ICES Survey Protocols – Offshore Beam Trawl Surveys, Coordinated by Working group on Beam Trawl Surveys (WGBEAM)

Volume 69 I January 2023

ICES TECHNIQUES IN MARINE ENVIRONMENTAL SCIENCES

Version 04

Update of Series of ICES Survey Protocols (SISP) 14

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
CIEM CONSEIL INTERNATIONAL POUR L'EXPLORATION DE LA MER

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

Series editor: Tatiana Tsagaraki
Prepared under the auspices of ICES Working group on Beam Trawl Surveys (WGBEAM), and internally reviewed by ICES Ecosystem Observation Steering Group Chair (Joël Vigneau; co-editor for ICES Survey Protocols)
Peer-reviewed by Maria Teresa Spedicato (COISPA Technology and Research, Italy) and Donald S. Clark (retired)

ISBN number: 978-87-7482-978-2
ISSN number: 2707-6997
Cover image: Héðinn Valdimarsson, Marine and Freshwater Research Institute, Iceland

ICES Techniques in Marine Environmental Sciences

Volume 69 I January 2023

ICES Survey Protocols – Offshore Beam Trawl Surveys, Coordinated by Working group on Beam Trawl Surveys (WGBEAM)

Version 04

Update of Series of ICES Survey Protocols (SISP) 14 - https://doi.org/10.17895/ices.pub.5353

Authors

Ingeborg J. de Boois • Gary Burt • Jean-Baptiste Lecomte • Francesco Masnadi • Kay Panten • Heleen Raat • Gudjon M. Sigurdsson • Magnús Thorlacius

Recommended format for purpose of citation:

de Boois, I. J., Burt, G., Lecomte, J.-B., Masnadi, F., Panten, K., Raat, H., Sigurdsson, G. M., Thorlacius, M. 2023. ICES Survey Protocols – Offshore beam trawl surveys, coordinated by Working group on Beam Trawl Surveys (WGBEAM). Version 04. ICES Techniques in Marine Environmental Sciences Vol. 69. 70 pp. https://doi.org/10.17895/ices.pub.21603336

ICES International Council for the Exploration of the Sea
CIEM Conseil International pour l'Exploration de la Mer

Contents

I Background i

II Version history v

1 Survey objectives 1

2 Data and reporting 2

2.1 Data availability and data products 2

2.2 Reporting of survey performance and results 2

2.3 Guidance for data use (analysis and caveats) 3

2.3.1 Swept-area calculation 3
2.3.2 Treatment of biological information 4
2.3.3 Data use for flatfish stock assessments 4
2.3.4 Use for elasmobranch stock assessments 6
2.3.5 Use for biodiversity and/or length distributions 6

3 Current survey sampling designs 8

3.1 Sampling areas and periods 8

3.2 Survey stratification 8

3.2.1 Fixed station design 8
3.2.2 Stratified random design 10
3.2.3 Systematic design 11

3.3 Survey gears 11

3.3.1 Variety of beam trawls 11
3.3.2 Overview by country 12

4 Observation methodologies 14

4.1 Haul procedures 14

4.1.1 Haul duration 14
4.1.2 Fishing speed 15
4.1.3 Warp length 15

4.2 Catch processing 15

4.3 Subsampling 16

4.4 Species sorting and identification 17

4.4.1 Finfish and elasmobranch species 17
4.4.2 Other species 17
4.4.3 Exceptions 18

4.5 Length measurements 19

4.5.1 Finfish and elasmobranch species 19
4.5.2 Other species 19
4.5.3 Exceptions 19

4.6 Biological Information (age, sex, maturity) 20

4.6.1 Biological information collected 20
4.6.2 Stratification of biological samples 26
4.6.3 Processing of age material 26

5 Additional data 31

5.1 Environmental data 31

5.2 Marine litter 31
6 Data recording and storage 32
6.1 Recording trawl information 32
6.2 Recording catch and biological information 32
6.3 Data storage 33
6.3.1 Trawl, catch, and biological information 33
6.3.2 Environmental data 33
6.3.3 Litter data 33
7 Quality assurance 34
7.1 National manuals 34
7.2 Gear 34
7.3 Subsampling 35
7.4 Species identification 35
7.5 Data quality 36
8 History of the surveys by area 37
8.1 North Sea and eastern English Channel 37
8.1.1 Belgian offshore beam trawl survey 37
8.1.2 German survey 37
8.1.3 Dutch offshore beam trawl survey 37
8.1.4 Eastern English Channel survey [UK (Cefas)] 43
8.2 Irish Sea and Bristol Channel survey [UK (Cefas)] 44
8.3 Western English Channel, Celtic Sea, and southwest of Ireland [UK (Cefas)] 44
8.3.1 Sampling design 2006–2012 45
8.3.2 Sampling design 2013–2015 46
8.3.3 Sampling design since 2016 46
8.4 Ceased survey: Western English Channel survey [UK (Cefas)] 47
8.5 Bay of Biscay survey (France) 47
8.6 Adriatic Sea survey (Italy, Slovenia, and Croatia) 48
8.7 Iceland Sea survey (Iceland) 48
8.8 History and developments of the survey gears 49
References 50
Annex 1: Author contact information 51
Annex 2: List of abbreviations and acronyms 52
Annex 3: Overview of WGBEAM offshore surveys (current situation) 53
Annex 4: Beam trawl dimensions 56
Annex 5: Geographic distribution of the surveys 63
Annex 6: Biological sampling stratification areas 65
Annex 7: Closed species lists offshore beam trawl surveys 67
Annex 8: Maturity key for skates and rays (Rajidae) 69
Annex 9: Guidelines for starting a new beam trawl survey 70

