

Diet Calculator – Quick Reference Guide

Version 0.8.5, 11 June 2018, JS



Ecopath
International
Initiative

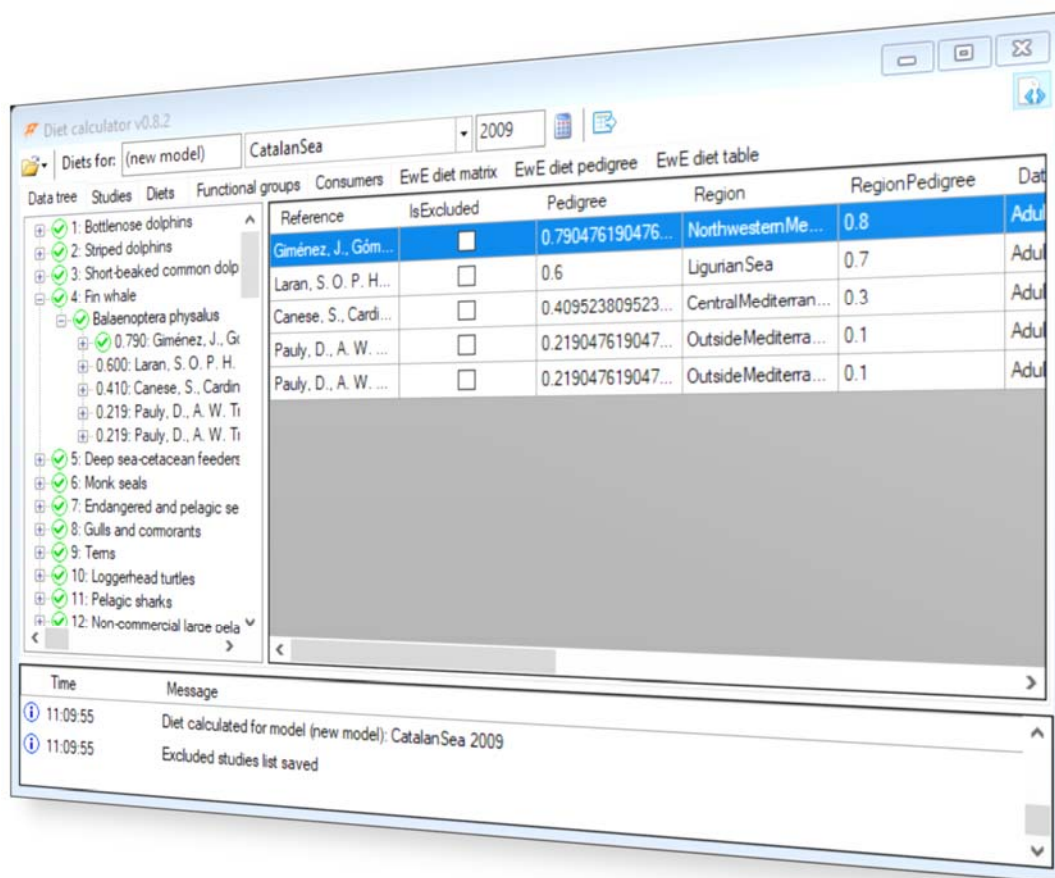


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1 Methodology

When constructing a new model for a given region and year, the diet calculator software ('the software') determines the most suitable studies for providing diet records to functional groups in the new model, from which the software generates a diet matrix and diet pedigree matrix. Figure 1 summarizes this process in five steps.

