03#DWA-030#a#31222	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1024	2003	HHADWA03#DWA-031#a#31227	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1025	2003	HHADWA03#DWA-032#a#31225	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1026	2003	HHADWA03#DWA-033#a#30811	0	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1027	2003	HHADWA03#DWA-035#a#30807	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1028	2003	HHADWA03#DWA-038#a#30812	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1029	2003	HHADWA03#DWA-039#a#31258	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1030	2003	HHADWA03#DWA-040#a#31229	0	5	0	14	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1031	2003	HHADWA03#DWA-042#a#31239	0	1	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1032	2003	HHADWA03#DWA-043#a#30808	0	1	0	0	0	0	0	1	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1033	2003	HHADWA03#DWA-051#a#31145	0	5	0	33	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1034	2003	HHADWA03#DWA-053#a#31147	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1035	2003	HHADWA03#DWA-054#a#31146	0	5	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1036	2003	HHADWA03#DWA-100#a#31243	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1037	2003	HHADWA03#DWA-101#a#31234	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1038	2003	HHADWA03#DWA-102#a#31233	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
1039	2003	HHADWA03#DWA-103#a#31232	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1040	2003	HHADWA03#DWA-104#a#31246	0	8	0	24	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0
1041	2003	HHADWA03#DWA-105#a#31244	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1042	2003	HHADWA03#DWA-106#a#31235	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1043	2003	HHADWA03#DWA-108#a#31230	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1044	2003	HHADWA03#DWA-109#a#31241	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1045	2003	HHADWA03#DWA-110#a#31255	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
1046	2003	HHADWA03#DWA-111#a#31247	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0
1047	2003	HHADWA03#DWA-112#a#31248	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1048	2003	HHADWA03#DWA-113#a#31249	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1049	2003	HHADWA03#DWA-114#a#31245	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1050	2003	HHADWA03#DWA-115#a#31242	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1051	2003	HHADWA03#DWA-116#a#31236	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1052	2003	HHADWA03#DWA-117#a#31231	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1053	2003	HHADWA03#DWA-118#a#31237	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1054	2003	HHADWA03#DWA-119#a#31256	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1055	2003	HHADWA03#DWA-120#a#31250	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1056	2003	HHADWA03#DWA-121#a#31251	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
1057	2003	HHADWA03#DWA-122#a#31253	0	0	0	1	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
1058	2003	HHADWA03#DWA-123#a#30809	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1059	2003	HHADWA03#DWA-124#a#31257	0	4	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1060	2003	HHADWA03#DWA-125#a#31240	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1061	2003	HHADWA03#DWA-309#a#31200	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1062	2003	HHADWA03#DWA-310#a#31136	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
1063	2003	HHADWA03#DWA-314#a#31198	0	1	0	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1064	2003	HHADWA03#DWA-317#a#31197	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1065	2003	HHADWA03#DWA-324#a#31199	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1066	2003	HHADWA03#DWA-331#a#31137	0	3	0	4	0	0	0	0	0	0	0	0	5	0	0	0	0	3	0	0	0	0	0	0	0
1067	2003	HHADWA03#DWA-500#a#31211	0	0	0	0	0	1	0	4	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
1068	2003	HHADWA03#DWA-501#a#31212	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1069	2003	HHADWA03#DWA-502#a#31116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1070	2003	HHADWA03#DWA-503#a#31114	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1071	2003	HHADWA03#DWA-504#a#31139	0	0	0	0	0	1	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
1072	2003	HHADWA03#DWA-505#a#31214	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1073	2003	HHADWA03#DWA-506#a#31228	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1074	2003	HHADWA03#DWA-507#a#31238	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1075	2003	HHADWA03#DWA-509#a#31254	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1076	2003	HHADWA03#DWA-510#a#30810	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1077	2003	HHADWA03#DWA-511#a#31252	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1078	2003	HHADWA03#DWA-512#a#30805	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1079	2003	HHADWA03#DWA-513#a#31196	0	7	0	13	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1080	2003	HHADWA03#DWA-514#a#31194	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1081	2003	HHADWA03#DWA-515#a#31193	0	8	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
1082	2003	HHADWA03#DWA-516#a#31192	0	3	0	47	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0
1083	2003	HHADWA03#DWA-517#a#31262	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0
1084	2003	HHADWA03#DWA-518#a#31144	0	3	0	0	0	0	0	12	0	0	0	0	4	0	0	0	11	0	0	0	0	0	0	0	0