I Background

Six countries [Belgium, France, Germany, Iceland, the Netherlands, and UK (England)] are participating in the offshore beam trawl surveys in ICES area. This manual also addresses the beam trawl survey in the Mediterranean, conducted by Italy, Slovenia, and Croatia, to comply with the EU obligation to coordinate surveys under the European Union (EU) Data Collection Framework (DCF), as no other beam trawl surveys take place in the Mediterranean. WGBEAM also coordinates inshore beam trawl surveys (Beier *et al.*, in prep.), and industry beam trawl surveys (described in national manuals). The present manual has its origin in national manuals for offshore beam trawl surveys, and can be considered the public version of the national manuals, which are often access-restricted (see Section 7.1).

In total, data are collected during nine offshore research surveys, which reach from Iceland Sea to the Irish Sea, Eastern and Western Channel, North Sea, Bay of Biscay, and Adriatic Sea (Figure I.1, Annex 3). The surveys are conducted annually, and the sampling season of each survey depends on its specific goals (Table I.1, Annex 3).

Figure I.1. Overview of sampling areas (map base obtained from https://data.ices.dk/view-map). Detailed maps can be found in Annex 5.

Beam trawls are towed over the seabed. They consist of a heavy tubular steel beam supported by steel beam heads at each end, with shoes at the bottom which slide over the seabed. As a result of the rigid construction, the gears have a fixed width. Beam trawls of 3.5, 4, 7, and 8 m are used by the surveys in this manual (example in Figure I.2, details in Table I.1 and Annex 4). The beam width is mainly determined by practical considerations, primarily the size of the vessel and the fishing method (over the side vs. over the stern). The rigging of the beam trawls is directly related to the sampling area (bottom structure) and can consist of chain mats or

chains. All surveys use a 40-mm mesh in the codend, and, in principle, the same towing speed (4 knots). During most surveys, tows are conducted for 30 min at a speed of 4 knots. In general, fishing is conducted during daytime, with the exception of the survey in Iceland Sea where it is also conducted at night-time.

Figure I.2. Example of a beam trawl (used in the Dutch survey) with its elements indicated.

The surveys in this manual have independent origins and have not been harmonized into a single survey design. Although the history and background of the surveys varies, the current objectives are similar for all areas:

- Data collection to create fisheries-independent abundance indices by age group (1-year old and older) for a number of demersal fish species (e.g. plaice, sole, dab, lemon sole, flounder, turbot, brill, and monk fish) for the sampled area.
- Collection of biological data, including length measurements, on all fish species, including elasmobranch species, for ecosystem analysis purposes.
- Collection of data on at least a selection of epibenthos species for ecosystem analysis purposes.
- Collection of environmental data (at least temperature, salinity).
- Collection of marine litter data [1].

The abundance indices, and the information on elasmobranch species distribution and marine litter, are supplied to the relevant ICES working groups. Data from the surveys in the North and Celtic seas are also used by OSPAR for the Large Fish Index (LFI), one of the indicators related to the EU Marine Strategy Framework Directive (MSFD).

Due to differences in the rigging, a direct comparison across survey areas is not possible without a thorough scientific investigation. Combining information from different gears and/or areas is possible, as long as the spatial coverage of the respective gears has remained constant over time, or by using a model-based approach that is able to handle changes in coverage. Comparative tows have been conducted over time, although not systematically.

[1] Marine litter, or litter, refers in this document to marine macrolitter collected from the fish trawl hauls.

Table I.1. Summary of beam trawl surveys and gear characteristics. Detailed overviews can be found for the surveys in Annex 3 and for the gears in Annex 4. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia; UK: UK (Cefas).

Survey area	**North Sea and eastern English Channel (ICES area 4, 7d)**				**Western English Channel and Celtic Sea**	**Irish Sea and Bristol Channel**	**Bay of Biscay**	**Adriatic Sea**	**Iceland Waters**
Country	BE	DE	NL	UK	UK	UK	FR	IT-SI- HR	IS
Survey area	4bc [a] west	4b [a] east	4bc [a]	7d [a], 4c [a]	7efghj [a]	7afg [a]	8ab [a]	GSA17 [b]	5a [a]
Survey start	1992	1991	1985	1988	2006	1988	2007	2005	2016
Survey period	Aug/Sep	Aug/Sep	Aug/Sep	Jul	Feb–Apr	Sep	Nov/Dec	Nov/Dec	Aug/Sep
Num. survey days	10	11	35	14	30	21	22–27	15–20	16
Stations per year	62	63	146	79	131	108	45–55	67	81
Standard tow	30 min	30 min	30 min	30 min	2 nmi (~30 min)	30 min	30 min	30 min	30 min
Fishing speed (knots)	4	4	4	4	4	4	5	5.5	4
Beam width (m)	4	7	8	4	4	4	4	3.5	4
Gear attachments [1]	m	t	t(f)	m	m	m	t	none	m
Environmental sampling instrument [2]	CTD	CTD	CTD	CTD	CTD	CTD	SCANMAR temperature unit	CTD	CTD

[1] m: chain mat; t: tickler chains; f: flip-up rope.

