# Estimates of individual carbon masses of zooplankton taxa from the NE Atlantic and NW European shelf, based on ring nets and Continuous Plankton Recorder

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## Abstract

Zooplankton are enumerated in units of numerical concentration, but the taxa range over many orders of magnitude in individual body size, so it is hard to know whether the taxa that dominate numbers are also important in terms of biomass. Budgets, models and many other studies of the food web tend to prefer zooplankton data in units of carbon concentration, which makes the use of many datasets problematic. Here we have compiled 579 zooplankton individual carbon mass determinations for a wide range of net-caught metazoan zooplankton, based on two Continuous Plankton Recorder (CPR) data sources and two ring-net derived data sources, namely from Plymouth L4 and the Marine Directorate (various sites in the North Atlantic). We have used these data sources, alongside expert judgement from CPR analysts, to obtain individual carbon mass "best estimates" for the consistently identified CPR taxa that are used within the Plankton Lifeform Extraction Tool (PLET) for policy reporting. By combining appropriate estimates of individual carbon masses with abundance data, users can estimate biomass concentrations of zooplankton species or groups. The metadata describes the data construction and individual column headings, how the data were obtained, with pointers and caveats to their use. Please use the data citation above when using these data.

## Metadata

### 1. Introduction: strengths, uses and limitations of the compilation

As part of the Defra-funded marine Natural Capital Ecosystems Assessment PelCap project, we have combined data on individual zooplankton estimated carbon masses from available UK sources into a single spreadsheet. The primary aim was to provide data for most of the common net-caught zooplankton taxa, in a traceable manner, to allow zooplankton biomass to be estimated crudely from abundance. Data were compiled from four sources, two being specific to CPR data: namely an original source precursor excel file provided by Clare Ostle and a unpublished CPR species trait database compiled by Nicolas Djeghri. The other two sources were first, published carbon mass estimates for zooplankton caught with a 200 micron ring net at the Plymouth L4 site. https://doi.org/10.5285/D7FB6CE3-7BC9-307B-E053-6C86ABC0671B (see McEvoy et al. 2023, McQuatters-Gollop et al. 2024 for presentation of these biomass estimates) and a zooplankton traits database published by the Marine Directorate (previous organisational names: Marine Scotland Science, Fisheries Research Service) https://doi.org/10.7489/12495-1. The Marine Directorate zooplankton traits database contains, among other traits, measured and literature values of carbon content of zooplankton species in the North Atlantic. For 8 key non-zooplankton taxa where the above sources were either insufficient or gave very widely varying estimates, we have used current expert opinion on body size from the CPR analysts (see detailed description below)

There are a series of zooplankton trait databases that include carbon mass determinations. However, most of these either focus on copepods with very poor coverage for other taxa, include only adult carbon masses (which are often unrepresentative of the sizes caught with nets) or the data sources are hard to trace or not specific to waters around UK. We have therefore compiled 576 individual determinations of carbon mass from net-caught UK taxa which allow the users to see both the range of determinations that have been derived for individual taxa, as well as have traceable notes to how these were obtained.

It is important to emphasise that individual carbon masses can vary enormously, dependent on geographical location, the mesh size and sampling method of the net, the life stages prevailing at any given time of year and importantly the method used for estimating biomass. For most carbon mass estimates, individuals are not directly analysed through a CHN analyser but instead the individuals are often measured, and length mass conversions from the literature are used, with these equations often (but not always) species or genus specific, but usually derived in other geographic regions. Even adult female copepods from the same location can vary over twofold throughout the year according to the temperature size rule (Corona et al. 2021). For these reasons the data can only provide a crude indication of biomass. While a rough estimate is better than none, we hope that future workers can refine the estimates, and particularly focus on the non-copepod taxa which range greatly in size but are major contributors to biomass in UK waters.

## 2. Structure of the spreadsheet

The Table below outlines the columns A-J of the spreadsheet, what they mean and a description of the information they contain. We have provided an index number to enable re-sorting, because there is no single, sortable search term, whether based on Aphia ID or on taxonomic name that provides an adequate logical ordering of the data. As an example, Appendicularia can appear under larvacean or Appendicularia, depending on the source dataset, each with valid and different Aphia IDs. Therefore, the data are provided in blocks (coloured for ease of reading) first for copepods, then non copepods with each in broad alphabetical order on taxon name, with (in the above example) lavaceans shuffled into the data block alongside appendicularians.

