$y = -0,1176x + 163,02$

$r^2 = 0,70$

Manual for Application of the European Fish Index (EFI)

Development, Evaluation and Implementation of a standardised Fish-based Assessment Method for the Ecological Status of European Rivers (FAME)

A Contribution to the
Water Framework Directive

A research project supported by the European Commission under FP 5

MANUAL
FOR THE APPLICATION
OF THE European Fish Index - EFI

A FISH-BASED METHOD TO ASSESS THE ECOLOGICAL STATUS OF EUROPEAN RIVERS
IN SUPPORT OF THE WATER FRAMEWORK DIRECTIVE

VERSION 1.1, January 2005
DEVELOPED BY THE FAME CONSORTIUM

FAME - Development, Evaluation and Implementation of a Standardised Fish-based Assessment Method for the Ecological Status of European Rivers. A Contribution to the Water Framework Directive
A project under the 5th Framework Programme Energy, Environment and Sustainable Development
Key Action 1: Sustainable Management and Quality of Water
Contract No: EVK1 -CT-2001-00094
http://fame.boku.ac.at

To be cited as: FAME CONSORTIUM (2004). Manual for the application of the European Fish Index - EFI. A fish-based method to assess the ecological status of European rivers in support of the Water Framework Directive. Version 1.1, January 2005.

The text of this manual was written by Jan Breine, Ilse Simoens, Gertrud Haidvogl, Andreas Melcher, Didier Pont, & Stefan Schmutz.

Acknowledgements

The FAME consortium would like to thank numerous individual persons, private and public institutions throughout Europe for providing the large volume of data that made the FAME project possible. Special thanks are dedicated to Paul Angermeier, Virginia TECH US, and Robert Konecny, Environmental Agency Austria, for reviewing the FAME project. We are grateful to Richard Noble for his critical revision and valuable suggestions. The consortium greatly appreciated the support of Hartmut Barth and Mogens Gadeberg, the Scientific Officers of the EC.
The FAME project was financed by the EC contract no. EVK1 -CT-2001-00094.

Help desk: Please direct all questions and suggestions for improvements to fame@boku.ac.at.

Layout: Filip Coopman

Printed in 2004 by Ministerie van de Vlaamse Gemeenschap, Departement L.I.N. A.A.D. afd. Logistiek-Digitale drukkerij

Contents

Annexes

List of figures, pictures and tables

Preface

This manual describes the European Fish Index - EFI - and its application software. The EFI and the manual have been developed within the EU research and development project FAME (Development, Evaluation and Implementation of a Standardised Fish-based Assessment Method for the Ecological Status of European Rivers - A Contribution to the Water Framework Directive). FAME was a project under the 5th Framework Programme Energy, Environment and Sustainable Development; Key Action 1: Sustainable Management and Quality of Water of the European Commission.

In the year 2000, the European Commission adopted a new legislation, the Water Framework Directive. This new legislation, now implemented in 25 EU member countries, strives for good ecological conditions in all surface waters. Fishes are, for the first time, part of a European monitoring network designed to observe the ecological status of running waters. Due to the lack of standardised fish-based assessment methods, FAME aimed to develop a new assessment method, the European Fish Index. This method is founded on the concept of the Index of Biotic Integrity (Karr 1981). FAME started in 2001 and was finished in 2004. Further information on FAME is provided at the project website http://fame.boku.ac.at.

General introduction

This manual contains three parts. Part I introduces the Water Framework Directive and the basic ideas of the Index of Biotic Integrity. The advantages of fishes as indicators for assessing the ecological quality in running waters are described.

Part II gives an overview of the European FAME project and its achievements. The main features of the European Fish Index (EFI) are described and the field sampling procedures required to collect suitable data are briefly discussed. The limitations of the newly developed index are also demonstrated. Additionally, the EFI software tool also enables sites to be assigned to “European Fish Types” (EFT) defined within the FAME project. Descriptions of the EFTs are given based on the species composition of the fish assemblages.

Part III is the instruction manual to the software, it details the different steps required to obtain the EFT, the EFI and ecological status assessment for new sites.

Part I: Introduction

1. The Water Framework Directive (WFD)

The aim of the WFD is to create a European framework for the protection of inland surface waters, transitional waters, coastal waters and groundwater (EU Water Framework Directive, 2000). Its principal objective is to protect, enhance and restore all bodies of surface waters with the aim of achieving a good status by 2015 (WFD Article 4). The WFD requires member states to assess the ecological quality status (EcoQ) of their water bodies (Article 8). The EcoQ is based on the status of biological quality elements supported by hydromorphological and chemical/physicochemical quality elements. Consequently, the implementation of the WFD requires appropriate and standardised methods to assess ecological status. The four biological elements to be considered in rivers are (1) phytoplankton, (2) phytobenthos and macrophytes, (3) benthic invertebrate fauna and (4) fish fauna.
The WFD prescribes the following steps for ecological status assessment (Figure 1 below):

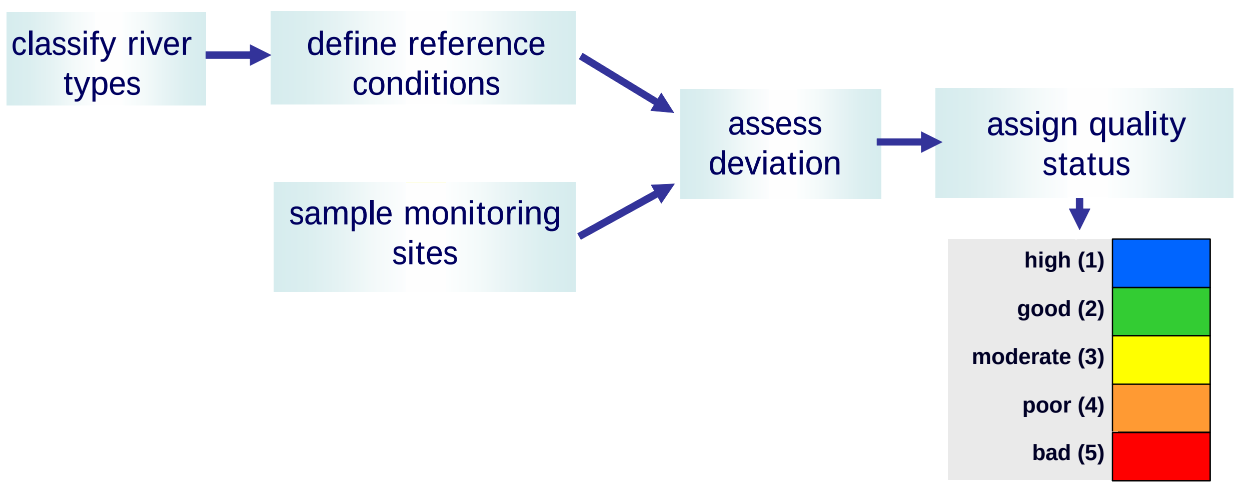


***Figure 1**: Steps prescribed in the WFD for ecological status assessment*

Initially, river types have to be defined. Each type is described by abiotic parameters (System A or B, WFD Annex II 1.2) and verified by the biota. For each type, reference conditions with no or only very minor anthropogenic alterations have to be defined for each biological quality element. Reference conditions may be derived from actual data, historical data or modelling techniques. Finally, an assessment method for each quality element has to be developed. The assessment of a specific site is based on its deviation from type-specific reference conditions. The status of the fish fauna should be assessed with the following criteria: s*pecies composition, abundance, sensitive species, age structure and reproduction* (Annex V 1.2.1). The WFD distinguishes between five levels of ecological status: (1) ***high status***, (2) ***good status***, (3) ***moderate status***, (4) ***poor status*** and (5) ***bad status***. The approach adopted by the FAME project was designed to follow the principles of the WFD summarised briefly here (see Part II).

2. Fish-based ecological assessment methods in Europe

Currently, different fish-based methods are used in Europe, while most countries have not yet included fish in their routine monitoring programs. Thus, the successful implementation of the WFD depends on the provision of reliable and standardised assessment tools. This was the motivation for the EC-funded FAME project. The project aimed to develop, evaluate and implement a fish-based assessment method for the ecological status of European rivers to guarantee coherent and standardised monitoring throughout Europe.

3. What is an Index of Biotic Integrity (IBI)?

The principle of the Index of Biotic Integrity (IBI, Karr 1981) is based on the fact that fish communities respond to human alterations of aquatic ecosystems in a predictable and quantifiable manner. An IBI is a tool to quantify human pressures by analysing alterations of the structure of fish communities. The original IBI (Karr 1981) uses several components of fish communities, e.g. taxonomic composition, trophic levels, abundance and fish health. Each component is quantified by metrics (e.g. proportion of intolerant species). A metric is a measurable variable or process that represents an aspect of the biological structure, function, or other component of the fish community and changes in value along a gradient of human influence. Depending on the underlying biological hypotheses, a metric may decrease (e.g. number of sensitive species) or increase (e.g. number of tolerant species) with the intensity of human disturbances.

4. Why fish?

Fishes have proved their suitability as indicators for human disturbances for many reasons:

- Fishes are present in most surface waters.
- The identification of fishes is relatively easy and their taxonomy, ecological requirements and life histories are generally better known than in other species groups.
- Fishes have evolved complex migration patterns making them sensitive to continuum interruptions.
- The longevity of many fish species enables assessments to be sensitive to disturbance over relatively long time scales.
- The natural history and sensitivity to disturbances are well documented for many species and their responses to environmental stressors are often known.
- Fishes generally occupy high trophic levels, and thus integrate conditions of lower trophic levels. In addition, different fish species represent distinct trophic levels: omnivores, herbivores, insectivores, planktivores and piscivores.
- Fishes occupy a variety of habitats in rivers: benthic, pelagic, rheophilic, limnophilic, etc., Species have specific habitat requirements and thus exhibit predictable responses to human induced habitat alterations.
- Depressed growth and recruitment are easily assessed and reflect stress.
- Fishes are valuable economic resources and are of public concern. Using fishes as indicators confers an easy and intuitive understanding of cause effect relationships to stakeholders beyond the scientific community.

Part II: The European research project FAME

1. Introduction

FAME stands for ‘Development, Evaluation and Implementation of a standardised **F**ish-based **A**ssessment **M**ethod for the Ecological Status of **E**uropean Rivers’ and is a contribution to the Water Framework Directive. The following 12 countries participated in the project: Austria, Belgium, France, Germany, Greece, Lithuania, Poland, Portugal, Spain, Sweden, the Netherlands and the United Kingdom.

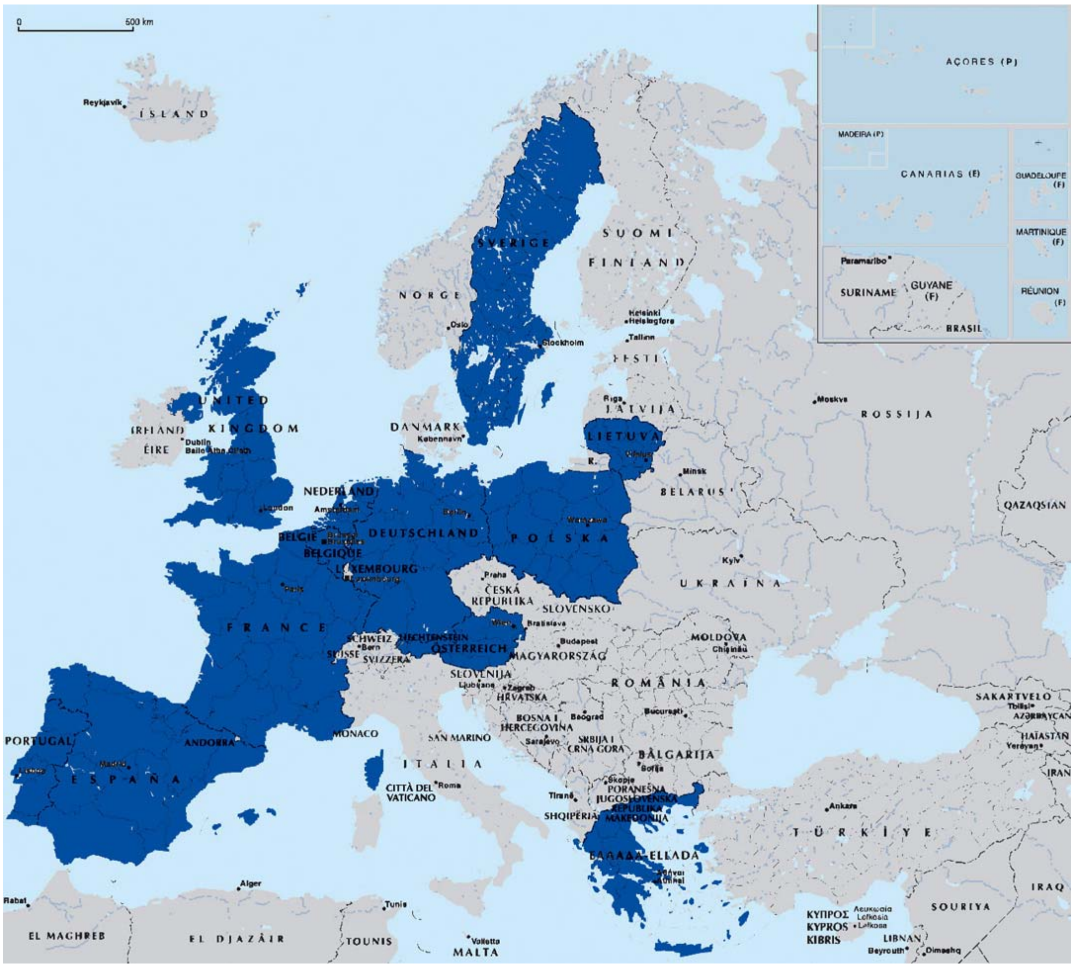


***Figure 2**: Countries participating in FAME*

FAME developed and tested several fish-based assessment methods for the ecological status of rivers. Finally, the European Fish Index (EFI) was selected as the method most suitable to meet the requirements of the WFD. The FAME consortium comprised both scientific (academic institutions) and applied (national institutions responsible for water management) partners to ensure the successful uptake of the FAME tool by end-users and to support its implementation into routine monitoring for the WFD.

2. Basic tools of FAME used to develop the EFI

FIDES (Fish Database of European Streams) is a large database of about **15 000 fish samples** covering 8 000 sites from 2 700 rivers in 16 European eco-regions contributed by 12 countries (Figure 3). For each site information about the sampled fish, abiotic variables and human pressures was collected. FIDES also includes a comprehensive **list of European freshwater fish species** assigned to **ecological guilds** according to their ecological characteristics. This information was used to calculate metrics for the newly developed index (Annexes 3 and 4).

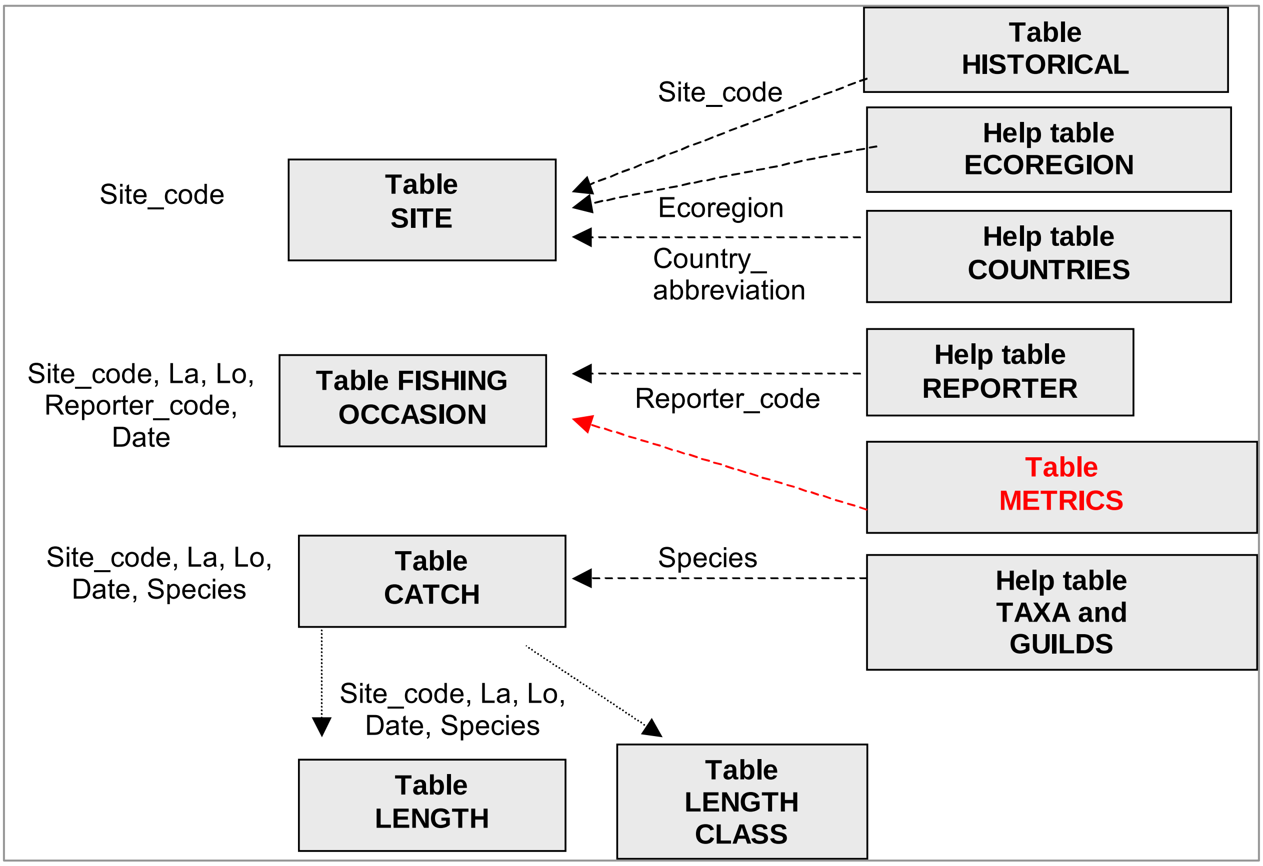


__Figure 3:__ Structure of the central database, FIDES (Fish Database of European Streams,) and relations between tables (La, Lo = latitude and longitude)

3. The European Fish Index (EFI)

The European Fish Index (EFI) is based on a predictive model that derives reference conditions for individual sites and quantifies the deviation between predicted and observed conditions of the fish fauna. The ecological status is expressed as an index ranging from 1 (high ecological status) to 0 (bad ecological status).

1. In the first step the EFI uses data from single-pass electric fishing catches to calculate the assessment metrics (Figure 4, p. 17). The EFI employs 10 metrics belonging to the following ecological functional groups: trophic structure, reproduction guilds, physical habitat, migratory behaviour and capacity to tolerate disturbance in general (Table 1, Annex 4). Six metrics are based on species richness and four on densities.

Table 1*: The 10 metrics used by the EFI and their response to human pressures (↓ = decrease; ↑ = increase of metric)*

Selected metrics	Response to human pressures
Trophic level	
1. Density of insectivorous species	↓
2. Density of omnivorous species	↑
Reproduction strategy	
3. Density of phytophilic species	↑
4. Relative abundance of lithophilic species	↓
Physical habitat	
5. Number of benthic species	↓
6. Number of rheophilic species	↓
General tolerance	
7. Relative number of intolerant species	↓
8. Relative number of tolerant species	↑
Migratory behaviour	
9. Number of species migrating over long distances	↓
10. Number of potamodromous species	↓

2. In the second step a theoretical reference value, indicating no or only slight human disturbances (equals high or good status), is predicted for each metric using environmental variables by means of a multilinear regression model calibrated with FIDES reference data (p. 17, Figure 4, step 2). Ten environmental factors and three sampling variables pertaining to the specific site and sampling strategy are used to predict reference values. Additional information on location, site name, sampling date is required (Table 2, p. 16). Nine environmental variables account for local natural

variability in fish communities (e.g. altitude, slope). One environmental variable, river region, is used to explain regional differences. To identify the main river regions 36 hydrological units were defined using two criteria: each large basin (over 25 000 km^2) was considered as a separate unit characterised by its native fauna list, whereas all smaller basins flowing to the same sea coast were grouped (IHBS Sea area codes). Finally, the 36 hydrological units were grouped into 11 main river regions based on the similarity of their native fish fauna (see Annex 2, Table 1 and Figure 1).

3. The residuals of the multilinear regression models are used to quantify the level of degradation. Residuals are calculated as observed metric values minus theoretical (predicted) metric values (p. 17, Figure 4, step 3).

4. Residual metric values scatter around the theoretical value. Impacted sites exhibit a greater deviation from the theoretical value and thus are less likely to belong to the reference residual distribution than unimpacted or only slightly impacted sites (p. 17, Figure 4, step 4).

5. The metrics in the EFI are based on different units (e.g. number of species, number of individuals). To make metrics comparable they are standardised through subtraction and division by the mean and the standard deviation of the residuals of the reference sites, respectively (p. 17, Figure 4, step 5).

6. As some standardised residuals values tend to increase with disturbance (i.e. density of omnivorous species), whereas others decrease (i.e. density of insectivorous species, Table 1, p. 13), they are transformed into probabilities (p. 17, Figure 4, step 6). This transformation presents two main advantages. Firstly, all metrics will vary between 0 and 1, whereas the standardised residuals have no finite values, and secondly, all metrics will have the same response to disturbance, i.e. a decrease. This final metric value describes the probability for a site to be a reference site, i.e. a site belonging to the two best ecological integrity classes (1 and 2). A site that fits perfectly with the prediction (theoretical value) will have a final metric value of 0.5, whereas the value for an impaired site will decrease when disturbance intensity increases. If the final probability value of the metric is higher than 0.5, the situation observed on the field is better than the predicted one and the probability for these site to be an excellent site (ecological integrity class 1) increases.

7. The final European Fish Index (EFI) is obtained by summing the ten metrics, and then by rescaling the score from 0 to 1 (Figure 4, step 7).

8. The final step is to assign index scores to ecological status classes. Class boundaries have been defined based on the comparison of data sets with different degrees of human pressures. The class boundaries for the five status classes are shown in Figure 4, step 8 (p. 17).

The EFI was validated within the FAME project with independent data stets. The EFI was also validated against a pre-classification of site status based on assessment of human pressures to the hydrology, morphology and chemical quality of the water body. The EFI was able to discriminate between non-impacted and impacted sites in about 80 % of the cases.

Table 2: *Abiotic variables and sampling method variables required for the EFI to predict reference conditions (variable codes for the EFI software in italics)*

Environmental variables describing the sampling site	
Altitude***** *E_altitude*	The altitude of the site in **metres above sea level** (data source: maps).
Lakes upstream *E_lakeupstream*	Are there natural lakes present upstream of the site? Answer *Yes* or *No*. Only applicable if the lake affects the fish fauna of the site, e.g. by altering thermal regime, flow regime or providing seston. Use national definition of a lake (see glossary Annex 5).
Distance from source* *E_distsource*	Distance from source **in kilometres** to the sampling site measured along the river. In the case of multiple sources, measurement shall be made to the most distant upstream source (data source: maps).
Flow regime *E_flowregime*	*Permanent*: never drying out. *Summer dry*: drying out during summer (data source: gauging station or hydrological reports).
Wetted width* *E_wettedwidth*	Wetted width **in metres** is normally calculated as the average of several transects across the stream. The wetted width is measured during fish sampling (performed manly in autumn during low flow conditions) (data source: field measurement).
Geology *E_geotypo*	*Siliceous* or *calcareous* (based on dominating category) (data source: geological maps).
Mean air temperature* *E_tempmean*	Yearly average air temperature measured for at least 10 years. Given **in degrees Celsius (°C)** (data source: nearby measuring site, interpolated data).
Slope* *E_slope*	Slope of streambed along stream expressed **as per mill**, m/km (‰). The slope is the drop of altitude divided by stream segment length. The stream segment should be as close as possible to 1 km for small streams, 5 km for intermediate streams and 10 km for large streams (Data source: maps with scale 1:50 000 or 1:100 000).
Size of catchment *E_catchclass*	Size of the catchment (watershed) upstream of the sampling site. Classes are: *<10, <100, <1000, <10 000, >10 000* **km^2**.
River region *E_riverregion*	To define the river region use Table and map in part III (e.g. *Danube, Ebro, North_Sea, Mediterranean_Sea_WB*).
Variables describing the sampling methods	
Sampling strategy *E_strategy*	Definition of how the section was sampled. Whole river width (*Whole*) or only parts of the river (*Partial*).
Method *E_method*	Define if electric fishing was carried out by wading (*Wading*) or boat (*Boat*).
Fished area *E_fishedarea*	Area of the section that has been sampled (sampled length * sampled width) given **in m^2**.
Variables describing the location, name of site and date of fishing	
Site code *E_sitecode*	Unique reference number per sampling site. User defined schemes.
Date *E_date*	Day/Month/Year e.g. 23/04/2004.
Latitude *E_latitude*	Latitude is given in degrees followed by a decimal point and than minutes and seconds, two digits each. It is always followed by N (e.g. 51.1927N) (data source: GPS, digital maps).
Longitude *E_longitude*	Longitude is given in degrees followed by a decimal point and than minutes and seconds, two digits each. It is always followed by E or W (e.g. 4.5509E) (data source: GPS, digital maps).
X** *E_x*	X co-ordinate decimal unit WGS84 (e.g. *52.5314*) (data source: GPS, digital maps).
Y** *E_y*	Y co-ordinate decimal unit WGS84 (e.g. *00.5219*) (data source: GPS, digital maps).
River name *E_rivername*	The official name used in your country.
Site name *E_sitename*	Location name e.g. indicating a nearby town or village.

Abiotic variables also (*) or only (**) used to predict European Fish Types (see chapter 5 European Fish Types)

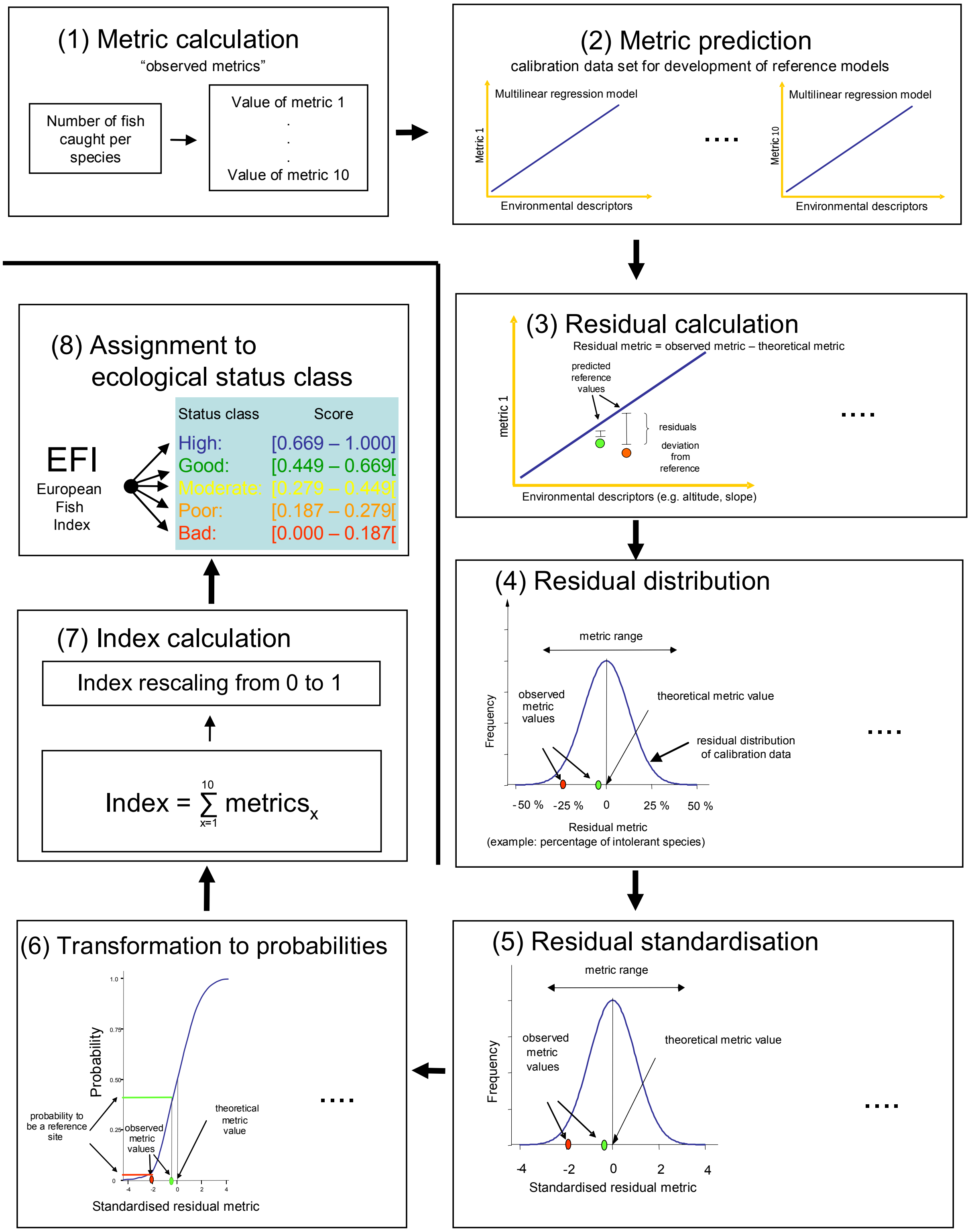


Figure 4: *The methodology of the EFI: In step 3 to 6 two examples, a reference site (green) and a disturbed site (red) are shown*

Example of application

To calculate the EFI the information about the environmental variables and the fish caught at a given site are needed (see example in Table 3). Based on the number of fish caught, the software calculates first the value of the metrics (Figure 5, p. 19). These are called the observed metric values. In a second step, the model predicts, as a function of the environmental variables, the theoretical metric values. These are the reference values expected at a particular site. Finally, the model quantifies the deviation from the theoretical reference condition by calculating for each metric the difference between the observed and theoretical value. This is called the residual metric value. The residual metric value is standardised into a probability metric, indicating the probability of a site being unimpacted, with values ranging from 0 (bad status) to 1 (high status). The rescored sum of these ten values gives the final EFI (see also part III).

Table 3: *Example of site information and environmental variables - River Dropt, France*

Variables describing the location, name of site and date of fishing	
Site code	FR05470095
Latitude	44.3816N
Longitude	00.4411E
Date	09/10/1985
River region	Garonne
River name	Dropt
Site name	Villereal
Environmental variables	
Geology	Calcareous
Size of catchment	<1000 km^2
Altitude	100 m
Flow regime	Permanent
Lakes upstream	Yes
Mean air temperature	13 °C
Slope	2 ‰
Distance from source	22 km
Wetted width	4 m
Sampling strategy	Whole
Method	Wading
Fished area	400 m^2

Assigning species to guilds

Number of fish caught	
Gobio gobio	225
Alburnus alburnus	69
Rutilus rutilus	41
Chondrostoma toxostoma	30
Phoxinus phoxinus	22
Leuciscus cephalus	20
Barbatula barbatula	15
Lepomis gibbosus	11
Rhodeus sericeus	9
Barbus barbus	2
Leuciscus leuciscus	2
Perca fluviatilis	2
Anguilla anguilla	1

Intol	Tol	Benth	Rheo	Litho	Phyto	Insec	Omni	Diadr	Pota
0	0	1	1	0	0	0	0	0	0
0	1	0	0	0	0	0	1	0	0
0	1	0	0	0	0	0	1	0	0
1	0	1	1	1	0	0	1	0	1
0	0	0	1	1	0	0	0	0	0
0	0	0	1	1	0	0	1	0	1
0	0	1	1	1	0	0	0	0	0
0	1	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0	0	1
0	0	0	1	1	0	0	1	0	0
0	1	0	0	0	0	0	0	0	0
0	1	1	0	0	0	0	0	1	0

Calculating "observed metrics"

Insectivorous species (Insec)	275 ind.ha^{-1}
Omnivorous species (Omni)	4050 ind.ha^{-1}
Phytophilous species (Phyto)	0 ind.ha^{-1}
Lithophilic species (Litho)	19 % ind.
Benthic species (Benth)	5 species
Rheophilic species (Rheo)	7 species
Diadromous species (Diadr)	1 species
Potamodromous species (Pota)	3 species
Intolerant species (Intol)	15 % species
Tolerant species (Tol)	38 % species

***Figure 5**: Process of converting species data into observed metric values - River Dropt, France*

The environmental data, fishing method and number of fish caught obtained during the survey in the river Dropt (France) are given as an example (Table 3, p. 18). Figure 5 (p. 19) illustrates how the species abundance data are converted into observed metric values. Table 4 (p. 20) shows the observed, theoretical and probability metric values for the French example.