[2] See Section 5.1

[a] ICES area

[b] GFCM geographical subarea

Table I.2. Summary of changes in data collection or reporting in offshore research beam trawl surveys (see Section 8 for details and a full tabular overview, including other changes, such as vessel changes and expansion of survey coverage). BE: Belgium; DE: Germany; NL: the Netherlands; UK: UK (Cefas); CPUE: Catch-per-unit-effort

Year	Geographic region	Type of change	Description of change	Effect of change on data use
2021	All areas	Data reporting	All countries: If the catch of two nets has been sorted as one sample, GearExp = DB (double beam) should be entered, otherwise SB (single beam). -9 can assumed to be SB	Data from NL beam trawl survey before 2002 have been affected. For CPUE calculation, the methodology in Section 2.3.1 should be used. For CPUE calculation per hour, haul duration should be multiplied by 2 for GearExp = DB
2019	All areas	Data collection	All countries: Maturity information is collected for most species, despite the recommendation in ICES (2010)	Maturity information available for most species (except dab). However, macroscopic maturity information collected outside the optimal period (two months prior to and until the end of the spawning period) should be treated with care
2017	North Sea	Data collection	NL: Litter collection in ICES Area 4c	Litter data available
			NL: Registration of sampled weight by species in ICES Area 4c	Weight data by species available
2017	North Sea	Data collection	BE: Vessel change	Full sampling possible (comparable with 2011–2014)
2015, 2016	North Sea	Data collection	BE: Minimum sampling	Only the absolute minimum sampling could be carried out due to a vessel change, resulting in sampling according to the period before 2010
2011	North Sea	Data collection	BE: Litter data collection started DE: Litter data collection started NL: Litter data collection started (central North Sea)	Litter data available
2010	North Sea	Data collection	BE: Length information for all fish species	Length data available for fish species other than plaice and sole
2010	All areas	Data collection	All countries: Maturity information is only collected from two months prior to spawning season and until the end of the spawning season [following ICES (2010)]	Limited information on maturity (e.g. in Q3 surveys absent for plaice, sole, dab, turbot, and brill)
2009	North Sea, eastern English Channel	Data collection	UK: Litter data collection started	Litter data available
2009	North Sea	Data collection	BE: Epibenthos registeration started	Data on epibenthos available

II Version history

WGBEAM is responsible for the manual for offshore beam trawl surveys. Prior to 2019, survey details were included in the annual WGBEAM reports [2]. In 2019, the first full manual for offshore surveys was released in the Series of ICES Survey Protocols (SISP) as SISP 14 (ICES, 2019). It is recorded as version 3.4.

Date	Version	Changes
2022-04-01	4 (TIMES 69)	Format changed to fit the standard for ICES Techniques in Marine Environmental Sciences (TIMES) series. Tabular overview of changes added (Table 8.1). Data use: Section on elasmobranchs added. Number of stations in Dutch survey changed in southeastern North Sea and German Bight. Italian-Slovenian-Croatian survey: • Link to Italian-Slovenian-Croatian manual added. • Information on *Ostrea* spp., brill, turbot, and deep-water rose shrimp measurements added. • Tables updated. • Text on marine litter collection updated. • Information on data use updated. • Information on the history of the survey updated.
2019-04-15	3.5 (SISP 14) ICES (2019)	First full version of the manual.
Prior to 2019	Multiple	Survey descriptions were part of WGBEAM annual reports [2].

[2] https://ices-library.figshare.com/search?q=%3Atitle%3A%20WGBEAM&sortBy=publication_date&sortType=desc&groups=37170,37188. Last accessed November 2022

1 Survey objectives

The impetus for all the beam trawl surveys in this manual is the need for fisheries-independent information on commercial flatfish species. The prime target species and type of beam trawl are set depending on the survey area and/or the relevance of the species for the national or EU fisheries. Nowadays, one of the driving forces for the EU countries involved in the surveys is the data needs specified by DCF.

Over time, data collection within the surveys has expanded due both to a shift towards a more ecosystem-related general focus and to new data requests by end-users. As a consequence, the collection of epibenthos data has become more detailed over time and age data are collected for more species than at the time the surveys were developed.