1085	2003	HHADWA03#DWA-519#a#31223	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1086	2003	HHADWA03#DWA-520#a#31259	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1087	2003	HHADWA03#DWA-521#a#31143	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1088	2003	HHADWA03#DWA-522#a#30814	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0
1089	2003	HHADWA03#DWA-523#a#30816	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1090	2003	HHADWA03#DWA-524#a#30819	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1091	2003	HHADWA03#N1#a#31117	0	0	1	5	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1092	2003	HHADWA03#N2#a#31118	0	0	1	0	0	10	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
1093	2003	HHADWA03#N3#a#31119	0	0	4	26	0	29	0	5	0	227	0	0	4	0	0	0	0	2	0	0	0	0	0	0	0
1094	2003	HHADWA03#N4#a#31120	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1095	2003	HHADWA03#N5#a#31121	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
721	2003	HHASTO03#150#A#30499	90	0	0	107	0	0	147	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
722	2003	HHASTO03#151#A#30500	5	0	18	357	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0
723	2003	HHASTO03#152#A#30501	102	0	10	164	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
724	2003	HHASTO03#153#A#30502	57	0	0	49	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
725	2003	HHASTO03#154#A#30673	35	0	117	112	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
726	2003	HHASTO03#155#A#30503	10	0	0	16	0	0	0	0	501	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
727	2003	HHASTO03#156#A#30504	31	0	0	35	0	0	0	0	50	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0
728	2003	HHASTO03#157#A#30505	56	0	100	440	0	0	0	0	224	0	0	0	0	0	0	0	0	0	0	0	0	31	0	0	0
729	2003	HHASTO03#158#A#30506	0	1	0	0	0	0	0	0	363	0	0	0	5	0	0	0	0	0	0	0	0	138	0	0	0
730	2003	HHASTO03#159#A#30507	46	0	0	3	0	0	6	0	7	0	0	0	9	0	0	0	0	0	0	0	0	1	0	0	0
731	2003	HHASTO03#160#A#30508	22	1	2	70	0	0	0	0	79	0	0	0	0	0	0	0	0	0	0	0	0	329	0	0	0
732	2003	HHASTO03#161#A#30509	0	6	0	2539	0	0	0	0	2	0	0	0	26	0	0	0	0	0	0	0	0	284	0	0	0
733	2003	HHASTO03#163#A#30510	0	0	0	4	0	0	0	0	391	0	0	0	0	0	0	0	0	0	0	0	0	49	0	0	0
734	2003	HHASTO03#164#A#30511	0	1	0	8	0	0	0	1	294	0	0	0	0	0	0	0	0	0	0	0	0	679	0	0	0
735	2003	HHASTO03#165#A#30512	0	0	0	8	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
736	2003	HHASTO03#166#A#30513	1	4	1	636	0	0	0	1	3	0	0	0	135	0	0	0	0	0	0	0	0	6	0	0	0
737	2003	HHASTO03#168#A#30514	4	3	0	469	0	0	0	0	444	0	0	0	2	0	0	0	0	0	0	0	0	672	0	0	0
738	2003	HHASTO03#169#A#30515	2	5	0	459	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	134	0	1	0
739	2003	HHASTO03#170#A#30516	0	3	0	6	0	0	0	1	0	0	0	0	141	0	0	0	0	0	0	0	0	1	0	0	0
740	2003	HHASTO03#171#A#30517	0	4	0	557	0	0	0	129	30	0	0	0	0	0	0	0	0	0	0	0	0	211	0	0	0
741	2003	HHASTO03#172#A#30518	2	5	3	1539	0	0	0	12	2	22	0	0	0	0	0	0	0	0	0	0	0	14	0	4	0
742	2003	HHASTO03#173#A#30519	0	11	2	145	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	2	0	0	0
743	2003	HHASTO03#174#A#30520	1	3	0	570	0	0	0	2	2	0	0	0	11	0	0	0	0	0	0	0	0	4	0	2	0
744	2003	HHASTO03#175#A#30521	1	10	4	273	0	0	0	24	14	0	0	0	0	0	0	0	0	0	0	0	0	42	0	0	0
745	2003	HHASTO03#176#A#30522	4	6	1	28	0	0	0	3	1	0	0	0	24	0	0	0	0	2	0	0	0	5	0	2	0
746	2003	HHASTO03#177#A#30523	1	3	7	665	0	0	0	1	6	0	0	0	89	0	0	0	0	1	0	0	0	2	0	0	0
747	2003	HHASTO03#178#A#30524	0	8	0	179	0	0	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0
748	2003	HHASTO03#179#A#30525	0	9	0	26	0	0	0	4	0	0	0	0	357	0	0	0	0	0	0	0	0	1	0	2	0
749	2003	HHASTO03#180#A#30526	0	7	2	12	0	0	0	0	22	0	0	0	58	0	0	0	0	0	0	3	0	0	0	0	0
750	2003	HHASTO03#181#A#30527	0	11	0	1	0	0	0	1	0	0	0	0	77	0	0	0	0	0	0	0	0	0	0	0	0
751	2003	HHASTO03#182#A#30528	0	10	0	3	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0
752	2003	HHASTO03#183#A#30529	4	1	0	39	0	0	2	18	78	1	0	0	129	0	0	0	0	0	0	0	0	0	0	0	0
753	2003	HHASTO03#184#A#30530	3	6	2	45	0	0	1	7	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
754	2003	HHASTO03#185#A#30531	1	1	0	65	0	0	0	4	63	1747	0	0	60	0	0	0	0	0	0	2	0	0	0	0	0
755	2003	HHASTO03#186#A#30532	0	2	0	3	0	1	0	8	0	0	0	0	7	0	0	0	0	0	0	11	0	0	0	5	0
756	2003	HHASTO03#187#A#30533	2	12	12	34	0	0	0	2	1	0	4	0	6	0	0	0	0	0	0	0	0	0	0	0	0
757	2003	HHASTO03#188#A#30534	0	0	0	0	0	0	0	1	91	1793	0	0	75	0	0	0	0	0	0	9	0	3	0	0	0
758	2003	HHASTO03#189#A#30535	1	0	0	1	0	0	0	1	1	0	0	0	16	0	0	0	0	3	0	12	0	0	0	0	0
759	2003	HHASTO03#190#A#30536	0	2	0	3	0	0	0	1	6	5120	9	0	115	0	0	0	0	0	0	14	0	3	0	0	0
760	2003	HHASTO03#191#A#30537	2	0	2	2	0	0	0	1	19	48	8	0	29	0	0	0	0	0	0	7	0	13	0	3	0
761	2003	HHASTO03#192#A#30538	0	8	0	3	0	0	0	3	1	0	18	0	71	0	0	0	0	0	0	1	0	0	0	2	0
762	2003	HHASTO03#193#A#30539	0	3	17	213	0	0	0	3	25	0	0	0	0	0	0	0	0	0	0	0	0	18	0	1	0
763	2003	HHASTO03#194#A#30540	1	9	1	5	0	0	0	4	48	1	1	0	2	0	0	0	0	0	0	4	0	0	0	0	0
764	2003	HHASTO03#195#A#30541	0	0	0	0	0	3	0	5	65	0	0	0	63	0	0	0	0	9	0	12	0	2	0	2	0
765	2003	HHASTO03#197#A#30542	4	2	2	33	0	0	0	0	9	1	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
766	2003	HHASTO03#198#A#30543	0	7	1	30	0	2	0	2	1	0	0	0	183	0	0	0	0	8	0	0	0	0	0	2	0
767	2003	HHASTO03#199#A#30544	0	4	0	2	0	20	0	21	0	1	0	0	4	0	0	0	0	0	0	1	0	0	0	4	0
768	2003	HHASTO03#200#A#30545	0	3	0	3	0	54	0	6	0	0	0	0	12	0	0	0	0	1	0	0	0	0	0	4	0
769	2003	HHASTO03#201#A#30546	0	7	1	16	0	0	0	0	8	0	0	0	106	0	0	0	0	0	0	0	0	2	0	0	0
770	2003	HHASTO03#202#A#30547	1	11	0	3	0	0	0	1	19	0	0	0	102	0	0	0	0	5	0	0	0	0	0	0	0
771	2003	HHASTO03#203#A#30548	0	3	0	0	0	0	0	0	0	0	0	0	41	0	0	0	0	2	0	0	0	0	0	0	0
772	2003	HHASTO03#204#A#30549	0	7	0	21	0	0	0	10	1	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0