To obtain the final EFI for the site the ten probability metric values are summed (example River Dropt: total = 5.334; see Table 4, p. 20) and rescaled from zero to one (example River Dropt: EFI = 0.5334).

Each site is assigned to an ecological status class according to the EFI score obtained. The final ratings of the index for the five integrity classes are shown in Figure 4, step 8 (p. 17).

The site from the River Dropt with an EFI of 0.53 is assigned to class 2 (good ecological status).

***Table 4**: Observed, theoretical and probability metric values - River Dropt, France*

Metrics	Observed values	Theoretical values	Probability metric values
Insectivorous species	275 ind.ha^{-1}	383 ind.ha^{-1}	0.423
Omnivorous species	4050 ind.ha^{-1}	255 ind.ha^{-1}	0.099
Phytophilic species	0 ind.ha^{-1}	5 ind.ha^{-1}	0.912
Lithophilic species	19 % ind	57 % ind	0.032
Benthic species	5 species	4.1 species	0.658
Rheophilic species	7 species	5.9 species	0.677
Diadromous species	1 species	0.5 species	0.841
Potamodromous species	3 species	1.5 species	0.894
Intolerant species	15 % species	17 % species	0.379
Tolerant species	38 % species	37 % species	0.419
Total			5.334

4. Limitations of the EFI

This index has been developed for sites located in the ecoregions presented in Annex 2. A sufficient number of sites was available in 11 of the 25 European ecoregions. Therefore, the EFI should not be applied in areas with a fish fauna deviating from those of the tested ecoregions. The EFI should not be used (or only used with caution) in e.g. Mediterranean rivers with high proportion of endemic species or in the rivers of the south-eastern part of Europe which support fish communities that differ greatly in species composition. Although the validation of the EFI also proved its applicability for large rivers the index should be used with caution in the lowland reaches of very large rivers such as the Rhine and Danube as no reference sites from these reaches have been used for the calibration of the EFI. In those cases the EFI uses only extrapolated predictions based on the trends observed in the models.

The statistical models that are used for the EFI reflect the average response of fish communities to environmental conditions. The application of the EFI for particular environmental situations such as the outlet of lakes or predominantly spring fed lowland rivers might cause problems. However, those unique situations are mostly spatially limited and are therefore less important in countrywide monitoring programmes.

Only fish data obtained with single-pass electric fishing may be used to calculate the EFI. If data from multiple passes are used (i.e. same site fished several times and catches cumulated) the EFI produces erroneous results.

As the EFI is a statistical method to assess the community composition, a minimum number of data is required to run the software. For a given site, 30 specimens is the minimum sample size required to be able to calculate the EFI with appropriate statistical confidence. When fewer specimens were caught the software still allows you to calculate the EFI, but the results must be considered with care. The same applies when the sampled area is smaller than 100 m². Consequently, when no fish occur at a site, this method is not applicable. Two cases could be problematic and the EFI should be used with care: (1) undisturbed rivers with naturally low fish density and (2) heavily disturbed sites where fish are nearly extinct. In the first case, fish are close to the natural limits of occurrence and therefore might not be good indicators for human impacts. The occurrence of fish in those rivers is highly coincidental and therefore not predictable. If the very low density is caused by severe human impacts more simple methods or even expert judgement are sufficient to assess the ecological status of the river.

The EFI provides a continuous score from 0 to 1. The discrimination between ecological classes, i.e. between unimpacted and impacted sites was based on validated statistical tests. However, due to the low number of minimally disturbed sites (class 1) and heavily disturbed sites (class 5) in FIDES, the limits between class 1 and 2 and class 4 and 5 were set arbitrarily. Therefore, the probability to misclassify sites of high and bad status is higher than for sites of good, moderate and poor status.

The model was developed using data from sites with environmental characteristics ranging between specific limits. These values are given in Table 5. Your site should have characteristics within these ranges in order to obtain a confident EFI.

Table 5*: Minimum, median and maximal values of environmental characteristics*

Characteristics	Minimum	Median	Maximum
Distance from source [km]	0.0	20.0	990.0
Altitude [m.a.s]	0.0	56.0	1950.0
Slope gradient [m.km-1]	0.50	7.00	199.00
Wetted width [m]	0.5	7.0	1600
Mean air temperature [°C]	-2.0	10.0	16.0

The WFD requires the use of s*pecies composition, abundance, sensitive species, age structure and reproduction* within assessment criteria. The ten metrics used in the EFI only represent the species composition, abundance and sensitive species criteria. However, at the time the FAME project was developed, the data on fish length necessary to calculate metrics for age structure and reproduction were not available in all European countries. These metrics could be integrated in a future version of the EFI.

5. European Fish Types (EFT)

The European Fish Index predicts reference conditions specifically for each site - thus it is not based on pre-classified river types. To be in accordance with the WFD European Fish Types were defined as accompanying tool. Based on FIDES references sites spread over 11 ecoregions, 15 European Fish Types were identified.

Table 6: *The 15 European Fish Types and relative species composition (%), only species >2% are listed (species >12 % in bold)*

	European Fish Type														
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Number of Sites	148	365	553	229	1130	832	69	84	7	81	9	446	148	67	432
Fish species															
Salmo trutta fario	**94**	**81**	**43**	**37**	11	5	**45**	7	**25**	14		9	4	1	3
Cottus gobio	0	**14**	**38**	5	**19**	**12**	4	**13**				**17**	0	1	0
Phoxinus phoxinus	0	1	7	**17**	**21**	**31**		9				7	**15**	3	2
Barbatula barbatula		0	3	**13**	**14**	**13**	1	1				1		1	3
Anguilla anguilla	3	0	0	0	**16**	1		0		3		0	9		1
Leuciscus souffia			0	12		0									
Thymallus thymallus		1	1	0	0	1	**45**	11	**18**			1		0	0
Salmo salar	2		1	0	7	0		**45**	9			3		0	
Cottus poecilopus		2	0	1				5	**47**			0			4
Leuciscus carolitertii	0									**36**					
Chondrostoma polylepis	1									**23**					
Rutilus arcasii	0									**14**					
Barbus bocagei										10					
Salmo trutta lacustris		0				0	0				**100**	6			2
Salmo trutta trutta			0		0	0		0	1			**40**		0	
Barbus meridionalis		0		1		0							**53**		
Leuciscus cephalus		0	1	4	2	5	1	2				0	11	10	8
Barbus haasi													8		
Gasterosteus aculeatus			0		2	1		1				1	0	**39**	1
Alburnoides bipunctatus			0	0	0	3	0							**15**	1
Rutilus rutilus		0	0	0	3	6		1				2		10	**37**
Alburnus alburnus			0		0	4	0					0		6	7
Gobio gobio	0	0	1	6	1	5	0	0				1		4	7
Perca fluviatilis		0	0	0	0	3		1				4		1	6
Lota lota		0	0	0	0	0		1				4		0	2
Leuciscus leuciscus			0	0	1	4		1						2	4
Esox lucius		0	0		0	1		1				1		1	3
Barbus barbus		0	0	1	0	1	1	0						0	2

Nine abiotic variables were selected to discriminate between the 15 European Fish Types (Table 7, p. 24). These variables are used to classify the river type of a new site that has to be assessed.

The limitations defined for the EFI in chapter 4 are principally also valid for the EFT. The calculation of the EFT should only be done within the spatial and environmental limits the method was designed for.

Table 7: *Distribution of European fish types across ecoregions and abiotic variables (mean values) discriminating between the 15 European Fish Types*

EFT	Altitude (m)	Wetted width (m)	Mean air temperature (°C)	Slope (m/km)	Distance from source (km)	X co-ordinate	Y co-ordinate
1	856	7	8.1	18.9	15	n.a.	n.a.
2	633	9	6.1	22.1	14	n.a.	n.a.
3	173	6	9	9.5	12	n.a.	n.a.
4	487	7	9.5	16.9	16	n.a.	n.a.
5	41	9	10	3.5	30	n.a.	n.a.
6	110	12	9.6	2	48	n.a.	n.a.
7	562	33	7.1	3.2	110	n.a.	n.a.
8	61	54	7.4	2.8	90	n.a.	n.a.
9	582	19	-0.1	35.4	26	n.a.	n.a.
10	214	21	13.8	7	43	n.a.	n.a.
11	718	9	0.7	19.5	6	n.a.	n.a.
12	45	46	8.1	3.9	65	n.a.	n.a.
13	291	5	13.4	23.3	14	n.a.	n.a.
14	61	30	6.1	0.7	151	n.a.	n.a.
15	120	163	9.8	0.9	273	n.a.	n.a.

6. Collecting data for the EFI

To employ the assessment method and to define the European Fish Type the following procedure should be applied. The different steps are explained in the text below.

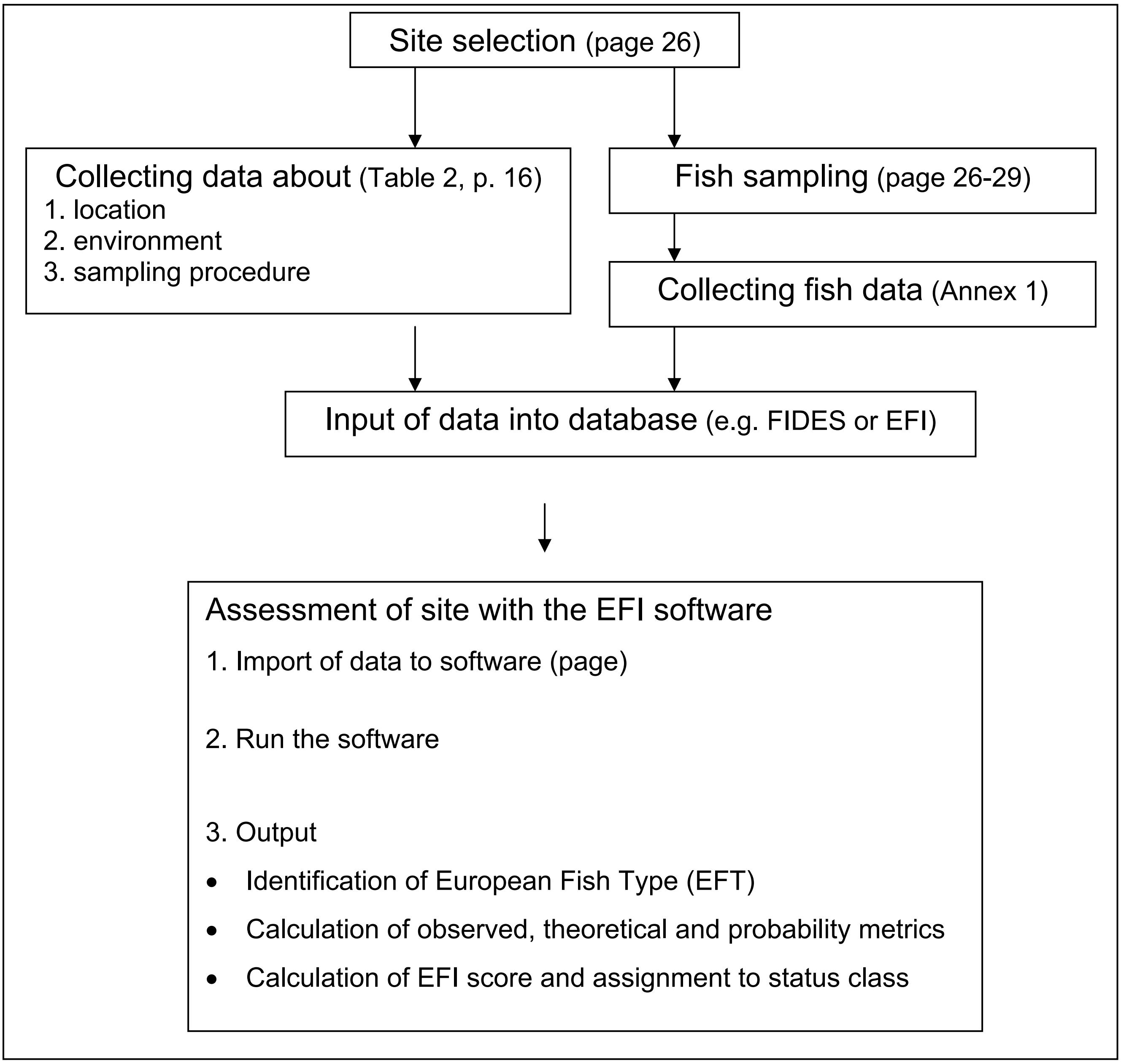


***Figure 6**: Different steps required to apply the assessment method*

Site selection

The selected site should be representative, within the river segment, in terms of habitat types and diversity, landscape use and intensity of human pressures.

A river segment is defined as:

1 km for small rivers (catchment<100 km^2)

5 km for medium-sized rivers (100-1000 km^2)

10 km for large rivers (>1000 km^2)

A segment for a small river will thus be 500 m upstream and 500 m downstream of the sampling site.

Environmental variables and sampling methods

To model the reference situation for the sampled site the variables from Table 2 (p. 16) should be recorded in the data sheet (see field protocol in Annex 1-Table 2 and environmental and method data in part III).

Fish sampling

To calculate the index only fish data obtained by electric fishing can be used. Standardised electric fishing procedures are precisely described in the CEN directive, "Water Analysis – Fishing with Electricity (EN 14011; CEN, 2003) for wadable and non-wadable rivers.

Fishing procedures and equipment differ depending upon the water depth and wetted width of the sampling site. The selection of waveform, DC (Direct Current) or PDC (Pulsed Direct Current), depends on the conductivity of the water, the dimensions of the water body and the fish species to be expected. AC (Alternating Current) is harmful for the fish and should not be used. The fishing procedure is summarised below, separately for wadable and non-wadable rivers. In both cases, fishing equipment must be suitable to sample small individuals (young-of-the-year).

In the Tables 9 and 10 (p. 28 and 29), the river width corresponds with wetted width. According to the CEN-standard, the main purpose of the standardised sampling procedure is to record information concerning fish composition and abundance; therefore, no sampling period is defined (according to CEN). However, FAME agreed on a sampling period of late summer/early autumn except for non-permanent Mediterranean rivers where spring samples may be more appropriate.

Concerning the minimum river length to be sampled, because of the variability of habitats and fish communities within rivers sections and in order to ensure accurate characterisation of a fish community, electric fishing at a given site must be conducted over a river length of 10 to 20 times the river width, with a minimum length of 100 m. However, in large and shallow rivers (width >15 m and water depth <70 cm) where electric fishing by wading can be used, several sampling areas cumulating in total at least 1000 m^2 should be prospected, covering all types of mesohabitats present in a given sampling site (partial sampling method). The length of the sampling site (station) is also calculated as 10 to 20 times the river width. Fishing of longer river sections should be avoided as some metrics referring to the number of species caught (e.g. number of rheophilic species) might be biased due to over sampling.

In wadable rivers as a general guide one anode per 5 m width should be appropriate. The operators should fish upstream so that water discoloured by wading does not affect efficiency. They should move slowly, covering the habitat with a sweeping movement of the anodes and attempt to draw fish out of hiding. To aid effective fish capture in fast flowing water the catching nets should be held in the wake of the anode. Each anode is generally followed by one or two hand-netters (hand net: mesh size of 6 mm maximum) and one suitable vessel for transporting fish (Table 8 p. 28).

In large rivers, the depth (> 0.7 m) and variety of habitats makes prospecting the entire area impossible. Therefore, a partial sampling procedure is applied covering all types of habitats to obtain a representative sample of the site. Qualitative and semi-quantitative information can be obtained by using conventional electric fishing with hand held electrodes in the river margins and delimited areas of habitat. Alternatively, where resources exist capture efficiency can be improved by increasing the size of the effective electric field relative to the area being fished by increasing the number of catching electrodes (electric fishing boats with booms). Arrays comprising many pendant electrodes can be mounted on booms attached to the bows of the fishing boat. The principal array should be entirely anodic with separate provision being made for cathodes. Depending upon water conductivity, the current demands of multiple electrodes can be high and large generators and powerful control boxes may be needed (Table 9, p. 29).

Table 8: *Rivers < 0.7 m depth = wadable rivers*

Waveform selection:	DC or PDC
Number of anodes:	One anode per 5 m width
Number of hand-netters:	Each anode followed by 1 or 2 hand-netters (mesh size of 6 mm maximum) and 1 suitable vessel for holding fish.
Number of runs:	One run
Time of the day:	Daylight hours
Fishing length:	10 - 20 times the wetted width, with a minimum length of 100 m
Fished area:	river width <15 m: The whole site surface river width >15 m: Several separated sampling areas are selected and prospected within a sampling site, with a minimum of 1000 m² (partial sampling method)
Fishing direction:	Upstream
Movement:	Slowly, covering the habitat with a sweeping movement of the anodes and attempt to draw fish out of hiding.
Stop nets:	Used if necessary and feasible

Picture 1: *Electric fishing in a wadable river*

Table 9: *Rivers > 0.7 m depth = non-wadable rivers (boat fishing)*

Waveform selection:	DC or PDC
Number of anodes:	Depending on boat configuration
Number of runs:	One run
Time of the day:	Daylight hours
Fishing length:	10 -20 times the wetted width, with a minimum length of 100 m
Fished area:	Both banks of the river or a number of sub-samples proportional to the diversity of the habitats present with a minimum of 1000 m² (partial sampling method)
Fishing direction:	Normal flow: downstream in such a manner as to facilitate good coverage of the habitat, especially where weed beds are present or hiding places of any kind are likely to conceal fish High flow: upstream Low flow: not necessary to match boat movement to water flow, and the boat can be controlled by ropes from the bank side if required
Movement:	Slowly, covering the habitat with a sweeping movement of the anodes or drifting with the boom along selected habitats and attempting to draw fish out of hiding.
Stop net	Used if necessary and feasible

Picture 2: *Electric fishing from a boat*

Fish data

To calculate the EFI, each collected specimen should be identified to species level by external morphological characters and the total number of specimens per species should be recorded on the field protocol data sheet (see Annex 1-Table 1: fish data).

The EFI software or the FAME database FIDES can be used for data input. The blank FIDES database structure can by downloaded from the FAME homepage http://fame.boku.ac.at.

Part III: A manual for application

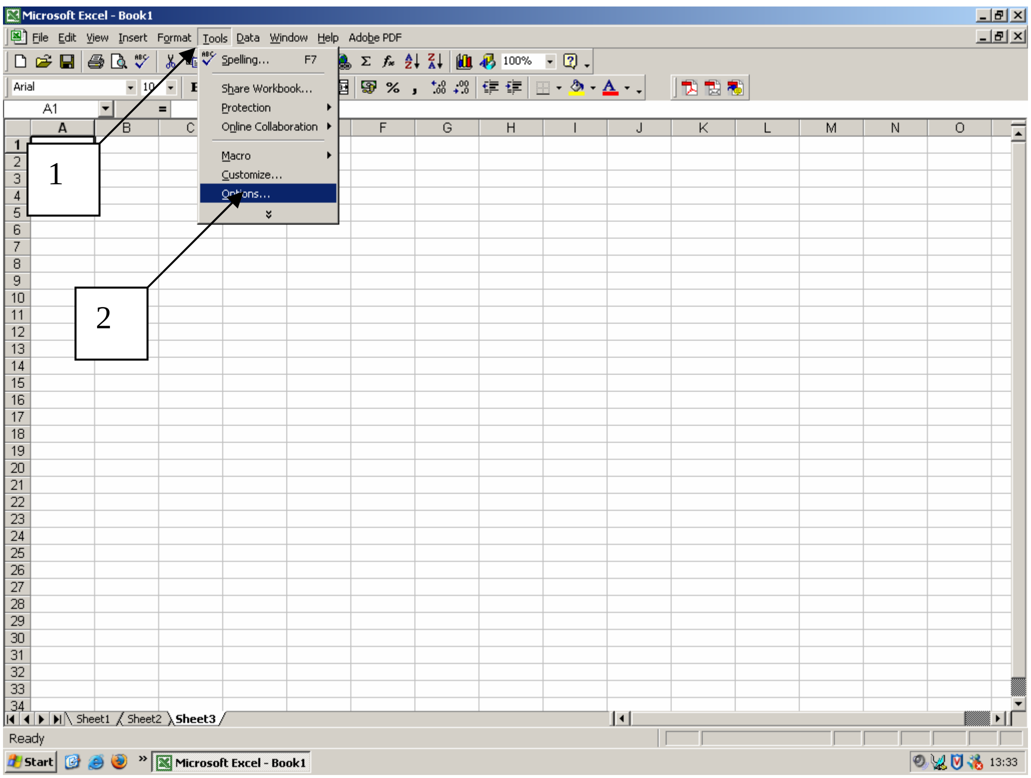
First copy the software EuropeanFishIndex.xls to a directory of your choice. In addition the program file Comdlg32.ocx needs to be installed in C:\WINDOWS\SYSTEM\ if not already present there. **You must not rename the file EuropeanFishIndex.xls** as this would cause problems in running the software. The software was developed for Microsoft Office version 2000 and 2003. Running the software with older Microsoft Office versions is not recommended as some features may not function properly.

1. Preparing data in MS Excel: data organisation and format

Before using the software you have to prepare your data in separate Microsoft Excel® file. Use two different files, one for the EFI and one for the EFT. In this manual these files are referred to as the EFI-file and EFT-file.

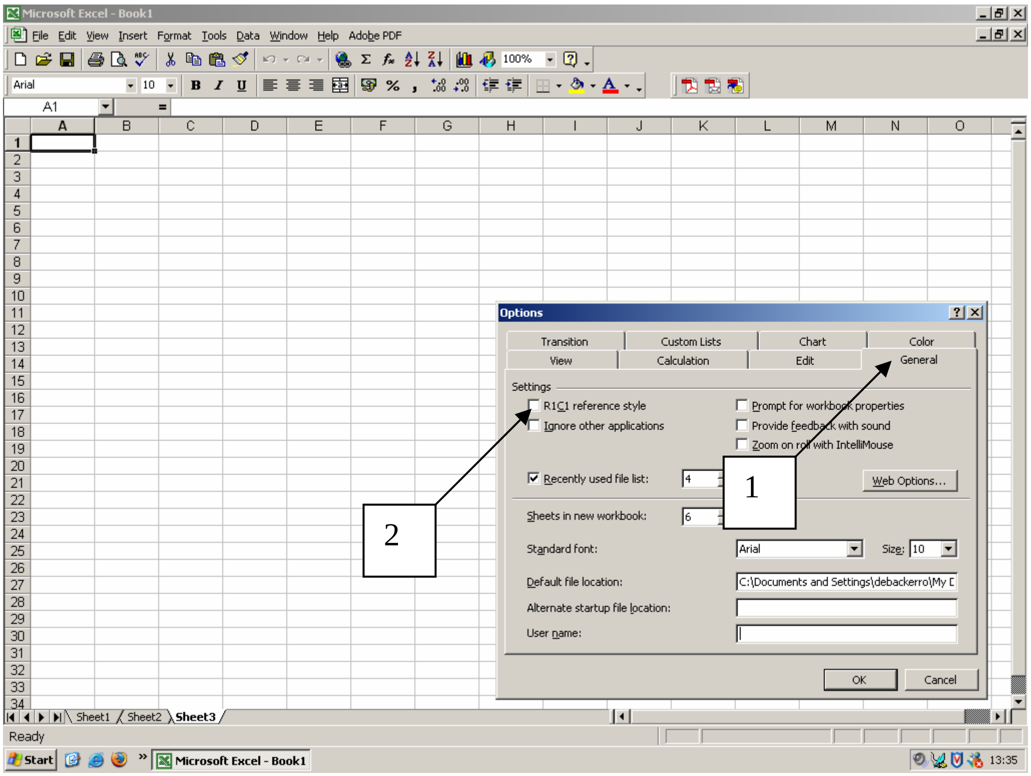
You must make sure that your Excel is not set to the R1C1 reference style. The software requires that columns are referenced by letters, numbers indicate rows. If this is not so you change this by selecting in the opened Excel file (e.g. spreadsheet 1) the "Tools" in the menu (1), then select "Options" (2).

Spreadsheet 1



Choose “General” (step 1 in spreadsheet 2) and make sure that in “settings” the ‘R1C1 reference style’ option (step 2) is not highlighted.

Spreadsheet 2



Both files should contain variables formatted in an appropriate way so that the software can recognise the variable names, the variable values and variable types. The column sequence is not important.

In the **EFI-file** you need to include a list of 19 obligatory variables. Additional variables can be included but will not be used to calculate the European Fish Index (EFI.).
Table 2 (Part II, p. 16) gives the exact spelling of the 19 obligatory variables to be included (variable codes in 1st column are in italics). Variable names are case-sensitive! If you make a mistake in the variable name (incorrect spelling) or use an unexpected value, the software will propose a list of solutions in a pop-up menu (see example in data control). Make sure that you use the right units (**metres** for altitude, **kilometres** for distance from source, **metres** for wetted width, **degree Celsius** for mean air temperature, **per mill** (m/km, ‰) for slope and **m^2** for fished area). Variable names and data should be checked carefully to avoid time consuming corrections once you use the software. Make sure you have no empty cells for the

obligatory variables. Another way to prepare the EFI-file is to download the EFI-input-file from the FAME web site (http://fame.boku.ac.at) and use the template to store your own data.

The river regions (variable *E_riverregion*) aggregated to river groups are represented in Annex 2. Use the correct spelling of the river region names as indicated in Annex 2-Table 1.

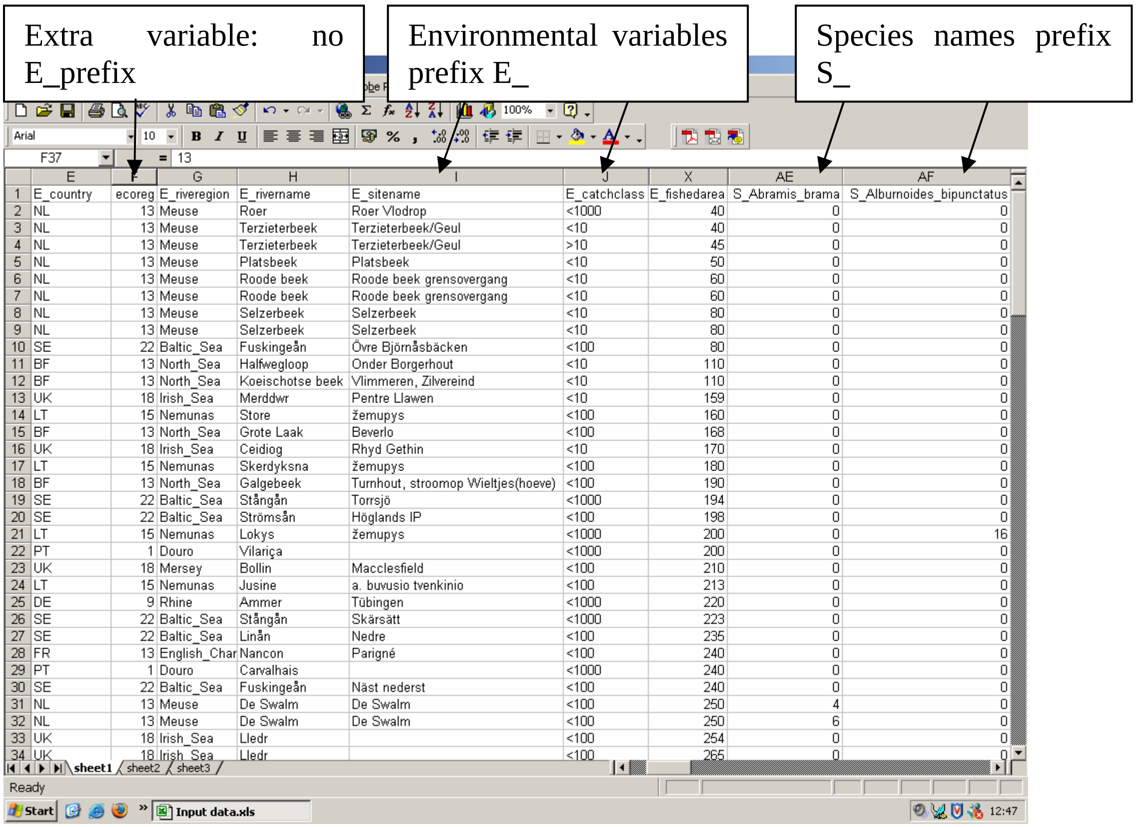
In addition you can include in the data file extra information about the ecoregion. The ecoregion is defined according to the Illies' classification and the WFD (Annex 2-Table 2, Figure Annex_2-1).

You can include extra data. However, they will not be taken into account for the EFI calculation. If you add extra variables do not use the prefix 'E_'.

In the same EFI-file you add in the next columns the fish data, i.e. number of specimen, with each species in a separate column. Annex 3 gives the names of the fish species used in the EFI. The species variables must have the prefix 'S_' before the species name (S_Genus_species). This naming procedure must be respected whether the species name is listed or not. If you add a new species do not forget this prefix. The new species, however, will not be taken into account for the EFI calculation. A mistake can be corrected using a list that the software proposes in a pop-up menu (see example).

You have now completed your data preparation. These data can now be used to calculate the EFI. Spreadsheet 3 gives a detailed example of what your prepared Excel spreadsheet should look like.