The current survey objectives are similar for all areas:

- Data collection to create fisheries-independent abundance indices by age group (1-year olds and older) for a number of fish species [e.g. plaice (*Pleuronectes platessa*), sole (*Solea solea*), dab (*Limanda limanda*), lemon sole (*Microstomus kitt*), flounder (*Platichthys flesus*), turbot (*Scopthalmus maximus*), brill (*Scophthalmus rhombus*), and monk fish (*Lophius* spp.)] for the sampled area.
- Data collection to create fisheries-independent abundance indices for mantis shrimp (*Squilla mantis*), caramote prawn (*Mazzancolla* sp.), and common cuttlefish (*Sepia officinalis*) in the Mediterranean Sea.
- Collection of biological data, including length measurements, on all fish species, including elasmobranch species, for ecosystem analysis purposes.
- Collection of data on at least a selection of epibenthos species for ecosystem analysis purposes.
- Collection of environmental data (at least temperature and salinity).
- Collection of marine litter data.

The end-users of the offshore beam trawl survey data have traditionally been stock assessment groups working within ICES Area or the Mediterranean Sea. These groups use the data from offshore research surveys as fisheries-independent sources of information, often as tuning series for the stock assessment models.

Over the past decades, data collection and use has broadened to meet ecosystem assessment as well as fisheries requirements. They are used by OSPAR and ICES ecosystem-focused working groups, and by MSFD for the EU Member States. As an example, ICES Working Group on Marine Litter (WGML) requested data collection on marine litter from the trawl survey catches.

Finally, the wider audience frequently uses data from the surveys. With the exception of the Icelandic survey, all survey data are publicly available via ICES data portal [3] (on ICES Database of Trawl Surveys (DATRAS) [4] and on the ICES Oceanographic Database [5]).

[3] https://data.ices.dk/view-map. Last accessed 24 November 2022.

[4] https://www.ices.dk/data/data-portals/Pages/DATRAS.aspx. Last accessed 24 November 2022.

[5] https://www.ices.dk/data/data-portals/Pages/ocean.aspx. Last accessed 24 November 2022.

2 Data and reporting

2.1 Data availability and data products

The data of all beam trawl survey, except the Iceland Sea survey (request pending), are uploaded to, and can be downloaded from DATRAS [6]. This applies to both the biological and marine litter data. Data submission deadlines [7] are set by WGBEAM based on the completion of age reading and data checks.

For the surveys in ICES areas 4, 7, and 8, a calculated data product is available: CPUE (catch per unit effort) per length per hour and swept area. CPUE are available for all countable species, and are standardized to a swept area of 1 km^2 and to 1 h of fishing. This product can be used for determining length–frequency distributions, as well as for calculating CPUE over a larger area. It should be noted that weight information is not consistently available for all species and/or surveys.

For the surveys in ICES areas 4 and 7, the DATRAS calculated products ALK (age–length key) and SMALK (smoothed age–length key) are available for all species for which age data are available (Section 4.6.1).

Data from the offshore beam trawl surveys can be downloaded directly from DATRAS, either as a product [8] (survey = BTS; BTS-VIII; BTS-GSA17), or by using the existing webservices [9].

Requests for new data products can be sent to datrasadministration@ices.dk, or, if the request comes from an ICES Working Group, it can be handed in via the ICES recommendations database directed to DATRAS team, WGBEAM, and ICES Working Group on DATRAS Governance (WGDG).

2.2 Reporting of survey performance and results

Reporting on the surveys is done annually in the WGBEAM report [10]. A tabular survey summary is provided for all beam trawl surveys in the report, and also sent separately to known ICES end-user groups meeting before the WGBEAM report is ready, and contains:

- Survey, country
- Area coverage
- Running since
- Methodology described in
- Information to ICES assessment working group
- Data availability
- Comments on last year's survey
- Data collected

[6] https://www.ices.dk/data/data-portals/Pages/DATRAS.aspx. Last accessed 24 November 2022.

[7] https://www.ices.dk/data/data-portals/Pages/DATRAS-deadlines.aspx. Last accessed 24 November 2022.

[8] https://datras.ices.dk/Data_products/Download/Download_Data_public.aspx. Last accessed 24 November 2022.

[9] https://datras.ices.dk/WebServices/Webservices.aspx. Last accessed 24 November 2022.

[10] Latest version to be obtained via: https://www.ices.dk/community/groups/Pages/wgbeam.aspx. Last accessed 02 January 2023.

If possible, a presentation session on the surveys of the previous year is organized for WGBEAM and end-users during the annual group meeting. Upon request, the WGBEAM Chair can present the surveys to end-user groups during their annual meeting.

WGBEAM also evaluates the survey results by geographic area and species, and presents the outcomes in the annual working group report [10]. As a minimum, the abundance indices for plaice and sole are evaluated, and species identification consistency is checked by region. The latest overview of the WGBEAM terms of reference can be found on the group webpage [11].

2.3 Guidance for data use (analysis and caveats)

This section provides guidance on how to best interpret the data from beam trawl surveys for a number of data use scenarios, and summarizes the main sampling differences among surveys. For all user scenarios the following rule applies: when it is unclear if signals in a time-series are caused by a change in sampling strategy, by a change in data submission, or by something else, it is recommended to contact the data submitter for the country (via datrasadministration@ices.dk) or the country WGBEAM representative (this information can be found in latest WGBEAM report [11]).