773	2003	HHASTO03#205#A#30550	0	0	1	2	0	0	0	2	1	0	0	0	12	0	0	0	0	14	0	0	0	1	0	1	0
774	2003	HHASTO03#206#A#30551	0	4	0	78	0	0	0	0	65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
775	2003	HHASTO03#207#A#30552	0	2	1	2	0	0	0	0	9	68	2	0	86	0	0	0	0	0	0	12	0	0	0	0	0
776	2003	HHASTO03#208#A#30553	0	24	0	65	0	0	0	1	2	0	0	0	14	0	0	0	0	0	0	0	0	1	0	2	0
777	2003	HHASTO03#209#A#30554	5	5	0	5	0	0	0	2	46	1	1	0	20	0	0	0	0	0	0	14	0	0	0	0	0
778	2003	HHASTO03#210#A#30555	0	5	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	0	0	0	0	1	0
779	2003	HHASTO03#211#A#30556	0	0	1	32	0	1	0	2	0	0	0	0	186	0	0	0	0	28	0	0	0	2	0	0	0
780	2003	HHASTO03#213#A#30557	0	2	0	1	0	0	0	0	2	0	0	0	3	0	0	0	0	8	0	0	0	0	0	2	0
781	2003	HHASTO03#214#A#30558	2	6	4	47	0	0	0	3	11	0	0	0	324	0	0	0	0	5	0	0	0	9	0	5	0
782	2003	HHASTO03#215#A#30559	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	43	0	1	0	1	0	0	0
783	2003	HHASTO03#216#A#30560	0	5	0	6	0	0	0	0	4	0	0	0	83	0	0	0	0	0	0	0	0	0	0	0	0
784	2003	HHASTO03#217#A#30561	0	0	0	2	0	0	0	1	0	0	0	0	9	0	0	0	0	20	0	0	0	0	0	0	0
785	2003	HHASTO03#218#A#30562	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	4	0	0	0	0	0	0	0
786	2003	HHASTO03#219#A#30563	0	0	0	10	0	1	0	0	0	0	0	0	25	0	0	0	0	74	0	0	0	1	0	0	0
787	2003	HHASTO03#220#A#30564	0	5	0	15	0	3	0	4	0	0	0	0	95	0	0	0	0	30	0	0	0	0	0	1	0
788	2003	HHASTO03#221#A#30565	1	0	0	13	1	1	0	2	1	0	0	0	62	0	0	0	0	22	0	0	0	1	0	0	0
789	2003	HHASTO03#222#A#30566	0	14	0	15	0	0	0	3	4	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0
790	2003	HHASTO03#223#A#30567	0	0	2	5	0	7	0	3	4	0	1	0	24	0	0	0	0	8	0	2	0	2	0	0	0
791	2003	HHASTO03#224#A#30568	0	0	0	1	0	15	0	5	0	0	0	0	16	0	0	0	0	97	0	2	0	11	0	0	0
792	2003	HHASTO03#225#A#30569	0	1	4	10	0	0	0	0	0	0	0	0	12	0	0	0	0	1	0	0	0	1	0	0	0
793	2003	HHASTO03#226#A#30570	0	19	0	94	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0
794	2003	HHASTO03#227#A#30571	0	10	0	25	0	0	0	1	12	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
795	2003	HHASTO03#228#A#30572	0	14	3	33	0	0	0	0	12	0	0	0	163	0	0	0	0	0	0	0	0	4	0	1	0
796	2003	HHASTO03#229#A#30573	0	6	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	6	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
797	2003	HHASTO03#230#A#30574	0	1	16	69	0	8	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0
798	2003	HHASTO03#231#A#30575	0	5	0	32	0	0	0	1	1	0	1	0	79	0	0	0	0	18	0	0	0	2	0	0	0	0
799	2003	HHASTO03#232#A#30576	0	0	0	10	0	0	0	0	0	0	0	0	1	0	0	0	0	11	0	0	0	0	0	0	0	0
800	2003	HHASTO03#233#A#30577	0	1	0	2	0	0	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
801	2003	HHASTO03#234#A#30578	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
802	2003	HHASTO03#235#A#30579	0	9	0	58	0	0	0	5	0	0	0	0	27	0	0	0	0	0	0	0	0	3	0	1	0	0
803	2003	HHASTO03#236#A#30580	0	7	0	103	0	0	0	5	0	1	0	0	152	0	0	0	0	0	0	0	0	7	0	8	0	0
804	2003	HHASTO03#237#A#30581	0	0	0	0	0	1	0	19	7	0	2	0	25	0	0	0	0	0	0	2	0	3	0	0	0	0
805	2003	HHASTO03#238#A#30582	2	2	0	2	0	0	0	35	7	0	5	0	142	0	0	0	0	0	0	1	0	3	0	7	0	0
806	2003	HHASTO03#239#A#30583	0	6	0	2	0	0	0	0	0	0	0	0	99	0	0	0	0	0	0	0	0	0	0	0	0	0
807	2003	HHASTO03#241#A#30584	0	6	0	2	0	1	0	1	0	0	2	0	69	0	0	0	0	0	0	0	0	0	0	4	0	0
808	2003	HHASTO03#243#A#30585	0	1	0	0	0	5	0	2	2	0	1	0	109	0	0	0	0	4	0	6	0	1	0	0	0	0
809	2003	HHASTO03#244#A#30586	0	4	2	0	0	2	1	5	11	3	7	0	25	0	0	0	0	1	0	2	0	2	0	0	0	0
810	2003	HHASTO03#245#A#30587	0	2	0	0	0	0	0	10	7	1	6	0	10	0	0	0	0	1	0	0	0	0	0	0	0	0
811	2003	HHASTO03#246#A#30588	0	0	0	0	0	3	0	5	3	0	0	0	107	0	0	0	0	0	0	6	0	0	0	1	0	0
812	2003	HHASTO03#247#A#30589	2	1	3	3	0	1	0	1	0	0	0	0	15	0	0	0	0	1	0	1	0	0	0	2	0	0
813	2003	HHASTO03#248#A#30590	0	2	0	0	0	0	0	0	0	0	0	0	30	0	0	0	0	25	0	0	0	0	0	0	0	0
814	2003	HHASTO03#249#A#30591	0	4	0	11	0	0	0	4	0	0	0	0	71	0	0	0	0	0	0	0	0	0	0	2	0	0
815	2003	HHASTO03#250#A#30592	1	1	12	769	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	279	0	1	0	0
816	2003	HHASTO03#251#A#30593	0	1	9	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	84	0	17	0	0
817	2003	HHASTO03#252#A#30594	0	2	1	1402	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	1	0	0
818	2003	HHASTO03#253#A#30595	0	3	1	1749	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	309	0	2	0	0
819	2003	HHASTO03#254#A#30596	0	1	21	2108	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	333	0	8	0	0
820	2003	HHASTO03#255#A#30597	2	1	1	23	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	538	0	0	0	0
821	2003	HHASTO03#256#A#30598	0	4	1	1377	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	125	0	27	0	0
822	2003	HHASTO03#257#A#30599	0	4	71	1686	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	62	0	0	0	0
823	2003	HHASTO03#258#A#30600	1	1	0	689	0	0	1	1	4	64	0	0	0	0	0	0	0	0	0	0	0	84	0	0	0	0
824	2003	HHASTO03#259#A#30601	0	2	40	177	0	6	0	0	0	109	4	0	16	0	0	0	0	0	0	0	0	43	0	8	0	0
825	2003	HHASTO03#260#A#30602	2	0	5	318	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	64	0	0	0	0
826	2003	HHASTO03#261#A#30603	5	11	8	1779	0	0	0	0	13	0	0	0	6	0	0	0	0	0	0	0	0	102	0	1	0	0
827	2003	HHASTO03#262#A#30604	1	13	1	133	0	0	0	0	6	0	0	0	504	0	0	0	0	0	0	0	0	6	0	0	0	0
828	2003	HHASTO03#263#A#30605	2	10	9	1258	0	0	0	0	210	0	0	0	4	0	0	0	0	0	0	0	0	141	0	0	0	0
829	2003	HHASTO03#264#A#30606	0	8	5	407	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	132	0	0	0	0
830	2003	HHASTO03#265#A#30618	0	2	14	7	0	1	0	4	7	2	0	0	25	0	0	0	0	3	0	2	0	5	0	0	0	0
831	2003	HHASTO03#266#A#30619	0	7	19	576	0	0	0	0	14	2	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
832	2003	HHASTO03#267#A#30620	18	1	1	11	0	0	11	0	129	2	0	0	184	0	0	0	0	0	0	1	0	73	0	0	0	0