Spreadsheet 3



	E	F	G	H	I	J	X	AE	AF
1	E_country	ecoreg	E_riveregion	E_rivername	E_sitename	E_catchclass	E_fishedarea	S_Abramis_brama	S_Alburnoides_bipunctatus
2	NL	13	Meuse	Roer	Roer Vlodrop	<1000	40	0	0
3	NL	13	Meuse	Terzieterbeek	Terzieterbeek/Geul	<10	40	0	0
4	NL	13	Meuse	Terzieterbeek	Terzieterbeek/Geul	>10	45	0	0
5	NL	13	Meuse	Platsbeek	Platsbeek	<10	50	0	0
6	NL	13	Meuse	Roode beek	Roode beek grensovergang	<10	60	0	0
7	NL	13	Meuse	Roode beek	Roode beek grensovergang	<10	60	0	0
8	NL	13	Meuse	Selzerbeek	Selzerbeek	<10	80	0	0
9	NL	13	Meuse	Selzerbeek	Selzerbeek	<10	80	0	0
10	SE	22	Baltic_Sea	Fuskingeån	Övre Björnåsbäcken	<100	80	0	0
11	BF	13	North_Sea	Halfwegloop	Onder Borgerhout	<10	110	0	0
12	BF	13	North_Sea	Koeischotse beek	Vlimmeren, Zilvereind	<10	110	0	0
13	UK	18	Irish_Sea	Merddwr	Pentre Llawen	<10	159	0	0
14	LT	15	Nemunas	Store	žemupys	<100	160	0	0
15	BF	13	North_Sea	Grote Laak	Beverlo	<100	168	0	0
16	UK	18	Irish_Sea	Ceidiog	Rhyd Gethin	<10	170	0	0
17	LT	15	Nemunas	Skerdyksna	žemupys	<100	180	0	0
18	BF	13	North_Sea	Galgebeek	Turnhout, stroomop Wieltjes(hoeve)	<100	190	0	0
19	SE	22	Baltic_Sea	Stångån	Torrsjö	<1000	194	0	0
20	SE	22	Baltic_Sea	Strömsån	Höglands IP	<100	198	0	0
21	LT	15	Nemunas	Lokys	žemupys	<1000	200	0	16
22	PT	1	Douro	Vilariça		<1000	200	0	0
23	UK	18	Mersey	Bollin	Macclesfield	<100	210	0	0
24	LT	15	Nemunas	Jusine	a. buvusio tvenkinio	<100	213	0	0
25	DE	9	Rhine	Ammer	Tübingen	<1000	220	0	0
26	SE	22	Baltic_Sea	Stångån	Skärsätt	<1000	223	0	0
27	SE	22	Baltic_Sea	Linån	Nedre	<100	235	0	0
28	FR	13	English_Char	Nancon	Parigné	<100	240	0	0
29	PT	1	Douro	Carvalhais		<1000	240	0	0
30	SE	22	Baltic_Sea	Fuskingeån	Näst nederst	<100	240	0	0
31	NL	13	Meuse	De Swalm	De Swalm	<100	250	4	0
32	NL	13	Meuse	De Swalm	De Swalm	<100	250	6	0
33	UK	18	Irish_Sea	Lledr		<100	254	0	0
34	UK	18	Irish_Sea	Lledr		<100	265	0	0

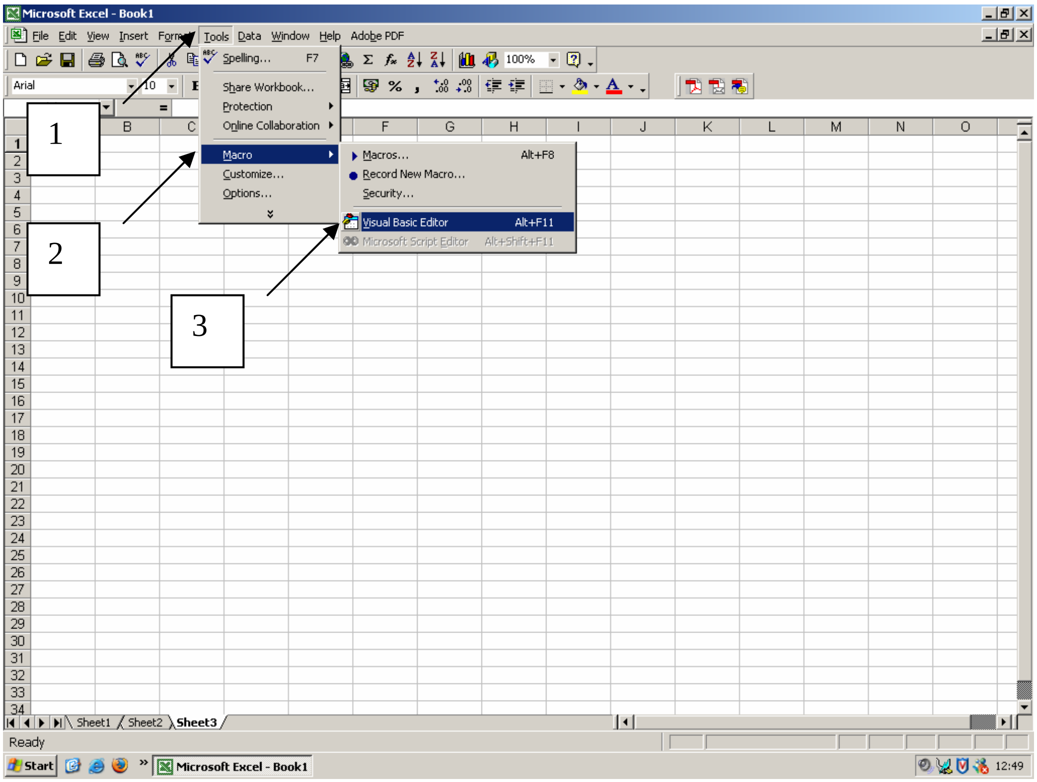
In the **EFT-file** you must include 9 obligatory variables. Table 2 (Part II, p. 16) gives the exact spelling of the 9 variables to be included. Variable names are case-sensitive! If you make a mistake in the variable name (incorrect spelling), the software will propose a list of solutions in a pop-up menu (see example in data control).

The variable names (Table 2, p. 16) and data should be checked carefully to avoid time consuming corrections once you use the software. Make sure you have no empty cells for the obligatory variables as the software does not check for empty cells in the EFT procedure. If empty cells are in your data the calculated EFT will be wrong! In addition, for the EFT calculation the software does not check for unexpected values. Again additional variables can be included but will not be used to calculate the European Fish Type (EFT). If you add extra data do not use the prefix ‘E_’. Once you have completed your data preparation, they can be used to calculate the EFT.

2. Installing the software

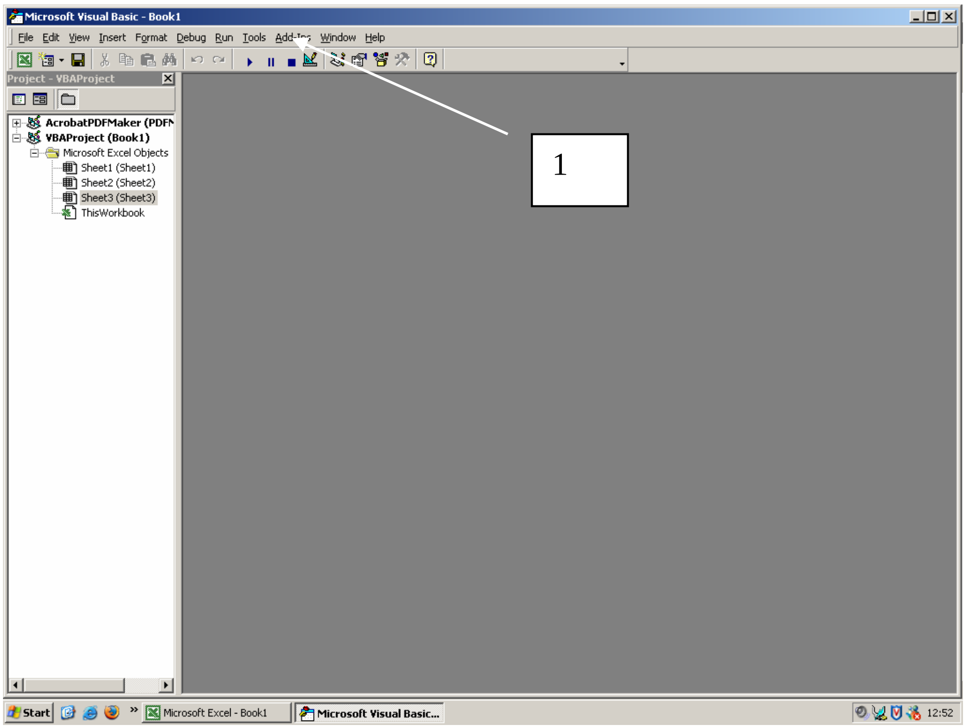
Start by opening an empty Excel file and activate the Visual Basic Application (VBA). You can do that by typing simultaneously the keys “Alt” + “F11” or via the menu by activating “Tools” (1), “Macro” (2), Select “Visual Basic Editor” (3)

Spreadsheet 4



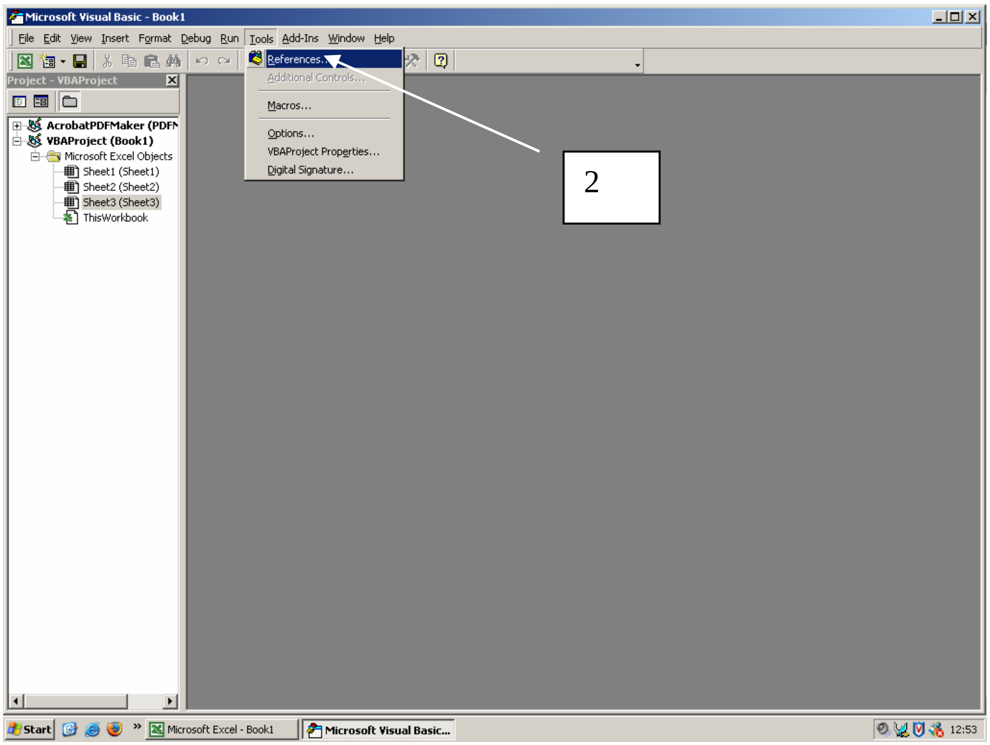
Once you have activated the VBA the following dialog box appears.

Microsoft Visual Basic dialog 1



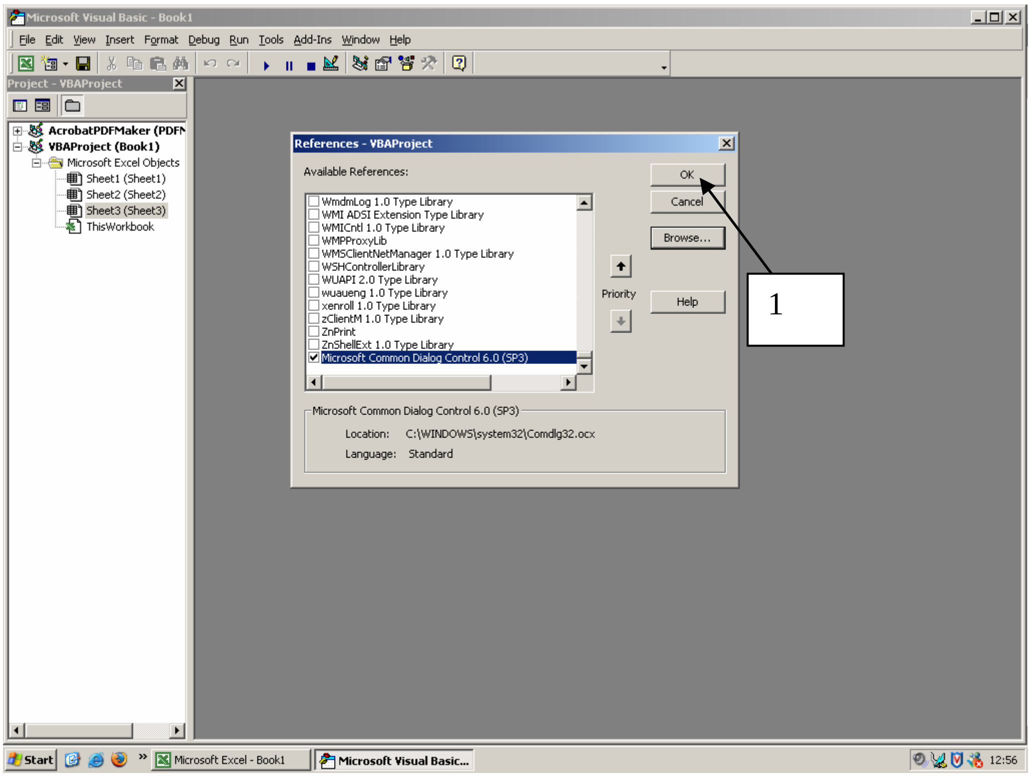
Select "Tools" in the menu (1). In the next dialog screen select "References" (2).

Microsoft Visual Basic dialog 2



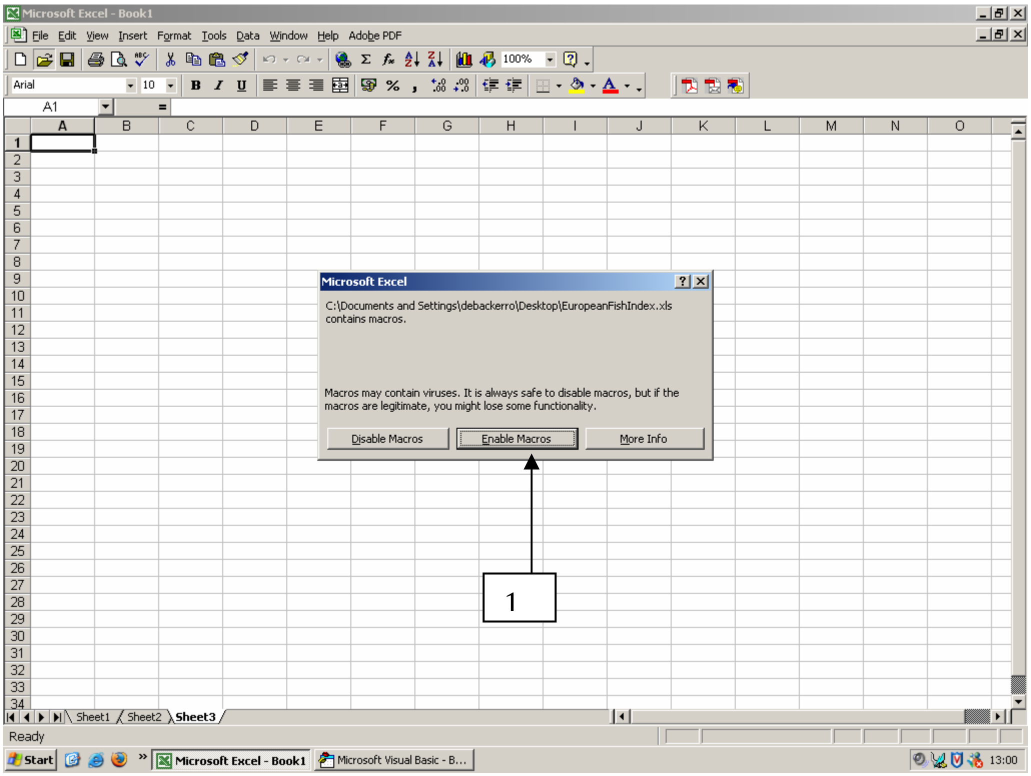
In the new dialog box (Microsoft Visual Basic dialog 3), you need to activate “Microsoft Common Dialog Control 6.0”. If you cannot find it you’ll have to import it as follows: use the browser and go to Windows/System/**comdlg32.ocx**. This is the required file and you activate it after selecting. “Microsoft Common Dialog Control 6.0” will appear in the dialog box. Then click “OK” (1).

Microsoft Visual Basic dialog 3



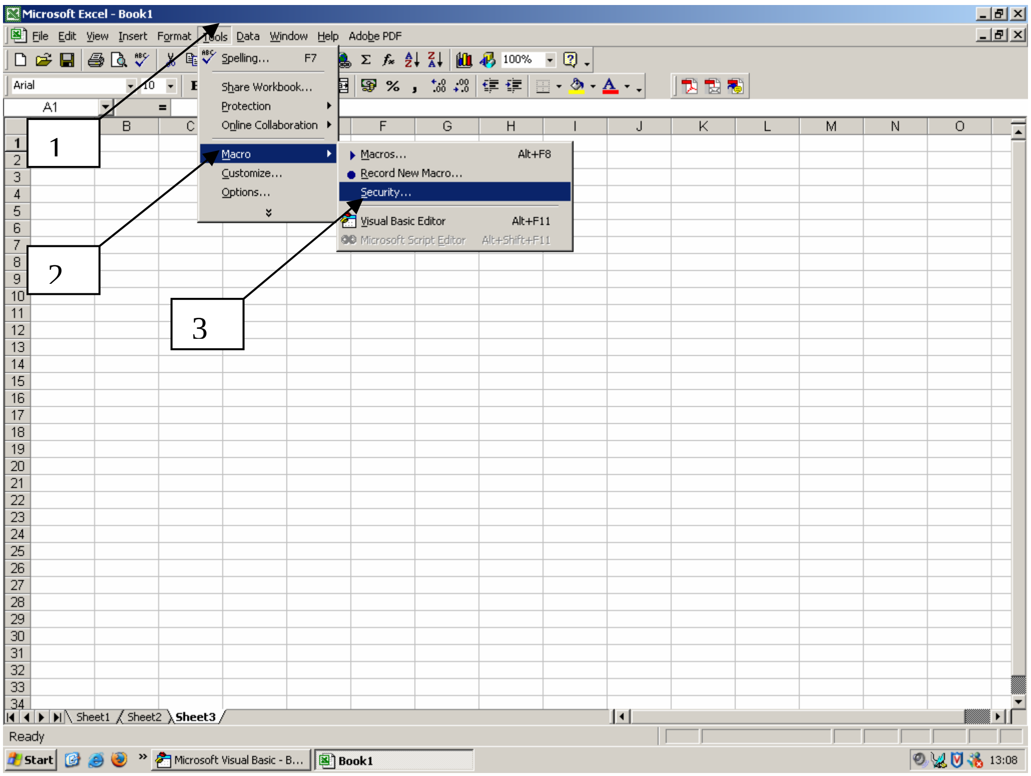
Once this is done successfully return to the Excel file you have previously opened. Select “File”, next “Open” and select the “EuropeanFishIndex.xls” file. In the Excel spreadsheet a message will appear that this file contains Macros. Click on “Enable Macros” (1) (spreadsheet 5).

Spreadsheet 5



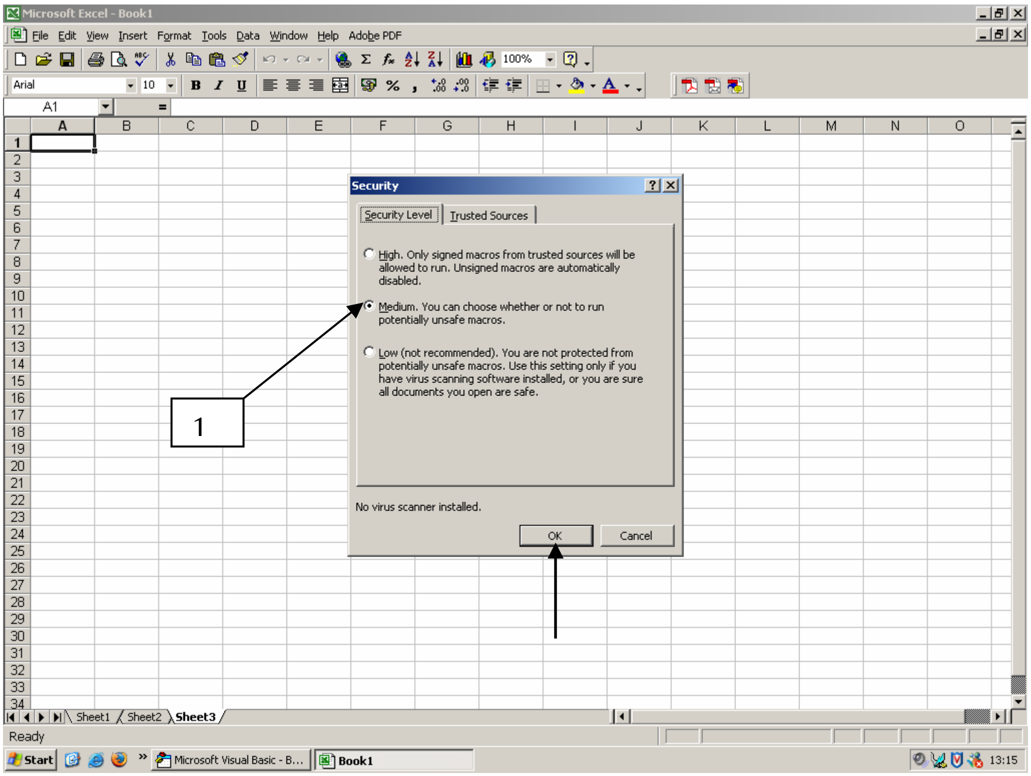
Now the file will be loaded and a new menu "Fame" will be created. However, if you have problems loading the "EuropeanFishIndex.xls" file you will have to adjust the Excel security level setting. In the Excel file select "Tools" (1) then "Macro" (2) and "Security" (3).

Spreadsheet 6



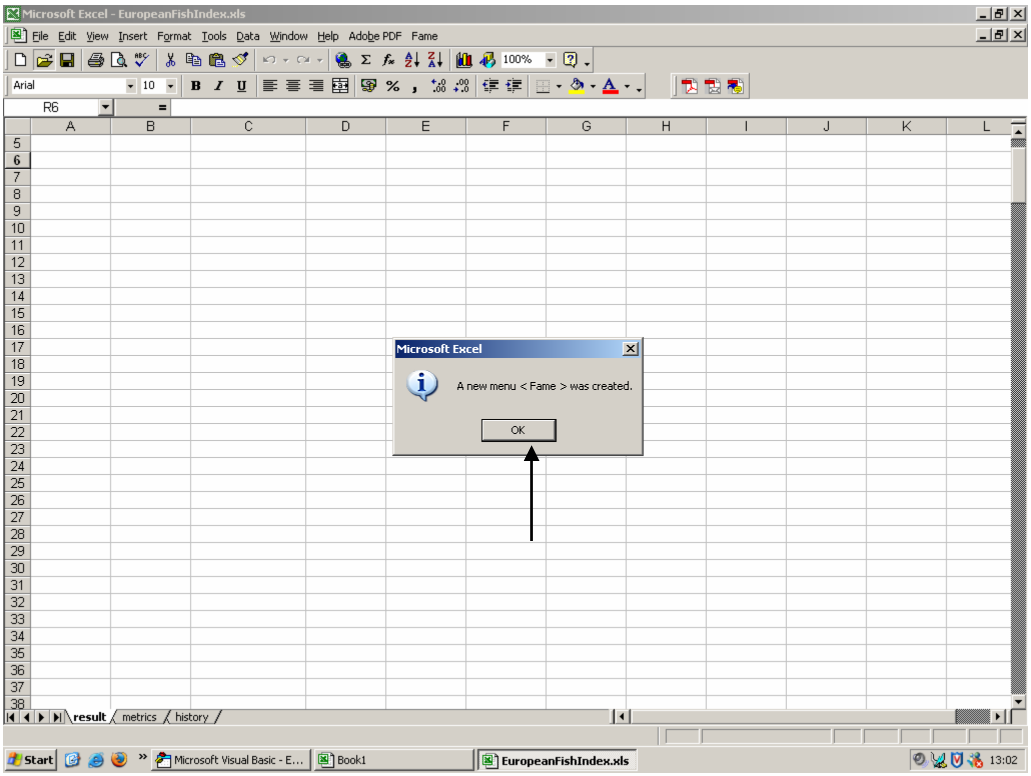
Set Security to “Medium” or “Low” (1 in spreadsheet 7) and click “OK”.

Spreadsheet 7



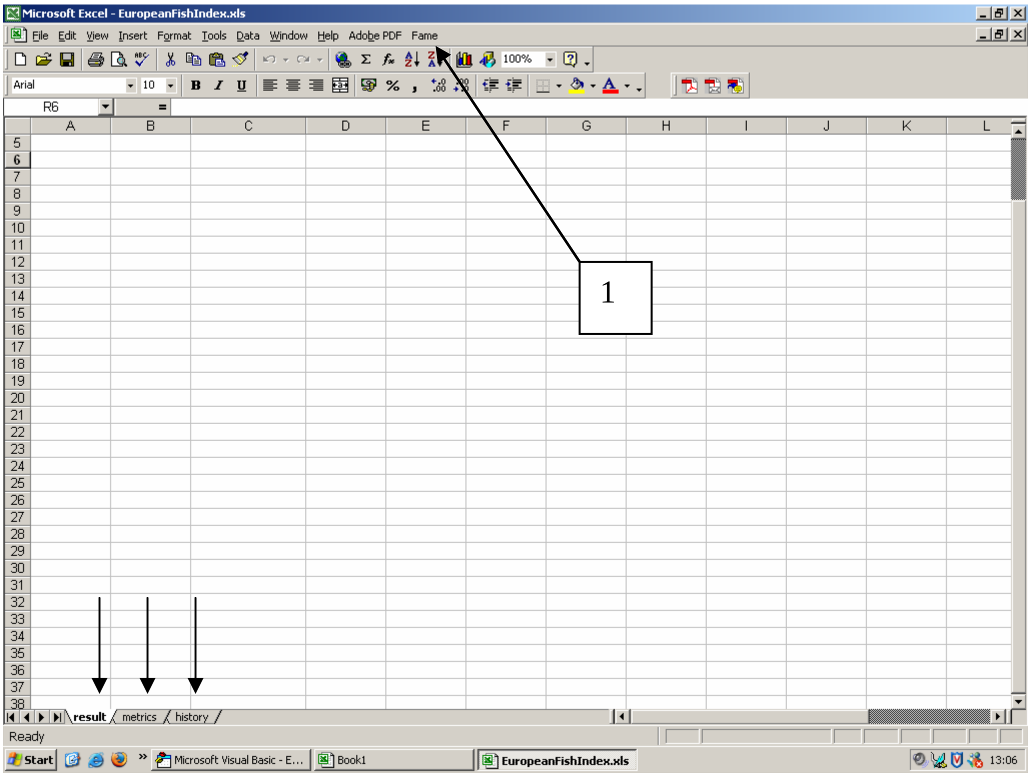
Now, reload the “EuropeanFishIndex.xls” file and select the option to activate the Macros (Spreadsheet 5). Click “OK” and spreadsheet 8 appears.

Spreadsheet 8



Click “OK” and once it is loaded you will see in the menu bar that “Fame” has been added (1 in spreadsheet 9).

Spreadsheet 9



Note, that three worksheets are formed: result, metrics and history.

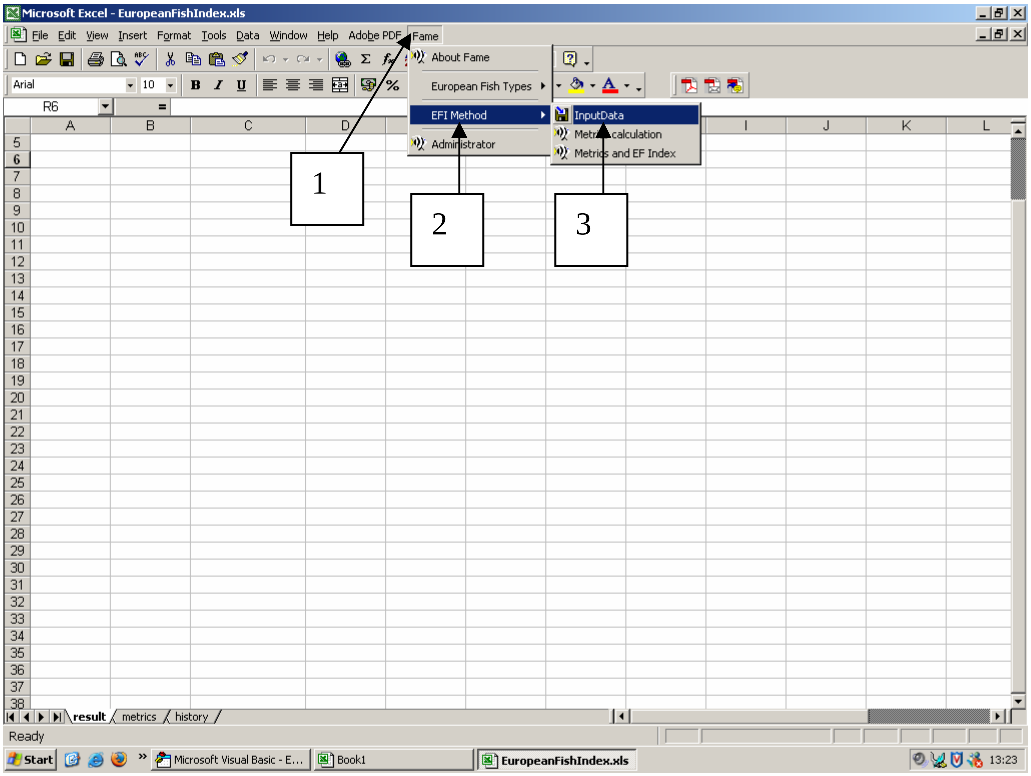
3. Entering new data in the software

You can now load your data into the software.

This section describes how to calculate the European Fish Index (EFI).

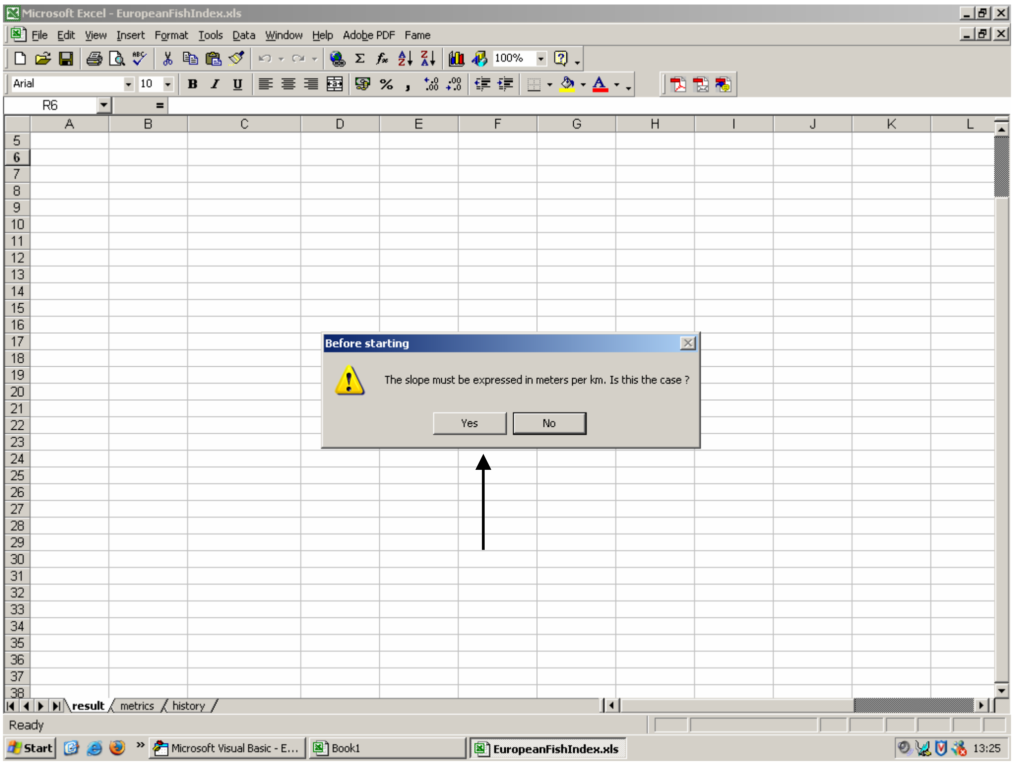
Click on the “Fame” menu (1 in spreadsheet 10). Choose “EFI method” (2) and select “InputData” (3).

