EU tender stomach dataset – Cod in the Eastern Baltic Sea

Background and summary

The current reform of the Common Fisheries Policy anticipates more extensive use of long-term management plans which are consistent with the ecosystem approach to fishery management. Both long term management plans and estimates of the fishing mortality providing MSY are particularly sensitive to changes in natural mortality, and a prerequisite for estimating natural mortality correctly is the accurate knowledge of species interactions for application in multispecies models. The use of historic data in the multispecies models has so far been limited by the need for data to represent a full spatial coverage. However, the recent model developments have made it possible to integrate regional samples of stomach content data into the multispecies and ecosystem models. It is hence no longer necessary to have complete spatial coverage in a given year, before new stomach data can be included into the models. This provided a unique opportunity to utilize the vast amount of historic data available at individual fisheries research institutes.

DTU Aqua together with 8 partners from the Baltic and North Sea has conducted a stomach collection and analysis project in order to (i) include all appropriate historical stomach content information into the Baltic and North Sea stomach content databases, (ii) conduct stomach content analyses of new cod stomachs collected in the Baltic Sea, to support our knowledge of the spatial and temporal stability of cod preferences, and (iii) conduct stomach content analyses of whiting stomachs collected in the Baltic Sea and grey gurnard, mackerel and hake collected in the North Sea to support our knowledge of potentially important predators for which the diet is presently poorly known or is expected to have changed significantly since the last sampling efforts in this area.

All existing and new samples and data are included in the final product of this tender, i.e. a common stomach database, which is here made available to the scientific community via ICES. This database can then be used to re-estimate multispecies reference points such as F_{MSY} of the different fish species.

Within the **Baltic Sea**, efforts were focused on stomach content analyses of **Baltic cod** as the most abundant piscivorous fish in this ecosystem. The latest data in the cod stomach content database are from 1993. Since then, the Baltic has changed markedly. Both abundance and spatial distribution of cod and its major fish prey, herring and sprat have changed. Furthermore, due to the occurrence of extended hypoxic areas on the sea-bed, the availability of benthic food may also have changed dramatically.

In addition to cod, a limited number of **whiting** stomach samples from the westernmost areas of the Baltic were collected and analyzed, as this species is potentially another important piscivorous predator in these regions.

Before the start of the project, pooled stomach content data for 49476 Baltic cod from the period 1977-1993 were available. Since these data are pooled, they are not included in the database. The initial estimate in the proposal for the present stomach tender was that this number could be increased by ca. 170% during the course of the project. However, considerably more data have been made available during the project, especially due to the initial underestimation of the available number of historic data. The new data that have been made available increased the number of data to 255% of the initially available data.

Scope of the database

The database now contains more than 100 000 individual cod stomachs collected between 1993 and 2014 (see Figure 1). The aim is that when new stomachs are collected and analyzed, they will be included in the database.

Quality control

All participating institutes that conducted the actual stomach analyses have extensive experience in this type of work. Due to the large number of Baltic cod stomachs, none of the institutes in the Baltic area had the necessary capacities to analyze all stomach samples alone. Therefore, the stomach samples of Baltic cod have been processed at three locations, i.e. at NMFRI (Poland), DTU Aqua (Denmark) and BIOR (Latvia). This work has been conducted by very experienced personnel, such that a quality control regarding the identification of prey species has not been necessary.

However, in order to analyze potential differences in the interpretation of the digestive status of individual prey items beyond the usual application in multispecies models, the digestive stage of a sub-sample of individual prey items has been evaluated by all 3 institutes. For this purpose, photographs of a total of 76 individual prey items (25 sprat, 19 herring, 26 clupeid fish and 6 cod) have been taken and their digestive status has been judged by all three institutes. Out of the 76 prey items, DTU Aqua and BIOR interpreted the digestive stage of 64 and 65 items identical to NMFRI, corresponding to a match in interpretation of 84% and 86%, respectively.