Columns G to H contain various information on how the data were obtained. To declutter the detail on the methods we have referenced papers and data doi's (e.g. for Plymouth L4) as much as possible for further detail. Two of the data sources were unpublished spreadsheets, and for these we have provided as much information as was available to us. Please note that paper published by Pitois and Fox (2006) also describes dry masses of copepod and cladoceran taxa based on CPR data.

| Column | Column header | Column description |
|---|---|---|
| A | Index number of record | Increments from 1 to 597, identifying each record and helping in re-sorting into a logical order. This eases the finding and grouping of some taxa which have varying alphabetic names and differing Aphia IDs (eg Larvacaean/Appendicularia) |
| B | Copepod or non-copepod | Self-explanatory: helps sorting |
| C | Taxon | This is transcribed directly from source data without amendment, e.g. specific maturity stages will be specific to the source time series from which it was derived. Each successive taxon is given a separate block of rows with same colour (pale blue or green) to help readability. Common taxonomic categories do not always correspond to the same Aphia IDs, due to varying taxonomic resolution (e.g. *Para/Pseudocalanus* identified in CPR are listed here under Calanoid copepods C1-CVI, although their carbon masses correspond to those we have estimated for *Para/Pseudocalanus* ) |
| D | Aphia ID | This is transcribed directly from source data without amendment, except for one typo in Aphia ID being corrected (for Caridea). Aphia IDs sometimes vary (e.g. for Appendicularians and Thaliaceans) according to level of taxonomic resolution or reclassifications of a taxon over time. Not every Aphia ID was checked here against the taxon, although random checks did not uncover errors. |
| E | Longest maximum axis of the species - diameter (mm) or bell height (mm) for jellies, for rest it's max body length of adults of the species at L4 (prosome plus urosome in copepods) see doi for detailed L4 methods | This column is still very incomplete, as the aim was to obtain C masses rather than morphometric data |
| F | Body mass as µgC per individual | This is transcribed directly from the source dataset for each record, except where the source data (column I) is listed as "*CPR Ranking data from Matt Holland*", in which case a mean value was obtained from the available values for that taxon (excluding eggs and nauplii in the case of copepods, and excluding eggs in the case of chaetognaths). The only exceptions were for 8 non-copepod taxa where masses were derived from expert opinion of CPR analysts and for Calanoida C1-6 where a mean value of *Para/Pseudocalanus* was used as described in the "Method notes 1" column. |
| G | Method notes 1: (see doi for detail) | First column of Methods notes |
| H | Method notes 2. PML data only: 1= consistently identified since 1988, 0= consistently identified later than 1988. CPR data compiled by Nicolas Djeghri: trav = traverse, eye = eyecount only) | Second column of Methods notes, specific just to L4 and some CPR data records from trait database of Nicolas Djeghri - see column header for details. For CPR trav means the record applies to the traverse counting method and eye means it is specific to eyecount method |
| I | Source Institute and dataset | PML L4 data OR Marine Directorate data OR CPR data: provided by Clare Ostle OR CPR: data from Nicolas Djeghri OR CPR: Ranking species list from PLET from Matt Holland. The latter (red rows) conform to the consistently identified taxonomic CPR categories in the PLET for NE Atlantic for which we have estimated carbon masses according to the procedure in column "Method notes 1". |
| J | Doi/source of data | Self-explanatory: see Djeghri metadata description for the references. A few of the entries here are a continuation of the methods notes including references to data sources |
| | | |

### 3. Obtaining biomass estimates for CPR-derived data

The CPR data span about 65 years and the source data on abundance have been used in many studies. While some studies (Pitois and Fox 2006) have estimated biomass from subsets of CPR data, we are not aware of any study that attempts to convert abundances to biomass units for the entire assemblage sampled in the OSPAR assessment area of the NE Atlantic and NW European shelf. To obtain this we used the 108 taxa that have been sampled consistently with the same taxonomic resolution for OSPAR reports (Holland et al. 2023). These are stored and obtainable in the PLET (Ostle et al. 2021). For most of these taxa we simply estimated individual carbon masses from all available data in our spreadsheet that corresponded to this taxonomic unit. These mean values excluded eggs and nauplii in the case of copepods, and excluded eggs in the case of euphausiids and chaetognaths. Only the different (unique) determinations were averaged. In a minority of taxa averaging was not used or possible (for example where the component mass values was thought to be erroneous, or there were no species-specific measurements available). In these cases, the method used is provided in the column "Method notes 1".