Spreadsheet 10



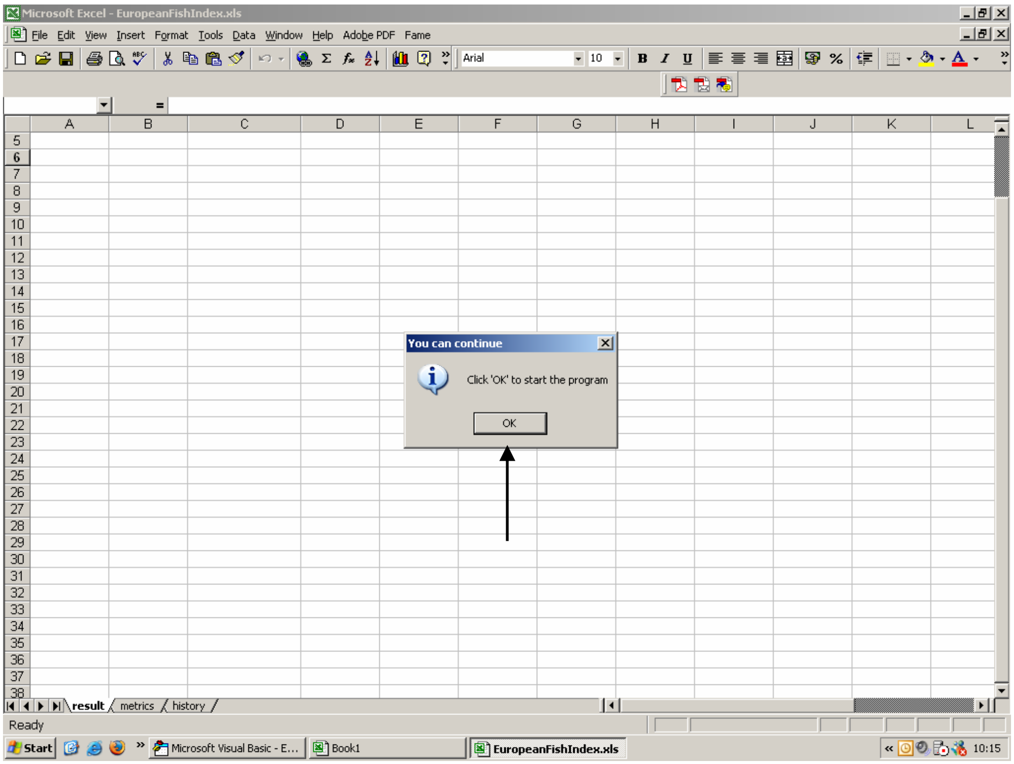
A common dialog box will be displayed to remind you that the slope should be expressed in metres per km. Choose “Yes” if this is the case (spreadsheet 11). If you have not entered the slope data as metres per km you will need to re-calculate these values in the EFI-file before loading the data into the software and proceeding with the EFI calculation.

Spreadsheet 11



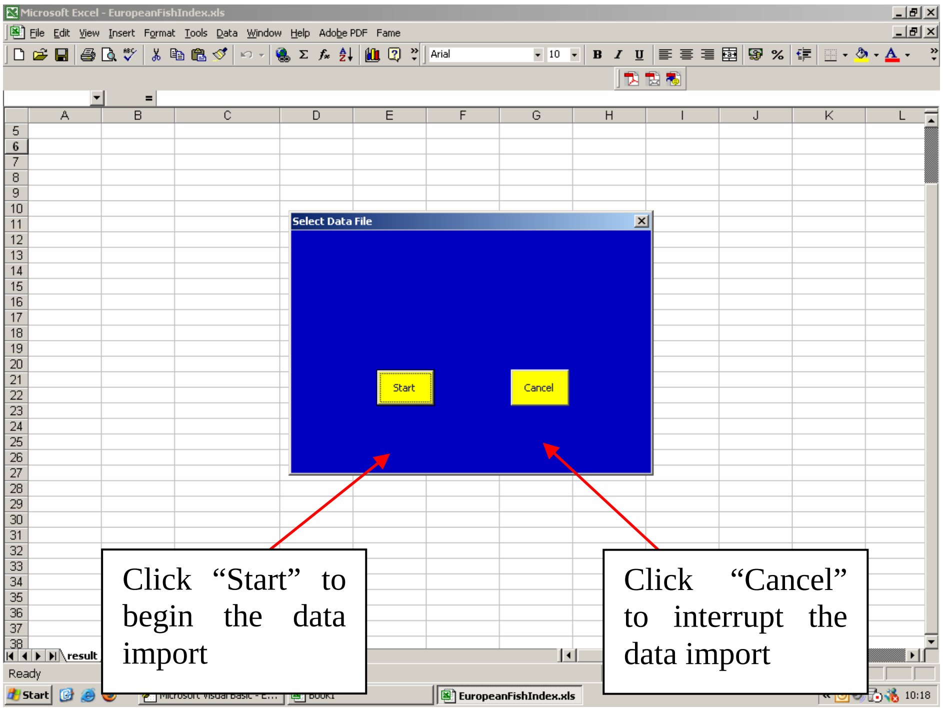
Once you have confirmed the units of the slope variable, a message appears informing you that you can start the program (spreadsheet 12). Click “OK”.

Spreadsheet 12



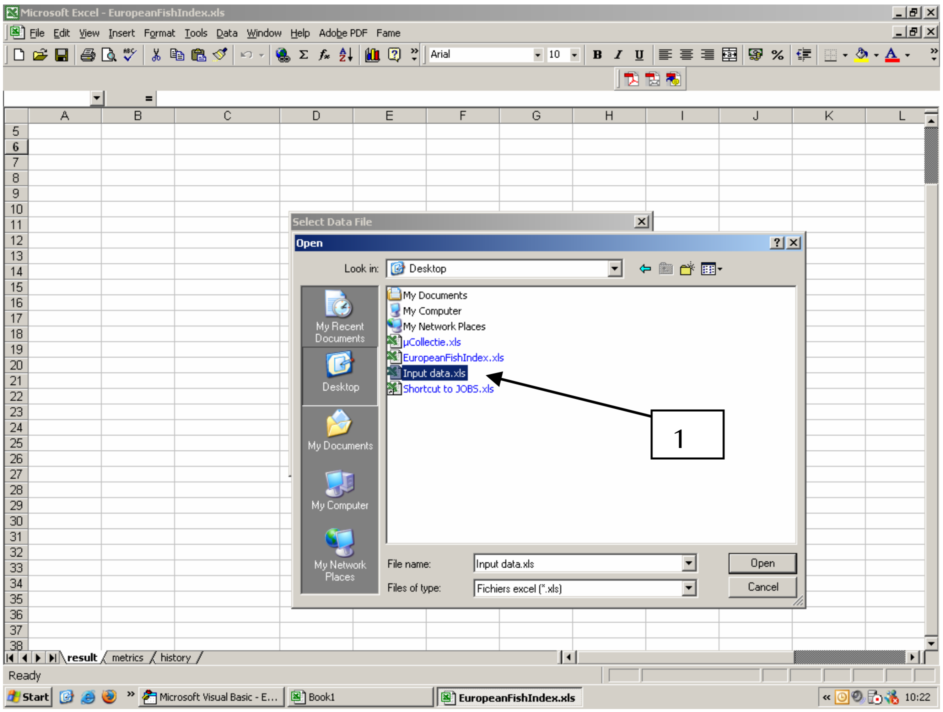
A common dialog box will be displayed to initiate the data import process (spreadsheet 13)

Spreadsheet 13



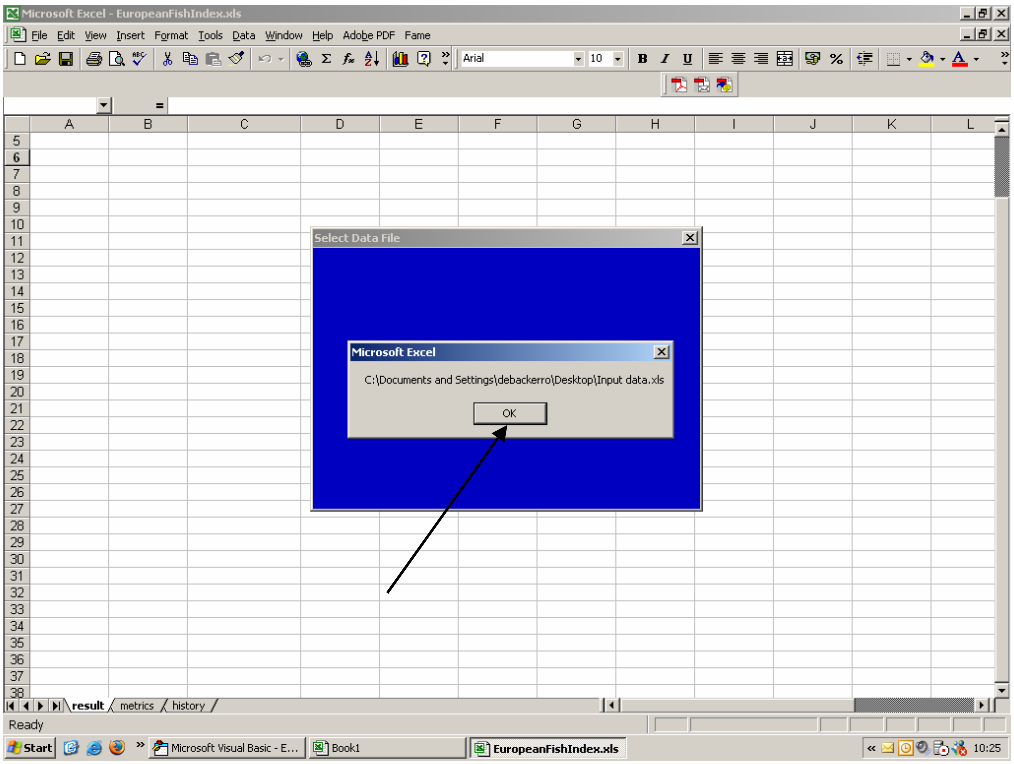
If you choose "Start" the standard MS Windows "Open" pop-up window will appear.

Spreadsheet 14



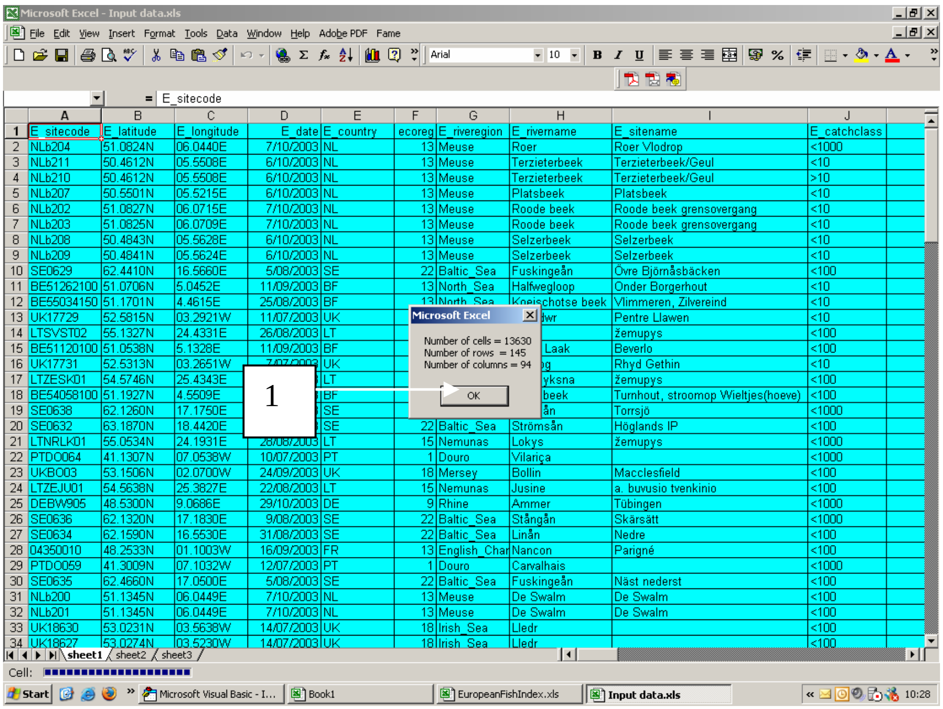
Now you select the file you have prepared to import. Accepted file formats are Excel files and Text Files. In this example the 'Input data' file is imported (1 in spreadsheet 14). Once you have selected the file, the file path is displayed. You can check if this is the required file (spreadsheet 15).

Spreadsheet 15



Click "OK" to confirm your choice and the file will be opened (spreadsheet 16).

Spreadsheet 16

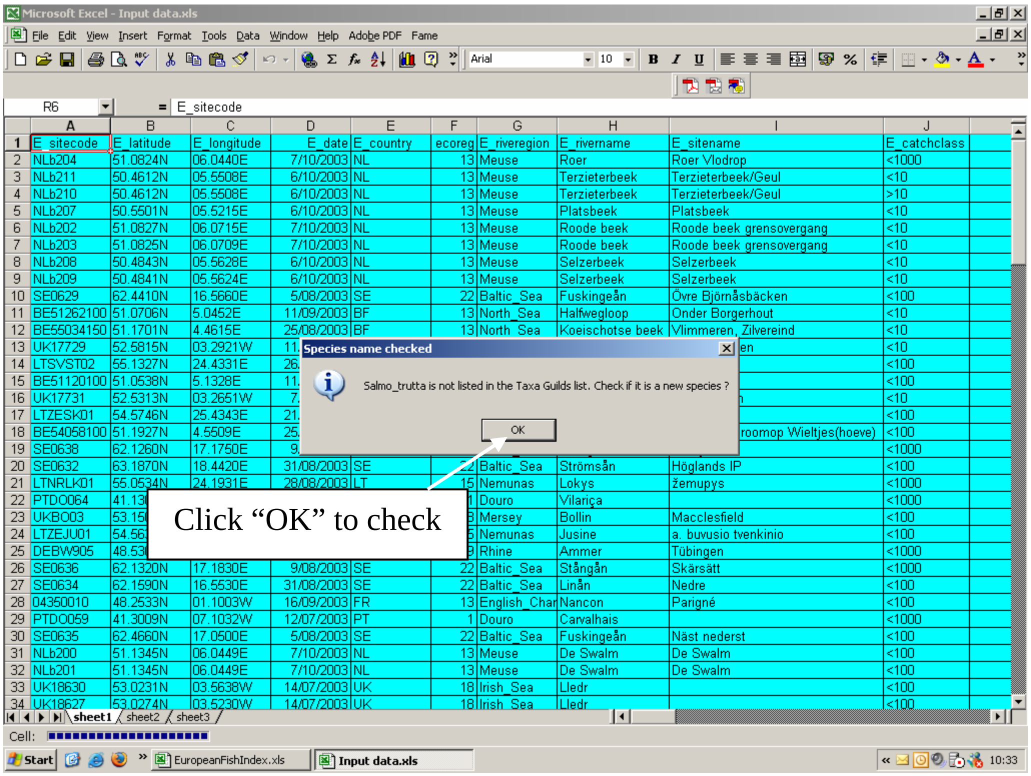


When the file opens, the number of cells, rows and columns in the dataset is displayed (1). The selected dataset is displayed in blue. Click "OK" to initiate the data verification process.

4. Data quality control with an example

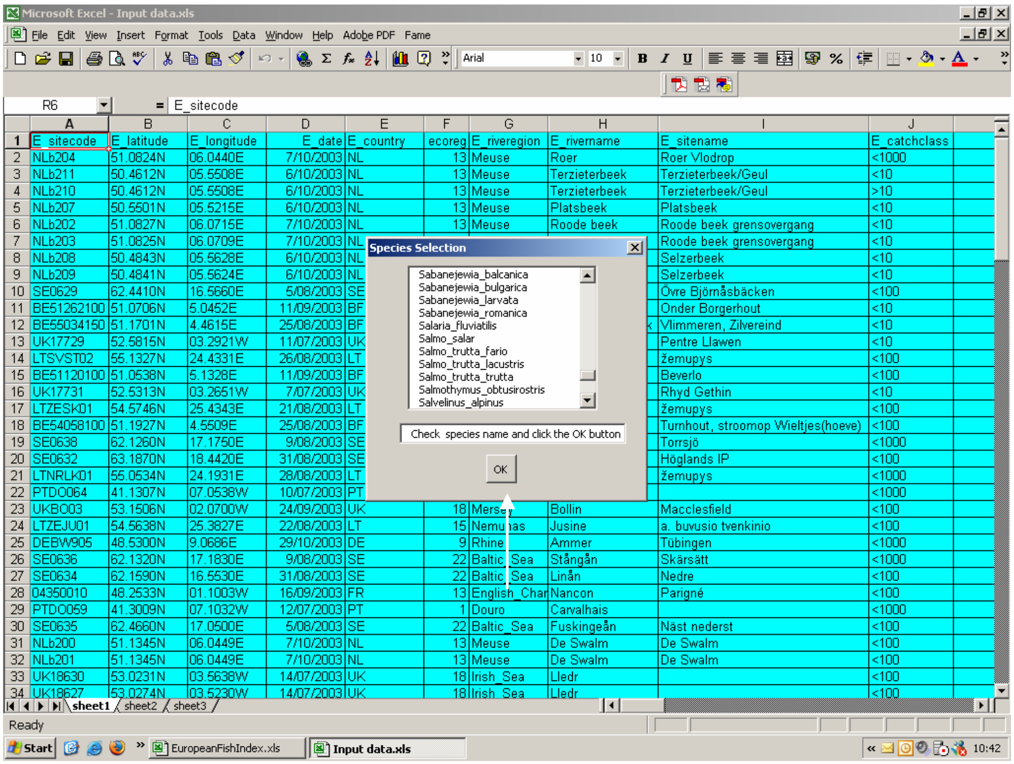
The software will first check the species names in the imported file. Spreadsheet 17 shows the example of a species e.g. "*Salmo_trutta*" which is not a valid variable name as it is not present in the taxa list in that format.

Spreadsheet 17



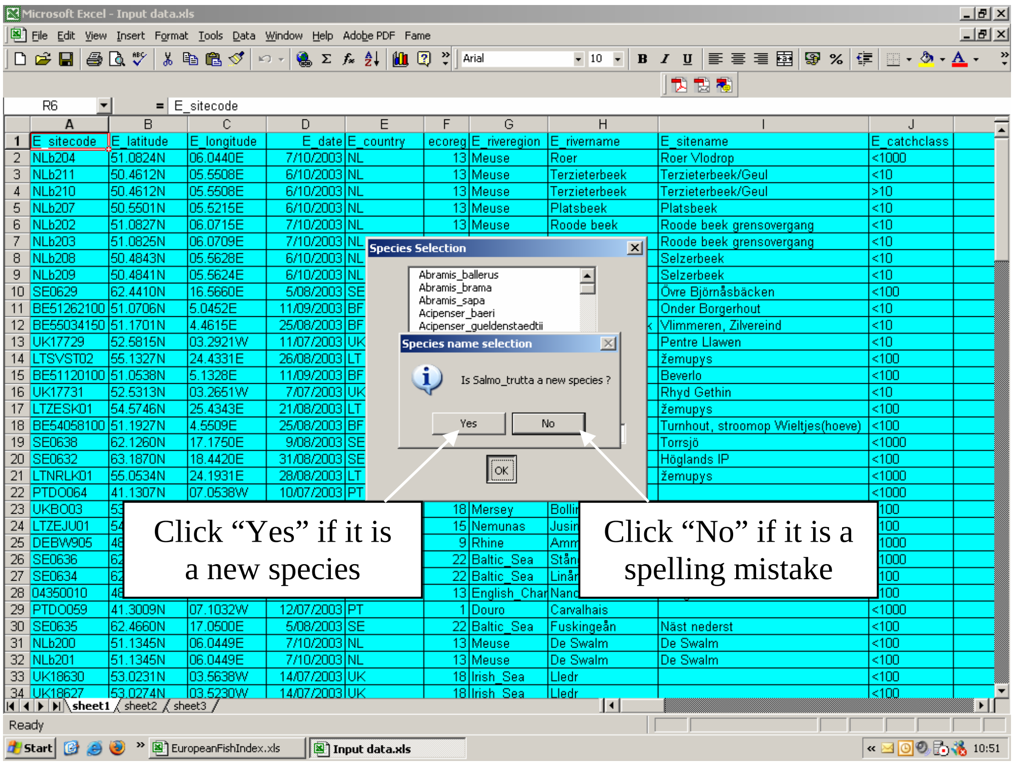
After clicking "OK" a pop-up help list with recognised fish species names will appear (spreadsheet 18). A message informs you that you can now check the species name.

Spreadsheet 18



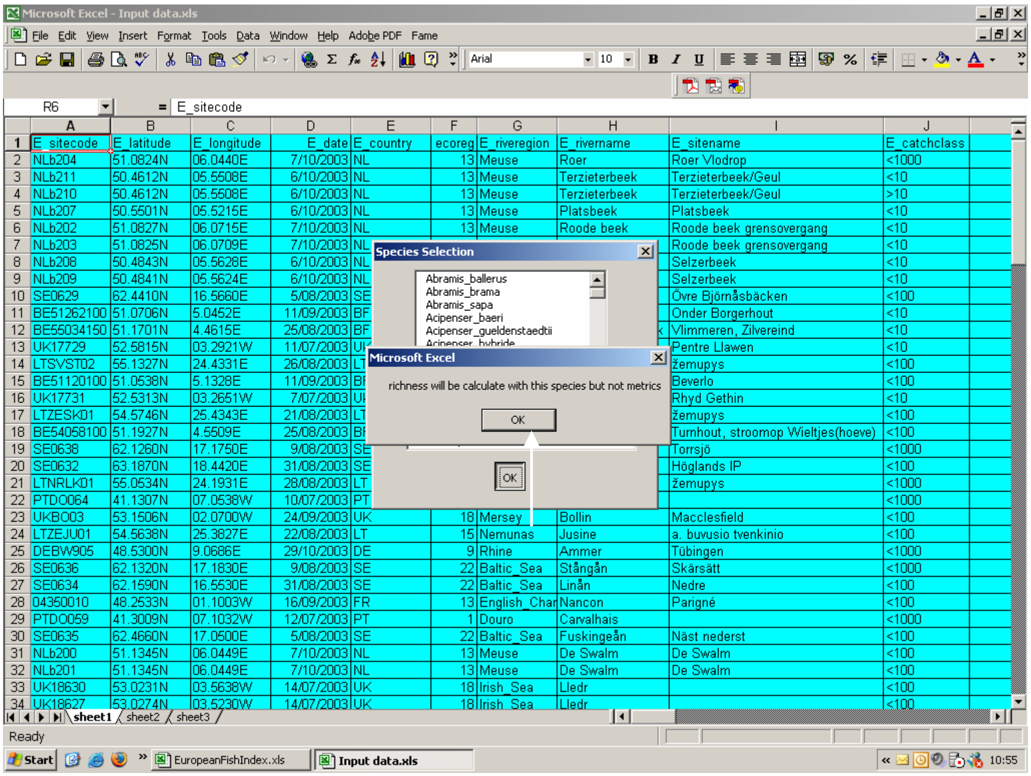
You click “OK” and a pop-up asks you if the species is indeed a new species (spreadsheet 19).

Spreadsheet 19



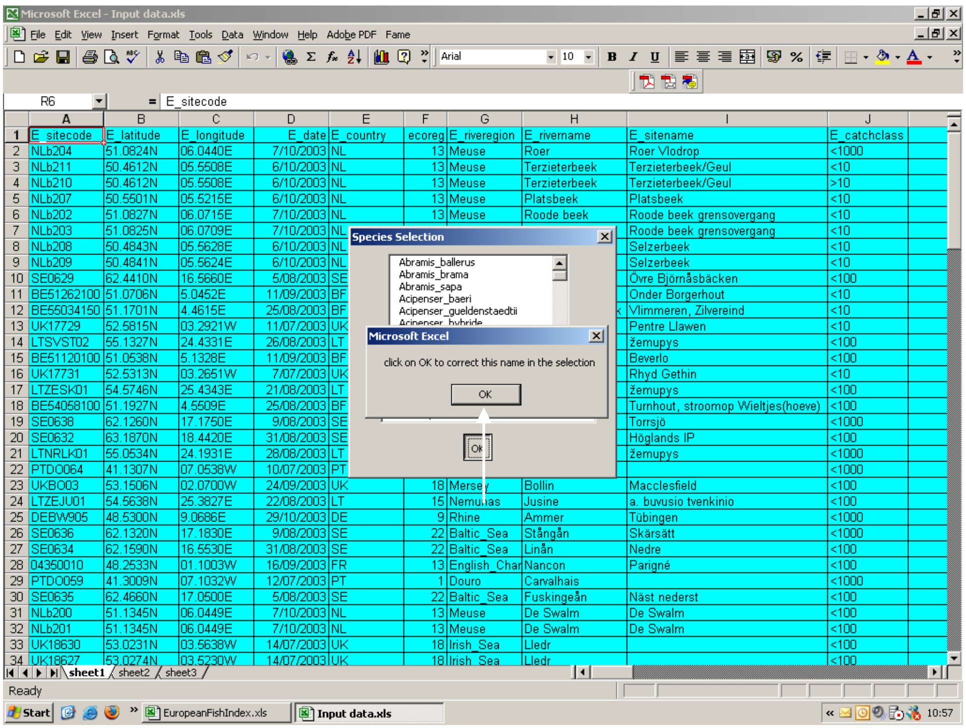
If you click “Yes”, a message informs you that the species richness will be computed with the new species. However, it will not be considered during the EFI calculation (spreadsheet 20).

Spreadsheet 20



If you click "No" in spreadsheet 19, a message will appear telling you that you can now correct the name (spreadsheet 21).

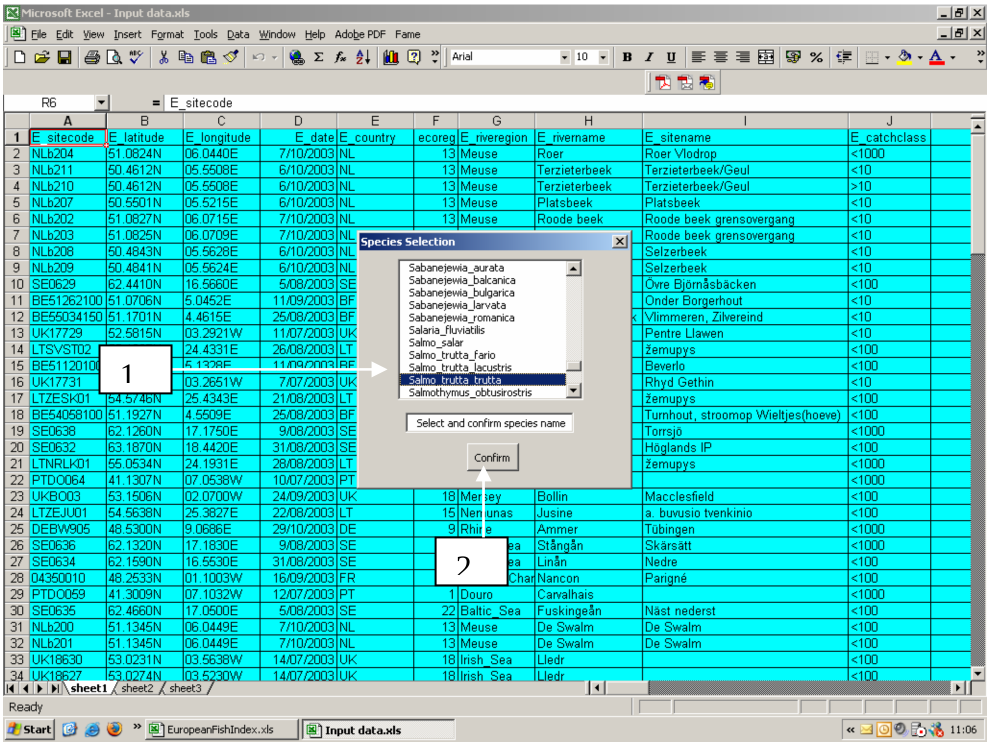
Spreadsheet 21



Click "OK" and a pop-up help list with valid fish species names ("Species selection" in spreadsheet 22) appears.

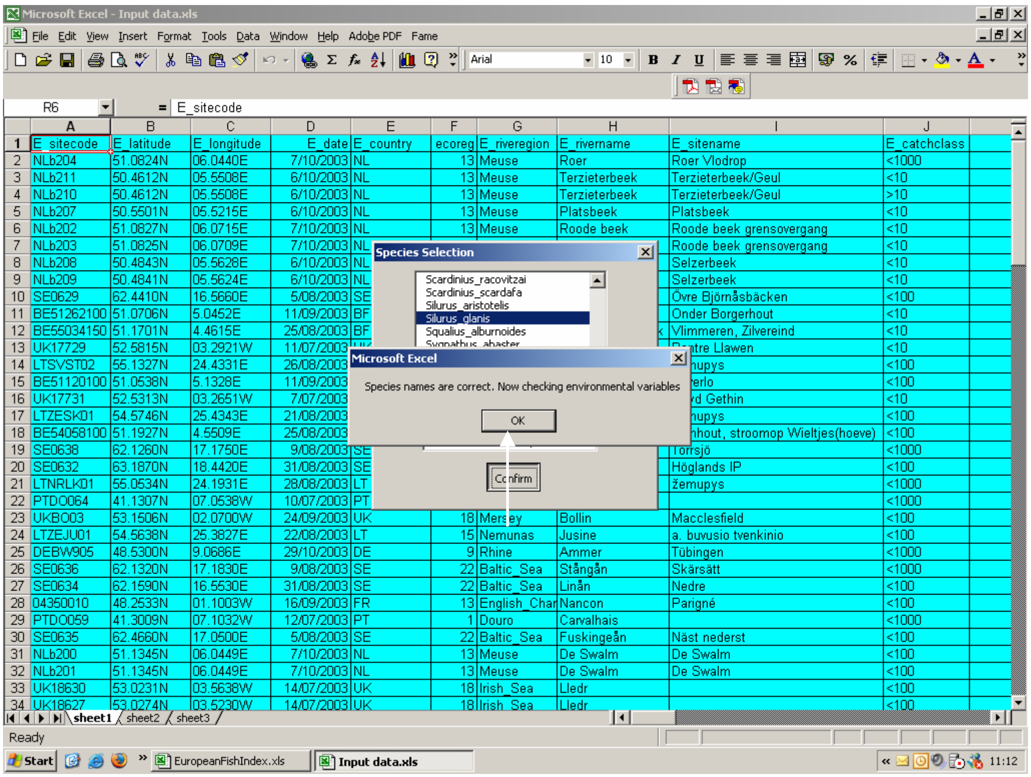
In this example *Salmo_trutta_trutta* is selected (1) and confirmed (2).

Spreadsheet 22



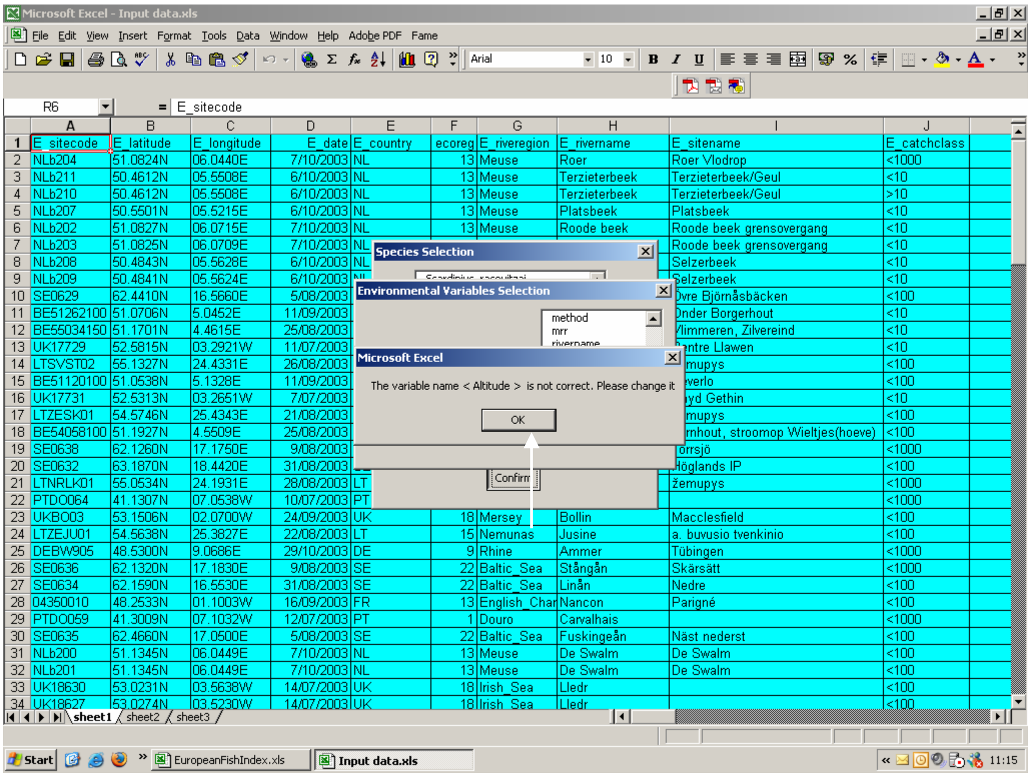
A pop-up will indicate if there are more mistakes in the species names or not. Following verification of the species names a message will appear (spreadsheet 23) indicating that all species names are correct and that the environmental variables will now be checked.