Appendix B gives an overview and examples of identified issue in the data:

The data have been submitted with variable names for a given prey species. In order to use the database, the names should be unified. Table 2 gives an overview over the prey names in the database, and proposes unified Latin prey names.

In the Latvian data from before 2000, prey weight is NOT given per prey item, but PER PREY SPECIES AND DIGESTIONS STAGE in one single stomach. The example in table 3 shows data for 13 sprat ingested by 1 cod. 5 of the sprat were not length measurable, while 8 were measured. The prey weight of 307.6 grams is for all og the 13 sprat together. Individual weights have not been available for this period of the data. From 2000 onwards, as well as in the data from other countries, prey weight is given per prey specimen.

The stomach data had to be punched in by hand, naturally resulting in punching errors. A quality check to this end has shown, that some prey weights are unrealistically high, however, there is no consistent pattern. These data have not been deleted form the material submitted to the database. A 893 g sprat is highly unreliable, however, there might be border cases where judgment is difficult. Hence, caution should be taken, and using the prey weight data, users should have a look at outliers.

End product

DTU Aqua has worked with the ICES Data Centre and the various contributors to the tender to:

- Collate the datasets into one location
- Standardize references and formats
- Create an online, downloadable dataset
- Secure the dataset for future use by the scientific community

Figure 1: Number of cod stomachs included in the cod stomach content database resulting from the Tender No MARE/2012/02. The data are here represented by 10-year periods and ICES rectangles. The pooled data that so far has been used for multispecies modelling are not shown in this graph.

Stomach database

The current stomach database is stored in a relational database and it is available at the address: http://ecosystemdata.ices.dk/stomachdata

Table 1 give a list of variables in the database:

Record_type	Always 'SS' for single stomach

Quarter	Quarter of the year
Country	Country that collected the data
Ship	Vessel that collected the data
Method	DEM' for pelagic sampling; 'PEL' for pelagic sampling; 'OTM' for other method
Square	ICES square
Haul_number	Haul number unique for Country, year, quarter and ship
Fish_ID	Fish ID unique for Country, year, quarter and ship
Temperature	°C
Year	
Month	
Day	
Predator_code	AphiaID CODES
Length	Predator length in cm
Number_with_food	As the predators are analyzed individually there is either a 1 or nothing
Number_regurgitated	As the predators are analyzed individually there is either a 1 or nothing
Number_with_skeletal_remains	As the predators are analyzed individually there is either a 1 or nothing
Number_empty	As the predators are analyzed individually there is either a 1 or nothing

Prey_species_code	AphiaID CODES
Latin name	Prey latin name (see Appendix 2)
Prey_size	cm
prey_weight	grams
Prey_number	
Stage_of_digestion	0= Intact prey (skin, fins, legs and flesh is complete), 1= partially digested prey (prey in more advanced stages of digestion), 2= partially digested prey (prey in more advanced stages of digestion), 3= skeletal material (no flesh, only bones, shells, otoliths)

Acknowledgements

We highly acknowledge the great efforts of all people involved in the opportunistic collection of stomach samples at sea, mainly on the BITS (Baltic International Trawl Survey), but also on various other research cruises. In particular, we would like to thank Holger Haslob, Jan Dierking, Burkhard von Dewitz and colleagues from GEOMAR (Helmholtz Centre for Ocean Research Kiel, Germany) as well as Romas Statkus and Marijus Spegys from the Fishery Service under the Ministry of Agriculture, Lithuania for their willingness to opportunistically collect and provide stomach samples for the present project, despite not being official partners.

We also would like to thank Anna Osypchuk and Carlos Pinto from the ICES data center for their assistance to incorporate the stomach data in to the ICEs database, also despite not being official partners.

Special thanks to BIOR (Institute of Food Safety, Animal Health and Environment, Fish Resources Research Department, Latvia) for making the long term data from back to 1963 available for the database.