833	2003	HHASTO03#268#A#30621	0	10	0	4	0	0	0	1	1	0	0	0	106	0	0	0	0	1	0	0	0	0	0	0	0	0
834	2003	HHASTO03#269#A#30622	0	8	0	16	0	0	0	0	57	3	0	0	15	0	0	0	0	0	0	39	0	0	0	0	0	0
835	2003	HHASTO03#270#A#30623	0	17	0	222	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	7	0	0	0	0
836	2003	HHASTO03#271#A#30624	0	0	3	7	0	31	0	2	2	0	0	0	3	0	0	0	0	2	0	2	0	2	0	0	0	0
837	2003	HHASTO03#272#A#30625	0	10	12	104	0	0	0	0	7	1	1	0	6	0	0	0	0	0	0	0	0	0	0	2	0	0
838	2003	HHASTO03#273#A#30626	1	3	0	12	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	29	0	0	0	0
839	2003	HHASTO03#274#A#30627	0	0	1	3	0	0	0	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	0	0
840	2003	HHASTO03#275#A#30628	1	10	6	103	0	0	0	0	41	0	0	0	5	0	0	0	0	0	0	0	0	5	0	0	0	0
841	2003	HHASTO03#276#A#30629	2	14	4	61	0	0	0	5	468	0	0	0	118	0	0	0	0	0	0	0	0	107	0	4	0	0
842	2003	HHASTO03#277#A#30630	0	5	32	3	0	71	0	1	0	0	1	0	54	0	0	0	0	1	0	0	0	1	0	2	0	0
843	2003	HHASTO03#278#A#30631	0	10	1	2	0	0	0	0	0	0	0	0	240	0	0	0	0	7	0	0	0	0	0	0	0	0
844	2003	HHASTO03#279#A#30632	0	7	5	38	0	0	0	0	162	0	0	0	7	0	0	0	0	0	0	22	0	0	0	0	0	0
845	2003	HHASTO03#280#A#30633	0	8	1	5	0	0	0	0	7	0	0	0	316	0	0	0	0	0	0	0	0	0	0	0	0	0
846	2003	HHASTO03#281#A#30634	0	0	2	1	0	32	0	4	0	0	1	0	3	0	0	0	0	15	0	1	0	0	0	0	0	0
847	2003	HHASTO03#282#A#30635	1	0	0	28	0	54	0	15	6	0	0	0	24	0	0	0	0	15	0	6	0	2	0	0	0	0
848	2003	HHASTO03#283#A#30636	5	2	0	19	0	0	0	0	19	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
849	2003	HHASTO03#284#A#30637	0	0	0	5	0	0	0	1	11	678	0	0	19	0	0	0	0	0	0	2	0	5	0	0	0	0
850	2003	HHASTO03#285#A#30638	0	0	1	1	0	1	0	3	0	0	3	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0
851	2003	HHASTO03#286#A#30639	0	0	4	1	0	10	0	0	0	0	0	0	3	0	0	0	0	25	0	7	0	0	0	0	0	0
852	2003	HHASTO03#287#A#30640	0	5	4	4	0	0	0	0	25	0	0	0	50	0	0	0	0	0	0	0	0	2	0	0	0	0
853	2003	HHASTO03#288#A#30641	1	17	0	2	0	0	0	0	42	0	0	0	93	0	0	0	0	0	0	0	0	0	0	0	0	0
854	2003	HHASTO03#289#A#30642	0	0	1	0	0	51	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
855	2003	HHASTO03#290#A#30643	1	0	9	3	0	0	0	0	2	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
856	2003	HHASTO03#291#A#30644	0	7	0	0	0	0	0	0	20	0	0	0	115	0	0	0	0	0	0	0	0	2	0	0	0	0
857	2003	HHASTO03#292#A#30645	0	0	8	5	0	0	0	0	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
858	2003	HHASTO03#293#A#30646	0	3	0	11	0	0	0	0	1	0	0	0	343	0	0	0	0	1	0	0	0	0	0	1	0	0
859	2003	HHASTO03#294#A#30647	0	0	0	5	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0
860	2003	HHASTO03#295#A#30648	0	2	1	17	0	1	0	0	0	0	0	0	1	0	0	0	0	3	0	0	0	3	0	2	0	0
861	2003	HHASTO03#296#A#30649	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0
862	2003	HHASTO03#298#A#30650	0	18	0	6	0	0	0	0	0	0	0	0	127	0	0	0	0	0	0	0	0	1	0	0	0	0
863	2003	HHASTO03#299#A#30651	0	10	0	110	0	1	0	4	3	0	0	0	362	0	0	0	0	0	0	0	0	16	0	2	0	0
864	2003	HHASTO03#300#A#30652	1	23	0	62	0	0	0	0	2	1	0	0	12	0	0	0	0	0	0	0	0	2	0	5	0	0
865	2003	HHASTO03#301#A#30653	0	1	0	51	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
866	2003	HHASTO03#302#A#30654	0	2	3	346	0	0	0	5	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	24	0	0
867	2003	HHASTO03#303#A#30655	0	0	0	59	0	11	0	5	1	0	0	0	7	0	0	0	0	9	0	0	0	4	0	0	0	0
868	2003	HHASTO03#304#A#30656	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0
869	2003	HHASTO03#305#A#30657	0	0	0	1	0	0	0	0	0	0	1	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0
870	2003	HHASTO03#306#A#30658	0	8	8	2	0	1938	1	0	10	0	0	0	3	0	0	0	0	0	0	1	0	0	0	0	0	0
871	2003	HHASTO03#525#A#30659	0	0	2	764	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	68	0	1	0	0
872	2003	HHASTO03#526#A#30660	0	1	3	862	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	151	0	50	0	0
873	2003	HHASTO03#527#A#30661	0	6	30	1855	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	70	0	39	0	0
874	2003	HHASTO03#528#A#30662	0	10	7	521	0	1	0	0	0	0	0	0	142	0	0	0	0	0	1	0	0	104	0	9	0	0
875	2003	HHASTO03#534#A#30663	1	1	0	5	0	0	0	5	0	0	3	0	257	0	0	0	0	5	0	2	0	0	0	0	0	0
876	2003	HHASTO03#535#A#30664	0	0	0	68	0	0	0	6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	6	0	0
877	2003	HHASTO03#536#A#30665	0	6	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
878	2003	HHASTO03#537#A#30666	9	8	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
879	2003	HHASTO03#538#A#30667	2	12	12	80	0	0	0	10	0	0	0	0	8	0	0	0	0	0	0	5	0	3	0	1	0	0
880	2003	HHASTO03#539#A#30668	0	9	5	46	0	0	0	8	2	0	0	0	1	0	0	0	0	0	0	3	0	0	0	2	0	0
881	2003	HHASTO03#543#A#30669	93	0	0	0	0	0	0	0	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
882	2003	HHASTO03#545#A#30670	71	0	42	54	0	0	0	0	1	116	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
883	2003	HHASTO03#546#A#30671	2	3	0	1	0	0	0	15	3	6820	34	0	1	0	0	0	0	0	0	4	0	1	0	0	0	0
884	2003	HHASTO03#547#A#30672	0	1	0	2	0	39	0	0	3	0	6	0	64	0	0	0	0	0	0	9	0	0	0	1	0	0
1096	2008	HHAFEL08#12#a#43339	0	0	0	0	0	0	0	0	0	0	0	0	8	0	4	0	0	48	0	0	0	0	0	0	0	0
1097	2008	HHAFEL08#12#b#43340	0	0	0	1	0	0	0	2	0	0	0	0	16	0	5	0	0	81	0	0	0	8	0	0	0	0
1098	2008	HHAFEL08#12#c#43341	0	0	0	1	0	0	0	2	0	0	0	0	8	0	5	0	0	88	0	0	0	0	0	0	0	0
1099	2008	HHAFEL08#13#a#43342	0	0	0	0	0	0	0	1	0	0	0	0	26	0	0	0	0	102	0	0	0	5	0	0	0	0
1100	2008	HHAFEL08#13#b#43343	0	0	0	0	0	0	0	0	0	0	0	0	40	0	2	0	0	38	0	0	0	7	0	0	0	0
1101	2008	HHAFEL08#13#c#43344	0	1	0	1	0	0	0	0	1	0	0	0	16	0	3	0	0	43	0	0	0	1	0	0	0	0
1102	2008	HHAFEL08#32#a#43345	0	6	0	2	0	0	0	0	8	0	0	0	43	0	0	0	0	3	0	0	0	3	0	1	0	0
1103	2008	HHAFEL08#32#b#43346	0	8	0	4	0	0	0	19	0	0	0	0	6	0	0	0	0	3	0	0	0	1	0	1	0	0
1104	2008	HHAFEL08#32#c#43347	0	5	0	3	0	0	0	59	0	0	0	0	16	0	0	0	0	1	0	0	0	15	0	8	0	0