Spreadsheet 23



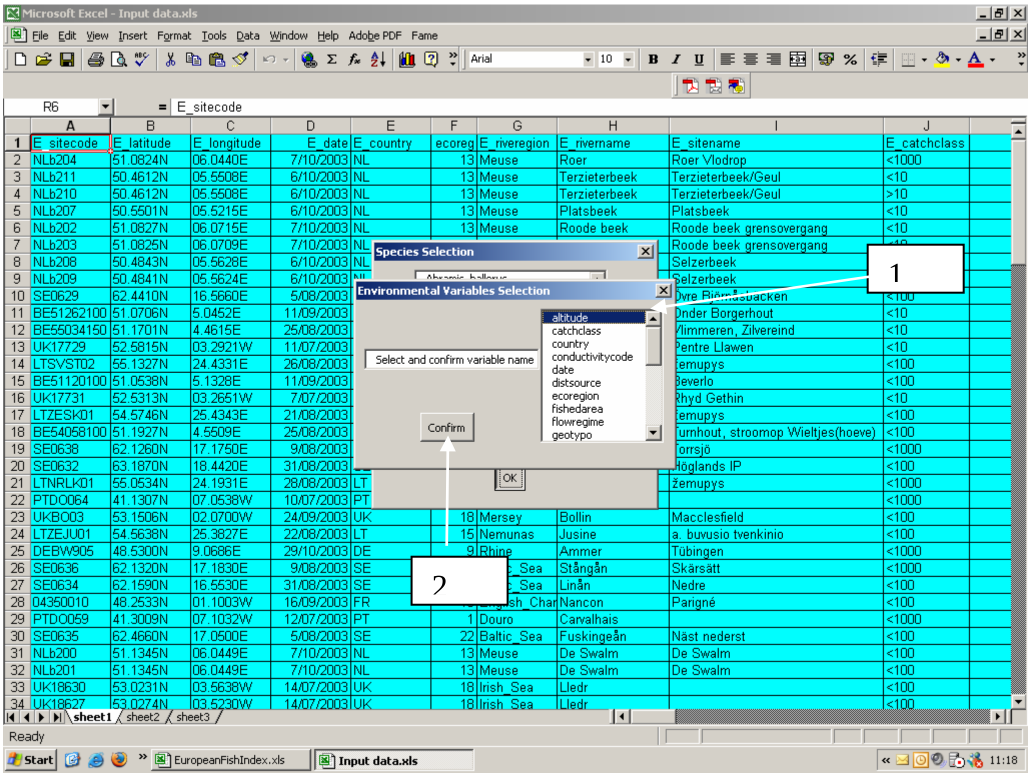
Click “OK” and the software will now start to verify the environmental variable names. The following spreadsheets illustrate two types of spelling mistakes. Spreadsheet 24 indicates that the name ‘altitude’ was formatted incorrectly as ‘Altitude’. The variable names are case sensitive!

Spreadsheet 24



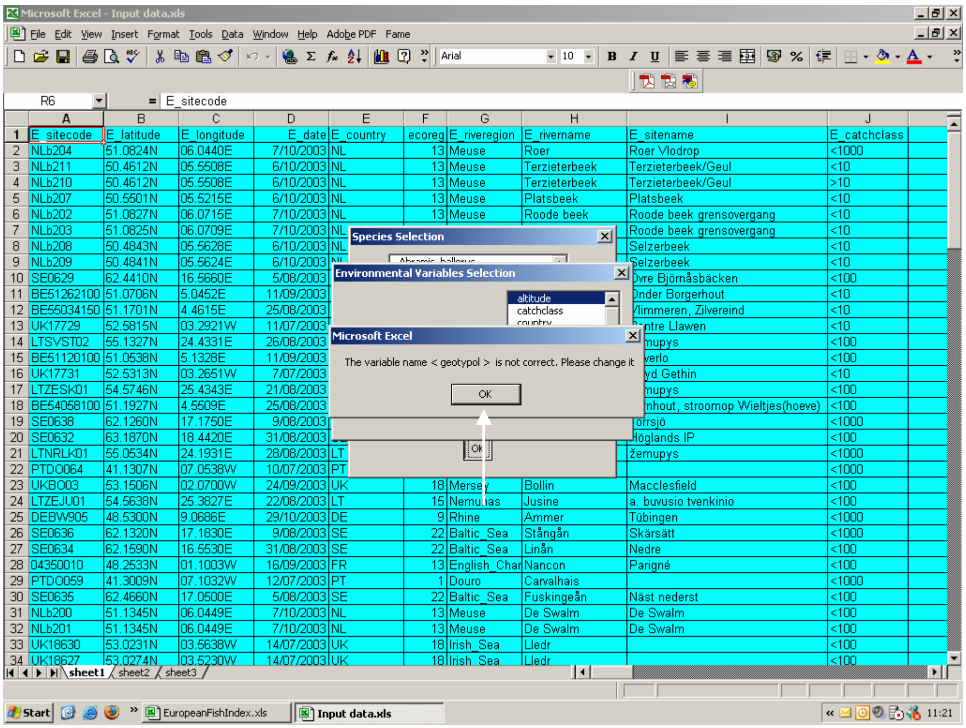
Click “OK” and select the correct name. In this case ‘altitude’ (1) and confirm (2) (see spreadsheet 25).

Spreadsheet 25



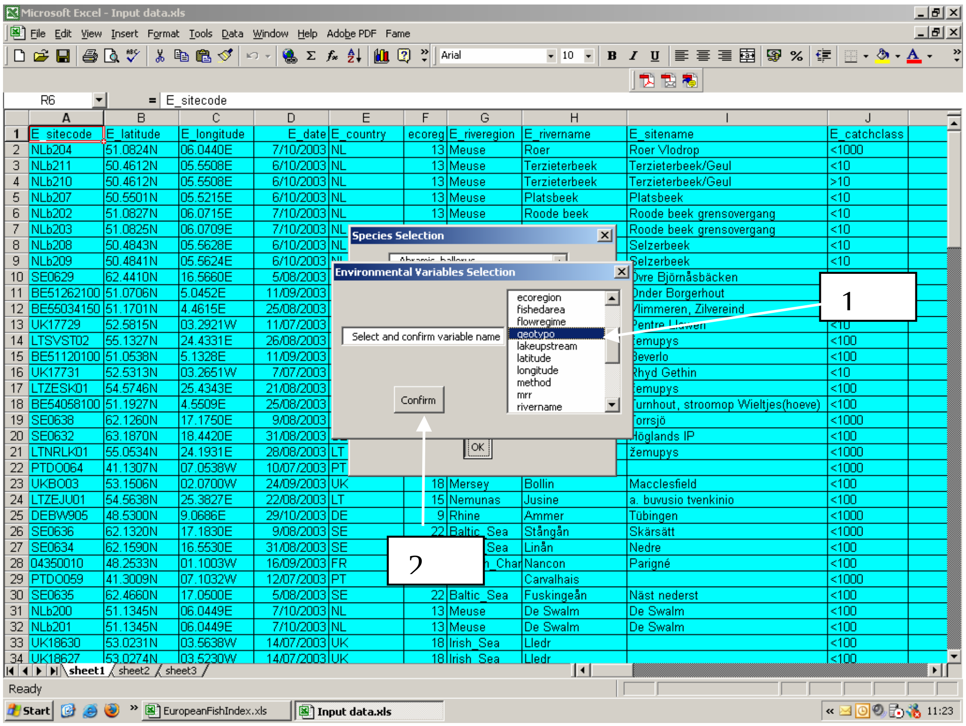
In this example another mistake is present. The variable name ‘geotypol’ is misspelled (spreadsheet 26).

Spreadsheet 26



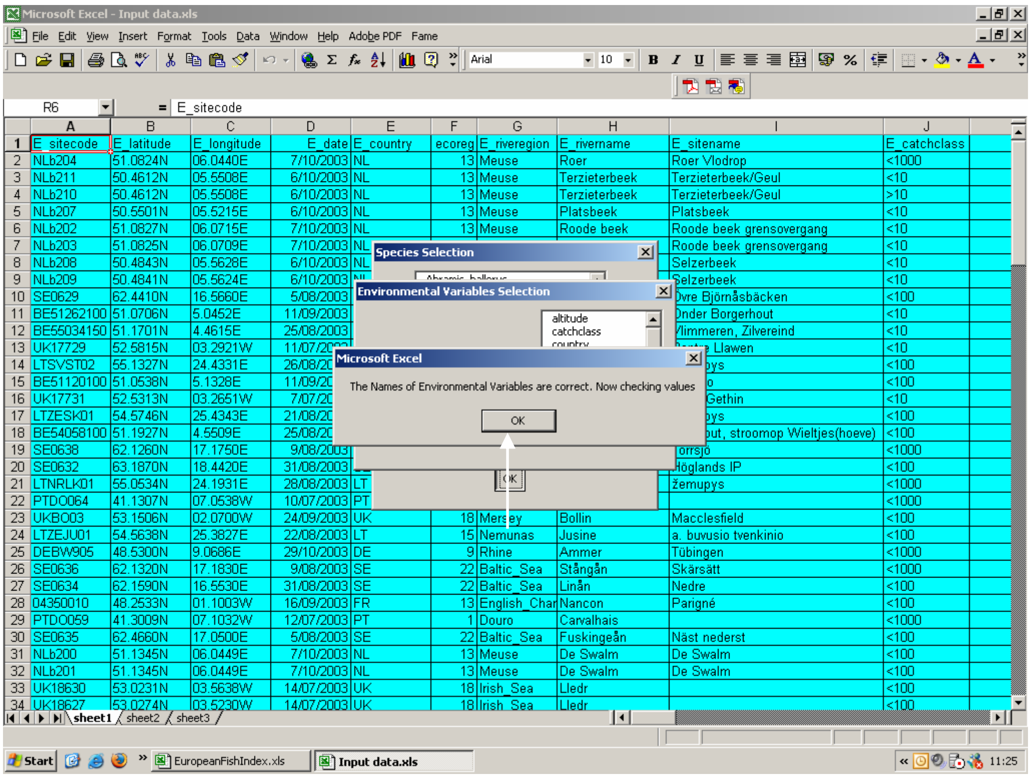
Click “OK”, select the correct spelling (1 spreadsheet 27) and confirm the variable name (2).

Spreadsheet 27



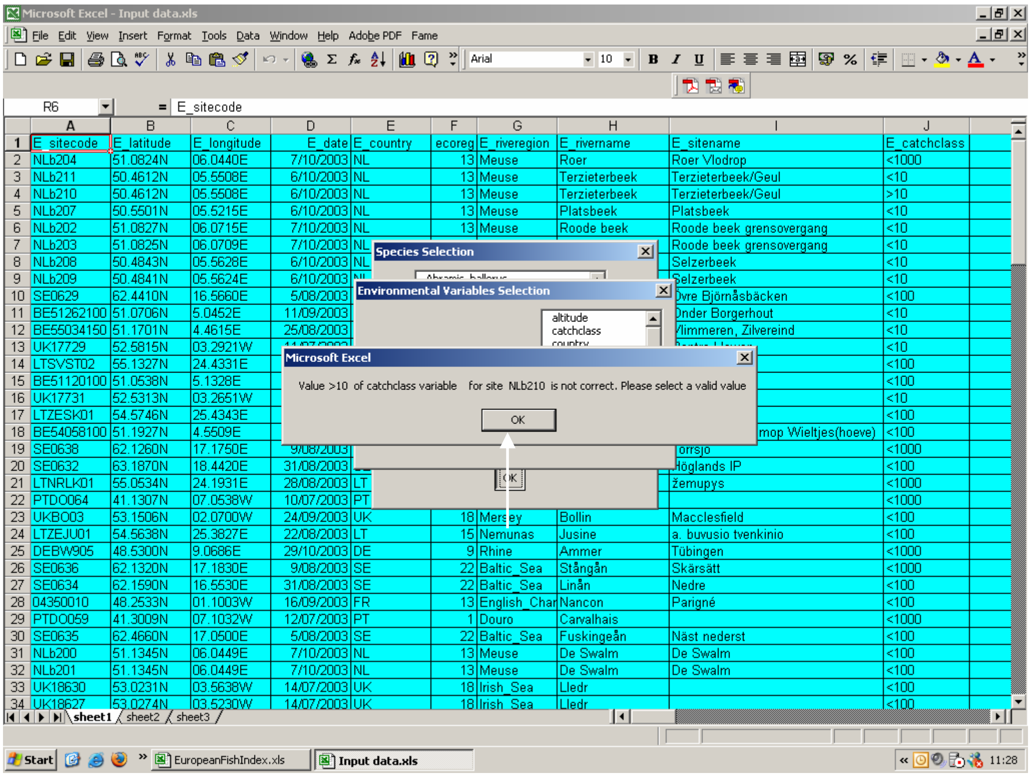
Once all names are checked and corrected and no more mistakes occur, a message appears: “Names of Environmental Variables are correct, now checking values”.

Spreadsheet 28



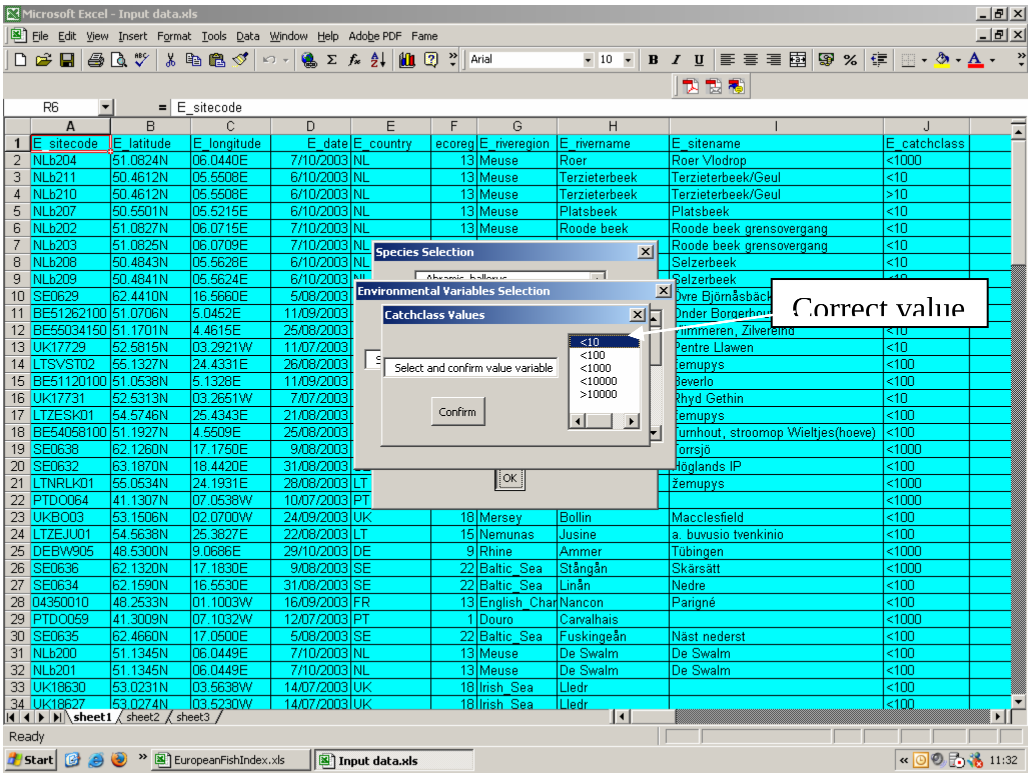
Click “OK” to start the verification of the environmental variables values. In this example one value has been entered incorrectly (spreadsheet 29). It is a value for the catchment class being indicated as ‘>10’. In this case it was miss-typed and it should be ‘<10’ (The only valid codes for catchment size are <10, <100, <1000, <10000, >10000).

Spreadsheet 29



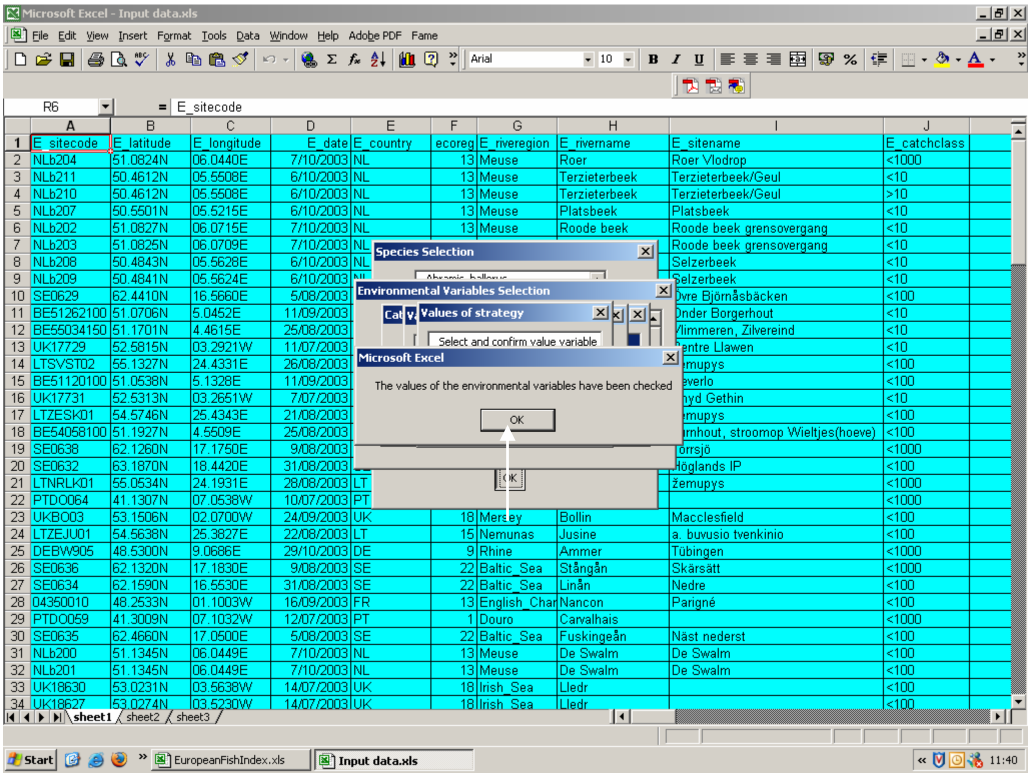
Click “OK” and a list of authorised values is displayed. Select the correct value.

Spreadsheet 30



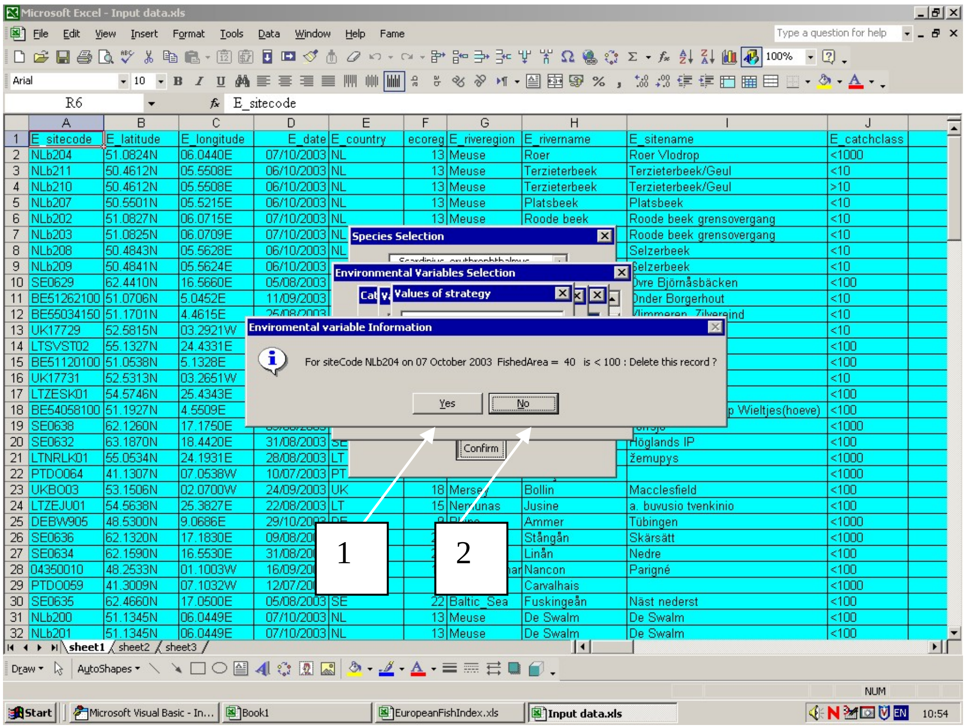
The software macro will continue, step by step, to check all values of the obligatory variables required for the EFI (Table 2, p.16). Finally a message appears to confirm that the value verification is completed (spreadsheet 31).

Spreadsheet 31



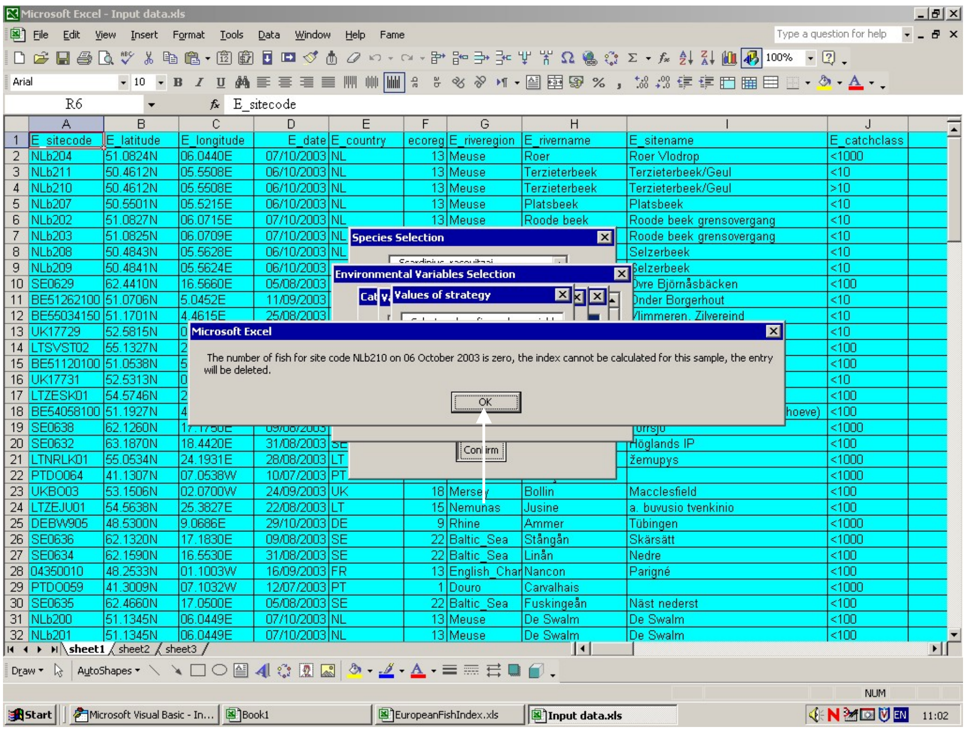
Click “OK” and the software will now check the number of fish caught and the value of the fished area to verify if they comply with the EFI requirements. For each record that does not meet the requirements the site code will be listed and a message displayed. Spreadsheet 32 shows a site where the surface area sampled is insufficient (less than 100 m²). You can choose to keep (1) or delete (2) this record. If you choose to keep the record bear in mind that the result should be treated with caution since the EFI is designed to work with results obtained from sampling areas of at least 100 m².

Spreadsheet 32



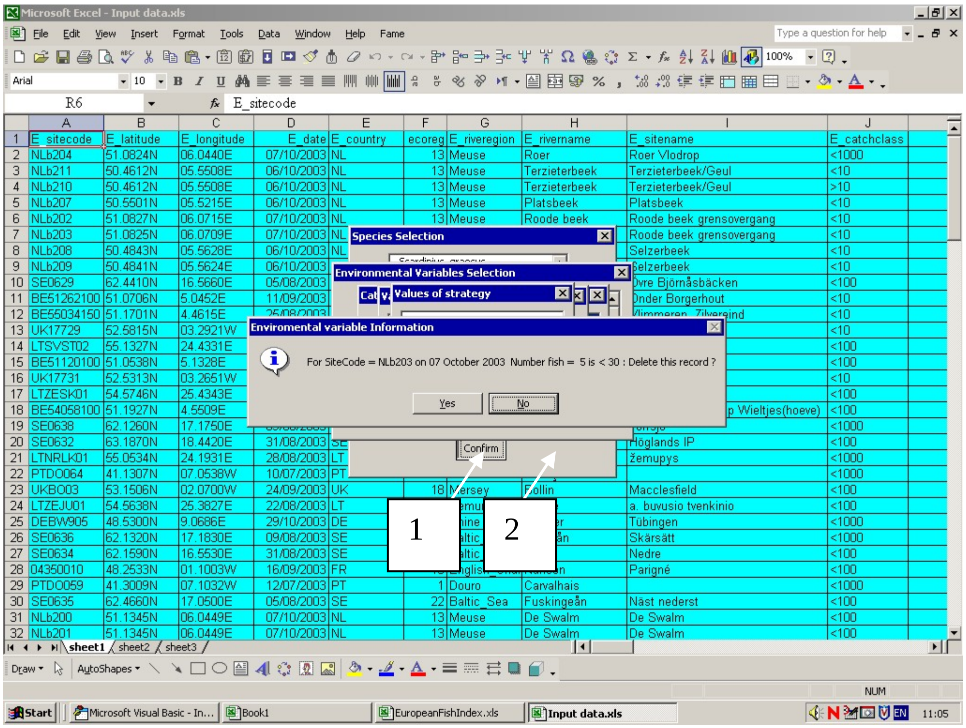
If no fish were caught in a certain sample a message appears informing you that the index cannot be calculated and that this entry will be deleted (spreadsheet 33). Click “OK” to delete such a record.

Spreadsheet 33



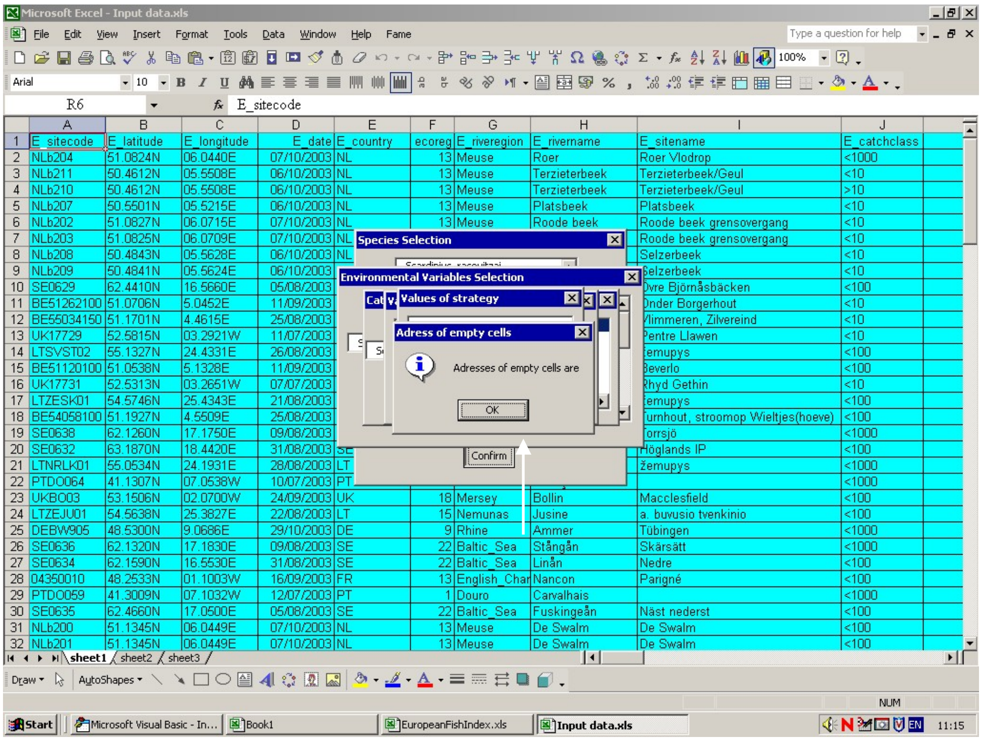
The EFI requires a minimum number of 30 specimens in a sample to make a proper assessment of the site. When fewer fish are caught the result is not reliable. In this example (spreadsheet 34) there is a sample with a number of fish of more than 0 but less than the required number (=30). This record can be kept (1) or deleted (2).

Spreadsheet 34



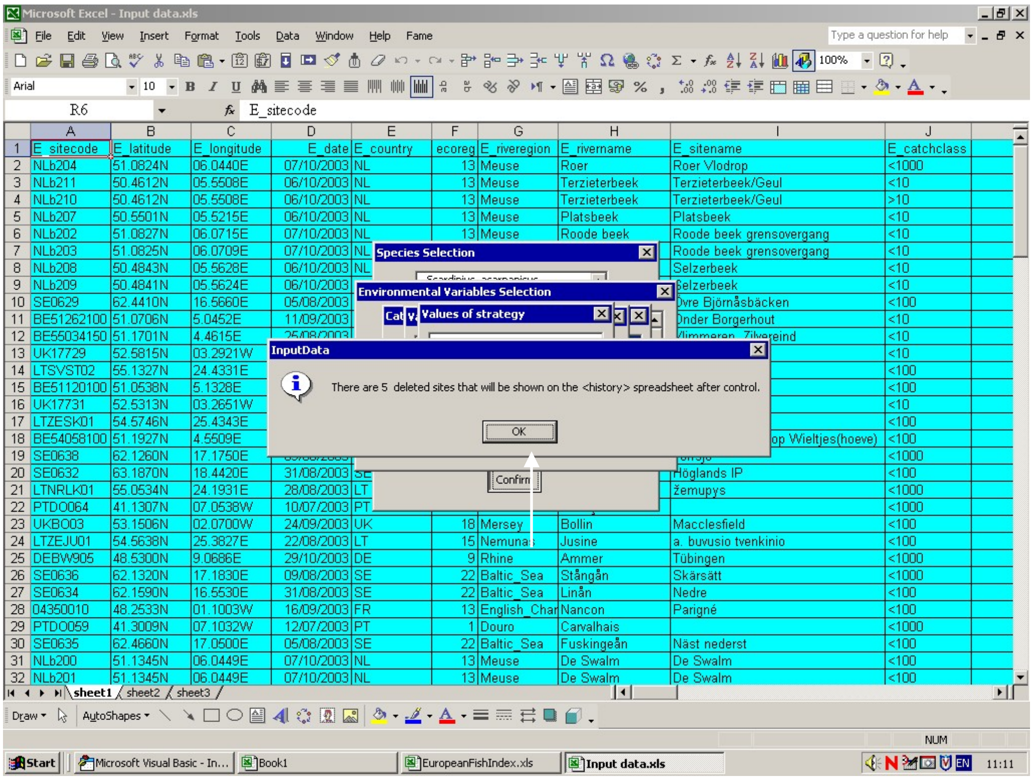
Once this control is finished the software lists the ‘Addresses of empty cells’. This informs you of the number and location of missing values (empty cells). Click “OK”.