Without the help of all the people involved in the stomach collection at sea, we would not have been able to achieve such a broad coverage of stomach content data in time and space.

Data Acknowledgement

Please acknowledge the following data sources when using the data:

ICES Stomach Dataset 2010, ICES, Copenhagen

DTU Aqua – Technical University of Denmark, National Institute of Aquatic Resources, Denmark

NMFRI - National Marine Fisheries Research Institute, Poland

BIOR - Institute of Food Safety, Animal Health and Environment, Fish Resources Research Department, Latvia

TI-OF - Institute of Baltic Sea Fisheries, Johann Heinrich von Thünen Institute, Federal Research Institute for Rural Areas, Forestry and Fisheries, Rostock, Germany

SLU - Swedish University of Agricultural Sciences, Department of Aquatic Resources, Sweden

Contact:

Web : http://ecosystemdata.ices.dk/stomachdata
Email: stomachdata@ices.dk
Tel : +45 3338 6700

Web : http://info.ices.dk/data
Email: accessions@ices.dk

Tel : +45 3338 6700

Appendix A

Data Policy

In October 2005, the ICES Council adopted a new Data Policy having considered that

A) ICES is committed to openness for the scientific process and to free access to scientific data;

B) ICES recognises that proper data interpretation requires insight into the sampling design, compilation, and analysis;

C) To ensure proper interpretation of the data, data sources may define access procedures either as a general policy or in relation to specific datasets;

D) By making the data publicly available, data contributors and users continue to make ICES the focal point for data in the NE Atlantic area and serve the scientific community.

ICES Data Policy 2006 (http://info.ices.dk/datacentre/datapolicy.asp) applies to data submitted from May 1, 2006.

For data submitted prior to May 1st, 2006, data sources will be contacted individually and may specify access restrictions in agreement with ICES. The former Data Policy of 1994 can be found http://info.ices.dk/Datacentre/PreMay2006_data_policy.pdf.

ICES Data Policy 2006 conforms to the IOC Oceanographic Data Exchange Policy (http://www.iode.org/index.php?option=com_content&task=view&id=51&Itemid=95).

Appendix B – Data quality issues

Latin prey names in the database

The data been submitted with variable names for a given prey species. In order to use the database, the names should be unified. Table 2 gives an overview over the prey names in the database, and proposes unified Latin prey names:

Latin name (as in the database)	Correct
Q	Lost
Algae	Algae
Algea	Algae
Unidentified algae covered with eggs	Algae covered with eggs
Ammodytes tobianus	Ammodytes tobianus
Ammodytidae	Ammodytidae
Amphibalanus improvisus	Amphibalanus improvisus
Amphipoda	Amphipoda
Eel	Anguilla anguilla
Unidentified worm	Annelida
Wood	Annelida
Annelida	Annelida
Annelidae	Annelida
Worm	Annelida
A. islandica	Arctica islandica
Aurelia aurita	Aurelia aurita
Bathyporeia pilosa	Bathyporeia pilosa
Belone belone	Belone belone
Bivalvia	Bivalvia
Bylgides sarsi	Bylgides sarsi
Bylgides	Bylgides sp.
Caprellidae	Caprellidae
Carbon	Carbon

carbon	Carbon
Cardium edule	Cardium edule
Cerastoderma glaucum	Cerastoderma glaucum
Chicken bone	Chicken bone
Clay	Clay
Clupea	Clupea harengus
C. harengus	Clupea harengus
Clupea harengus	Clupea harengus
Herring	Clupea harengus
Clupeidae	Clupeidae
Clupeidiae ssp	Clupeidae
Clupeidae scales	Clupeidae Scales
Copepoda	Copepoda
Corophium volutator	Corophium volutator
Cottidae	Cottidae
Cottus gobio	Cottus gobio
C. crangon	Crangon crangon
Crangon crangon	Crangon crangon
Crustacea	Crustacea
Crustacea ssp	Crustacea
cumacea	Cumacea
Cumacea	Cumacea
cummaceer sp.	Cumacea
Diastylis rathkei	Diastylis rathkei
e	Empty
Emty	Empty
R. cimbrius	Enchelyopus cimbrius
Enchelyopus cimbrius	Enchelyopus cimbrius
Four-bearded rockling	Enchelyopus cimbrius
Enchelyopus eggs	Enchelyopus cimbrius Eggs
Fucus	Fucus sp.
Gadidae	Gadidae