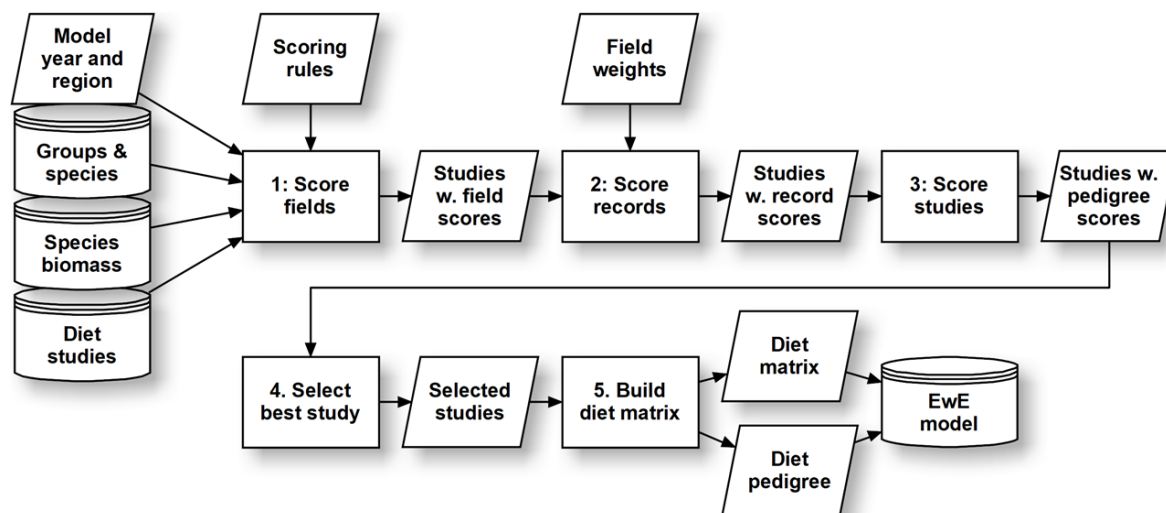


Figure 1 – An overview of the Diet Calculator workflow, broken down in five steps, and showing required data sources.

The software requires four essential data sources as input. Besides a model year and region specification, three databases are required: a functional grouping structure of species, species biomasses, and a repository of diet studies. The diet matrix building logic uses these data throughout. Appendix A, Table 1 to Table 5 explain the format of the databases.

1.1 Scoring fields

The first step to scoring diet studies is to assign a suitability score to the individual data fields in a study: region, collection time, diet collection method, and diet data.

1.1.1 Regions

In the software regions are numbered (e.g., Appendix B, Table 6), and each diet study provides records for one region only. A look-up table such as shown in Figure 2 then tells the software how suitable a diet record obtained in any given region will be for application to the model region, considering the region attribute only.

Users will need to populate the region suitability table. Note that the software interprets this table by row, where each row expresses how compatible data collected in one region for use in any other.

For instance, the first row in Figure 2, and using the region definitions in Table 6, tells us that data obtained for the entire Mediterranean Sea is fully compatible with models that cover the entire Mediterranean, but are only 50% compatible with models that cover only the Western or Eastern Med, etc.

Region suitability data is read from Microsoft Excel file *RegionCompatibility.xlsx* In the configuration directory (see § 2.3). Modify the content of this file to suit your needs, but ensure that this configuration file contains rows and columns for all of your regions.

From\To	1	2	3	..	12	13	14	FunctionalGroup
1	1	0.5	0.5	..	0.2	0.1	0.4	
2	0.5	1	0.3	..	0.5	0.1	0.7	
3	0.5	0.3	1	..	0.2	0.1	0.2	
..	
12	0.2	0.5	0.2	..	1	0.1	0.2	
13	0.1	0.1	0.1	..	0.1	1	0.1	
14	0.4	0.7	0.2	..	0.2	0.1	1	

Figure 2 – An example of the region suitability grid with hypothetical values, stating how well diet data obtained in one region (first column) is for application to another region (other columns). Suitability values are expressed as [0, 1], where 0 is totally incompatible, and 1 is fully compatible. Repeated rows for individual functional groups to provide different, group-specific region suitability values.

1.1.2 Collection time

Each diet study reports a time span for its diet records. This time span covers one or more years. To score diet collection times, the software uses a linear measure between the time span for which a diet is recorded and the target model year.

Diet records collected in the period that contains the model year receive a full suitability score of one. Every year difference between the model year and the data collection time span incurs a one percent suitability penalty.

1.1.3 Diet collection method

Diet collection methods have been classified (for instance as shown in Appendix B, Table 7), and each diet record is collected using exactly one method type.

Suitability scores for diet collection methods are derived from a method pedigree table (e.g., Figure 3), where each method type has a pedigree score describing its confidence. The software simply looks up the method pedigree to score the diet collection field.

Diet collection scoring data is read from Microsoft Excel file *MethodPedigree.xlsx* In the configuration directory (see § 2.3). Modify the content of this file to suit your needs, but ensure that this configuration file contains rows for all of your collection methods.

Method	Pedigree	FunctionalGroup
1	1	
2	0.8	
3	0.75	
4	0.4	

Figure 3 – An example of a table with hypothetical pedigree scores for data collection methods, stating the pedigree or confidence in each method (left-most row). Values are expressed as [0, 1] ranging from totally unreliable to fully reliable. Repeat rows for individual functional groups to provide different, group-specific pedigree scores.