Spreadsheet 35



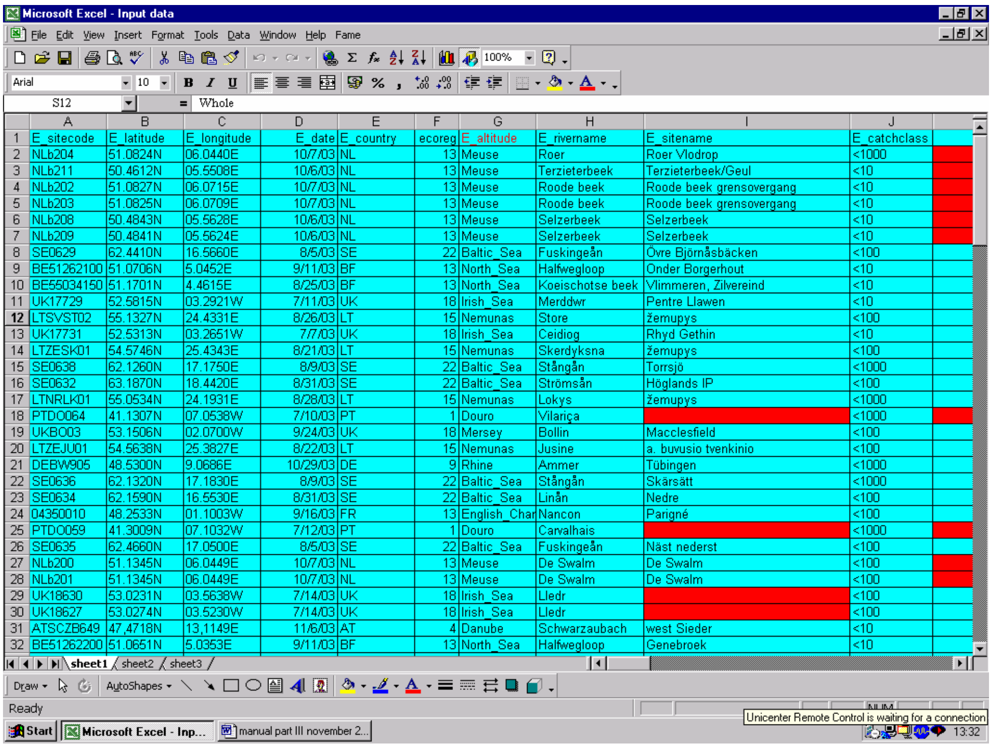
The next spreadsheet informs you on the number of samples deleted.

Spreadsheet 36



Click “OK” and the imported file will appear.

Spreadsheet 37

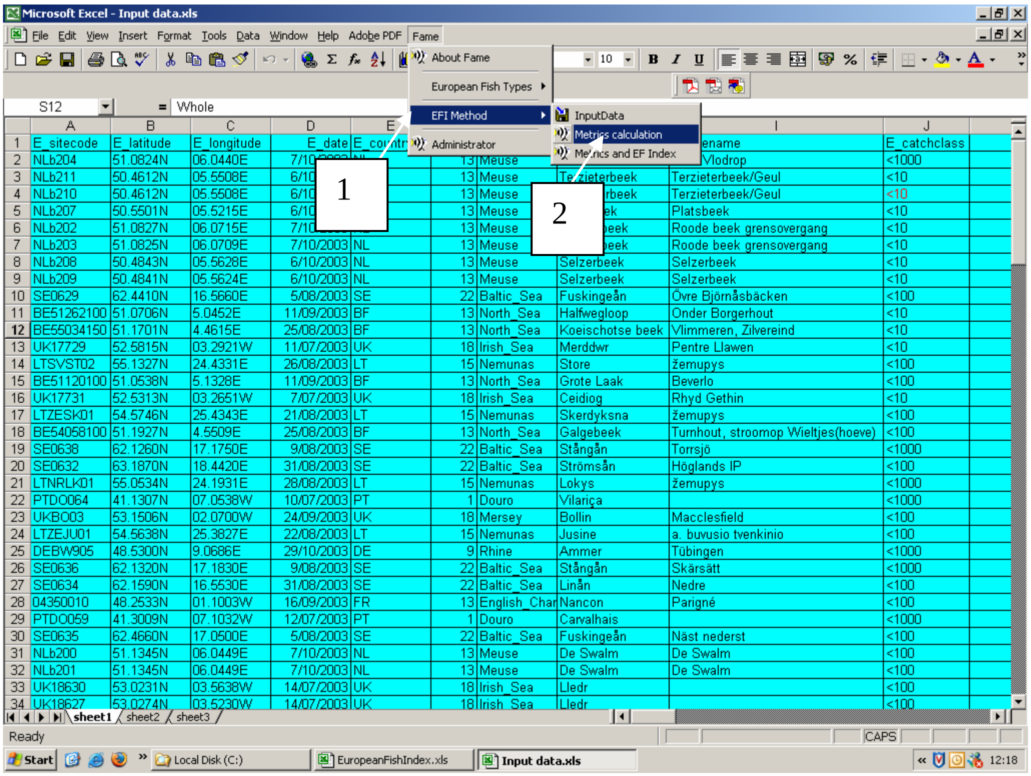


Empty cells are highlighted in red. All validations are done and the software can now start to compute the EFI.

5. Index calculation

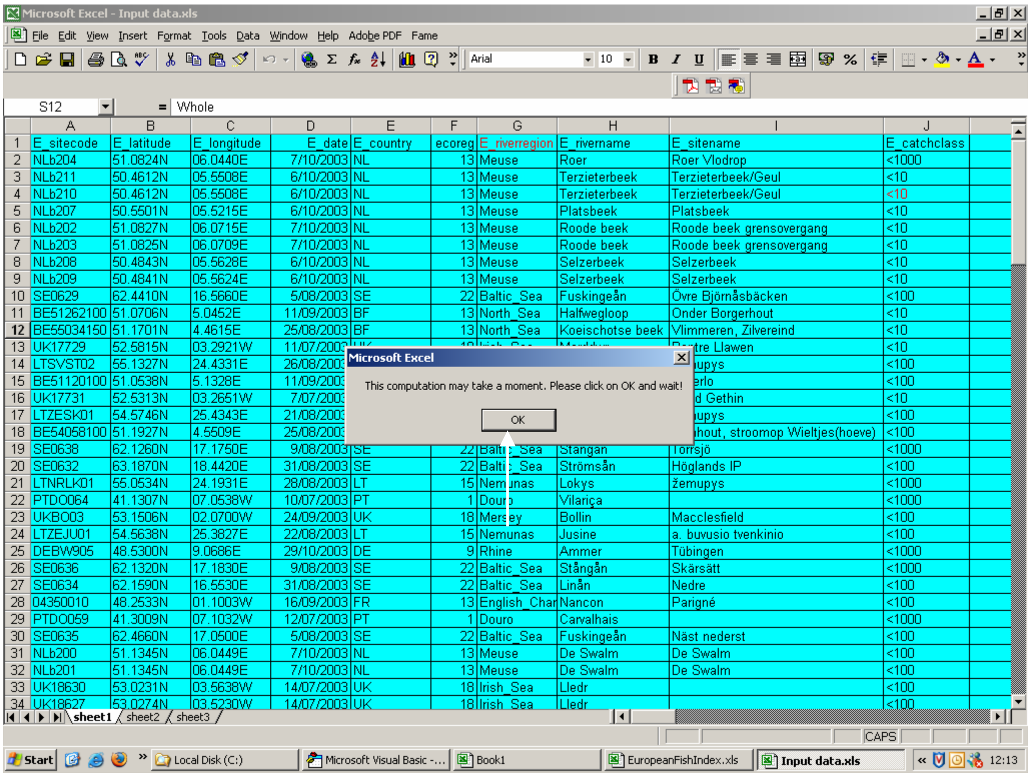
In the “Fame” menu you select “EFI Method” (1), “Metrics calculation” (2).

Spreadsheet 38



The next message indicates that the EFI calculation can take a moment (spreadsheet 39). You click “OK”.

Spreadsheet 39



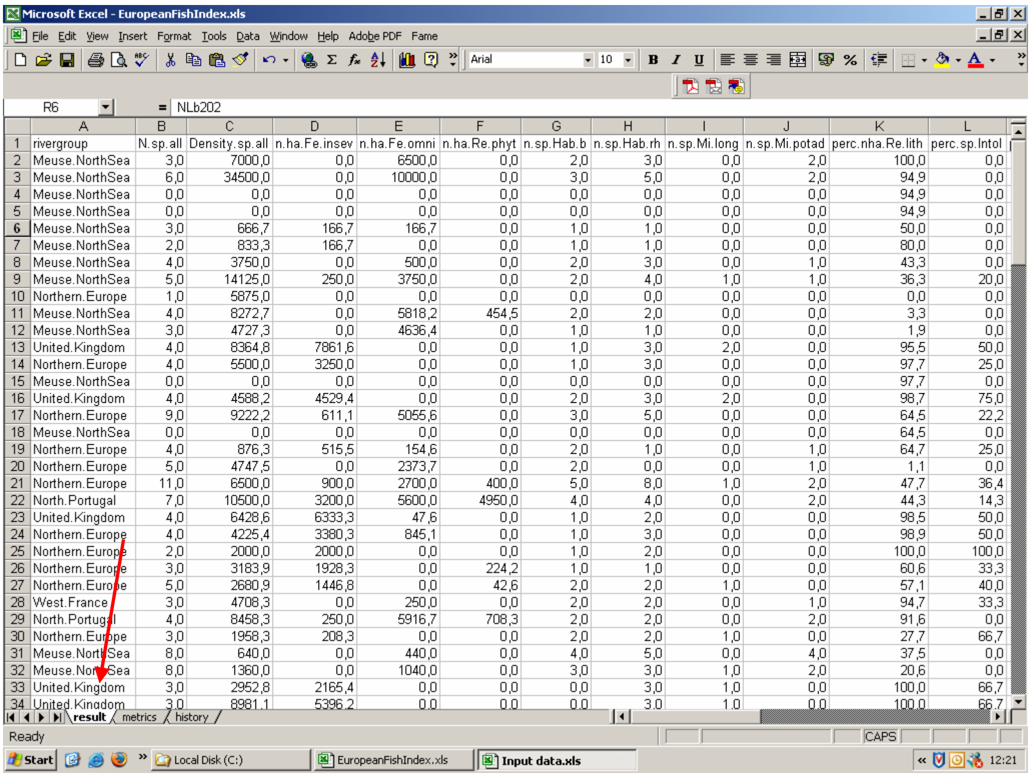
	A	B	C	D	E	F	G	H	I	J
1	E_sitecode	E_latitude	E_longitude	E_date	E_country	ecoreg	E_riverregion	E_rivername	E_sitename	E_catchclass
2	NLb204	51.0824N	06.0440E	7/10/2003	NL	13	Meuse	Roer	Roer Vlodrop	<1000
3	NLb211	50.4612N	05.5508E	6/10/2003	NL	13	Meuse	Terzieterbeek	Terzieterbeek/Geul	<10
4	NLb210	50.4612N	05.5508E	6/10/2003	NL	13	Meuse	Terzieterbeek	Terzieterbeek/Geul	<10
5	NLb207	50.5501N	05.5215E	6/10/2003	NL	13	Meuse	Platsbeek	Platsbeek	<10
6	NLb202	51.0827N	06.0715E	7/10/2003	NL	13	Meuse	Roode beek	Roode beek grensovergang	<10
7	NLb203	51.0825N	06.0709E	7/10/2003	NL	13	Meuse	Roode beek	Roode beek grensovergang	<10
8	NLb208	50.4843N	05.5628E	6/10/2003	NL	13	Meuse	Selzerbeek	Selzerbeek	<10
9	NLb209	50.4841N	05.5624E	6/10/2003	NL	13	Meuse	Selzerbeek	Selzerbeek	<10
10	SE0629	62.4410N	16.5660E	5/08/2003	SE	22	Baltic_Sea	Fuskingeån	Övre Björnåsbäcken	<100
11	BE51262100	51.0706N	5.0452E	11/09/2003	BF	13	North_Sea	Halfwegloop	Onder Borgerhout	<10
12	BE55034150	51.1701N	4.4615E	25/08/2003	BF	13	North_Sea	Koeischotse beek	Vlimmeren, Zilvereind	<10
13	UK17729	52.5815N	03.2921W	11/07/200	[illegible]	[illegible]	[illegible]	[illegible]	tre Llawen	<10
14	LTSVST02	55.1327N	24.4331E	26/08/200					upys	<100
15	BE51120100	51.0538N	5.1328E	11/09/200					erlo	<100
16	UK17731	52.5313N	03.2651W	7/07/200					d Gethin	<10
17	LTZESK01	54.5746N	25.4343E	21/08/200					upys	<100
18	BE54058100	51.1927N	4.5509E	25/08/200					hout, stroomop Wieltjes(hoeve)	<100
19	SE0638	62.1260N	17.1750E	9/08/2003	SE	22	Baltic_Sea	Stangan	Torrsjö	<1000
20	SE0632	63.1870N	18.4420E	31/08/2003	SE	22	Baltic_Sea	Strömsån	Höglands IP	<100
21	LTNRLK01	55.0534N	24.1931E	28/08/2003	LT	15	Nemunas	Lokys	žemupys	<1000
22	PTDO064	41.1307N	07.0538W	10/07/2003	PT	1	Douro	Vilariça		<1000
23	UKBO03	53.1506N	02.0700W	24/09/2003	UK	18	Mersey	Bollin	Macclesfield	<100
24	LTZEJU01	54.5638N	25.3827E	22/08/2003	LT	15	Nemunas	Jusine	a. buvusio tvenkinio	<100
25	DEBW905	48.5300N	9.0686E	29/10/2003	DE	9	Rhine	Ammer	Tübingen	<1000
26	SE0636	62.1320N	17.1830E	9/08/2003	SE	22	Baltic_Sea	Stångån	Skärsätt	<1000
27	SE0634	62.1590N	16.5530E	31/08/2003	SE	22	Baltic_Sea	Linån	Nedre	<100
28	04350010	48.2533N	01.1003W	16/09/2003	FR	13	English_Char	Nancon	Parigné	<100
29	PTDO059	41.3009N	07.1032W	12/07/2003	PT	1	Douro	Carvalhais		<1000
30	SE0635	62.4660N	17.0500E	5/08/2003	SE	22	Baltic_Sea	Fuskingeån	Näst nederst	<100
31	NLb200	51.1345N	06.0449E	7/10/2003	NL	13	Meuse	De Swalm	De Swalm	<100
32	NLb201	51.1345N	06.0449E	7/10/2003	NL	13	Meuse	De Swalm	De Swalm	<100
33	UK18630	53.0231N	03.5638W	14/07/2003	UK	18	Irish_Sea	Lledr		<100
34	UK18627	53.0274N	03.5230W	14/07/2003	UK	18	Irish_Sea	Lledr		<100

The software now starts to calculate the index. This calculation is done in two steps.

Step 1

Calculation of the observed metric values.

Spreadsheet 40



	A	B	C	D	E	F	G	H	I	J	K	L
1	rivergroup	N.sp.all	Density.sp.all	n.ha.Fe.insev	n.ha.Fe.omni	n.ha.Re.phyt	n.sp.Hab.b	n.sp.Hab.rh	n.sp.Mi.long	n.sp.Mi.potad	perc.nha.Re.lith	perc.sp.Intol
2	Meuse.NorthSea	3,0	7000,0	0,0	6500,0	0,0	2,0	3,0	0,0	2,0	100,0	0,0
3	Meuse.NorthSea	6,0	34500,0	0,0	10000,0	0,0	3,0	5,0	0,0	2,0	94,9	0,0
4	Meuse.NorthSea	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	94,9	0,0
5	Meuse.NorthSea	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	94,9	0,0
6	Meuse.NorthSea	3,0	666,7	166,7	166,7	0,0	1,0	1,0	0,0	0,0	50,0	0,0
7	Meuse.NorthSea	2,0	833,3	166,7	0,0	0,0	1,0	1,0	0,0	0,0	80,0	0,0
8	Meuse.NorthSea	4,0	3750,0	0,0	500,0	0,0	2,0	3,0	0,0	1,0	43,3	0,0
9	Meuse.NorthSea	5,0	14125,0	250,0	3750,0	0,0	2,0	4,0	1,0	1,0	36,3	20,0
10	Northern.Europe	1,0	5875,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
11	Meuse.NorthSea	4,0	8272,7	0,0	5818,2	454,5	2,0	2,0	0,0	0,0	3,3	0,0
12	Meuse.NorthSea	3,0	4727,3	0,0	4636,4	0,0	1,0	1,0	0,0	0,0	1,9	0,0
13	United.Kingdom	4,0	8364,8	7861,6	0,0	0,0	1,0	3,0	2,0	0,0	95,5	50,0
14	Northern.Europe	4,0	5500,0	3250,0	0,0	0,0	1,0	3,0	0,0	0,0	97,7	25,0
15	Meuse.NorthSea	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	97,7	0,0
16	United.Kingdom	4,0	4588,2	4529,4	0,0	0,0	2,0	3,0	2,0	0,0	98,7	75,0
17	Northern.Europe	9,0	9222,2	611,1	5055,6	0,0	3,0	5,0	0,0	0,0	64,5	22,2
18	Meuse.NorthSea	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0	64,5	0,0
19	Northern.Europe	4,0	876,3	515,5	154,6	0,0	2,0	1,0	0,0	1,0	64,7	25,0
20	Northern.Europe	5,0	4747,5	0,0	2373,7	0,0	2,0	0,0	0,0	1,0	1,1	0,0
21	Northern.Europe	11,0	6500,0	900,0	2700,0	400,0	5,0	8,0	1,0	2,0	47,7	36,4
22	North.Portugal	7,0	10500,0	3200,0	5600,0	4950,0	4,0	4,0	0,0	2,0	44,3	14,3
23	United.Kingdom	4,0	6428,6	6333,3	47,6	0,0	1,0	2,0	0,0	0,0	98,5	50,0
24	Northern.Europe	4,0	4225,4	3380,3	845,1	0,0	1,0	3,0	0,0	0,0	98,9	50,0
25	Northern.Europe	2,0	2000,0	2000,0	0,0	0,0	1,0	2,0	0,0	0,0	100,0	100,0
26	Northern.Europe	3,0	3183,9	1928,3	0,0	224,2	1,0	1,0	0,0	0,0	60,6	33,3
27	Northern.Europe	5,0	2680,9	1446,8	0,0	42,6	2,0	2,0	1,0	0,0	57,1	40,0
28	West.France	3,0	4708,3	0,0	250,0	0,0	2,0	2,0	0,0	1,0	94,7	33,3
29	North.Portugal	4,0	8458,3	250,0	5916,7	708,3	2,0	2,0	0,0	2,0	91,6	0,0
30	Northern.Europe	3,0	1958,3	208,3	0,0	0,0	2,0	2,0	1,0	0,0	27,7	66,7
31	Meuse.NorthSea	8,0	640,0	0,0	440,0	0,0	4,0	5,0	0,0	4,0	37,5	0,0
32	Meuse.NorthSea	8,0	1360,0	0,0	1040,0	0,0	3,0	3,0	1,0	2,0	20,6	0,0
33	United.Kingdom	3,0	2952,8	2165,4	0,0	0,0	0,0	3,0	1,0	0,0	100,0	66,7
34	United.Kingdom	3,0	8981,1	5396,2	0,0	0,0	0,0	3,0	1,0	0,0	100,0	66,7

The results of this calculation are automatically written in the worksheet “result”. There are 33 columns. The first column (column A) gives the calculated river group for each sample (automatically defined based on the variable river region). In the second column (B) the total number of species found in each sample is documented. In the third column (C) the total number of individuals per hectare (first run) is calculated. From the 4th to the 13th column (D-M) the calculated metric values are represented (abbreviations see Table 10). The Environmental variables, as given in the input-file, are copied to the 14th to 33rd columns (N-AG).

Table 10: *Metrics and abbreviations in result spreadsheet, ‘MA’ metric abbreviations used in metrics spreadsheet. N.ha = number per hectare; n.sp = number of species; perc.nha = percent of number per hectare; perc.sp = percent number of species*

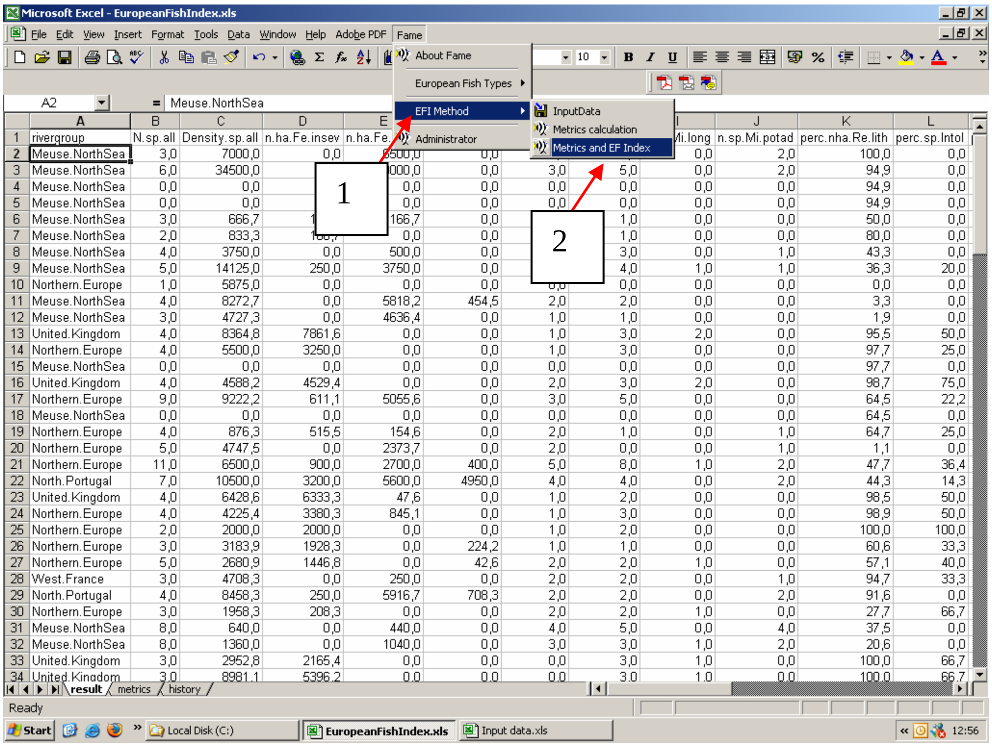
Metric abbreviation	Metric	MA
n.ha.Fe.insev	Density of insectivorous species	INSE
n.ha.Fe.omni	Density of omnivorous species	OMNI
n.ha.Re.phyt	Density of phytophilous species	PHYT
perc.nha.Re.lith	Relative abundance of lithophilous species	LITH
n.sp.Hab.b	Number of benthic species	BENT
n.sp.Hab.rh	Number of rheophilic species	RHEO
perc.sp.Intol	Relative number of intolerant species	INTO
perc.sp.Tol	Relative number of tolerant species	TOLE
n.sp.Mi.long	Number of long migratory species	LONG
n.sp.Mi.potad	Number of potamodromous species	POTA

The total number (N.sp.all) and density of species (Density.sp.all) values, shown in the result worksheet, are metrics that are not used for the EFI computation.

Step 2

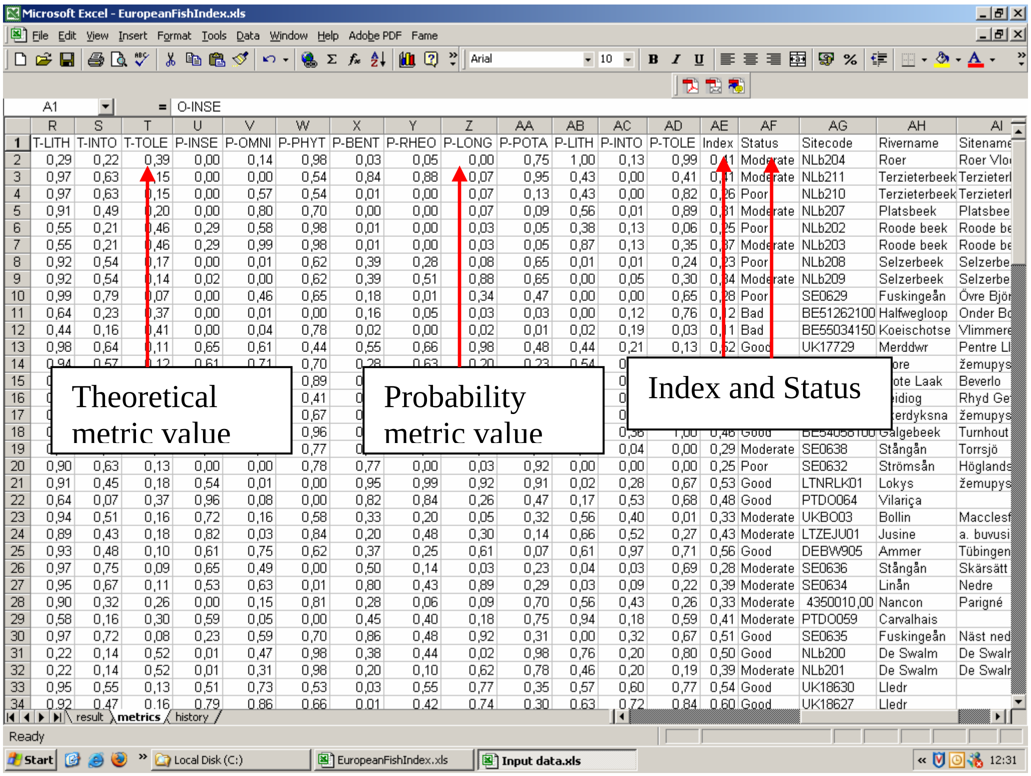
In step two the software calculates the theoretical metric values (reference values), the probability metric values and the EFI. In the “Fame” menu select “EFI Method” (1) then “Metrics and EF Index” (2) (spreadsheet 41).

Spreadsheet 41



The results of these computations are presented in the “metrics” worksheet. In the “metrics” worksheet 36 columns of data appear. In the first block the 10 *observed metric* values for each sample are represented (column A-J). Those are the same as in the “result” worksheet. In the second block the *theoretical metric* values are indicated representing the forecasted reference values (column K-T). In the third block, the *probability metric* values are given (column U-AD). The probability metrics are the standardised residuals transformed into probabilities indicating the deviation from the reference values. In column AE and AF the index values as the rescaled sum of the ten probability metrics (ranging from 0 to 1) and the assigned ecological status are given. The abbreviations in the column names are explained in Table 11: Prefix ‘O-‘ stands for observed, ‘T-‘ for theoretical and ‘P-‘ for probability metrics. Additionally, the data concerning the location and fishing occasion (site code, river name, site name, sampling date) are added in the last columns (AG-AJ). Spreadsheet 42 shows the last columns in the worksheet “metrics” obtained after executing step 2.

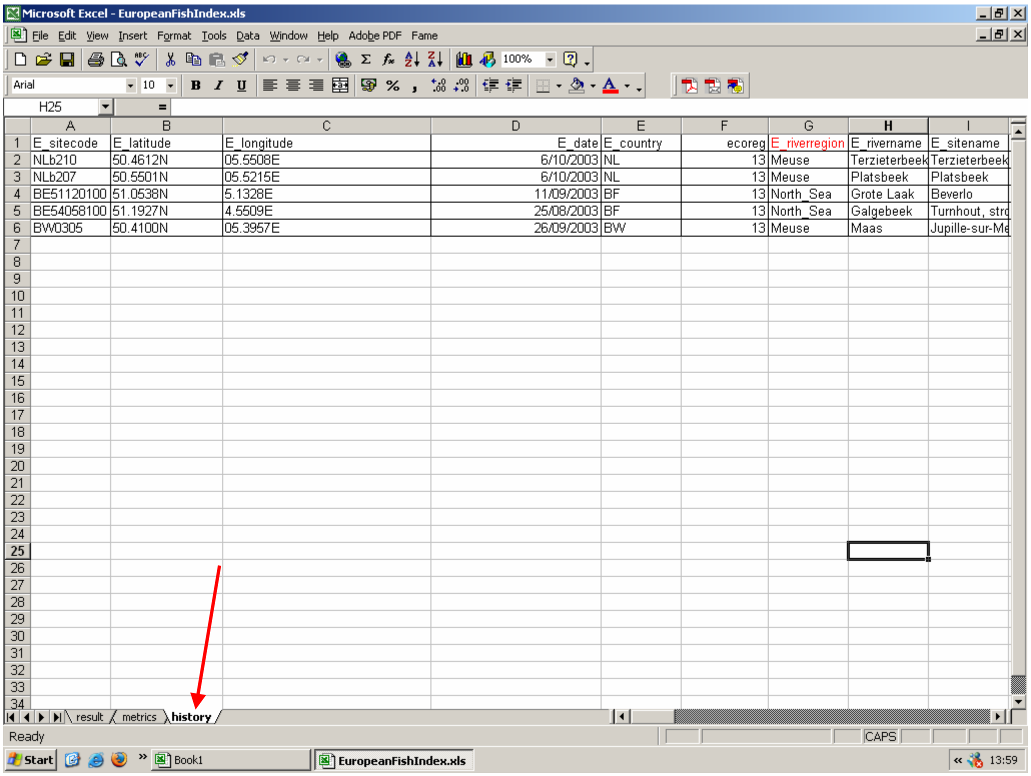
Spreadsheet 42



You have successfully calculated the EFI!

The sites deleted during the verification process are copied to the 'history' worksheet.

Spreadsheet 43

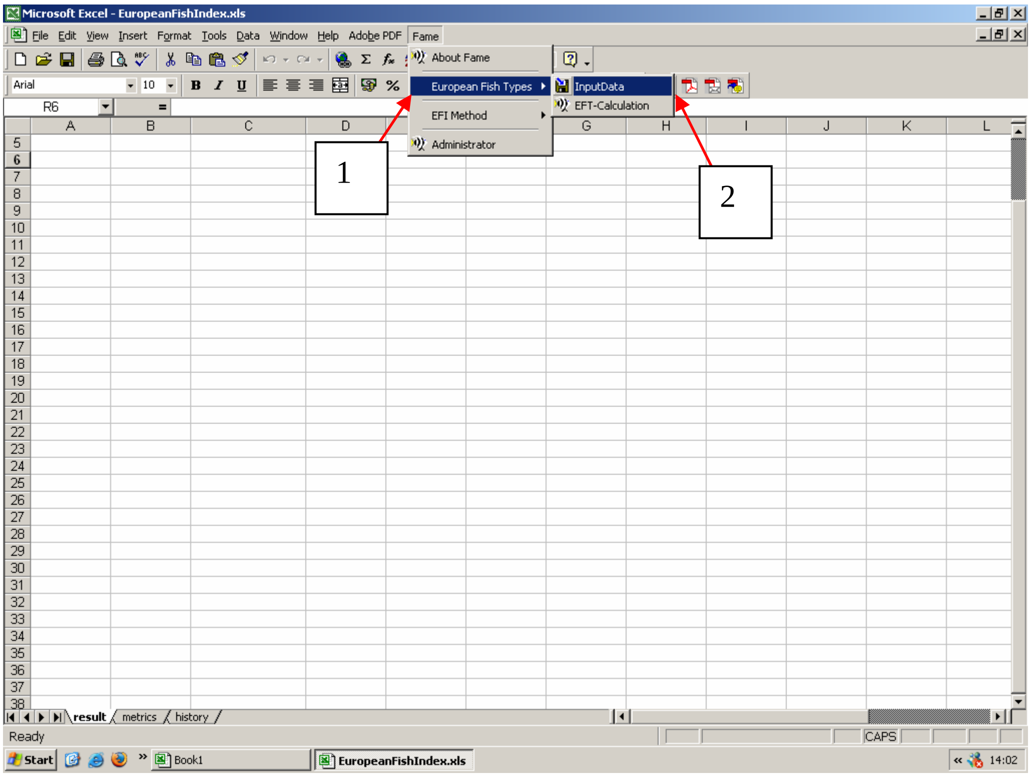


E_sitecode	E_latitude	E_longitude	E_date	E_country	ecoreg	E_riverregion	E_rivername	E_sitename
NLb210	50.4612N	05.5508E	6/10/2003	NL	13	Meuse	Terzieterbeek	Terzieterbeek
NLb207	50.5501N	05.5215E	6/10/2003	NL	13	Meuse	Platsbeek	Platsbeek
BE51120100	51.0538N	5.1328E	11/09/2003	BE	13	North_Sea	Grote Laak	Beverlo
BE54058100	51.1927N	4.5509E	25/08/2003	BE	13	North_Sea	Galgebeek	Turnhout, strc
BW0305	50.4100N	05.3957E	26/09/2003	BW	13	Meuse	Maas	Jupille-sur-Me

6. Defining the European Fish Type

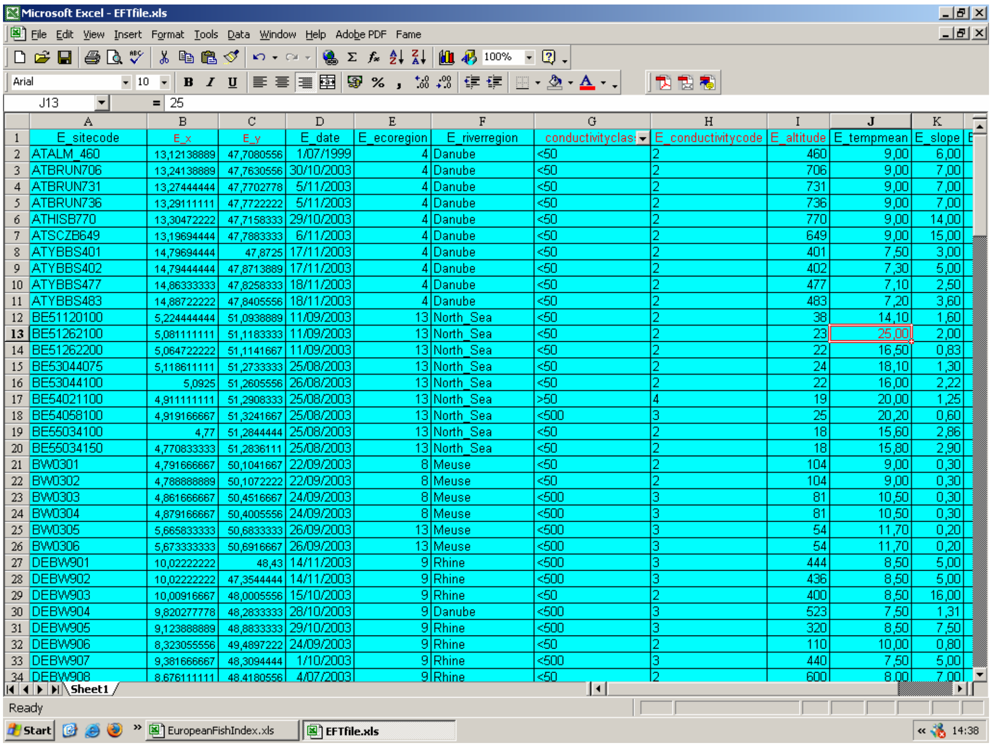
You can now define the EFT using the prepared EFT-file. The first steps are similar to the EFI calculation. Click on the “Fame” menu, choose “European Fish Types” (1) and select “InputData” (2).