1105	2008	HHAFEL08#33#a#43348	0	4	0	6	0	0	0	11	0	0	0	0	78	0	0	0	0	0	0	0	0	13	0	9	0	0
1106	2008	HHAFEL08#33#b#43349	0	6	0	3	0	0	0	7	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0
1107	2008	HHAFEL08#33#c#43350	0	4	0	6	0	0	0	32	0	0	0	0	4	0	0	0	0	0	0	0	0	7	0	7	0	0
1108	2008	HHAFEL08#41#a#43351	0	5	0	15	0	0	0	20	0	0	0	0	1.001	0	0	0	0	0	0	0	0	0	0	0	0	0
1109	2008	HHAFEL08#41#b#43352	0	6	0	6	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1110	2008	HHAFEL08#41#c#43353	0	6	0	7	0	0	0	19	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1111	2008	HHAFEL08#43#a#43354	0	1	0	4	0	5	0	23	2	0	1	0	28	0	0	0	0	39	0	5	0	14	0	0	0	0
1112	2008	HHAFEL08#43#b#43355	0	0	0	0	0	24	0	10	0	0	2	0	42	0	0	0	0	43	0	5	0	3	0	0	0	0
1113	2008	HHAFEL08#43#c#43356	0	2	0	1	0	3	0	2	4	0	0	0	51	0	4	0	0	56	0	5	0	11	0	4	0	0
885	2008	HHASTO08#150#a#43548	37	0	0	1	0	0	59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
886	2008	HHASTO08#152#a#43549	33	0	0	12	0	0	12	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
887	2008	HHASTO08#153#a#43550	36	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
888	2008	HHASTO08#154#a#43551	26	0	5	27	0	0	3	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
889	2008	HHASTO08#155#a#43552	2	1	0	0	0	0	0	0	428	0	0	0	0	0	0	0	0	0	0	0	181	0	0	0	2
890	2008	HHASTO08#157#a#43553	0	0	0	1	0	0	0	0	414	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
891	2008	HHASTO08#158#a#43554	0	1	0	0	0	0	0	0	119	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
892	2008	HHASTO08#163#a#43555	0	0	0	0	0	0	0	0	506	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
893	2008	HHASTO08#169#a#43556	1	7	0	89	0	0	0	99	0	0	0	0	0	0	0	0	0	0	0	0	60	0	15	0	0
894	2008	HHASTO08#171#a#43557	0	8	0	460	0	0	0	123	49	0	0	0	0	0	0	0	0	0	0	0	265	68	30	0	0
895	2008	HHASTO08#172#a#43558	2	4	0	735	0	0	0	45	0	0	0	0	4	0	0	0	0	0	3	0	27	0	10	0	0
896	2008	HHASTO08#174#a#43559	0	3	1	172	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	9	0	2	0	0
897	2008	HHASTO08#179#a#43560	0	15	0	5	0	0	0	1	0	0	0	0	378	0	0	0	0	0	0	0	3	0	0	0	0
898	2008	HHASTO08#180#a#43561	1	12	0	188	0	0	0	33	0	0	0	0	2	0	0	0	0	0	1	0	29	0	1	0	0
899	2008	HHASTO08#181#a#43562	0	8	0	1	0	0	0	0	0	0	0	0	102	0	0	0	0	1	0	0	0	0	0	0	0
900	2008	HHASTO08#189#a#43563	0	0	0	1	0	0	0	0	1	0	37	0	74	0	1	0	0	7	0	10	0	0	0	0	0
901	2008	HHASTO08#191#a#43564	0	0	0	0	0	0	0	0	6	0	1	0	12	0	0	0	0	1	0	5	0	2	0	0	0
902	2008	HHASTO08#192#a#43565	0	2	0	1	0	0	0	1	0	0	0	0	141	0	0	0	0	14	0	0	0	0	0	0	0
903	2008	HHASTO08#193#a#43566	0	7	0	10	0	0	0	17	105	0	0	0	0	0	0	0	0	1	0	0	0	143	12	1	0	0
904	2008	HHASTO08#194#a#43567	1	7	0	1	0	0	0	31	61	0	0	0	45	0	0	0	0	7	0	48	0	27	0	0	0	0
905	2008	HHASTO08#195#a#43568	0	1	0	1	0	42	0	55	1	0	1	0	61	0	0	0	0	1	0	8	0	0	0	20	0	0
906	2008	HHASTO08#204#a#43569	0	11	0	108	0	0	0	17	2	0	0	0	3	0	0	0	0	0	0	0	16	0	0	0	0
907	2008	HHASTO08#206#a#43570	3	1	0	17	0	0	0	1	84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
908	2008	HHASTO08#207#a#43571	1	0	1	2	0	0	0	7	47	120	0	0	32	0	0	0	0	7	0	91	0	9	0	0	0	0
909	2008	HHASTO08#209#a#43572	1	5	1	14	0	0	0	18	29	0	0	0	1	0	0	0	0	1	0	0	0	10	0	0	0	0
910	2008	HHASTO08#249#a#43573	0	7	0	12	0	0	0	29	0	0	0	0	3	0	0	0	0	0	0	0	0	5	0	4	0	0
911	2008	HHASTO08#258#a#43574	1	2	7	368	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	69	0	0	0	1
912	2008	HHASTO08#260#a#43575	12	0	33	836	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	2	0	310	0	0	0	0
913	2008	HHASTO08#261#a#43576	13	11	38	408	0	0	0	0	4	0	0	0	1	0	0	0	0	0	0	0	0	51	0	0	0	0
914	2008	HHASTO08#263#a#43577	7	4	9	168	0	0	0	0	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
915	2008	HHASTO08#267#a#43578	0	1	6	127	0	0	0	0	32	0	0	0	9	0	0	0	0	0	0	0	0	22	0	0	0	0
916	2008	HHASTO08#269#a#43579	0	7	4	33	0	0	0	0	14	8	0	0	0	0	0	0	0	0	0	41	0	12	0	1	0	1
917	2008	HHASTO08#272#a#43580	0	7	4	83	0	0	0	23	0	0	13	0	4	0	0	0	0	1	0	0	0	48	0	9	0	0
918	2008	HHASTO08#275#a#43581	0	10	0	25	0	0	0	5	1	0	0	0	0	0	0	0	0	1	0	0	0	11	0	1	0	0
919	2008	HHASTO08#285#a#43582	0	0	0	0	0	0	0	8	3	0	5	0	6	0	0	0	0	33	0	1	0	1	0	0	0	0
920	2008	HHASTO08#289#a#43583	0	0	0	1	0	9	0	8	1	0	0	0	0	0	1	0	0	18	0	5	0	0	0	0	0	0
921	2008	HHASTO08#295#a#43584	0	1	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0
922	2008	HHASTO08#296#a#43585	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
923	2008	HHASTO08#300#a#43586	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
924	2008	HHASTO08#301#a#43587	0	3	0	49	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	5	0	0
925	2008	HHASTO08#303#a#43588	0	1	0	0	0	116	0	13	7	0	0	0	3	0	0	0	0	1	0	1	0	0	0	2	0	0
926	2008	HHASTO08#306#a#43589	0	3	2	2	0	0	0	0	7	0	0	0	1	0	0	0	0	5	0	0	0	0	0	2	0	0
927	2008	HHASTO08#548#a#43590	0	40	0	4	0	0	0	152	53	0	0	0	12	0	0	0	0	0	0	0	0	148	0	4	0	0
928	2008	HHASTO08#549#a#43591	2	10	0	58	0	0	0	152	170	0	0	0	0	0	0	0	0	0	0	0	0	129	4	0	0	0
1114	2009	HHAFEL09#12#a#45622	0	0	0	2	0	0	0	0	0	0	0	0	9	0	0	0	0	35	0	0	0	0	0	0	0	0
1115	2009	HHAFEL09#12#b#45623	0	0	0	0	1	0	0	0	0	0	2	0	12	0	1	0	0	84	0	0	0	0	0	0	5	0
1116	2009	HHAFEL09#12#c#45624	0	0	0	0	2	0	0	1	0	1	0	0	4	0	0	0	0	30	0	0	0	1	0	0	1	0
1117	2009	HHAFEL09#13#a#45625	0	0	0	3	0	0	0	0	0	0	0	0	18	0	0	0	0	60	0	0	0	2	0	0	0	0
1118	2009	HHAFEL09#13#b#45626	0	2	0	2	0	0	0	0	0	0	0	0	28	0	0	0	0	30	0	0	0	2	0	0	1	0
1119	2009	HHAFEL09#13#c#45627	0	0	0	2	0	0	0	0	0	0	0	0	13	0	1	0	0	104	0	0	0	2	0	0	0	0
1120	2009	HHAFEL09#32#a#45628	0	8	0	1	0	0	0	0	0	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0
1121	2009	HHAFEL09#32#b#45629	0	0	0	0	0	0	0	0	2	0	0	0	33	0	0	0	0	0	0	0	0	0	0	0	0	0
1122	2009	HHAFEL09#32#c#45630	0	6	0	1	0	0	0	0	0	0	0	0	35	0	0	0	0	0	0	0	0	0	0	0	0	0