1.1.4 Diet data

Diet data types are also classified, and states which cross-section of a species' age structure the diet record applies to (e.g., Appendix B, Table 8). Each diet record belongs to one data type, and each functional group in the target model represent one of these data types too. The software uses a lookup table as shown in Figure 4 to determine how well data obtained from one part of the population to a given functional group.

From\To	1	2	3	4	FunctionalGroup
1	1	0.4	0.6	0.1	
2	0.6	1	0.6	0	
3	0.4	0.4	1	0.3	
4	0.1	0	0.3	1	

Figure 4 – An example table with hypothetical compatibility scores for data types, stating how applicable diets obtained from the data type in the left-most row are for functional groups that represent the each data type (other columns). Values range from 0 to 1, representing total incompatibility to full compatibility. Optionally add rows for individual functional groups to provide different compatibility values.

Diet method lookup data is read from Microsoft Excel file *DataCompatibility.xlsx* In the configuration directory (see § 2.3). Modify the content of this file to suit your needs, but ensure that this configuration file contains rows and columns for all of your collection diet data types.

1.2 Scoring records

Once all individual study fields have a score, the software computes a total pedigree value for each diet record, which is a weighted average of the four field scores as discussed above.

Region	Year	Data	Method	FunctionalGroup
1	0.8	0.6	0.5	

Figure 5 – An example lookup table with hypothetical field weights. Optionally repeat rows to specify group specific field weights.

Figure 5 shows an example of these field weights, which are read from Microsoft Excel file *FieldWeights.xlsx* In the configuration directory (see § 2.3). Modify the content of this file to suit your needs.

1.3 Scoring studies

Once all records have scores, the software proceeds to calculate a pedigree value for the entire study. The study pedigree is an average of the pedigree scores of all study records.

1.4 Selecting studies

For each predator that belongs to a functional group, and that has with biomass in the model area, the software selects the diet study with the highest pedigree score. The software merges multiple studies with the same score as follows:

1. Each predator-prey combination is assigned the average diet of this predator-prey combination across all studies
2. The total study diet amount is normalized to 100

1.5 Building the diet matrices

Last, the software generates the diet matrix and diet pedigree scores for use in Ecopath with Ecosim as shown in Appendix D, Figure 11.

All predator species with a non-zero biomass in the modelled area are consumers for EwE. Their diets are obtained from the diet study (or merged studies) with the highest pedigree.

Of these studies, all prey species with non-zero biomasses in the modelled area are allocated to the diets of the predator. The code omits undefined prey species, and prey species without biomass in the modelled area, because weighted diet proportions require biomasses. Diets of prey with biomass that do not belong to a defined functional group are imports.

All producers with a non-zero biomass are included in the diet table, even if there are no predators consuming them.

EwE6 accepts pedigree values for a predators' diet. In the software, this pedigree value is set to the pedigree rating of the selected study (or merged studies).

2 Using the software

2.1 Installing the software

The Diet Calculator software is available upon request from Jeroen Steenbeek or Marta Coll, and is delivered as a Windows installation package. The software runs on Windows PCs with the following requirements:

- Windows Vista or newer;
- Microsoft Office 2010 or newer, OR Microsoft Access 2010 database drivers or newer;
- .NET framework 4.6 or newer;
- 25 MB of disk space.

To install the software, launch the installer and follow the instructions. Double-click the desktop shortcut to Diet Calculator to run the software.

2.2 User interface elements

The software launches with an opening screen (Figure 6). This screen has the following elements:

- Toolbar with controls to configure and operate the software;
- Information area with various tabs, each showing a different breakdown of loaded data;
- History panel listing past actions and errors.