Spreadsheet 44



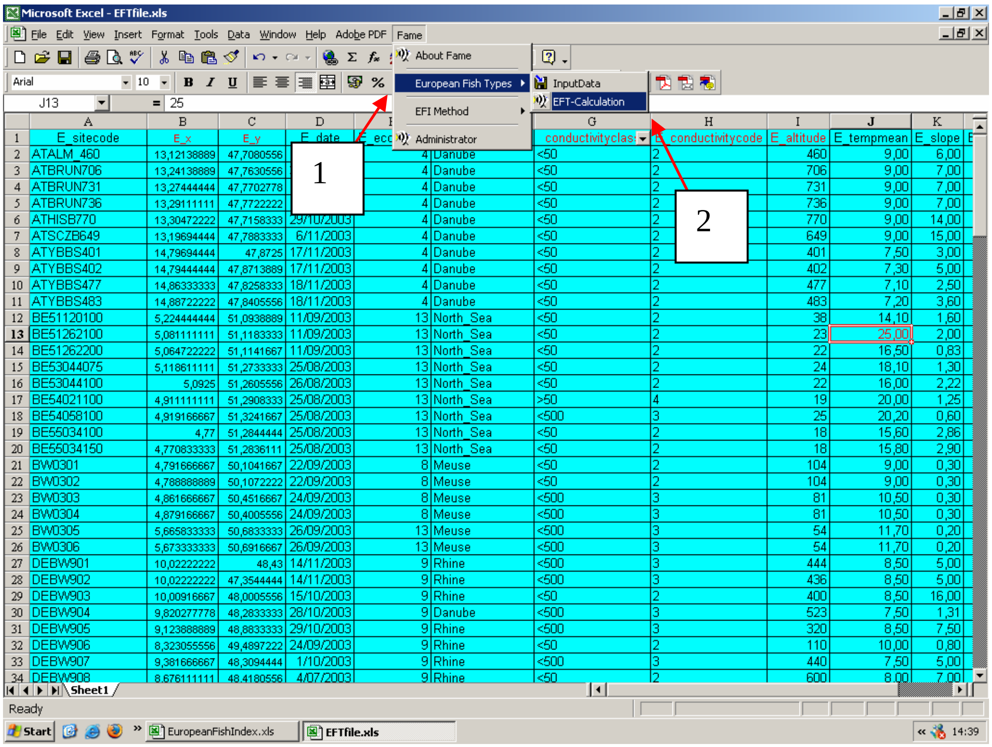
Spreadsheets 11, 12 and 13 will appear in sequence. If you choose “Start” the standard MS Windows “Open” pop-up window will appear (spreadsheet 14). You now select the file you have prepared to import. Accepted file formats are Excel files and text Files. Once you have selected the file, the file path is displayed to check if this is the required file (analogous to spreadsheet 15). You confirm and a similar spreadsheet as spreadsheet 16 will appear displaying details about the number of cells, rows and columns. The selected area will be in blue or another colour depending on your settings. Click “OK” and the data verification process will start. However, this verification is not as detailed as for the EFI calculation. The spelling of the environmental variable names is still controlled; however, values and empty cells are not always checked. At the end of the control your input data will appear and any change will be presented in a different colour (red in this example) (spreadsheet 45).

Spreadsheet 45



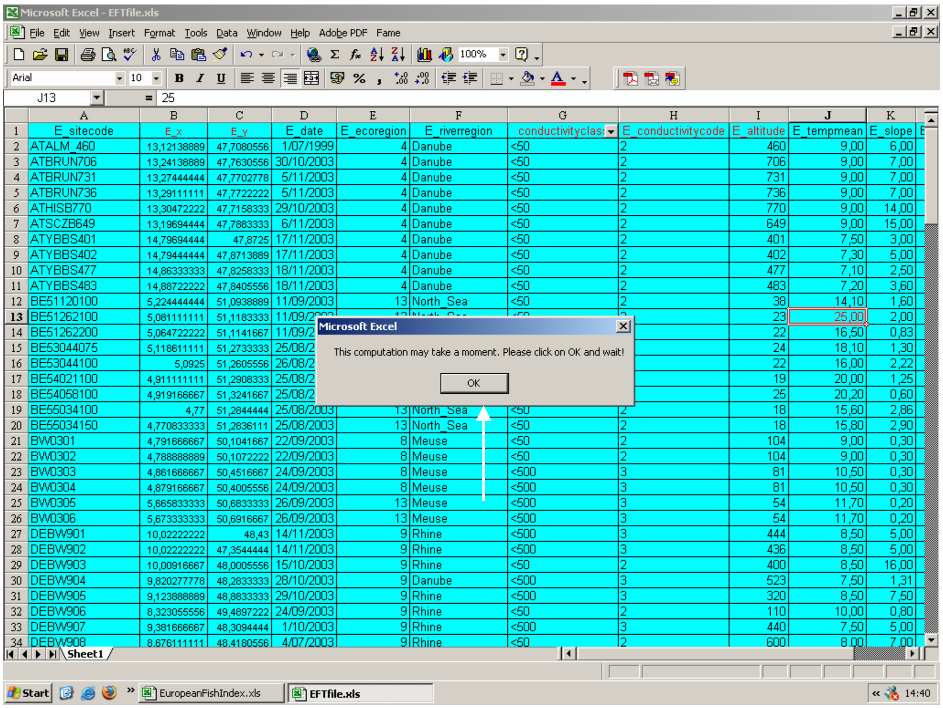
Now you click on the “Fame” menu. Choose “European Fish Types” (1) and select “EFT Calculation” (2) (spreadsheet 46).

Spreadsheet 46



As with the EFI computation a message informs you to be patient. Click “OK”.

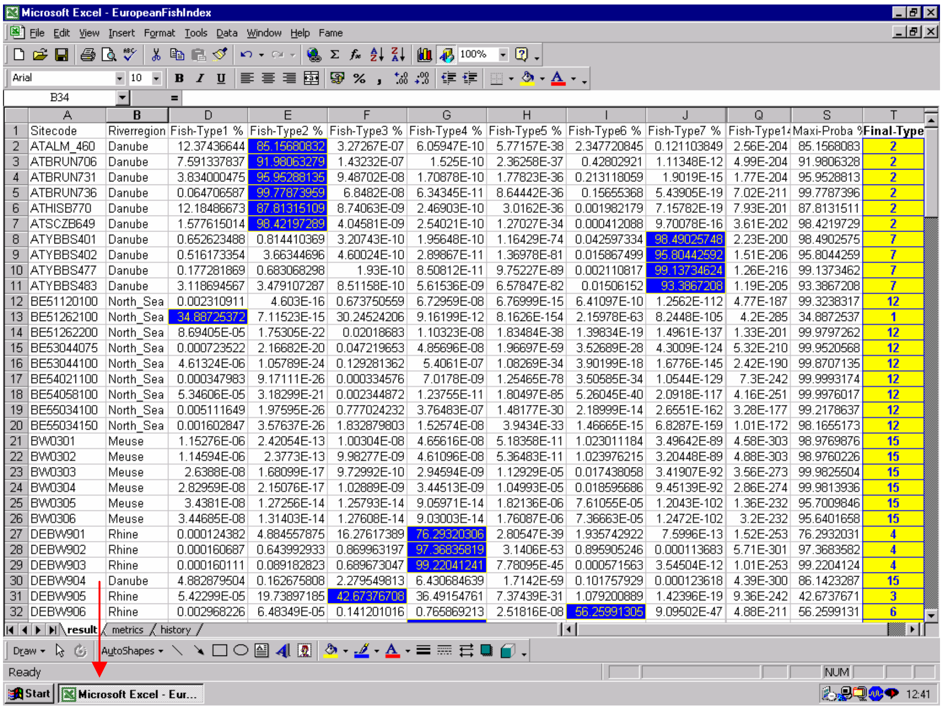
Spreadsheet 47



	E_sitecode	E_x	E_y	E_date	E_ecoregion	E_riverregion	conductivityclass	E_conductivitycode	E_altitude	E_tempmean	E_slope
2	ATALM_460	13,12138889	47,7080556	1/07/1999	4	Danube	<50	2	460	9,00	6,00
3	ATBRUN706	13,24138889	47,7630556	30/10/2003	4	Danube	<50	2	706	9,00	7,00
4	ATBRUN731	13,27444444	47,7702778	5/11/2003	4	Danube	<50	2	731	9,00	7,00
5	ATBRUN736	13,29111111	47,7722222	5/11/2003	4	Danube	<50	2	736	9,00	7,00
6	ATHISB770	13,30472222	47,7158333	29/10/2003	4	Danube	<50	2	770	9,00	14,00
7	ATSCZB649	13,19694444	47,7883333	6/11/2003	4	Danube	<50	2	649	9,00	15,00
8	ATYBBS401	14,79694444	47,8725	17/11/2003	4	Danube	<50	2	401	7,50	3,00
9	ATYBBS402	14,79444444	47,8713889	17/11/2003	4	Danube	<50	2	402	7,30	5,00
10	ATYBBS477	14,86333333	47,8258333	18/11/2003	4	Danube	<50	2	477	7,10	2,50
11	ATYBBS483	14,88722222	47,8405556	18/11/2003	4	Danube	<50	2	483	7,20	3,60
12	BE51120100	5,224444444	51,0938889	11/09/2003	13	North_Sea	<50	2	38	14,10	1,60
13	BE51262100	5,081111111	51,1183333	11/09/2					23	25,00	2,00
14	BE51262200	5,064722222	51,1141667	11/09/2					22	16,50	0,83
15	BE53044075	5,118611111	51,2733333	25/08/2					24	18,10	1,30
16	BE53044100	5,0925	51,2605556	26/08/2					22	16,00	2,22
17	BE54021100	4,911111111	51,2908333	25/08/2					19	20,00	1,25
18	BE54058100	4,919166667	51,3241667	25/08/2					25	20,20	0,60
19	BE55034100	4,77	51,2844444	25/08/2003	13	North_Sea	<50	2	18	15,60	2,86
20	BE55034150	4,770833333	51,2836111	25/08/2003	13	North_Sea	<50	2	18	15,80	2,90
21	BW0301	4,791666667	50,1041667	22/09/2003	8	Meuse	<50	2	104	9,00	0,30
22	BW0302	4,788888889	50,1072222	22/09/2003	8	Meuse	<50	2	104	9,00	0,30
23	BW0303	4,861666667	50,4516667	24/09/2003	8	Meuse	<500	3	81	10,50	0,30
24	BW0304	4,879166667	50,4005556	24/09/2003	8	Meuse	<500	3	81	10,50	0,30
25	BW0305	5,665833333	50,6833333	26/09/2003	13	Meuse	<500	3	54	11,70	0,20
26	BW0306	5,673333333	50,6916667	26/09/2003	13	Meuse	<500	3	54	11,70	0,20
27	DEBW901	10,02222222	48,43	14/11/2003	9	Rhine	<500	3	444	8,50	5,00
28	DEBW902	10,02222222	47,3544444	14/11/2003	9	Rhine	<500	3	436	8,50	5,00
29	DEBW903	10,00916667	48,0005556	15/10/2003	9	Rhine	<50	2	400	8,50	16,00
30	DEBW904	9,820277778	48,2833333	28/10/2003	9	Danube	<500	3	523	7,50	1,31
31	DEBW905	9,123888889	48,8833333	29/10/2003	9	Rhine	<500	3	320	8,50	7,50
32	DEBW906	8,323055556	49,4897222	24/09/2003	9	Rhine	<50	2	110	10,00	0,80
33	DEBW907	9,381666667	48,3094444	1/10/2003	9	Rhine	<500	3	440	7,50	5,00
34	DEBW908	8,676111111	48,4180556	4/07/2003	9	Rhine	<50	2	600	8,00	7,00

Spreadsheet 48 illustrates the results of the EFT calculation.

Spreadsheet 48



	Sitecode	Riverregion	Fish-Type1 %	Fish-Type2 %	Fish-Type3 %	Fish-Type4 %	Fish-Type5 %	Fish-Type6 %	Fish-Type7 %	Fish-Type14	Maxi-Proba %	Final-Type
2	ATALM_460	Danube	12.37436644	85.15680832	3.27267E-07	6.05947E-10	5.77157E-38	2.347720845	0.121103849	2.56E-204	85.1568083	2
3	ATBRUN706	Danube	7.591337837	91.98063279	1.43232E-07	1.525E-10	2.36258E-37	0.42802921	1.11348E-12	4.99E-204	91.9806328	2
4	ATBRUN731	Danube	3.834000475	95.95288135	9.48702E-08	1.70878E-10	1.77823E-36	0.213118059	1.9019E-15	1.77E-204	95.9528813	2
5	ATBRUN736	Danube	0.064706587	99.77873959	6.8482E-08	6.34345E-11	8.64442E-36	0.15655368	5.43905E-19	7.02E-211	99.7787396	2
6	ATHISB770	Danube	12.18486673	87.81315109	8.74063E-09	2.46903E-10	3.0162E-36	0.001982179	7.15782E-19	7.93E-201	87.8131511	2
7	ATSCZB649	Danube	1.577615014	98.42197289	4.04581E-09	2.54021E-10	1.27027E-34	0.000412088	9.70078E-16	3.61E-202	98.4219729	2
8	ATYBBS401	Danube	0.652623488	0.814410369	3.20743E-10	1.95648E-10	1.16429E-74	0.042597334	98.49025748	2.23E-200	98.4902575	7
9	ATYBBS402	Danube	0.516173354	3.66344696	4.60024E-10	2.89867E-11	1.36978E-81	0.015867499	95.80442592	1.51E-206	95.8044259	7
10	ATYBBS477	Danube	0.177281869	0.683068298	1.93E-10	8.50812E-11	9.75227E-89	0.002110817	99.13734624	1.26E-216	99.1373462	7
11	ATYBBS483	Danube	3.118694567	3.479107287	8.51158E-10	5.61536E-09	6.57847E-82	0.01506152	93.3867208	1.19E-205	93.3867208	7
12	BE51120100	North_Sea	0.002310911	4.603E-16	0.673750559	6.72959E-08	6.76999E-15	6.41097E-10	1.2562E-112	4.77E-187	99.3238317	12
13	BE51262100	North_Sea	34.88725372	7.11523E-15	30.24524206	9.16199E-12	8.1626E-154	2.15978E-63	8.2448E-105	4.2E-285	34.8872537	1
14	BE51262200	North_Sea	8.69405E-05	1.75305E-22	0.02018683	1.10323E-08	1.83484E-38	1.39834E-19	1.4961E-137	1.33E-201	99.9797262	12
15	BE53044075	North_Sea	0.000723522	2.16682E-20	0.047219653	4.85696E-08	1.96697E-59	3.52689E-28	4.3009E-124	5.32E-210	99.9520568	12
16	BE53044100	North_Sea	4.61324E-06	1.05789E-24	0.129281362	5.4061E-07	1.08269E-34	3.90199E-18	1.6776E-145	2.42E-190	99.8707135	12
17	BE54021100	North_Sea	0.000347983	9.17111E-26	0.000334576	7.0178E-09	1.25465E-78	3.50585E-34	1.0544E-129	7.3E-242	99.9993174	12
18	BE54058100	North_Sea	5.34606E-05	3.18299E-21	0.002344872	1.23755E-11	1.80497E-85	5.26045E-40	2.0918E-117	4.16E-251	99.9976017	12
19	BE55034100	North_Sea	0.005111649	1.97595E-26	0.777024232	3.76483E-07	1.48177E-30	2.18999E-14	2.6551E-162	3.28E-177	99.2178637	12
20	BE55034150	North_Sea	0.001602847	3.57637E-26	1.832879803	1.52574E-08	3.9434E-33	1.46665E-15	6.8287E-159	1.01E-172	98.1655173	12
21	BW0301	Meuse	1.15276E-06	2.42054E-13	1.00304E-08	4.65616E-08	5.18358E-11	1.023011184	3.49642E-89	4.58E-303	98.9769876	15
22	BW0302	Meuse	1.14594E-06	2.3773E-13	9.98277E-09	4.61096E-08	5.36483E-11	1.023976215	3.20448E-89	4.88E-303	98.9760226	15
23	BW0303	Meuse	2.6388E-08	1.68099E-17	9.72992E-10	2.94594E-09	1.12929E-05	0.017438058	3.41907E-92	3.56E-273	99.9825504	15
24	BW0304	Meuse	2.82959E-08	2.15076E-17	1.02889E-09	3.44513E-09	1.04993E-05	0.018595686	9.45139E-92	2.86E-274	99.9813936	15
25	BW0305	Meuse	3.4381E-08	1.27256E-14	1.25793E-14	9.05971E-14	1.82136E-06	7.61055E-05	1.2043E-102	1.36E-232	95.7009846	15
26	BW0306	Meuse	3.44685E-08	1.31403E-14	1.27608E-14	9.03003E-14	1.76087E-06	7.36663E-05	1.2472E-102	3.2E-232	95.6401658	15
27	DEBW901	Rhine	0.000124382	4.884557875	16.27617389	76.29320306	2.80547E-39	1.935742922	7.5996E-13	1.52E-253	76.2932031	4
28	DEBW902	Rhine	0.000160687	0.643992933	0.869963197	97.36835819	3.1406E-53	0.895905246	0.000113683	5.71E-301	97.3683582	4
29	DEBW903	Rhine	0.000160111	0.089182823	0.689673047	99.22041241	7.78095E-45	0.000571563	3.54504E-12	1.01E-253	99.2204124	4
30	DEBW904	Danube	4.882879504	0.162675808	2.279549813	6.430684639	1.7142E-59	0.101757929	0.000123618	4.39E-300	86.1423287	15
31	DEBW905	Rhine	5.42299E-05	19.73897185	42.67376708	36.49154761	7.37439E-31	1.079200889	1.42396E-19	9.36E-242	42.6737671	3
32	DEBW906	Rhine	0.002968226	6.48349E-05	0.141201016	0.765869213	2.51816E-08	56.25991305	9.09502E-47	4.88E-211	56.2599131	6

These results are given in the worksheet “result”. In the second and third column (B and C) the site code and date are given. In columns D to R the results are presented as the probability for each site to belong to each of the 15 European Fish Types. Highlighted cells and column S indicate the highest probability values, the value used to identify the most appropriate fish type. Finally, each site is assigned to one of the 15 European Fish Types in the last column (T) of the spreadsheet.

You have successfully calculated the EFT!

Remarks

In the “EuropeanFishIndex” the “Fame” menu contains the submenus “About Fame” and “Administrator”.
The “About Fame” menu contains information about the FAME project. The “Administrator” menu is password protected and is restricted to FAME software developers only.

7. References

CEN document, 2003; Water quality – Sampling of fish with electricity. CEN/TC 230, Ref. No. EN 14011:2003 E, 16 pp.

EU Water Framework Directive, 2000. Directive of the European parliament and of the council 2000/60/EC establishing a framework for community action in the field of water policy. Official Journal of the European Communities 22.12.2000 L 327/1

Karr, J.R., 1981. Assessment of biotic integrity using fish communities. Fisheries 6: 21-27.

Annex 1 – Field Protocol

Annex 1-Table 1: *Fish data*

	Date (dd/mm/yyyy)				
	Site data				
	Name of watercourse			Site code	
	XY co-ordinates			Main river region	
	Longitude, latitude			GPS co-ordinates	
	Site name			Transect length [m]	
	Fish data				
	species	**number of specimen**		**species**	**number of specimen**
1			41		
2			42		
3			43		
4			44		
5			45		
6			46		
7			47		
8			48		
9			49		
10			50		
11			51		
12			52		
13			53		
14			54		
15			55		
16			56		
17			57		
18			58		
19			59		
20			60		
21			61		
22			62		
23			63		
24			64		
25			65		
26			66		
27			67		
28			68		
29			69		
30			70		
31			71		
32			72		
33			73		
34			74		
35			75		
36			76		
37			77		
38			78		
39			79		
40			80		

Annex 1-Table 2: *Abiotic and method data*

Date	
Site data	
Name of watercourse	
XY co-ordinates or longitude latitude	
Site code	
GPS co-ordinates	
Abiotic variables	
Altitude	m
Lakes upstream affecting the site	Yes / No
Distance from source	km
Flow regime	Permanent / Summer dry
Wetted width	m
Geological typology	Siliceous / Calcareous
Mean air temperature	Celsius (°C)
Gradient slope	(‰)
Size of catchment class	Classes; <10, <100, <1000, <10000, >10000 km^2
Variables describing sampling methods	
Method	Electric fishing: Wading / by Boat.
Sampling strategy	Whole / Partial 1 bank / Partial 2 banks / Partial random / Partial proportional / Other (define)
Fished area	m^2

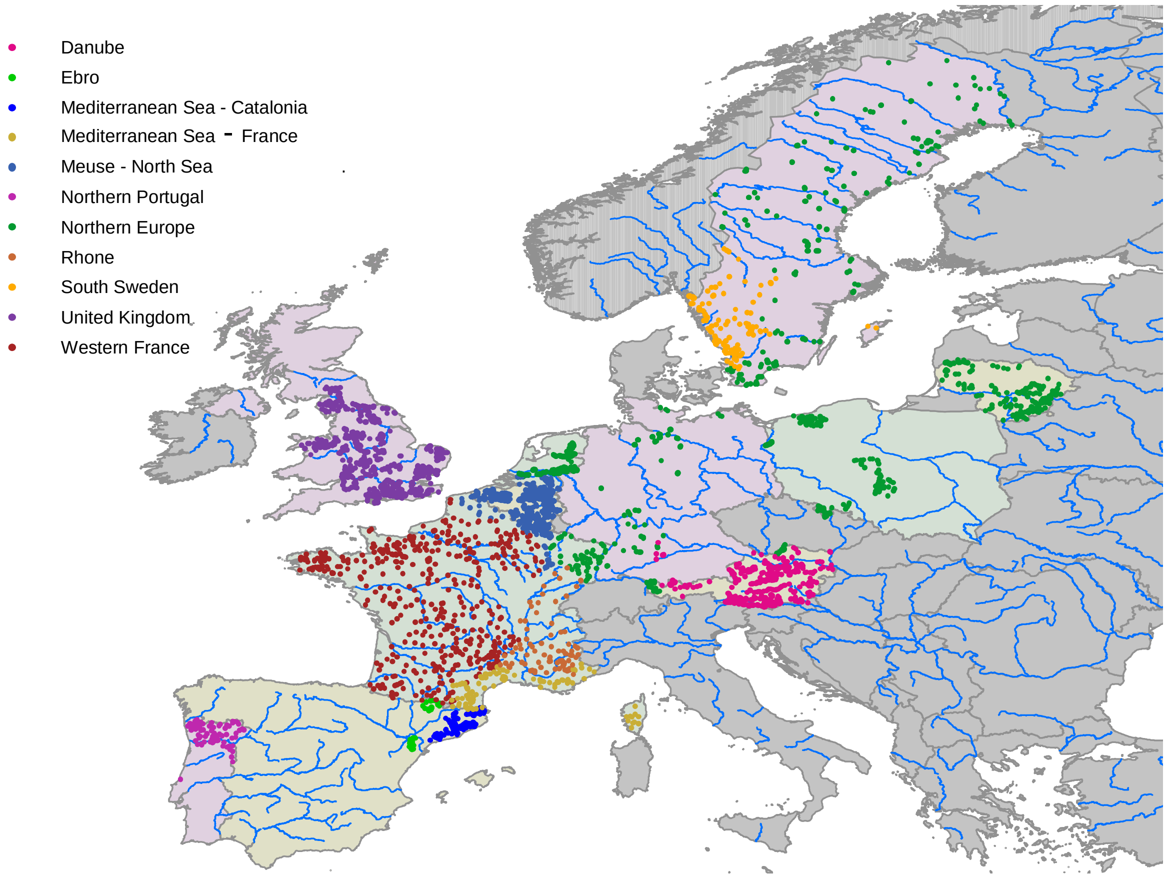
Annex 1-Table 3: *Human impact data (optional)*

Site data		**Chemical data**	
Name watercourse		Oxygen (mg/l or %)	
XY co-ordinates or longitude latitude	X:……………………(N) Y:……………………(E)	Conductivity (mS/cm)	
Site name		pH	
Site code		Phosphate (mg/l)	
Main river region		Nitrite (mg/l)	
Field responsible		Nitrate (mg/l)	
GPS co-ordinates		Turbidity (NTU)	
Sampling hour		Secchi depth (cm)	
Site characteristics			
Water level	low / normal / high		
Natural shelters	natural / poorly developed / absent		
Pools in transect	number:		
Riffles in transect	number:		
Meanders in transect	number:		
Bank	natural / partly artificial / overall reinforced		
Morphological condition	Minor / slight / moderate / strong / severe / disturbance		
Agricultural activities	range: 50 m from stream: none / along one bank / along both sides		
Prairies	range: 50 m from stream: none / along one bank / along both sides		
Trees	range: 20 m from stream: none / < 10 / >10 & < 50 / > 50 or forest		
Urbanisation (constructions)	range: 100 m from stream: none / < 5 / >5 & <10 / >10		
Industrial activities	Yes: describe………………………..……………..…./ none		
water flow	Minor / slight / moderate / strong / severe / disturbance		
Impact of agriculture in river basin upstream	> 40% cultivated land, severe impact: class 5;		
	> 40% cultivated land, strong impact: class 4;		
	< 40% cultivated land, moderate impact: class 3;		
	< 40% cultivated land, low impact: class 2;		
	< 10% cultivated land: class 1;		
Urbanisation in river basin upstream	>15% urban land severe impact: class 5		
	>15% urban land strong impact: class 4		
	<15% urban land moderate impact: class 3		
	<15% urban land low impact: class 2		
	<1% urban land: class 1		
Migration barriers (transect)	Yes: describe………………………..……………..…./ none		
Dam present upstream	Yes / No		
Migration barriers in the river (total river)	Barriers present: no passage for fish possible: class 5		
	passage for 1 single species occasionally: class 4		
	passage for certain species or certain years: class 3		
	passage for most species most years: class 2		
	No barriers (or functional bypass): class 1		

Annex 2 - River groups and ecoregions

Annex 2-Table 1: *Clustering of the 36 hydrological units (large basins and IHBS Sea areas) into 11 river groups, based on similarities between native fish fauna. Countries where sites belong to the corresponding hydrological unit are presented (A: Austria, B: Belgium, F: France, L: Lithuania, Ge: Germany, Gr: Greece, N: Netherland, Po: Poland, Pt: Portugal, Sw: Sweden, Sp: Spain, UK: United Kingdom)*

River Groups	Hydrological units= variable codes	Countries
Ebro River	*Ebro*	Sp
Mediterranean rivers from Catalunya	*Mediterranean_Sea_WB*	Sp
North Portugal rivers	*Douro*	Pt
North Portugal rivers	*NE_Atlantic_Ocean*	Pt
Danube	*Black_Sea*	-
Danube	*Danube*	A, Ge
South-west Sweden rivers	*Kattegat_Sound*	Sw
South-west Sweden rivers	*Skagerrak*	Sw
South-west Sweden rivers	*Baltic_Sea*	Sw, L, Po
European Northern plain rivers	*Elbe*	A, Ge
European Northern plain rivers	*Gulf_of_Riga*	L
European Northern plain rivers	*Nemunas*	L
European Northern plain rivers	*Odra*	Ge, Po
European Northern plain rivers	*Rhine*	A, N, F, Ge
European Northern plain rivers	*Weser*	-
Mediterranean rivers from France	*Mediterranean_Sea_WB_North_Pyrenees*	F
West France rivers	*English_Channel_ER 13*	F
West France rivers	*Garonne*	F
West France rivers	*Loire*	F
West France rivers	*North_Atlantic_Ocean*	F
West France rivers	*Seine*	F
United Kingdom rivers	*Anglian_Coast*	UK
United Kingdom rivers	*Bristol_Channel*	UK
United Kingdom rivers	*English_Channel_ER_18*	UK
United Kingdom rivers	*Great_Ouse*	UK
United Kingdom rivers	*Irish_Sea*	UK
United Kingdom rivers	*Medway*	UK
United Kingdom rivers	*Mersey*	UK
United Kingdom rivers	*Severn*	UK
United Kingdom rivers	*Tees*	UK
United Kingdom rivers	*Thames*	UK
United Kingdom rivers	*Trent*	UK
United Kingdom rivers	*Yorkshire_Ouse*	UK
Rhône River	*Rhone*	F
Meuse-group rivers	*Meuse*	B, F, N
Meuse-group rivers	*North_Sea*	B, F

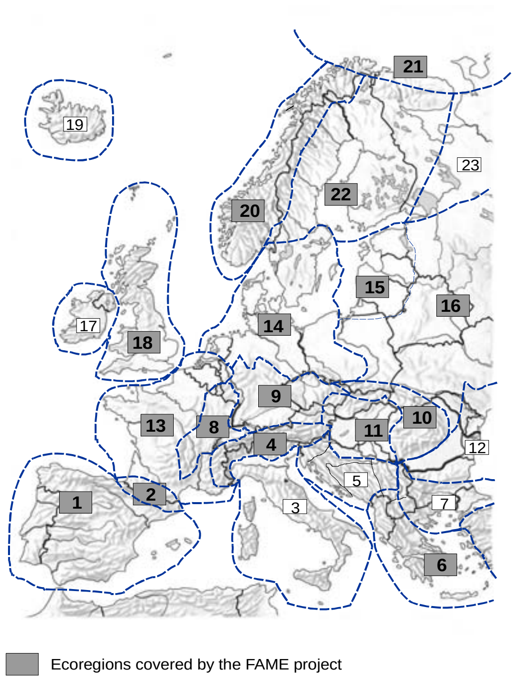


Annex 2-Figure 1: *Assignment of FIDES sites to the 11 river groups identified in the FAME project (see Annex 2-Table 1)*