1123	2009	HHAFEL09#33#a#45631	0	5	0	7	0	0	0	11	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0
1124	2009	HHAFEL09#33#b#45632	0	3	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	10	0	0	0	0	0	0	1	0
1125	2009	HHAFEL09#33#c#45633	0	4	0	0	0	0	0	0	0	0	0	0	12	0	0	0	0	62	0	0	0	0	0	0	0	0
1126	2009	HHAFEL09#41#a#45634	0	3	0	8	0	0	0	5	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
1127	2009	HHAFEL09#41#b#45635	0	2	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
1128	2009	HHAFEL09#41#c#45636	0	4	0	5	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
1129	2009	HHAFEL09#43#a#45637	0	1	0	0	0	9	0	0	2	0	0	0	29	0	0	0	0	38	0	3	0	0	0	0	0	3
1130	2009	HHAFEL09#43#b#45638	0	0	0	0	0	7	0	0	26	0	0	0	133	0	1	0	0	87	0	8	0	1	0	0	0	0
720	2009	HHAFEL09#43#c#45639	0	0	0	1	0	10	0	0	3	0	0	0	57	0	0	0	0	70	0	0	0	0	0	0	0	0
929	2009	HHASTO09#150#a#45732	52	5	0	32	0	0	1	0	4	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0
930	2009	HHASTO09#152#a#45733	38	0	0	11	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
931	2009	HHASTO09#153#a#45734	49	0	0	1	0	0	0	0	3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
932	2009	HHASTO09#154#a#45735	33	0	5	43	0	0	1	0	4	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
933	2009	HHASTO09#155#a#45736	0	0	0	3	0	0	0	0	1700	0	0	0	0	0	0	0	0	0	0	0	0	176	0	0	0	0
934	2009	HHASTO09#157#a#45737	0	2	0	2	0	0	0	0	49	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
935	2009	HHASTO09#158#a#45738	0	1	0	0	0	0	1	0	178	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	2
936	2009	HHASTO09#163#a#45739	0	0	0	0	0	0	0	0	360	0	0	0	0	0	0	0	0	0	0	0	0	40	0	0	0	0
937	2009	HHASTO09#169#a#45740	1	5	0	3	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0
938	2009	HHASTO09#171#a#45741	1	0	0	9	0	0	1	0	24	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0
939	2009	HHASTO09#172#a#45742	1	6	1	4	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
940	2009	HHASTO09#174#a#45743	0	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
941	2009	HHASTO09#179#a#45744	0	4	0	0	0	0	0	0	0	0	0	0	511	0	0	0	0	0	0	0	0	0	0	0	0	0
942	2009	HHASTO09#180#a#45745	0	9	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
943	2009	HHASTO09#181#a#45746	0	9	0	0	0	3	0	0	0	0	0	0	117	0	0	0	0	5	0	0	0	0	0	0	0	0
944	2009	HHASTO09#189#a#45747	0	0	0	0	0	4	0	0	0	0	28	0	114	0	0	0	0	0	0	10	0	0	0	0	0	0
945	2009	HHASTO09#191#a#45748	2	0	0	0	0	0	0	0	12	11	32	0	65	0	0	0	0	6	0	3	0	9	0	0	0	1
946	2009	HHASTO09#192#a#45749	0	2	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	1	0	0	0	0	0	0	0	0
947	2009	HHASTO09#193#a#45750	2	3	0	31	0	0	0	0	58	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0
948	2009	HHASTO09#194#a#45751	13	0	0	1	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	12	0	0	0	1
949	2009	HHASTO09#195#a#45752	0	1	0	0	0	24	0	0	9	0	1	0	259	0	0	0	0	39	0	3	0	0	0	0	0	0
950	2009	HHASTO09#204#a#45753	0	13	0	13	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
951	2009	HHASTO09#206#a#45754	12	4	0	44	0	0	0	12	394	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
952	2009	HHASTO09#207#a#45755	1	0	0	0	0	0	0	0	105	64	0	0	27	0	0	0	0	3	0	15	0	1	0	0	0	0
953	2009	HHASTO09#209#a#45756	0	9	0	7	0	0	0	0	23	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
954	2009	HHASTO09#249#a#45757	0	5	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
955	2009	HHASTO09#295#a#45768	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
956	2009	HHASTO09#296#a#45769	0	0	0	3	0	0	0	1	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	1	0	0
957	2009	HHASTO09#301#a#45771	0	3	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
477	2009	HHASTO-9#258#a#45758	11	0	1	38	0	0	25	0	3	0	1	0	0	0	0	0	0	0	0	0	0	183	0	0	0	0
478	2009	HHASTO-9#26-#a#45759	5	0	0	68	0	0	23	0	1	0	0	0	0	0	0	0	0	0	0	7	0	48	0	0	0	0
479	2009	HHASTO-9#261#a#4576-	12	4	4	24	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	43	0	0	0	0
480	2009	HHASTO-9#263#a#45761	3	4	5	26	0	0	0	0	23	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0
481	2009	HHASTO-9#267#a#45762	43	3	15	721	0	0	0	0	956	0	0	0	0	0	0	0	0	0	0	0	0	115	0	0	0	0
482	2009	HHASTO-9#269#a#45763	0	2	2	32	0	0	22	0	57	77	1	0	0	0	0	0	0	1	0	60	0	9	0	0	0	0
483	2009	HHASTO-9#272#a#45764	1	11	4	15	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	3	0	3	0	0
484	2009	HHASTO-9#275#a#45765	2	9	3	487	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	5	0	0	0	0
485	2009	HHASTO-9#285#a#45766	0	0	0	1	0	0	0	1	0	0	1	0	7	0	0	0	0	71	0	0	0	6	0	0	0	0
486	2009	HHASTO-9#289#a#45767	0	4	0	5	0	95	1	0	1	0	0	0	0	0	0	0	0	10	0	3	0	0	0	1	0	0
487	2009	HHASTO-9#3--#a#4577-	0	1	0	39	0	0	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	8	0	0	0	0
488	2009	HHASTO-9#3-3#a#45772	0	14	0	7	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
489	2009	HHASTO-9#3-6#a#45773	0	5	1	15	0	0	0	0	0	0	0	0	0	0	0	0	0	15	0	0	0	0	0	0	0	0
490	2009	HHASTO-9#548#a#45774	4	5	0	79	0	0	0	0	78	0	0	0	5	0	0	0	0	0	0	0	0	35	2	0	0	0
491	2009	HHASTO-9#549#a#45775	17	6	0	33	0	0	3	18	92	0	0	0	1	0	0	0	0	0	0	0	0	12	4	0	0	0
1	2010	HHAFEL10#12#A#47574	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	35	0	1	0	0	0	0	31	1
2	2010	HHAFEL10#12#B#47575	0	0	0	0	1	0	0	10	0	0	0	0	20	0	0	0	0	80	0	1	0	0	0	0	5	2
3	2010	HHAFEL10#12#C#47576	0	0	0	0	0	0	0	1	0	0	0	0	5	0	2	0	0	28	0	0	0	0	0	0	0	0
4	2010	HHAFEL10#13#A#47577	0	0	0	3	0	0	0	0	0	0	0	0	13	0	2	0	0	78	0	0	0	0	0	0	0	0
5	2010	HHAFEL10#13#B#47578	0	0	0	3	0	0	0	10	0	0	0	0	29	0	0	0	0	68	0	0	0	1	0	0	0	0
6	2010	HHAFEL10#13#C#47579	0	2	0	6	2	0	0	0	0	0	0	0	10	0	0	0	0	58	0	0	0	0	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
7	2010	HHAFEL10#32#A#47580	0	7	0	2	0	0	0	131	0	0	0	0	16	0	0	0	0	0	0	0	0	2	0	11	0	0