Gadidae ssp	Gadidae
Filet of Cod	Gadus morhua
Cod	Gadus morhua
G. morhua	Gadus morhua
Gadus morhua	Gadus morhua
Cod Eggs	Gadus morhua Eggs
Cod stomach	Gadus morhua Stomach
Gammarus	Gammarus sp.
Gammarus sp.	Gammarus sp.
Gasterosteus aculeatus	Gasterosteus aculeatus
Gastropoda	Gastropoda
Gastrosaccus spinifer	Gastrosaccus spinifer
Gobiidae	Gobiidae
Goby	Gobiidae
H. spinulosus	Halicryptus spinulosus
Halicryptus spimulosus	Halicryptus spinulosus
Halicryptus spinulosus	Halicryptus spinulosus
Hediste divericolor	Hediste diversicolor
Hediste diversicolor	Hediste diversicolor
Hediste diversicolos	Hediste diversicolor
Hydrobia	Hydrobia sp.
Hydrobia sp.	Hydrobia sp.
H. galba	Hyperia galba
Hyperia galba	Hyperia galba
Hyperoplus lanceolatus	Hyperoplus lanceolatus
Idotea balthica	Idotea balthica
Idotea Balthica	Idotea balthica
Insect	Insecta
Insecta	Insecta
Unidentified invertebrata	Invertebrata
Isopoda	Isopoda
Lampetra fluviatilis	Lampetra fluviatilis

Limanda limanda	Limanda limanda
Lumpenus lampretaeformis	Lumpenus lampretaeformis
M. baltica	Macoma balthica
Macoma balthica	Macoma balthica
Whiting	Merlangius merlangus
Mollusca	Mollusca
Monoporeia affinis	Monoporeia affinis
Pontoporeia affinis	Monoporeia affinis
Mya arenaria	Mya arenaria
Myoxocephalus quadricornis	Myoxocephalus quadricornis
Myoxocephalus quadricornis eggs	Myoxocephalus quadricornis Eggs
Myoxocephalus scorpius	Myoxocephalus scorpius
Mycidea ssp.	Mysidae
mysidae	Mysidae
Mysidae	Mysidae
Mysis mixta	Mysis mixta
Mysis oculata	Mysis oculata
Mysis relicta	Mysis relicta
Mytilidae sp.	Mytilidae
Mytilus edulis	Mytilus edulis
Neogobius melanostomus	Neogobius melanostomus
Round goby	Neogobius melanostomus
Neomysis integer	Neomysis integer
Nylon tred	Nylon thread
O. eperlanus	Osmerus eperlanus
Osmerus eperlanus	Osmerus eperlanus
Ostracoda	Ostracoda
Palaemon elegans	Palaemon elegans
Palaemon sp.	Palaemon sp.
Perca fluviatilis	Perca fluviatilis
Pholis gunnellus	Pholis gunnellus