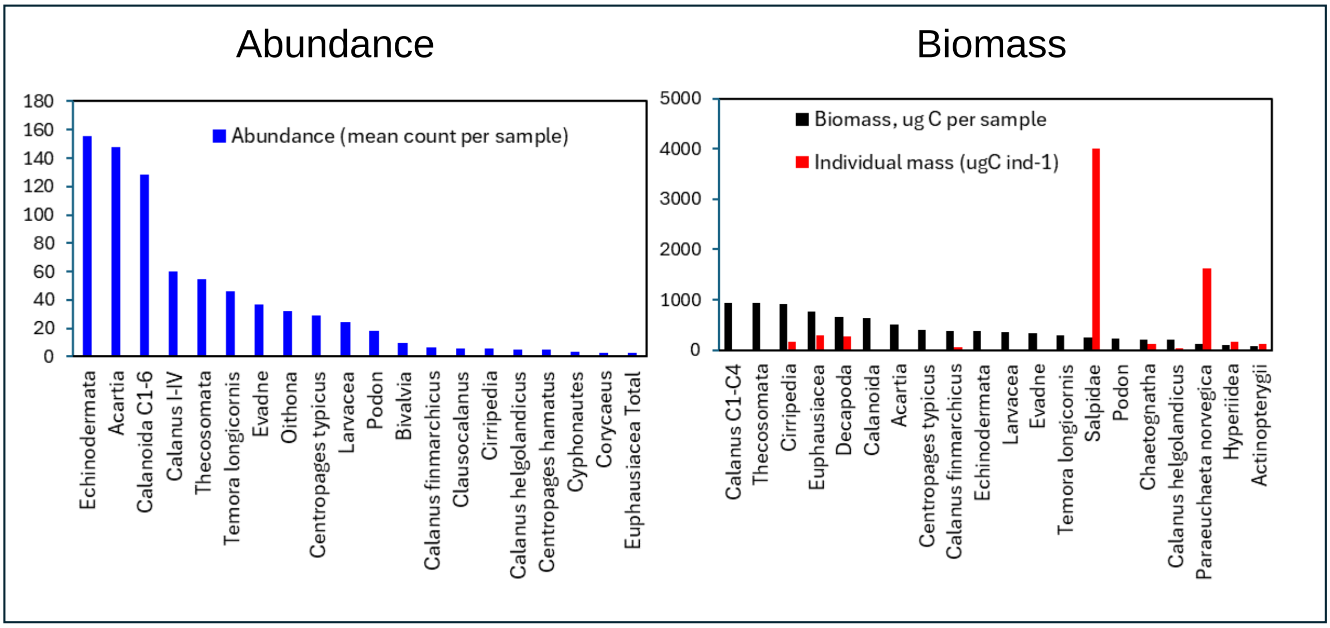
Several of the key non-copepod taxa such as euphausiids and decapods had very widely diverging individual carbon mass values and for eight of these we requested that the CPR analysts, gauged a value for their "representative average" biovolume based on 6 well-known "yardstick" copepods of increasing size, by asking the question: "*Which of the well-known adult copepods below does the "typical" non-copepod taxa listed across here most closely equate to, in terms of biovolume?*". Their collective reply, in terms of multiples of adult females of these copepods, is in the table below: We next estimated mean masses per female of these copepod species from our spreadsheet (*Oithona similis* 0.87 µg C; *Acartia clausi* 4.83 µg C; *Centropages typicus* 19.1 µg C; *Calanus helgolandicus* 66 µg C; *Calanus hyperboreus* 1567 µg C). We then used these to estimate individual carbon masses as determined against each of the 5 copepod species and took the respective sizes of non-copepod taxa as the median value of these estimates (which corresponded to that derived from *C typicus* in each case). These comparisons are based on biovolume, so to convert to carbon-specific values we used McConville et al. (2017) to obtain median ratio of median values of carbon to wet mass ratio both for calanoid copepods and for each of the 8 non-copepod taxa in the table below. We thereby adjusted the carbon per copepod values by the ratio of the carbon: wet mass of non-copepod to that of copepods to obtain best estimates of carbon per individual for these 8 taxa

| | Euphuasiids | Thecosome Pteropods | Echinodermata | Decapoda | Appendicularia (tails only) | Chaetognaths | Tomopteris | Clione |
|---|---|---|---|---|---|---|---|---|
| *Oithona similis* CVI fem | 45 | 5 | 4 | 27 | 4 | 40 | 25 | 17 |
| *Acartia clausi* CVI fem | 21 | 3 | 2 | 20 | 2 | 25 | 20 | 14 |
| *Centropgaes typicus* CVI fem | 11 | 1 | 0.75 | 12 | 0.75 | 12 | 12 | 8 |
| *Calanus helgolandicus* CVI fem | 5 | 0.5 | 0.3 | 4.5 | 0.3 | 4 | 5 | 3 |
| *Calanus hyperboreus* CVI fem | 2 | 0.25 | 0.2 | 2.5 | 0.15 | 2 | 2 | 1 |
| *Comments* | Euphausiids can vary a lot in size, so there was a large spread in estimates | close agreement | Close agreement | Decapoda can vary a lot in size so large spread in estimates | Close agreement | Close agreement except for comparison with the small copepods | Fairly close agreement but quite a large spread of estimates | Close agree-ment |

4. **Estimating carbon masses for the taxa consistently identified in CPR**

The rows containing the 108 taxa that are consistently identified using the CPR can be obtained by looking in the column "Source Institute and dataset" for the phrase "CPR: Ranking data from Matt Holland"

The figure below shows on the left the ranked abundance of the top 20 of the 108 consistently identified CPR zooplankton, based on mean abundance across the COMP4 assessment areas around the UK (Graves et al 2023). On the right is the top 20 ranked species based on their estimated biomass (a product of the count data and the mean individual carbon masses as estimated for the above rows labelled phrase "*CPR: Ranking data from Matt Holland*"). This illustrates the importance of non-zooplankton taxa including meroplankton around the UK, in terms of estimated biomass as well as abundance.

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