8	2010	HHAFEL10#32#B#47581	0	3	0	6	0	0	0	59	0	0	0	0	2	0	0	0	0	1	0	0	0	3	0	4	0	0
9	2010	HHAFEL10#32#C#47582	0	2	0	2	0	0	0	9	0	0	0	0	17	0	0	0	0	0	0	0	0	7	0	1	0	0
10	2010	HHAFEL10#33#A#47583	0	1	0	2	1	0	0	0	0	0	0	0	62	0	0	0	0	5	0	0	1	1.001	0	0	0	0
11	2010	HHAFEL10#33#B#47584	0	2	0	0	0	0	0	2	0	0	0	0	33	0	0	0	0	0	0	0	0	1	0	0	0	0
12	2010	HHAFEL10#33#C#47585	0	1	0	3	0	0	0	1	0	0	0	0	26	0	0	0	0	49	0	0	0	6	0	1	6	0
13	2010	HHAFEL10#41#A#47586	0	3	0	17	0	0	0	52	0	0	0	0	1	0	0	0	0	1	0	0	0	4	0	5	0	0
14	2010	HHAFEL10#41#B#47587	0	5	0	10	0	0	0	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
15	2010	HHAFEL10#41#C#47588	0	0	0	23	0	0	0	68	0	0	0	0	0	0	1	0	0	2	0	0	0	3	0	3	0	0
16	2010	HHAFEL10#43#A#47589	0	0	0	1	0	1	0	2	6	0	0	0	14	0	0	0	0	22	1	1	0	5	0	0	0	0
17	2010	HHAFEL10#43#B#47590	0	2	0	3	0	0	0	1	8	0	0	0	29	0	0	0	0	18	0	2	0	3	0	0	0	0
18	2010	HHAFEL10#43#C#47591	0	0	0	1	1	0	0	0	3	0	0	0	64	0	0	0	0	49	0	1	0	9	0	0	0	0
37	2010	HHASTO10#150#A#47796	44	0	0	3	0	0	25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
38	2010	HHASTO10#152#A#47797	52	0	3	104	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	2010	HHASTO10#153#A#47798	30	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	2010	HHASTO10#154#A#47799	58	0	56	288	0	0	1	0	10	393	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
41	2010	HHASTO10#155#A#47800	18	0	0	494	0	0	0	0	2359	0	0	0	0	0	0	0	0	0	0	0	0	38	0	0	0	0
42	2010	HHASTO10#157#A#47801	0	1	0	140	0	0	0	0	919	0	0	0	0	0	0	0	0	0	0	0	0	8	0	0	0	0
43	2010	HHASTO10#158#A#47802	3	0	0	3	0	0	0	0	207	0	0	0	0	0	0	0	0	0	0	0	0	586	0	0	0	10
44	2010	HHASTO10#163#A#47803	0	0	0	233	0	0	0	0	436	0	0	0	0	0	0	0	0	0	0	0	0	71	0	0	0	0
45	2010	HHASTO10#169#A#47804	1	8	0	646	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	121	0	1	0	0
46	2010	HHASTO10#171#A#47805	8	1	0	24	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
47	2010	HHASTO10#172#A#47806	1	12	0	247	0	0	0	11	2	0	0	0	0	0	0	0	0	0	0	0	0	17	0	0	0	0
48	2010	HHASTO10#174#A#47807	0	4	0	240	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	16	0	1	0	0
49	2010	HHASTO10#179#A#47808	0	7	0	8	0	0	0	0	0	0	0	0	374	0	0	0	0	0	0	0	0	0	0	0	0	0
50	2010	HHASTO10#180#A#47809	0	10	0	131	0	0	0	50	3	0	0	0	0	0	0	0	0	0	0	0	0	10	0	0	0	0
51	2010	HHASTO10#181#A#47810	0	2	0	1.001	0	0	0	0	0	0	0	0	375	0	0	0	0	0	0	0	0	0	0	0	0	0
52	2010	HHASTO10#189#A#47811	0	1	0	0	0	4	0	6	10	0	135	0	220	0	0	0	0	4	0	4	0	0	0	1	6	0
53	2010	HHASTO10#191#A#47812	0	0	0	1	0	0	0	12	0	0	315	0	206	0	0	0	0	7	0	4	0	16	0	0	1	1
54	2010	HHASTO10#192#A#47813	1	3	0	7	0	0	0	48	18	1	103	0	314	0	0	0	0	16	0	0	0	1	0	0	0	0
55	2010	HHASTO10#193#A#47814	1	5	0	51	0	0	0	0	115	0	0	0	0	0	0	0	0	0	0	0	0	18	0	0	0	0
56	2010	HHASTO10#194#A#47815	2	12	0	15	0	0	0	22	13	1	0	0	1	0	0	0	0	0	0	0	0	3	0	0	0	0
57	2010	HHASTO10#195#A#47816	0	5	0	0	0	0	0	0	2	0	2	0	303	0	0	0	0	8	0	0	0	0	0	0	1	0
58	2010	HHASTO10#204#A#47817	1	10	0	73	0	0	0	0	1	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0	0	0
59	2010	HHASTO10#206#A#47818	7	5	0	120	0	0	0	0	455	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
60	2010	HHASTO10#207#A#47819	27	10	32	27	0	0	0	0	473	0	0	0	142	0	0	0	0	0	0	5	0	0	0	0	0	0
61	2010	HHASTO10#209#A#47820	1	12	0	1	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	2010	HHASTO10#249#A#47821	1	1	0	1	0	0	0	0	1	0	10	0	41	0	0	0	0	3	0	34	0	2	0	0	0	0
63	2010	HHASTO10#258#A#47822	14	1	22	63	0	0	1	0	8	0	0	0	0	0	0	0	0	0	0	13	0	191	0	0	0	1
64	2010	HHASTO10#260#A#47823	9	0	220	258	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	32	0	1212	0	0	0	0
65	2010	HHASTO10#261#A#47824	0	4	7	88	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0	0
66	2010	HHASTO10#263#A#47825	23	4	42	182	0	0	0	0	76	0	0	0	0	0	0	0	0	0	0	0	0	79	0	0	0	0
67	2010	HHASTO10#267#A#47826	2	5	5	738	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	92	0	3	0	0
68	2010	HHASTO10#269#A#47827	1	7	49	83	0	0	25	12	186	163	0	0	0	0	0	0	0	0	0	95	0	3	0	0	0	0
69	2010	HHASTO10#272#A#47828	2	11	5	277	0	0	0	16	0	0	9	0	0	0	0	0	0	0	0	2	0	17	0	1	0	0
70	2010	HHASTO10#275#A#47829	0	8	0	38	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
71	2010	HHASTO10#285#A#47830	0	0	0	1	0	95	0	7	0	0	34	0	5	0	1	0	0	24	0	0	0	0	0	0	0	0
72	2010	HHASTO10#289#A#47831	0	0	0	3	0	10	0	14	2	0	0	0	5	0	1	0	0	14	0	10	0	0	0	0	0	0
73	2010	HHASTO10#295#A#47832	0	0	5	12	0	0	0	0	2	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
74	2010	HHASTO10#296#A#47833	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
75	2010	HHASTO10#300#A#47834	0	7	0	36	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	1	0	0
76	2010	HHASTO10#301#A#47835	0	1	0	23	0	0	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0
77	2010	HHASTO10#303#A#47836	1	3	1	6	0	127	0	0	18	0	1	0	0	0	0	0	0	3	0	6	0	10	0	5	0	0
78	2010	HHASTO10#306#A#47837	0	4	2	9	0	31	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	1	0	0	0	0
79	2010	HHASTO10#548#A#47838	1	10	0	25	0	0	0	22	40	0	0	0	1	0	0	0	0	1	0	0	0	21	0	0	0	0
80	2010	HHASTO10#549#A#47839	50	15	8	113	0	0	0	28	356	0	0	0	1	0	0	0	0	1	0	0	0	93	0	0	0	0
19	2011	HHAFEL11#12#A#49960	0	0	0	0	0	0	0	24	0	0	1	0	24	0	0	0	0	39	0	6	0	3	0	3	0	0
20	2011	HHAFEL11#12#B#49961	0	0	0	0	0	0	0	5	0	0	0	0	22	0	0	0	0	38	0	0	0	8	0	1	0	0
21	2011	HHAFEL11#12#C#49962	0	0	0	3	2	0	0	17	0	0	0	0	22	0	1	0	0	41	0	3	0	1	0	0	0	0
22	2011	HHAFEL11#13#A#49963	0	1	0	5	1	0	0	15	2	0	0	0	29	0	0	0	0	27	0	0	0	9	0	0	0	0
23	2011	HHAFEL11#13#B#49964	0	0	0	4	3	0	0	7	0	0	0	0	29	0	0	0	0	73	0	0	0	10	0	0	0	0
24	2011	HHAFEL11#13#C#49965	0	0	0	1	3	0	0	18	0	0	0	0	10	0	0	0	0	32	0	0	0	6	0	0	0	0
25	2011	HHAFEL11#32#A#49966	0	3	0	10	0	0	0	150	4	0	0	0	54	0	0	0	0	0	0	0	0	5	0	10	0	0