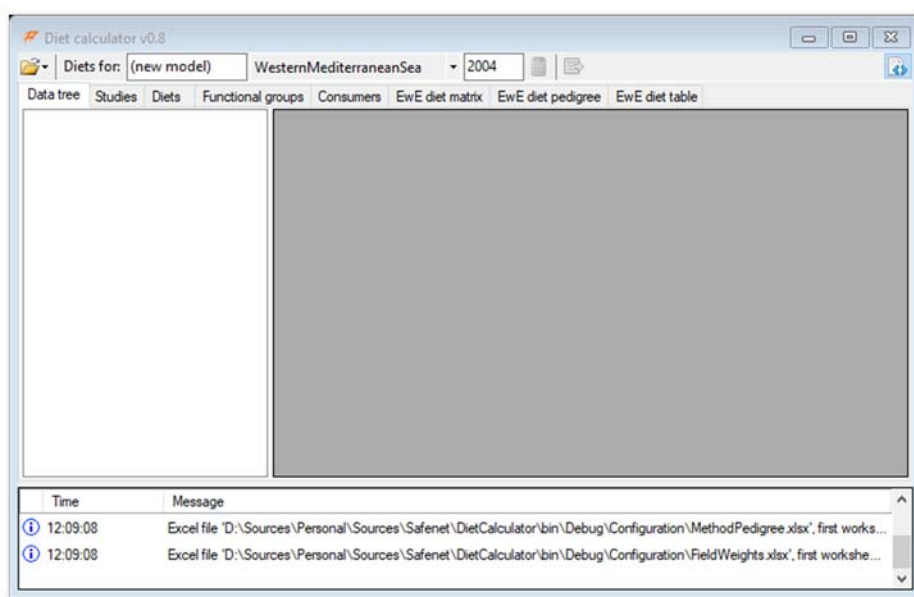



Figure 6 – The main interface of the Diet Calculator desktop software: control toolbar, information tabs, and history panel. The history panel shows that the various field weight files have been loaded successfully.

2.3 Loading data

The data to operate on is loaded from the file open option () on the toolbar. Here, you browse for the vital input data for the software. You must load three types of data here:

1. The diets database, which is a Microsoft access database containing functional groups, their species, species diets, and diet studies (see Appendix A, Table 1 to Table 4)

2. The biomass database, which is an Excel file containing a biomass record for each species (Appendix A, Table 5).
3. The configuration folder, which contains the four weighting factor tables described in § 1.1.1.

2.4 Calculating diets

When essential data is loaded the user interface will populate the various breakdowns in the information area, and the 'Calculate diet matrix' option on the toolbar is enabled (Figure 7).

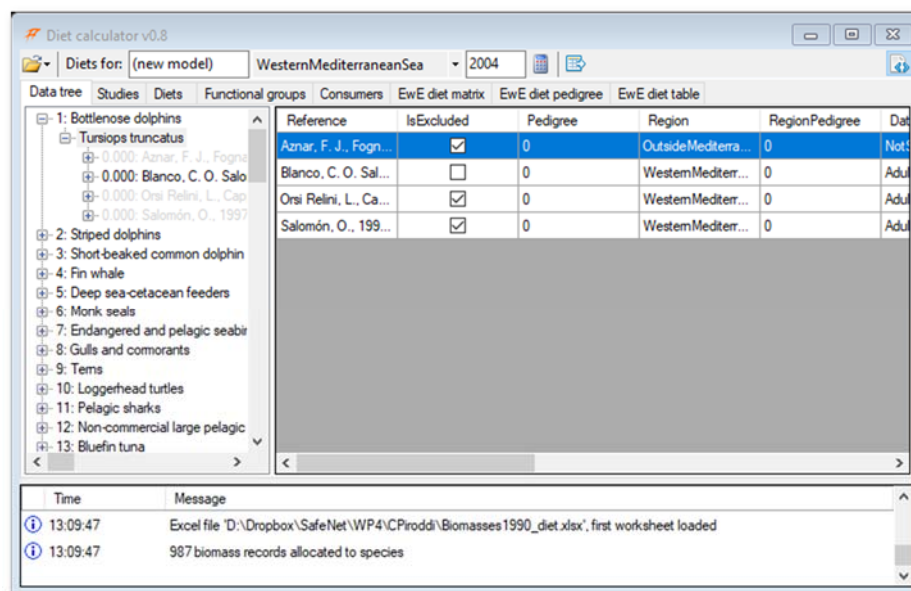



Figure 7 – Group, species, diet, study and biomass data has been loaded, and the information area is showing various breakdowns on the loaded data. Here, the 'Data tree' view is selected, showing a hierarchical tree of functional groups, species, studies, and diet records (left side) and a study breakdown for the selected species 'Tursiops truncatus'. The analysis shown here excludes three of the four studies.


The software is now ready to calculate diets.

To calculate diets, do the following:

1. In the toolbar, enter a name for the model
2. Select the model region
3. Enter a model year.
4. Press the calculator () button.