Annex 2-Table 2: *Ecoregion name and number according to Illies and the WFD*

Ecoregion according to WFD			
1	Iberian Peninsula	14	Central Plains
2	Pyrenees	15	Baltic Province
3	Italy*	16	Eastern Plains
4	Alps	17	Ireland*
5	Dinarian Western Balkan*	18	Great Britain
6	Hellenic Western Balkan	19	Iceland*
7	Eastern Balkan*	20	Borealic Uplands
8	Western Highlands	21	Tundra
9	Central Highlands	22	Fenno-Scandian Shield
10	The Carpathians	23	Taiga*
11	Hungarian Lowlands	24	The Caucasus
12	Pontic Province*	25	Caspic Depression
13	Western Plains		

*Ecoregions not covered by the FAME project



Annex 2-Figure 2: *Ecoregions accoring to Illies and WFD in Europe*

Annex 3 - Fish species in EFI software

Species name (with S_ prefix)	Species name (with S_ prefix)	Species name (with S_ prefix)
S_Abramis.ballerus	S_Barbus.macedonicus	S_Cobitis_taenia
S_Abramis.brama	S_Barbus.meridionalis	S_Cobitis.tanaitica
S_Abramis.sapa	S_Barbus.microcephalus	S_Cobitis.trichonica
S_Acipenser.baeri	S_Barbus.peloponnesius	S_Cobitis.vardarensis
S_Acipenser.gueldenstaedtii	S_Barbus.plebejus	S_Cobitis.vettonica
S_Acipenser.naccarii	S_Barbus.prespensis	S_Cobitis.zanandreai
S_Acipenser.nudiventris	S_Barbus.sclateri	S_Coregonus.albula
S_Acipenser.ruthenus	S_Barbus.steindachneri	S_Coregonus.autumnalis
S_Acipenser.stellatus	S_Barbus.tyberinus	S_Coregonus.lavaretus
S_Acipenser.sturio	S_Blicca.bjoerkna	S_Coregonus.muscun
S_Alburnoides.bipunctatus	S_Carassius.auratus	S_Coregonus.oxyrinchus
S_Alburnus.albidus	S_Carassius.carassius	S_Coregonus.peled
S_Alburnus.alburnus	S_Carassius.gibelio	S_Coregonus.pidschian
S_Alosa.alosa	S_Chalcalburnus.belvica	S_Coregonus.trybomi
S_Alosa.fallax	S_Chalcalburnus.chalcoides	S_Cottus.gobio
S_Alosa.immaculata	S_Chelon.labrosus	S_Cottus.koshewniko
S_Alosa.killarnensis	S_Chondrostoma.arrigonis	S_Cottus.petiti
S_Alosa.macedonica	S_Chondrostoma.genei	S_Cottus.poecilopus
S_Alosa.maeotica	S_Chondrostoma.knerii	S_Ctenopharyngodon.idella
S_Alosa.tanaica	S_Chondrostoma.lemmingii	S_Cyprinus.carpio
S_Alosa.vistonica	S_Chondrostoma.lusitanicum	S_Dicentrarchus.labrax
S_Ambloplites.rupestris	S_Chondrostoma.miegii	S_Dicentrarchus.punctatus
S_Ameiurus.melas	S_Chondrostoma.nasus	S_Economidichthys.pygmaeus
S_Ameiurus.nebulosus	S_Chondrostoma.phoxinus	S_Economidichthys.trichonis
S_Anaecypris.hispanica	S_Chondrostoma.polylepis	S_Eriocheir.sinensis
S_Anguilla.anguilla	S_Chondrostoma.prespense	S_Esox.lucius
S_Aphanius.fasciatus	S_Chondrostoma.soetta	S_Eudontomyzon.danfordi
S_Aphanius.iberus	S_Chondrostoma.toxostoma	S_Eudontomyzon.hellenicus
S_Aspius.aspius	S_Chondrostoma.vardarense	S_Eudontomyzon.mariae
S_Atherina.boyeri	S_Chondrostoma.willkommii	S_Eudontomyzon.stankokaramani
S_Atherina.hepsetus	S_Cichlasoma.facetum	S_Eudontomyzon.vladykovi
S_Atherina.presbyter	S_Clarius.batrachus	S_Eupallasella.perenurus
S_Aulopyge.huegelii	S_Clarius.gariepinus	S_Fundulus.heteroclitus
S_Barbatula.barbatula	S_Cobitis.arachthosensis	S_Gambusia.affinis
S_Barbatula.bureschi	S_Cobitis.bilineata	S_Gambusia.holbrooki
S_Barbatula.pindus	S_Cobitis.calderoni	S_Gasterosteus.aculeatus
S_Barbus.albanicus	S_Cobitis.dalmatina	S_Gobio.albipinnatus
S_Barbus.barbus	S_Cobitis.elongata	S_Gobio.banarescui
S_Barbus.bocagei	S_Cobitis.elongatoides	S_Gobio.benacensis
S_Barbus.caninus	S_Cobitis.hellenica	S_Gobio.elimeius
S_Barbus.comizo	S_Cobitis.megaspila	S_Gobio.gobio
S_Barbus.cyclolepis	S_Cobitis.meridionalis	S_Gobio.kesslerii
S_Barbus.euboicus	S_Cobitis.narentana	S_Gobio.uranoscopus
S_Barbus.graecus	S_Cobitis.ohridana	S_Gymnocephalus.baloni
S_Barbus.graellsii	S_Cobitis.paludica	S_Gymnocephalus.cernuus
S_Barbus.guiraonis	S_Cobitis.punctilineata	S_Gymnocephalus.schraetser
S_Barbus.haasi	S_Cobitis.rhodopensis	S_Hemichromis.bimaculatus

S_Hypophthalmichthys.molitrix	S_Cobitis.stephanidisi	S_Hemichromis.fasciatus
S_Hypophthalmichthys.nobilis	S_Cobitis.strumicae	S_Hucho.hucho
S_Iberocypris.palaciosi	S_Morone.saxatilis	S_Huso.huso
S_Ictalurus.nebulosus	S_Mugil.cephalus	S_Rutilus.aula
S_Ictalurus.punctatus	S_Mylopharyngodon.piceus	S_Rutilus.basak
S_Ictiobus.niger	S_Neogobius.gymnotrachelus	S_Rutilus.frisii
S_Knipowitschia.caucasica	S_Neogobius.kessleri	S_Rutilus.heckelii
S_Knipowitschia.goerneri	S_Neogobius.melanostomus	S_Rutilus.karamani
S_Knipowitschia.milleri	S_Odonthestes.bonariensis	S_Rutilus.lusitanicus
S_Knipowitschia.panizzae	S_Oncorhynchus.gorbuscha	S_Rutilus.macrolepidotus
S_Knipowitschia.thessala	S_Oncorhynchus.kisutch	S_Rutilus.meidingeri
S_Ladigesocypris.ghigii	S_Oncorhynchus.mykiss	S_Rutilus.ohridanus
S_Lampetra.fluviatilis	S_Oncorhynchus.tschawytscha	S_Rutilus.pigus
S_Lampetra.planeri	S_Orconectes.limosus	S_Rutilus.prespensis
S_Lepomis.auritus	S_Oreochromis.mossambicus	S_Rutilus.rubilio
S_Lepomis.cyanellus	S_Oreochromis.niloticus	S_Rutilus.rutilus
S_Lepomis.gibbosus	S_Osmerus.eperlanus	S_Rutilus.ylikiensis
S_Lethenteron.camtschaticum	S_Osmerus.eperlanus.eperlanus	S_Sabanejewia.aurata
S_Lethenteron.zanandreai	S_Pachychilon.macedonicum	S_Sabanejewia.balcanica
S_Leucaspius.delineatus	S_Pachychilon.pictum	S_Sabanejewia.bulgarica
S_Leuciscus.aradensis	S_Parabramis.pekinensis	S_Sabanejewia.larvata
S_Leuciscus.borysthenicus	S_Pelecus.cultratus	S_Sabanejewia.romanica
S_Leuciscus.burdigalensis	S_Perca.fluviatilis	S_Salaria.fluviatilis
S_Leuciscus.carolitertii	S_Perccottus.glenii	S_Salmo.salar
S_Leuciscus.cephalus	S_Petromyzon.marinus	S_Salmo.trutta.fario
S_Leuciscus.idus	S_Phoxinellus.adspersus	S_Salmo.trutta.lacustris
S_Leuciscus.illyricus	S_Phoxinellus.alepidotus	S_Salmo.trutta.trutta
S_Leuciscus.keadicus	S_Phoxinellus.croaticus	S_Salmothymus.obtusirostris
S_Leuciscus.leuciscus	S_Phoxinellus.epiroticus	S_Salvelinus.alpinus
S_Leuciscus.lucumonis	S_Phoxinellus.fontinalis	S_Salvelinus.fontinalis
S_Leuciscus.microlepis	S_Phoxinellus.ghetaldii	S_Salvelinus.namaycush
S_Leuciscus.montenigrinus	S_Phoxinellus.metohiensis	S_Sander.lucioperca
S_Leuciscus.muticellus	S_Phoxinellus.prespensis	S_Sander.volgensis
S_Leuciscus.pleurobipunctatus	S_Phoxinellus.pstrossii	S_Scardinius.acarnanicus
S_Leuciscus.polylepis	S_Phoxinus.phoxinus	S_Scardinius.erythrophthalmus
S_Leuciscus.pyrenaicus	S_Pimephales.promelas	S_Scardinius.graecus
S_Leuciscus.souffia	S_Platichthys.flesus	S_Scardinius.racovitzai
S_Leuciscus.svallize	S_Pleuronectes.platessa	S_Scardinius.scardafa
S_Leuciscus.torgalensis	S_Poecilia.reticulata	S_Silurus.aristotelis
S_Leuciscus.turskyi	S_Polyodon.spathula	S_Silurus.glanis
S_Leuciscus.ukliva	S_Proterorhinus.marmoratus	S_Squalius.alburnoides
S_Leuciscus.zrmanjae	S_Pseudophoxinus.beoticus	S_Sygnathus.abaster
S_Liza.aurata	S_Pseudophoxinus.minutus	S_Thymallus.baicalensis
S_Liza.ramada	S_Pseudophoxinus.stymphalicus	S_Thymallus.thymallus
S_Liza.saliens	S_Pseudorasbora.parva	S_Tilapia.zillii
S_Lota.lota	S_Pungitius.hellenicus	S_Tinca.tinca
S_Micropterus.dolomieui	S_Pungitius.platygaster	S_Triglopsis.quadricornis
S_Micropterus.salmoides	S_Pungitius.pungitius	S_Tropidophoxinellus.hellenicus
S_Misgurnus.anguillicaudatus	S_Rhodeus.sericeus	S_Tropidophoxinellus.spartiaticus
S_Misgurnus.fossilis	S_Romanichthys.valsanicola	S_Umbra.krameri

S_Valencia.letourneuxi	S_Rutilus.arcasii	S_Umbra.pygmaea
S_Vimba.elongata	S_Zigel.balcanicus	S_Valencia.hispanica
S_Vimba.melanops	S_Zingel.asper	S_Zingel.zingel
S_Vimba.vimba	S_Zingel.streber	S_Zosterisessor.ophiocephalus

Annex 4 - Guilds table

Annex 4-Table 1: *Guilds used within the FAME project (explanation see glossary)*

Feeding Metric	Reproductive Metric	Habitat Metric	Feeding Habitat Metric	Migration metric	Overall Tolerance Metric
Omnivorous	**L**ithophilic	**R**heophilic	**B**enthic	**P**otamodromous	**T**olerant
Invertivorous	**P**hytophilic	**L**imnophilic	**W**ater column	**L**ong distance migrants	**I**ntolerant
Piscivores		**E**urytopic			

Annex 4-Table 2: Fish species in FAME and their attributed guilds (X= yes, empty = no)

Fish species in FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration long	Potamodromous
Abramis_ballerus				X	X					
Abramis_brama		X	X					X		X
Abramis_sapa			X	X	X					
Acipenser_baeri			X		X				X	
Acipenser_gueldenstaedtii			X	X					X	
Acipenser_naccarii			X	X	X					
Acipenser_nudiventris			X	X					X	
Acipenser_ruthenus			X	X						X
Acipenser_stellatus			X	X					X	
Acipenser_sturio			X	X	X			X	X	
Alburnoides_bipunctatus	X			X	X		X			
Alburnus_albidus										
Alburnus_alburnus		X						X		
Alosa_alosa	X			X					X	
Alosa_fallax				X					X	
Alosa_immaculata										
Alosa_killarnensis										

Fish species in FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration long	Potamodromous
Alosa_macedonica					X					
Alosa_maeotica										
Alosa_tanaica										
Alosa_vistonica										
Ambloplites_rupestris			X	X						
Ameiurus_melas		X	X		X			X		
Ameiurus_nebulosus		X	X			X		X		
Anaecypris_hispanica	X									
Anguilla_anguilla		X	X						X	
Aphanius_fasciatus						X	X			
Aphanius_iberus	X					X	X			
Aspius_aspius					X					X
Atherina_boyeri						X				
Atherina_hepsetus										
Atherina_presbyter										
Aulopyge_huegelii										
Barbatula_barbatula			X	X	X					
Barbatula_bureschi										
Barbatula_pindus										
Barbus_albanicus			X					X		
Barbus_barbus			X	X	X					X
Barbus_bocagei		X	X		X			X		X
Barbus_caninus										
Barbus_comizo		X			X			X		X
Barbus_cyclolepis			X	X	X					
Barbus_euboicus			X	X	X					
Barbus_graecus			X		X			X		
Barbus_graellsii		X	X		X			X		X

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Barbus_guiraonis										
Barbus_haasi			X	X	X		X			
Barbus_macedonicus										
Barbus_meridionalis			X	X	X		X			X
Barbus_microcephalus			X		X			X		X
Barbus_peloponnesius			X	X	X					
Barbus_plebejus										
Barbus_prespensis			X		X					
Barbus_sclateri		X	X		X			X		X
Barbus_steindachneri										
Barbus_tyberinus										
Blicca_bjoerkna		X	X					X		
Carassius_auratus		X	X			X		X		
Carassius_carassius		X	X			X		X		
Carassius_gibelio		X	X			X		X		
Chalcalburnus_belvica								X		
Chalcalburnus_chalcoides					X			X		X
Chelon_labrosus										
Chondrostoma_arrigonis										
Chondrostoma_genei										
Chondrostoma_knerii										
Chondrostoma_lemmingii								X		
Chondrostoma_lusitanicum		X								
Chondrostoma_miegii	X		X	X	X					X
Chondrostoma_nasus			X	X	X					X
Chondrostoma_phoxinus										
Chondrostoma_polylepis			X	X	X					X
Chondrostoma_prespense										
Chondrostoma_soetta										
Chondrostoma_toxostoma	X		X	X	X			X		X

Species	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Chondrostoma_vardarense			X	X						
Chondrostoma_willkommii			X	X	X					X
Cichlasoma_facetum		X						X		
Clarius_batrachus										
Clarius_gariepinus						X		X		
Cobitis_arachthosensis			X							
Cobitis_bilineata										
Cobitis_calderoni	X		X	X	X		X			
Cobitis_dalmatina										
Cobitis_elongata										
Cobitis_elongatoides										
Cobitis_hellenica			X			X				
Cobitis_megaspila										
Cobitis_meridionalis			X		X			X		
Cobitis_narentana										
Cobitis_ohridana										
Cobitis_paludica		X	X				X			
Cobitis_punctilineata			X							
Cobitis_rhodopensis										
Cobitis_stephanidisi			X							
Cobitis_strumicae			X							
Cobitis_taenia			X			X				
Cobitis_tanaitica										
Cobitis_trichonica			X			X				
Cobitis_vardarensis			X	X						
Cobitis_vettonica										
Cobitis_zanandreai										
Coregonus_albula	X				X					
Coregonus_autumnalis					X				X	
Coregonus_lavaretus	X				X					X

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Coregonus_muscun										
Coregonus_oxyrinchus					X		X		X	
Coregonus_peled					X					X
Coregonus_pidschian					X				X	
Coregonus_trybomi										
Cottus_gobio	X		X	X	X		X			
Cottus_koshewniko			X	X	X		X			
Cottus_petiti	X		X	X	X		X			
Cottus_poecilopus	X		X	X	X		X			
Ctenopharyngodon_idella		X								
Cyprinus_carpio		X	X			X		X		
Dicentrarchus_labrax							X			
Dicentrarchus_punctatus										
Economidichthys_pygmaeus			X			X				
Economidichthys_trichonis						X				
Eriocheir_sinensis										
Esox_lucius						X				
Eudontomyzon_danfordi										
Eudontomyzon_hellenicus	X		X							
Eudontomyzon_mariae	X		X	X	X					X
Eudontomyzon_stankokaramani										
Eudontomyzon_vladykovi										
Eupallasella_perenurus						X		X		
Fundulus_heteroclitus		X								
Gambusia_affinis		X								
Gambusia_holbrooki		X					X			
Gasterosteus_aculeatus		X						X		
Gobio_albipinnatus			X	X	X					
Gobio_banarescui										
Gobio_benacensis										

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Gobio_elimeius			X	X						
Gobio_gobio			X	X						
Gobio_kesslerii			X	X	X					
Gobio_uranoscopus			X	X	X					
Gymnocephalus_baloni			X	X						
Gymnocephalus_cernuus			X							
Gymnocephalus_schraetser			X	X	X					
Hemichromis_bimaculatus			X				X			
Hemichromis_fasciatus		X	X					X		
Hucho_hucho	X			X	X					X
Huso_huso			X	X					X	
Hypophthalmichthys_molitrix		X								
Hypophthalmichthys_nobilis										
Iberocypris_palaciosi										
Ictalurus_nebulosus										
Ictalurus_punctatus										
Ictiobus_niger										
Knipowitschia_caucasica			X			X				
Knipowitschia_goerneri										
Knipowitschia_milleri			X							
Knipowitschia_panizzae			X				X			
Knipowitschia_thessala										
Ladigesocypris_ghigii							X			
Lampetra_fluviatilis	X		X	X	X				X	
Lampetra_planeri	X		X	X	X					X
Lepomis_auritus										
Lepomis_cyanellus										
Lepomis_gibbosus		X					X			
Lethenteron_camtschaticum										
Lethenteron_zanandreai										

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Leucaspius_delineatus						X		X		
Leuciscus_aradensis										
Leuciscus_borysthenicus					X					
Leuciscus_burdigalensis										
Leuciscus_carolitertii					X		X			
Leuciscus_cephalus				X	X			X		X
Leuciscus_idus				X				X		X
Leuciscus_illyricus										
Leuciscus_keadicus	X			X			X			
Leuciscus_leuciscus				X	X			X		
Leuciscus_lucumonis										
Leuciscus_microlepis										
Leuciscus_montenigrinus										
Leuciscus_muticellus										
Leuciscus_pleurobipunctatus				X				X		X
Leuciscus_polylepis										
Leuciscus_pyrenaicus					X		X			
Leuciscus_souffia	X			X	X					
Leuciscus_svallize							X			
Leuciscus_torgalensis										
Leuciscus_turskyi										
Leuciscus_ukliva										
Leuciscus_zrmanjae										
Liza_aurata								X		
Liza_ramada		X								
Liza_saliens										
Lota_lota			X		X					X
Micropterus_dolomieui										
Micropterus_salmoides		X				X				
Misgurnus_anguillicaudatus										

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Misgurnus_fossilis			X			X				
Morone_saxatilis								X	X	
Mugil_cephalus									X	
Mylopharyngodon_piceus										
Neogobius_gymnotrachelus			X					X		
Neogobius_kessleri			X		X					
Neogobius_melanostomus										
Odonthestes_bonariensis										
Oncorhynchus_gorbuscha										
Oncorhynchus_kisutch				X	X				X	
Oncorhynchus_mykiss				X	X					X
Oncorhynchus_tschawytscha										
Orconectes_limosus										
Oreochromis_mossambicus										
Oreochromis_niloticus										
Osmerus_eperlanus										
Osmerus_eperlanus_eperlanus				X						
Pachychilon_macedonicum										
Pachychilon_pictum			X	X	X			X		
Parabramis_pekinensis										
Pelecus_cultratus								X		X
Perca_fluviatilis		X								
Perccottus_glenii								X		
Petromyzon_marinus	X		X	X	X				X	
Phoxinellus_adspersus										
Phoxinellus_alepidotus										
Phoxinellus_croaticus										
Phoxinellus_epiroticus							X			
Phoxinellus_fontinalis										

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Phoxinellus_ghetaldii										
Phoxinellus_metohiensis										
Phoxinellus_prespensis										
Phoxinellus_pstrossii										
Phoxinus_phoxinus				X	X					
Pimephales_promelas		X						X		
Platichthys_flesus			X							
Pleuronectes_platessa			X							
Poecilia_reticulata										
Polyodon_spathula					X					X
Proterorhinus_marmoratus			X		X					
Pseudophoxinus_beoticus										
Pseudophoxinus_minutus										
Pseudophoxinus_stymphalicus						X		X		
Pseudorasbora_parva		X						X		
Pungitius_hellenicus	X					X	X			
Pungitius_platygaster										
Pungitius_pungitius		X						X		
Rhodeus_sericeus	X									
Romanichthys_valsanicola										
Rutilus_arcasii				X		X		X		
Rutilus_aula										
Rutilus_basak										
Rutilus_frisii				X	X					
Rutilus_heckelii										
Rutilus_karamani										
Rutilus_lusitanicus										
Rutilus_macrolepidotus		X				X				
Rutilus_meidingeri										
Rutilus_ohridanus										

Fish_species_in_FAME	**Intolerant**	**Tolerant**	**Benthic**	**Rheophilic**	**Lithophilic**	**Phytophilic**	**Invertivorous**	**Omnivorous**	**Migration_long**	**Potamodromous**
Rutilus_pigus			X	X						
Rutilus_prespensis										
Rutilus_rubilio										
Rutilus_rutilus		X						X		
Rutilus_ylikiensis								X		
Sabanejewia_aurata			X			X		X		
Sabanejewia_balcanica			X	X		X				
Sabanejewia_bulgarica										
Sabanejewia_larvata										
Sabanejewia_romanica										
Salaria_fluviatilis			X		X		X			
Salmo_salar	X			X	X		X		X	
Salmo_trutta_fario	X			X	X		X			
Salmo_trutta_lacustris	X				X		X			X
Salmo_trutta_trutta	X			X	X		X		X	
Salmothymus_obtusirostris										
Salvelinus_alpinus	X				X					
Salvelinus_fontinalis	X			X	X		X			
Salvelinus_namaycush	X		X		X		X			X
Sander_lucioperca										
Sander_volgensis			X							
Scardinius_acarnanicus						X		X		
Scardinius_erythrophthalmus						X		X		
Scardinius_graecus										
Scardinius_racovitzai										
Scardinius_scardafa										
Silurus_aristotelis			X			X				
Silurus_glanis			X			X				
Squalius_alburnoides						X	X			

Fish_species_in_FAME	Intolerant	Tolerant	Benthic	Rheophilic	Lithophilic	Phytophilic	Invertivorous	Omnivorous	Migration_long	Potamodromous
Sygnathus_abaster										
Thymallus_baicalensis					X		X			
Thymallus_thymallus	X			X	X		X			X
Tilapia_zillii										
Tinca_tinca		X	X			X		X		
Triglopsis_quadricornis			X		X		X			
Tropidophoxinellus_hellenicus						X		X		
Tropidophoxinellus_spartiaticus				X		X	X			
Umbra_krameri			X			X		X		
Umbra_pygmaea		X					X			
Valencia_hispanica	X					X	X			
Valencia_letourneuxi	X					X	X			
Vimba_elongata										
Vimba_melanops										
Vimba_vimba			X	X	X					X
Zigel_balcanicus										
Zingel_asper			X	X	X		X			
Zingel_streber	X		X	X	X					
Zingel_zingel	X		X	X	X					
Zosterisessor_ophiocephalus										

Annex 5 – Glossary for FAME

Abiotic
Refers to nonliving objects, substances or processes (see biotic below).

Anthropogenic
Related to man or human. Changes that people have introduced to the environment are anthropogenic changes.

Applied Partner
“Scientific Partners” in FAME were accompanied by “Applied Partners”. This partner is involved in performing the fish surveys or in fish monitoring for the WFD.

Aquatic Ecosystem
A dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit within water.

Benthic
Benthic fish are fish that live on the sediment surface. The term demersal has also been used for fish living on or near the bottom.

Biodiversity
Biodiversity, or biological diversity, is the number and variety of taxa in ecological systems ranging from parts of communities to ecosystems.

Biomes
Aquatic ecosystems, marine and freshwater may also be regarded as separate biomes.

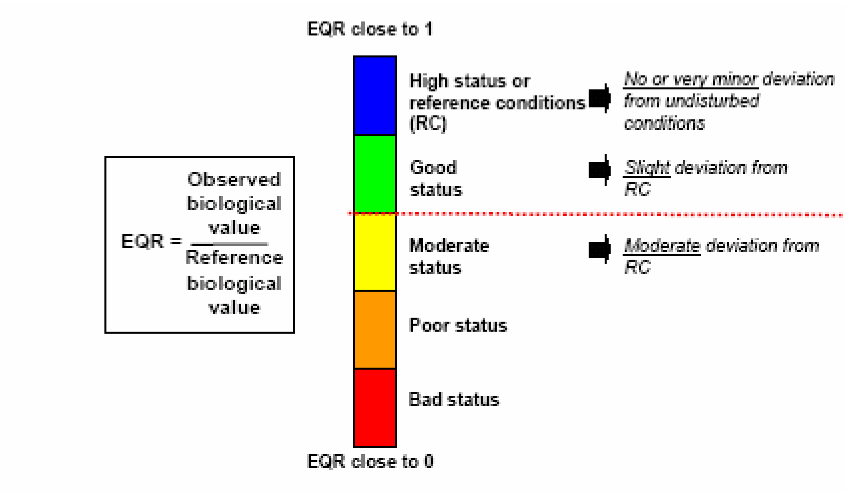
Biotic
Pertaining to any aspect of life, especially to characteristics of entire populations or ecosystems.

Biotic integrity
This is the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region. Or a river has a high biotic integrity when it is undisturbed. The more impacted a river the lower its biotic integrity will be.

Calcareous
Calcareous soils are composed of or contain or resemble calcium carbonate or calcite or chalk. Chalky is a synonym.

Ecological guild
Group of species with similar structural or functional features (e.g. functional feeding group)

Ecological Quality Ratio (EQR)
The ecological quality ratio represents the relationship between the values of the biological parameters observed for a given river and the values for these parameters in the reference conditions. It is expressed as a numerical value between zero and one, with high ecological status represented by values close to one and bad ecological status by values close to zero.



Ecoregion
Areas of relative homogeneity based on land use, soils, topography and potential natural vegetation.

Ecosystem
A dynamic complex ecological unit of plant, animal and micro-organism communities and their non-living environment interacting.

Eurytopic
This are organisms that tolerate a wide range of conditions and that have consequently a very widespread distribution.

FAME
The acronym FAME stands for: Development, Evaluation and Implementation of a standardised Fish-based Assessment Method for the Ecological Status of European Rivers. A Contribution to the Water Framework Directive.

FIDES
FIDES is a large central database of about 15000 fish samples covering 8000 sites in a total of 2700 rivers in 16 European eco-regions contributed by 12 countries.

Fish Shocking or Electrofishing
In order to count all types of fish in a portion of a stream without missing too many, researchers use an electro-shocker. This is the technique of passing electric current through the water to attract and stun fish, thus facilitating their capture.

Habitat
The place or type of environment in which an organism or biological population normally lives or occurs.

Herbivores
Organisms that consume only plant matter.

Holistic
Means based on the principles of the fact that everything in nature is connected in some way. A holistic approach is one that emphasizes the organic or functional relation between parts and the whole.

Invertebrates
Invertebrates are organisms that do not have a backbone.

Insectivore
An animal that mainly feeds on insects.

Lake
According to the WFD a lake is a body of standing inland surface water.

Limnophilic
This is a characteristic related to stagnant waters or the opposite of rheophilic.

Lithophilic
These are rock or gravel spawners with benthic larvae.

Macroinvertebrates
Large organism without a spinal column. Insects, crayfish, and worms are examples of macroinvertebrates.

Macrophytes
Macrophytes are aquatic plants, growing in or near water that are either emergent, submergent, or floating

Metric
A metric is a measurable factor that represents some aspect of biological assemblage structure, function or other community component.

Niche
Hutchinson (1957) defined it as the requirements that the environment hast to meet to allow persistence of a population of a species. These requirements are the tolerable ranges of conditions not influenced by the organism (e.g. salinity) and the tolerable ranges of resources that are depletable (such as food types and nesting sites). One can define it as the status of an organism within its environment and community (affecting its survival as a species).

Organic typology
Soil containing organic remains consisting of plant or animal material.

Omnivore
An animal that feeds on both animal and vegetable matter.

Planktivore
Organisms that consume only plankton.

Plankton
This is the aggregate of small plant and animal organisms (often microscopic) that float or drift in fresh or salt water.

Pelagic
This is the open water zone at a distance from the river banks.

Piscivore
Piscivorous fish eat mainly other fish.

Phytobenthos
Microscopic plants that live in the surface layers of the seabed, particularly in shallow water and intertidal areas.

Phytophilic
Fish that need plants to deposit their eggs. These eggs are adhesive and can be attached to a variety of plants.

Potamodromous
Species that migrate within the river having their entire life cycle occurring within fresh waters of a river system. They exhibit seasonal return movements to spawning areas, usually located upstream and migrate between the reproduction and feeding zones which may be separated by distances that can vary from a few metres to hundreds of kilometres.

Redundant
Metrics are redundant when they provide the same information, that is, they quantify a similar or identical aspect of the fish assemblage. These redundant metrics are alternative ways of representing the same information.

Rheophilic
Rheophilous species are species adapted to fluvial habitats.

Riparian Zone
Riparian zones are areas of transition between aquatic and upland ecosystems. The word riparian is derived from the Latin word ripa, which means bank.

River continuum
Because a river changes constantly as it moves downstream, it can only truly be understood as a continuum. The river continuum concept, first proposed by Vannote and others in 1980, provides a model of changes that might take place as water travels from headwater streams to larger rivers. The river continuum concept provides predictions of the way that biological communities might change from headwater streams to larger rivers.

River group
River groups were defined using hierarchical clustering with fish data (presence/absence) from all main river regions. As such, 11 groups, each having their own typical native fish species, were defined. These groups are automatically calculated in the EFI software.

River Region
In FAME 36 hydrological units were defined using two criteria: each large basin (over 25 000 km^2) was considered as a separate unit characterised by its native fauna list, whereas all smaller basins flowing to the same sea coast were grouped (IHBS Sea area codes).

Seston
Particulate matter suspended in water.

Species composition
The types of species that are present in an observed unit.

Site
A sampling site (also named sampling station in some countries) is defined as a stretch of river representative of the whole river reach in terms of habitat types and diversity, landscape use and intensity of human influence. It should include at least a riffle-run-pool unit, or two meanders.

Siliceous
Siliceous soils contain silica.

Stream biomonitoring
The use of organisms living in the aquatic system as a measure of water quality.

Taxa
The organism or species that fills a systematic category.

Throphic level
This is a position in a food chain e.g. herbivore, invertivore, omnivore and so on. It is related to nutrition.

Sources:

Calow, P., 1998. The encyclopedia of Ecology and Environmental Management. Blackwell Science Ltd., Oxford, 805 pp.

Coweeta LTER Glossary of Terms
U.S. Environmental Protection Agency (USEPA), 2000. Estuarine and coastal marine waters: Bioassessment and biocriteria technical guidance. EPA-822-B-00-024. Office of Water, Washington D.C.