Questions regarding the data (e.g. detection of presumed errors), can be directed to datrasadministration@ices.dk (WGBEAM Chair should be on CC on the e-mail [11]). The question will then be forwarded to the national data submitter. In all cases the question, urgency, and relevance should be clearly specified. It is recommended that non-offensive language is used, even when there is an urgent need for an answer.

Despite the similarity in objectives and sampling protocols, the survey designs and sampling gears remain sufficiently diverse that the production of indices across several surveys or survey areas remains complex and usually requires a model-based approach. Generally, such approaches depend on the objective and are difficult to generalize across species.

Due to the nature of surveys (fieldwork at sea within a relatively fixed time frame), sampling intensity can vary due to unforeseen circumstances [e.g. meteorological conditions or invalid tows due to sudden appearance of blooms of species (e.g. blooms of *Electra pilosa* that affected the Dutch survey in 2021 and 2022)] and/or spatial limitations that prevent fishing (e.g. wind farms and marine protected areas). To account for these differences, as well as for the differences in survey setup, a modelling approach can be used for data analyses.

Most data variables in DATRAS are self-explanatory, or their meaning can be looked up in the DATRAS documentation [12].

2.3.1 Swept-area calculation

For beam trawl surveys the calculation of the swept area (SA) is quite straightforward, since the width of the beam does not change and the gear more or less follows the surface of the seabed. The recommended formula will vary depending on which data are available. Three options are suggested by WGBEAM (shown below for two different conditions). It is advised to always use option 1, based on beam width and distance, except when the distance is missing from DATRAS, in which case option 2 is the best alternative. When both the fishing speed and distance are missing in DATRAS, the standard values reported in the manual can be taken as

[11] https://www.ices.dk/community/groups/Pages/WGBEAM.aspx. Last accessed 24 November 2022.

[12] https://datras.ices.dk/Data_products/ReportingFormat.aspx. Last accessed 24 November 2022.

the average fishing speed, or option 3 can be used (depending on the availability of information).

For conditions where GearExp = SB (single beam; catch of one net sorted):

a) Option 1:

$$\text{Swept area in km}^2 = \text{beam width} \times \text{distance} / 10^6 \quad (1)$$

b) Option 2:

$$\text{Swept area in km}^2 = \text{beam width} \times (\text{haul duration} / 60) \times \text{fishing speed} \times 1852 / 10^6 \quad (2)$$

c) Option 3: Calculate distance based on shooting and hauling position (formula available at ICES Data Centre, request at datrasadministration@ices.dk), and apply calculated distance to Equation (1).

For conditions where GearExp = DB (double beam; catches of two nets put together):

a) Option 1:

$$2 \times \text{Swept area in km}^2 = \text{beam width} \times \text{distance} / 10^6 \quad (3)$$

b) Option 2:

$$2 \times \text{Swept area in km}^2 = \text{beam width} \times (\text{haul duration} / 60) \times \text{fishing speed} \times 1852 / 10^6 \quad (4)$$

c) Option 3: Calculate distance based on shooting and hauling position (formula available at ICES Data Centre, request at datrasadministration@ices.dk), and apply calculated distance to Equation (3)

Where (words in italics reference DATRAS product terminology):

- Beam width: numerical value in *Gear* (in meters)
- Distance: *Distance* (in meters)
- Haul duration: *HaulDur* (in minutes)
- Fishing speed: *GroundSpeed* (in knots)
- Shooting position: *ShootLat*, *ShootLong*
- Hauling position: *HaulLat*, *HaulLong*

The standard haul duration and the fishing speed for the all of the offshore beam trawl surveys can be found in Section 4.1.1 and 4.1.2 respectively.

2.3.2 Treatment of biological information

Due to the spatial and length stratification of the biological sampling, it is not possible to treat age samples as random for the purposes of growth studies or ALK development, as the proportion of specimens with age data may not be consistent for all strata or datasets.

2.3.3 Data use for flatfish stock assessments

In general, the surveys in an area by country can be regarded as a time-series that can be used for stock assessments. When the spatial coverage by the different countries and gears is stable, data can be combined.

For the North Sea surveys (conducted by Belgium, Germany, the Netherlands, and UK) data may be combined on from 1998, as the international and national area coverage has remained constant since then. The difference in gear efficiency between the gears used on the different surveys can be assumed to be constant over time by species and size class, and of limited to no

importance for the use of the time-series as a relative measure in stock assessments. The only potential cause for a change in catchability would be a change in the behaviour of a certain species and size class.

For all surveys there can be shifts in the accuracy of stratification of biological data collection, e.g. current registration by haul in contrast to earlier registration by flatfish area. In general, it can be assumed that data are currently collected and registered on a more detailed level than historically. This is a fact that cannot be changed.