The diets and their pedigrees are now calculated, and the three diet tabs are populated.

To save the diet matrices to file, do the following:

1. In the toolbar, press the export option () on the toolbar
2. Browse to the desired output folder
3. Select the desired file type
4. Enter a file name (or select an existing file)
5. Press OK. The Excel format bundle the diet matrix, diet pedigree, and diet table in different worksheets in a single Excel file. The CSV format will generate three separate files.

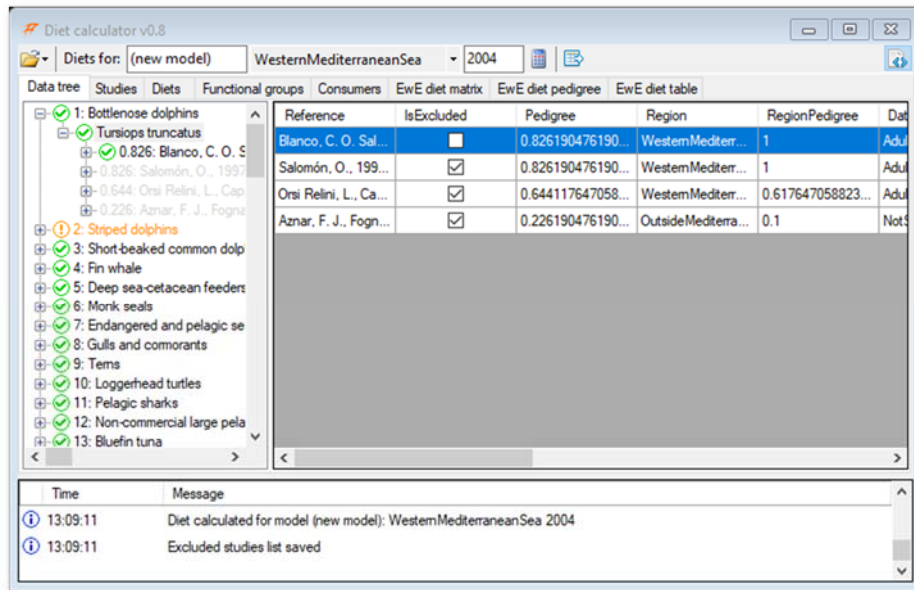


Figure 8 – Information area after running the diets calculations. Note that the data tree now is colour coded, shows allocation icons, and that studies now have pedigree scores.

2.5 Interpreting data breakdowns and troubleshooting

The different views in the software

2.5.1 Data tree breakdown

The data tree provides a birds-eye overview of all loaded data, its allocation to diets, and any allocation problems.

The data tree supports for quick data navigation. Clicking a functional group in the tree opens a species breakdown to the right showing all the species in the group; clicking a group in the tree shows its studies; clicking a study shows its diet records.

The data tree uses icons and colours to reflect whether there are problems with data used in the diet calculations, where icons mark any functional group, group, and study used in the diet calculations. There are three types of icons:

1. Success icons () indicate that there are no problems within the data allocated to a specific functional group, and that data was used successfully in the diet calculations.
2. Warning icons () indicate potential problems that may be caused by perhaps legitimate issues but worth checking. You can find the cause of the problem by expanding tree nodes chasing down other warning icons until you find the diet record(s) that cause the warning (Figure 9). Tree nodes with warnings have their texts drawn in orange.
3. Error icons () indicate data read errors, and must be fixed by editing the source data files presented to the software. Tree nodes with errors have their text drawn in red.