26	2011	HHAFEL11#32#B#49967	0	2	0	11	0	0	0	78	0	0	0	0	21	0	0	0	0	0	0	0	0	7	0	48	0	0
27	2011	HHAFEL11#32#C#49968	0	3	0	12	0	0	0	154	0	0	0	0	62	0	0	0	0	0	0	0	0	9	0	26	0	0
28	2011	HHAFEL11#33#A#49969	0	3	0	14	0	0	0	25	0	0	0	0	33	0	0	0	0	3	0	0	0	9	0	5	0	0
29	2011	HHAFEL11#33#B#49970	0	1	0	7	0	0	0	3	0	0	0	0	4	0	0	0	0	0	0	0	0	1	0	1	0	0
30	2011	HHAFEL11#33#C#49971	0	6	0	9	0	0	0	29	0	0	0	0	19	0	0	0	0	1	0	0	0	12	0	7	0	0
31	2011	HHAFEL11#41#A#49972	0	1	0	8	0	0	0	15	0	0	0	0	3	0	0	0	0	1	0	0	0	1	0	0	0	0
32	2011	HHAFEL11#41#B#49973	0	4	0	12	0	0	0	17	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0
33	2011	HHAFEL11#41#C#49974	0	5	0	31	0	0	0	69	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1	0	0
34	2011	HHAFEL11#43#A#49975	0	0	0	1	0	3	0	4	10	407	1	0	16	0	0	0	0	12	0	0	0	4	0	0	0	0
35	2011	HHAFEL11#43#B#49976	0	0	0	0	0	0	0	7	6	0	0	0	36	0	0	0	0	21	0	0	0	16	0	0	0	0
36	2011	HHAFEL11#43#C#49977	0	0	0	3	0	11	0	21	15	0	0	0	69	0	0	0	0	73	0	5	0	18	0	4	0	0
81	2011	HHASTO11#150#A#51421	49	0	4	151	0	0	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0
82	2011	HHASTO11#152#A#51422	64	0	0	18	0	0	340	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	2011	HHASTO11#153#A#51423	15	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	2011	HHASTO11#154#A#51424	49	0	2	98	0	0	0	0	4	20	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
85	2011	HHASTO11#155#A#51425	91	0	0	26	0	0	0	0	653	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	2
86	2011	HHASTO11#157#A#51426	0	2	0	17	0	0	0	0	266	0	0	0	0	0	0	0	0	0	0	0	0	25	0	0	0	0
87	2011	HHASTO11#158#A#51427	4	1	0	3	0	0	0	1	297	0	0	0	0	0	0	0	0	0	0	0	0	397	0	0	0	5
88	2011	HHASTO11#163#A#51428	0	0	0	0	0	0	0	0	954	0	0	0	0	0	0	0	0	0	0	0	0	24	0	0	0	1
89	2011	HHASTO11#169#A#51429	8	5	5	134	0	0	0	36	1	0	0	0	0	0	0	0	0	0	0	0	0	19	0	0	0	0
90	2011	HHASTO11#171#A#51430	0	4	0	214	0	0	0	5	9	0	0	0	0	0	0	0	0	0	0	0	0	67	0	0	0	0
91	2011	HHASTO11#172#A#51431	1	6	0	32	0	0	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0
92	2011	HHASTO11#174#A#51432	0	4	0	49	0	0	0	10	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0
93	2011	HHASTO11#179#A#51433	0	4	0	12	0	0	0	8	0	0	0	0	440	0	0	0	0	1	0	0	0	80	0	0	0	0
94	2011	HHASTO11#180#A#51434	0	5	0	28	0	0	0	22	2	0	0	0	3	0	0	0	0	0	0	0	0	4	0	1	0	0
95	2011	HHASTO11#181#A#51435	0	5	1	3	0	0	0	23	0	0	0	0	400	0	0	0	0	0	0	0	0	112	0	1	1	0
96	2011	HHASTO11#189#A#51436	0	2	4	1	0	1	0	2	0	0	72	0	267	0	0	0	0	4	0	10	0	0	0	3	0	0
97	2011	HHASTO11#191#A#51437	0	0	0	2	0	0	0	13	24	0	7	0	130	0	0	0	0	9	0	4	0	29	0	2	0	0
98	2011	HHASTO11#192#A#51438	0	4	0	4	0	0	0	16	0	0	0	0	118	0	0	0	0	28	0	0	0	4	0	0	0	0
99	2011	HHASTO11#193#A#51439	3	14	2	206	0	0	0	189	85	0	0	0	0	0	0	0	0	0	0	0	0	63	0	3	0	0
100	2011	HHASTO11#194#A#51440	1	10	0	59	0	0	0	121	9	0	0	0	2	0	0	0	0	1	0	0	0	4	0	19	0	0
101	2011	HHASTO11#195#A#51441	0	3	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	9	0	1
102	2011	HHASTO11#204#A#51442	0	8	0	66	0	0	0	13	0	0	0	0	2	0	0	0	0	0	0	0	0	30	0	1	0	0
103	2011	HHASTO11#206#A#51443	5	12	1	91	0	0	0	1	224	0	0	0	0	0	0	0	0	1	0	0	0	7	0	0	0	0
104	2011	HHASTO11#207#A#51444	7	5	2	5	0	0	0	27	194	0	0	0	2	0	0	0	0	0	0	0	0	4	0	0	0	0
105	2011	HHASTO11#209#A#51445	2	6	1	70	0	0	0	74	8	0	0	0	5	0	0	0	0	1	0	0	0	48	0	2	0	0
106	2011	HHASTO11#249#A#51446	3	4	0	58	0	0	0	53	9	0	0	0	15	0	0	0	0	0	0	0	0	8	0	5	0	0
107	2011	HHASTO11#258#A#51447	2	0	11	1359	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	389	0	0	0	0
108	2011	HHASTO11#260#A#51448	1	0	11	437	0	0	0	0	8	4	0	0	0	0	0	0	0	0	0	20	0	186	0	0	0	0
109	2011	HHASTO11#261#A#51449	8	2	8	292	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	303	0	0	0	0
110	2011	HHASTO11#263#A#51450	93	0	31	76	0	0	0	0	25	3	0	0	0	0	0	0	0	0	0	0	0	246	0	0	0	1
111	2011	HHASTO11#267#A#51451	1	7	0	83	0	0	0	0	17	0	0	0	6	0	0	0	0	0	0	0	0	80	0	0	0	0
112	2011	HHASTO11#269#A#51452	7	3	11	33	0	0	0	15	345	137	0	0	0	0	0	0	0	0	0	100	0	109	0	0	0	1
113	2011	HHASTO11#272#A#51453	1	8	0	145	0	0	0	8	1	0	0	0	0	0	0	0	0	0	0	0	0	89	0	9	0	0
114	2011	HHASTO11#275#A#51454	0	4	0	78	0	0	0	16	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	0
115	2011	HHASTO11#285#A#51455	0	0	0	3	0	2	0	12	0	0	5	0	4	0	0	0	0	13	0	1	0	2	0	0	0	0

Appendix 5. Numbers for selected species in all HHA Shipek grab surveys.

	Year	Sample	Hediste diversicolor	Nephtys hombergii	Polydora cornuta	Streblospio	Scalibregma inflatum	Sabella pavonina	Heterochaeta costata	Tubificoides amplivasatus	Tubificoides benedii	Elminius modestus	Crepidula fornicata	Aphelochaeta "species A"	Aphelochaeta marioni	Protocirrineris	Caulleriella alata	Chaetozone	Chaetozone gibber	Chaetozone zetlandica	Cirratulus (juv)	Cirriformia tentaculata	Dodecaceria	Tharyx "species A"	Ctenodrilus serratus	Cossura pygodactyla	Ammothea hilgendorfi	Venerupis philippinarum
116	2011	HHASTO11#289#A#51456	0	0	0	0	0	54	0	30	17	0	0	0	0	0	0	0	0	3	0	16	0	1	0	0	0	1
117	2011	HHASTO11#295#A#51457	0	0	1	9	0	0	0	1	0	0	0	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0
118	2011	HHASTO11#296#A#51458	1	2	0	11	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	4	0	10	0	0
119	2011	HHASTO11#300#A#51459	0	2	0	16	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	6	0	3	0	0
120	2011	HHASTO11#301#A#51460	0	1	0	14	0	58	0	16	1	0	0	0	0	0	0	0	0	3	0	0	0	2	0	18	0	0
121	2011	HHASTO11#303#A#51461	0	4	0	5	0	0	0	4	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0
122	2011	HHASTO11#306#A#51462	0	1	5	16	0	5	0	10	0	0	0	0	5	0	0	0	0	1	0	0	0	1	0	0	0	0
123	2011	HHASTO11#548#A#51463	0	15	0	95	0	0	0	65	29	0	0	0	3	0	0	0	0	1	0	0	0	46	0	3	0	0
124	2011	HHASTO11#549#A#51464	2	7	0	195	0	0	0	58	11	0	0	0	1	0	0	0	0	0	0	0	0	12	0	17	0	0