Specific points for attention:

- North Sea and eastern English Channel survey conducted by UK (Cefas):

  Otolith collections for species other than sole and plaice are based on stratified otolith targets at length, rather than targets by station. This needs to be considered in the calculation of age-based indices. Therefore, age-based indices calculation is particularly difficult in the North Sea area, as targets are regularly reached after completing only a small number of stations within an area. Additional/experimental survey stations, not used in the index calculations, are available on the national databases. More detailed information can be obtained from Cefas via the chair of WGBEAM or datrasadministration@ices.dk.

- Western English Channel survey conducted by UK (Cefas):

  During 1985–1997, the number of stations used for stock assessment was between 47 and 49 and was called "the grid". By 1998, two new in-shore stations had been fished for four years and it was decided to recalculate sole and plaice indices to include all stations that were fished each year. For the record, the 49 grid stations are all current 58 stations with the exception of nine prime stations [F (4), G (1), L (2), D0o, D0i].

- UK (Cefas) Ecosystem survey in the Western English Channel and Celtic Sea:

  Two gears are operated with different selectivity (mainly towards small individuals, since one gear uses a 40-mm liner). Samples should be either pooled for analysis or only a single gear used, as the catches are likely to be strongly correlated because of the common deployment of the gears. A tow is only considered valid when both gears have fished correctly and have no damage. If this is not the case, tows are repeated to always ensure valid catches from both gears. Both gears are reported separately in the ICES database DATRAS.

- Bay of Biscay survey conducted by France:

  Data from the survey have been used for the Bay of Biscay sole assessment since 2013. A list of 50 reference stations have been established for the abundance index calculation. However, in some years, it was not possible to fish all 50 reference stations, particularly in 2007 and 2010. In those years, the stratification affects the abundance index calculation, as the planned number of hauls in each stratum could not be fully completed.

- Since 2017, ICES North Sea Demersal Working Group (WGNSSK) creates a combined (Belgium, Germany, and the Netherlands) survey index for plaice in the North Sea, based on the benchmark in 2017 (ICES, 2017).

- Since 2020, WGNSSK creates a combined (Belgium, Germany, and the Netherlands) survey index for sole in the North Sea (ICES, 2020a).

- General Fisheries Commission for the Mediterranean Scientific Advisory Committees (GFCM-SAC) and European Commission (EC) Scientific, Technical and Economic Committee for Fisheries (STECF) working groups regularly use indices from the Adriatic Sea survey as a tuning index (both for abundance and for biomass, depending on the

assessment methodology) for the assessment of sole, mantis shrimp, and common cuttlefish.

2.3.4 Use for elasmobranch stock assessments

For elasmobranch stock assessments, it is recommended that the unaggregated data are used directly from DATRAS.

For elasmobranch species the following aspects are important:

- There can be potential differences in data collection (sections 4.4.1 and 4.5.1).
- Elasmobranch species are in general measured by sex. This provides the opportunity to calculate CPUE by sex, but it also means that for generic length–frequency calculations, the numbers have to be added up for the different length classes.
- Data on elasmobranch viable eggs may be part of the data extracted (Section 4.4.2, DATRAS Development stage code = 'E', see ICES vocabularies [13])

2.3.5 Use for biodiversity and/or length distributions

For finfish and elasmobranch species, all surveys can be used for their respective time-series. When the geographical area coverage for different gears has remained constant over the time-series, data from the different gears can be combined, preferably using numbers per SA (towed distance × beam width) as the CPUE.

For crustaceans, cephalopod species, and other epifauna species, the following aspects are important:

a) The potential use of a closed benthos list (see sections 4.4.3 and 4.5.3, and Annex 7).
b) The increasing attention to species identification may have resulted in species appearing in the survey in recent years for the first time, which were present in the catch in the past but remained unrecognized. This can give the false impression of an increased species diversity in a survey. Whenever possible, countries try to provide correct information. However, it is not always possible to correct historical information, because it is not always clear if the recording of a new species is caused by it not being previously recognized or by it not occurring previously in the surveyed area, such as *Liocarcinus* species in the Dutch survey.
c) The crustaceans *Nephrops norvegicus*, *Homarus gammarus*, and *Cancer pagurus* are in general measured by sex. This provides the opportunity to calculate CPUE by sex, but it also means that for generic length–frequency calculations, the numbers have to be added up for the different length classes (details in Section 4.5.2);
d) As the unified DATRAS format applies, data users should be aware that it is possible to upload different maturity stages for crustaceans [most often used for Norway lobster (*Nephrops norvegicus*) and European lobster (*Homarus Gammarus*); development stage code 'B', see ICES Vocabularies [13]]

Specific points of attention for the survey conducted by Belgium:

- Until 2009, the survey only measured all specimens for species of commercial interest and collected length for a closed fish species list (Annex 7).
- Since 2010, the survey collects length information for all fish species, as well as numbers for the epibenthos species (see Section 4).

[13] http://vocab.ices.dk/?ref=1397. Last accessed 02 January 2023.

- In 2015 and 2016, the survey was carried out by a commercial vessel and only the absolute minimum sampling could be carried out, resulting in sampling according to the protocols used before 2010.
- As a consequence of the points above, the data for all survey years can be used for determining length frequencies for fish species of commercial interest and for those on the closed fish species list, while for biodiversity analyses, the data prior to 2010 and from 2015 and 2016 are not suitable.