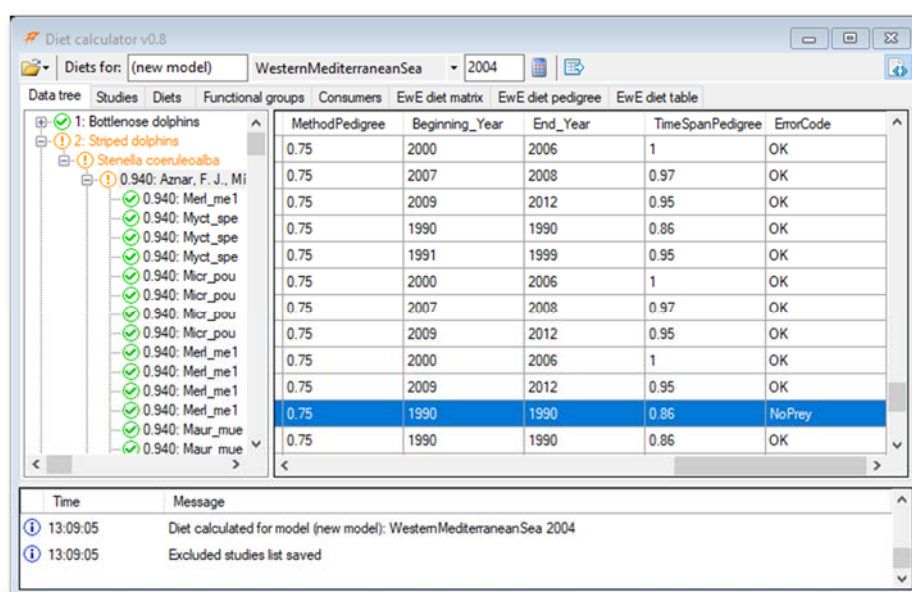


Figure 9 – A diet record flags a warning because its prey refers to an unknown species.

2.5.2 Studies

Despite high pedigree scores, studies may not be useful because they are too generic or too biased.

The studies breakdown shows detailed study records and diet records for the selected study. This breakdown is most useful for excluding studies from the analysis. Exclude a study by setting the checkmark in the 'IsExcluded' column, and include a study by clearing this checkmark.

Note that the list of excluded studies is stored on the local machine for future software sessions.

2.5.3 Diets

The diets breakdown shows a list of all diet records.

This breakdown is useful for checking whether there are any unexpected errors in the diet data. The right-most column shows errors. Click the header of this column to sort records by error code, and scroll down through the various error codes to spot possible problems.

2.5.4 Functional groups

The functional groups breakdown shows the list of functional groups and the species for the selected group below.

This breakdown is useful for checking whether there are any unexpected errors either in functional groups or in species data, and for excluding functional groups from the diet calculations. Exclude a functional group by setting the checkmark in the 'IsExcluded' column, and include the group again by clearing this checkmark.

Similar to the Diets breakdown, right-most group and species columns show error codes. Click the error column header to sort records by error code, and scroll down through the various error codes to spot possible problems.

2.5.5 Consumers

The consumer breakdown shows the list of species with diets, and the diets for each selected consumer.

Similar to the two previous breakdowns, here you can quickly check for species and diet record errors by exploring sorted error codes.

2.5.6 EwE diet matrix

The diet matrix breakdown shows the diet matrix as calculated by the software. Copy this matrix to the clipboard and paste it directly into the EwE software if the functional group structures between the two software tools match.

2.5.7 EwE diet pedigree

The diet pedigree breakdown shows the pedigree of each functional group. Its format is roughly compatible with the pedigree level structure of EwE.

2.5.8 Diet table

The diet table breakdown shows the EwE diet matrix as a list of {predator, prey, diet rows} for every non-zero diet.

Appendix A. Data descriptions

This section describes which data tables and fields are essential to the functioning of the software. Each table lists data type and a brief description of each field.

The software expects Table 1 to 4 to be stored in a Microsoft Access database, table 5 is expected to be provided as Microsoft Excel file. Both files are stored in the SafeNet Dropbox

Table 1 – Table 'FG' defining functional groups

Field	Format	Description
FG	Integer	Functional group
FG_name	Text	Name of a functional group
Category	Text	Consumer, Producer, Detritus

Table 2 - Table 'Species_data' defining species

Field	Format	Description
Code_species	Text	Species key
Scientific_name	Text	Scientific name of a species
Phylum	Text	Taxonomic classification
Class	Text	Taxonomic classification
Order	Text	Taxonomic classification
Family	Text	Taxonomic classification

Table 3 - Table 'FG-species_SAFENET' defining functional groupings of species

Field	Format	Description
FG	Integer	Foreign key to FG.ID
Code_species	Text	Foreign key to Species_data.Code_species

Table 4 - Table 'Diets_data' with species diet records

Field	Format	Description
Code_predator	Text	Foreign key to Species_data.Code_species
Code_preys	Text	Foreign key to Species_data.Code_species
%_both_preys	Text	Diet amount
Data	Integer	Kind of animal used in the data
Method	Integer	Data collection method
Beginning_year	Integer	First year when the data was collected
End_year	Integer	Last year when the data was collected
Region	Integer	Region where the data was collected
Reference	Long text ¹	Bibliographic reference

¹ In Microsoft Access 2013 and newer the data type 'Memo' is called 'Long text'

Table 5 - Table with biomass values per species in the modelled area

Field	Format	Description
Code_species	Text	Foreign key to Species_data.Code_species
Biomass_t_km2	Float	Biomass in the model area

Appendix B. Database structure

The relationships between the database tables described in Appendix A are shown in Figure 10.