Entrails	Pisces
Unidentified fish	Pisces
Fish	Pisces
Pisces	Pisces
pisces	Pisces
Fish remains	Pisces
Fish eggs	Pisces Eggs
plastic	Plastic
Plastic	Plastic
Plastik	Plastic
Flounder	Platichthys flesus
Platichthys flesus	Platichthys flesus
Place	Pleuronectes platessa
Polychaeta	Polychaeta
polychaeta sp.	Polychaeta
Pomatoschistus microps	Pomatoschistus microps
Pomatoschistus minutus	Pomatoschistus minutus
Pomatoschistus	Pomatoschistus sp.
Pomatoschistus otholyth	Pomatoschistus sp. Otholyth
Pontoporeia femorata	Pontoporeia femorata
Pontoporeia	Pontoporeia sp.
Praunus flexuosus	Praunus flexuosus
Praunus inermis	Praunus inermis
Priapulida	Priapulidae
Priapulidae	Priapulidae
Priapulus caudatus	Priapulus caudatus
Nine-spined stickleback	Pungitius pungitius
r	Regurgitated
Rutilus rutilus	Rutilus rutilus
Saduria entemone	Saduria entomon
Saduria entomon	Saduria entomon
Saduria entomon eggs	Saduria entomon Eggs

Salmon stomach	Salmon Stomach
Sand	Sand
Sander lucioperca	Sander lucioperca
Scales	Scales
scales	Scales
Scoloplos armiger	Scoloplos armiger
Scyphozoa	Scyphozoa
Fifteen-spined stickleback	Spinachia spinachia
Spinachia spinachia	Spinachia spinachia
Spine	Spine
S. sprattus	Sprattus sprattus
sprat	Sprattus sprattus
Sprat	Sprattus sprattus
Sprattus sprattus	Sprattus sprattus
Sprat eggs	Sprattus sprattus Eggs
Stickelbacks	Stickleback
Stickleback	Stickleback
ston	Stone
Stone	Stone
stone	Stone
Synchaeta	Synchaeta sp.
Broad-nosed pipefish	Syngnathus typhle
Taurulus bubalis	Taurulus bubalis
Taurulus bubalis eggs	Taurulus bubalis Eggs
Terebellides stoemi	Terebellides stroemii
Terebellides stroemi	Terebellides stroemii
Horse mackerel	Trachurus trachurus
Siphon	Unidentified mass
Spawn	Unidentified mass
Usp	Unidentified mass
USP	Unidentified mass
Other	Unidentified mass

Unidentified remains	Unidentified mass
Undefined mass	Unidentified mass
Unidentified mass	Unidentified mass
Waste	Waste
Vimba vimba	Vimba vimba
V. viviparus	Zoarces viviparus
Zoarces viviparus	Zoarces viviparus
Zoarces viviparus eggs	Zoarces viviparus Eggs
Zooplancton	Zooplankton

Prey weight in the historical Latvian data

In the Latvian data from before 2000, prey weight is NOT given per prey item, but PER PREY SPECIES AND DIGESTIONS STAGE in one single stomach. The example below shows data for 13 sprat ingested by 1 cod. 5 of the sprat were not length measurable, while 8 were measured. The prey weight of 307.6 grams is for all og the 13 sprat together. Individual weights have not been available for this period of the data. From 2000 onwards, as well as in the data from other countries, prey weight is given per prey specimen.

Table 3: Prey weight in the historical Latvian data

Country	Fish_ID	Year	Month	Day	Latin name	Prey_size	prey_weight	Prey_number
LAT	15	1975	04	12	Sprattus sprattus		307.6	5
LAT	15	1975	04	12	Sprattus sprattus	14.60	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	14.50	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	14.00	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	13.50	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	13.20	307.6	1

LAT	15	1975	04	12	Sprattus sprattus	13.10	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	13.00	307.6	1
LAT	15	1975	04	12	Sprattus sprattus	12.90	307.6	1

Punching errors

The data have been checked for punching errors, and some prey weights appear too high. 2 examples are given in the table below:

Country	Fish_ID	Year	Month	Day	Latin name	Prey_size	prey_weight
LAT	157	2004	03	14	Sprattus sprattus		324
LAT	35	2008	03	11	Sprattus sprattus	10.50	893

These data have not been deleted form the material submitted to the database, however, a 893 g sprat is highly unreliable. For this case it might not be a problem, but there are border cases where judgment is difficult. Hence, caution should be taken, and using the prey weight data, users should have a look at outliers.