In the Dutch survey in 2019, the haul duration was set to 15 min in some ICES rectangles, and the number of tows was reduced based on the catch size in some rectangles (see Section 8.1.3). Although an effect on the indices for stock assessment is not expected, it may result in changes in the recorded abundance of benthos species (e.g. starfish).

Two gears are operated with different selectivity (mainly towards small individuals, since one gear uses a 40-mm liner). Samples should be either pooled for analysis or only a single gear used, as the catches are likely to be strongly correlated because of the common deployment of the gears. A tow is only considered valid when both gears have fished correctly and have no damage. If this is not the case, tows are repeated to always ensure valid catches from both gears. Both gears are reported separately in the ICES database DATRAS.

3 Current survey sampling designs

3.1 Sampling areas and periods

The beam trawl survey sampling area originally covered the North Sea area, including the English Channel, and currently ranges from the Bay of Biscay to Iceland Sea in the Northeast Atlantic and the Adriatic Sea in the Mediterranean Sea. Maps of the sampling areas can be found in Annex 5.

The surveys in the North Sea, eastern English Channel, Irish Sea and Bristol Channel, and Iceland Sea occur between July and October. The surveys in the Bay of Biscay and Adriatic Sea are conducted in November/December. The survey in the western English Channel and Celtic Sea occurs between February and April. A full overview is available in Annex 3.

3.2 Survey stratification

Survey stratification describes the allocation of sampling effort in a survey. The stratification may have different origins, such as seabed characteristics or depth ranges in the survey area, fishing effort distribution, or an equal sampling effort distribution over the survey area. Independent of the origin, the design may be fixed (same stations fished over time; Section 3.2.1), random (station allocation varies between years based on a set of pre-defined selection criteria; Section 3.2.2), or systematic (sampling at a regular spatial interval; Section 3.2.3).

3.2.1 Fixed station design

North Sea survey conducted by Belgium

The Belgian 62 fixed stations in the North Sea (11 in ICES Area 4b and 51 in 4c) were historically chosen to adequately cover (a) the spatial area of the ICES statistical rectangles, and (b) the target species population. Safe fishing locations were defined at the start of the survey series, i.e. no wrecks are present and the seabed is suitable for fishing with a beam trawl with a chain mat. During the span of the time-series, some stations have moved slightly for various reasons. New station locations are required to be within 5 nmi from the original station and have similar seabed substrate and depth. These requirements try to ensure that sampling occurs in a habitat as similar as possible to the habitat of the previous fixed station, rather than a random sample within the area. There is no fixed order in which the stations are fished, but the survey tries to follow a similar yearly pattern. The order in which stations are fished in a certain year can be retrieved from the succession of haul numbers, whereas stations are unique.

North Sea survey conducted by Germany

This survey samples about 63 stations in ICES Area 4b in a grid of ICES statistical rectangles [14]. The original reasons for choosing the sampling locations are not known, but the same locations are fished every year. The stratification of the stations is related to the distance to the coast: four stations per rectangle in the most inshore areas (ICES rectangles ending with F7), three per

[14] https://www.ices.dk/data/maps/Pages/ICES-statistical-rectangles.aspx. Last accessed 02 January 2023.

rectangle in the next seaward ones (ICES rectangles ending with F6), and two in all other rectangles (ICES rectangles ending with F5).

UK (Cefas) North Sea beam trawl survey

The survey operates annually in the eastern English Channel and southern North Sea, following a fixed station design survey and using RV Cefas Endeavour. The positions of the stations were historically set in areas originally deemed of high importance for plaice and sole catches by commercial fishers and areas known to harbour juveniles. Prime stations (station numbers) are unique numbers that do not change, irrespective of the survey station number, and provide a fixed numbering system for sampling sites with minor variations. There is no particular order in which the stations are worked. As a consequence, the haul number identifies the annual order of each gear deployment (including invalid tows) of any gear that goes over the side of the vessel during the survey (i.e. the first deployment is 1, and subsequent hauls are incremental).

The current survey targets a total of 79 sampling locations, with 34 located in ICES Area 7d, 30 located in 7d, and 15 located in 4c. If static gears or other restrictions prevent the execution of a primary station, there are alternative tows in the same area. The chief scientist on board has a list of alternative tow positions that have been used before when the primary station was not accessible. Additionally, if time permits, there are five tows currently fished in the Belgian sampling area to provide a comparison point for the tows conducted on the Belgian survey, which have been completed in most years since 2004. These additional tows are not used in fish stock assessments. All tow positions are stored on board in the ships navigation system, and are backed up on Cefas own systems in spreadsheets and on the Cefas Fishing Survey System [15].