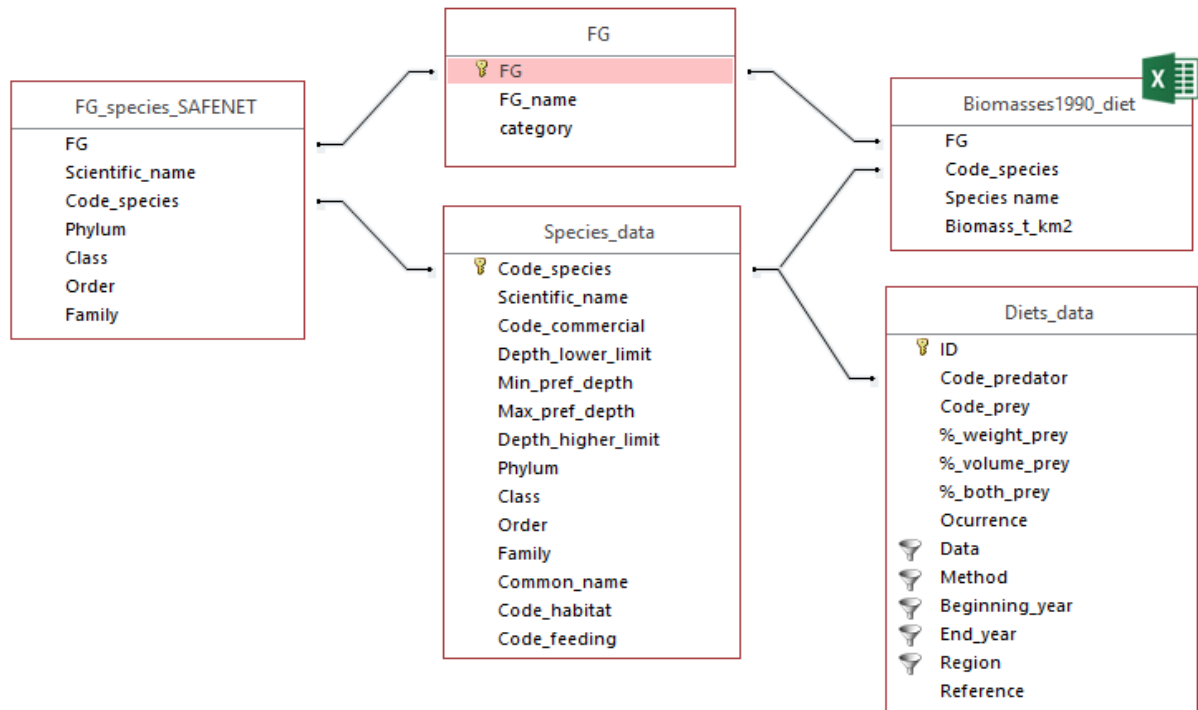


Figure 10 – Diet Calculator uses four inter-related Access database tables that define functional groups (table FG), species details (table Species_data), the Safenet metaweb group / species structure (table FG_species_SAFENET), and diets (table Diets_data). Biomass data is obtained from an external Excel spreadsheet which can have any name. Tables are linked by matching functional group codes (fields FG) or species code (fields Code_species, Code_predator, and Code_preym). Diet records pedigree is calculated over five fields (Data, Method, Beginning_year, End_year, and Region)

Appendix C. Field value classifications

Table 6- Region classifications as used for the Mediterranean case study

Code	Region
1	Mediterranean Sea
2	Western Mediterranean Sea
3	Eastern Mediterranean Sea
4	Central Mediterranean Sea
5	Catalan Sea
6	Balearic Sea
7	Lion Gulf
8	Ligurian Sea
9	Tyrrhenian Sea
10	Adriatic Sea
11	Ionian Sea
12	Aegean Sea
13	Out of Mediterranean Sea
14	North-western Mediterranean

Table 7 - Diet collection method classifications as used for the Mediterranean case study

Code	Diet collection method
1	Stable isotopes
2	Visual observations
3	Stomach content
4	Others (Experiment, body weight, personal comm., ...)

Table 8 - Diet data type classifications as used for the Mediterranean case study

Code	Diet data
0	Unknown
1	Data collected from adults and juveniles
2	Data collected from adults
3	Data collected from juveniles
4	Data collected from larvae

Appendix D. Flow diagram

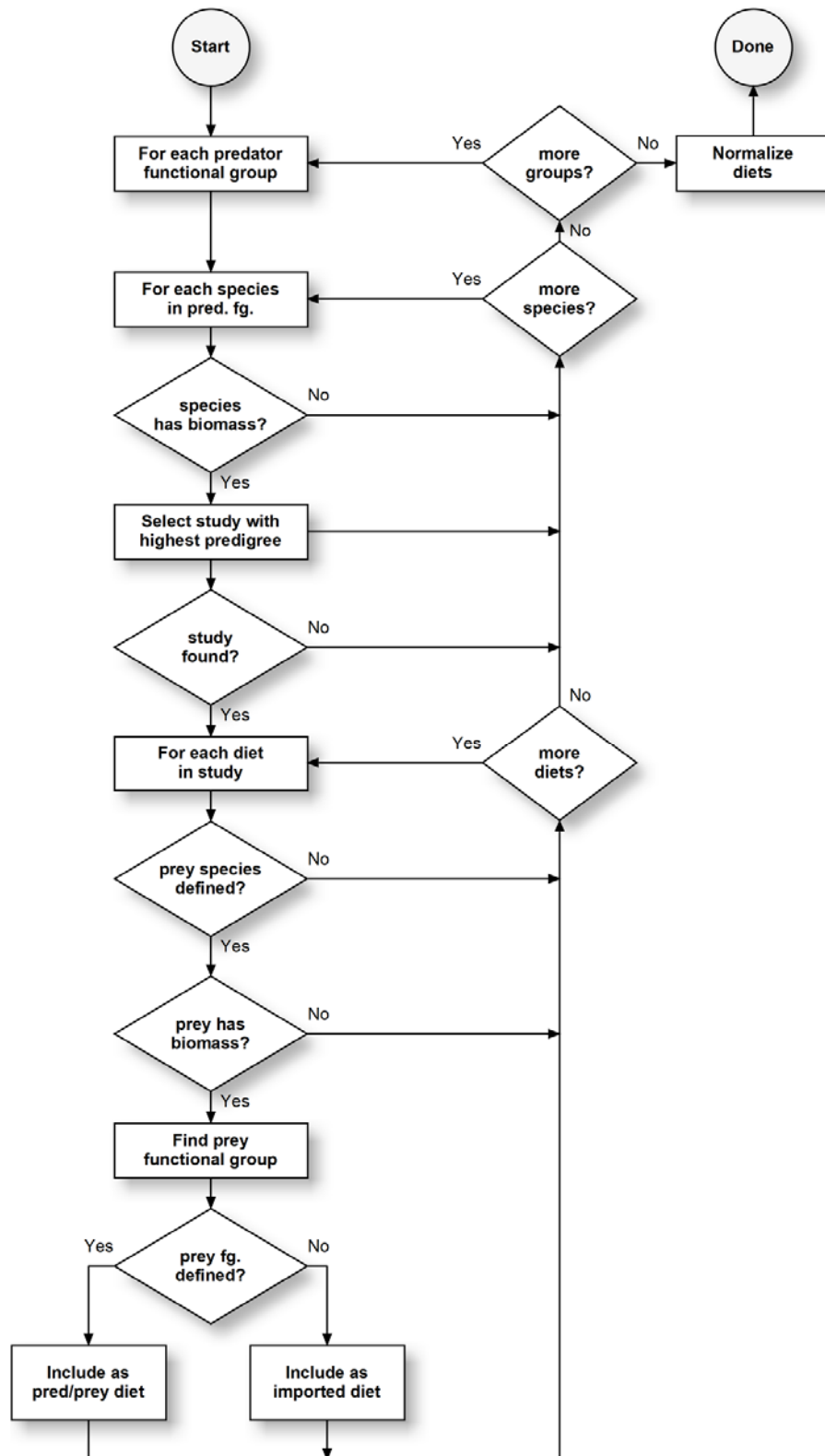


Figure 11 – Decision tree for building the diet matrix, as implemented in the diet calculator software. Only predator and prey species with biomass in the model area are included. Consumption of prey of an unknown functional group is treated as an imported diet.