UK (Cefas) Irish Sea and Bristol Channel beam trawl survey

ISBCBTS operates in the Irish Sea (ICES Division 7a) and Bristol Channel (7f and g) and targets a total of 108 tows. The survey has run annually each September since 1988, using RV Corystes (1988–2008) and RV Cefas Endeavour (2009–present). Of the 108 primary stations, 65 are in 7a and 43 in 7f and g. All primary station positions are fixed and can be identified by a unique prime station number (station number in DATRAS). The positions of stations were set in areas deemed of high importance for plaice and sole catches by commercial fishers. The stations are distributed over sectors and depth strata, for the purposes of otolith sampling. The number of primary survey stations within each sector amount to: Irish Sea south (ISS, 18 stations), Irish Sea north (ISN, 16 stations), Irish Sea west (ISW, 15 stations), Saint Georges Channel (SCG, 16 stations), Bristol Channel inner (BCI, 32 stations), Bristol Channel outer (BCO, 11 stations). The 11 BCO stations have the lowest priority, because the data currently do not contribute to the virtual population analysis (VPA) tuning, nor to the recruitment indices of any of the species for which biological data are collected (Section 4.6.1, Part C of Table 4.1).

Bay of Biscay survey conducted by France

The Bay of Biscay survey consists of a set of 49 stations with fixed positions, which are sampled each year in November/December. In the case of bad weather conditions or limited vessel availability, the number of stations can be reduced. The fixed station survey was defined according to information on sole fishing areas, and safe sampling locations were provided by fishers. Station positions were selected to achieve a uniform coverage of the sole fishing area by one or two hauls in two-thirds (48 out of 72) of the 10′ latitude by 10′ longitude rectangles of the fishing area. The remaining third of the 10′ latitude by 10′ longitude rectangles of the fishing

[15] https://www.cefas.co.uk/data-and-publications/dois/cefas-fishing-survey-system/. Last accessed 02 January 2023.

area are not sampled. Four strata are defined. Their weights are the surface of the sole habitat estimated by the fishing area (as the number of 10′ latitude by 10′ longitude rectangles). In each stratum, the sampling effort is planned in proportion to the surface area of the sole fishing ground in the Bay of Biscay. Every five years, or when weather conditions are favourable and a research vessel is available, six extra stations are sampled in the southern part of the Bay of Biscay, to investigate the southern distribution of the sole population.

Adriatic Sea survey conducted by Italy, Slovenia, and Croatia

The Adriatic Sea survey consists of 67 fixed positions originating from a depth stratified design (0–30 m: 39 stations; 30–50 m: 17 stations; and 50–100 m: 11 stations), where sampling allocation is based on fishing effort in the strata to cover the area (GSA17) and stocks adequately. The main stocks driving the sampling station allocation are sole, common cuttlefish, mantis shrimp, and caramote prawn. The same stations are sampled every year. There is no fixed order in which the stations are fished, but a similar yearly pattern is executed to the extent possible. During the span of the time-series, stations have been moved slightly. New locations are selected to be within 5 nmi of the original sampling location, and on similar ground and depth.

Iceland Sea survey

The Icelandic survey covers 80 fixed stations. The stations were selected based on four criteria: (i) tow depth < 50 m, (ii) within 5 nmi from the shore, (iii) sandy bottom according to the ship sonar, and (iv) within 10 nmi to areas marked by demersal seine fishers as areas where juvenile flatfish were found.

3.2.2 Stratified random design

UK (Cefas) western English Channel and Celtic Sea

The UK (Cefas) Ecosystem survey in the western English Channel and Celtic Sea (Q1SWECOS) is a stratified random survey covering the shelf area from roughly 9°W to the 200 m isobath on the shelf break. The approximately 27 stations are divided among strata (with a minimum of five stations per stratum), based on the distribution of a large number of species, community analysis, and environmental covariates. Sampling locations are randomly selected for each survey from 131 stations split over 23 strata (13 in the western English Channel and 10 in the Celtic Sea). All stations are randomly selected, along with some added spare locations that can be used if the primary stations prove unfishable. A different set of randomly selected stations (both primary and spares) are selected each survey year. Depending on budget and time availability, additional efforts are made to collect ecosystem information, in order to develop a full ecosystem monitoring programme without degrading the fisheries time-series information. The added sampling, with instruments other than the beam trawl, provides information on many additional ecosystem components, such as hydrography, epifauna, zooplankton, phytoplankton, sediment, infauna, and geochemistry.

To make the design effective, the area is subjectively parcelled out into relatively homogenous subregions or strata (based on a large number of species and/or indicators), so that the majority of the variance is explained between strata and minimized within each stratum. As much physical and biological information as possible is used to make the stratification consistent with the spatial scale of the habitats that make up the ecosystem. This is essential in order to provide useful information on as many species and ecosystem processes as possible.

As the physical conditions of habitats may vary, the stratification is based on the *post-facto* identified biological communities, using the long-term experience and knowledge of fishers in the area as a starting point. Traditionally, habitats have been described based on their physical

conditions. As these are variable, and the relative importance of each in the structuring of the biological communities is unknown, predictions on the appropriate structure become difficult. Consequently, a more biological-based approach was taken, where areas were *post-facto* assigned based on the biological communities. The starting point was the long-term experience and knowledge of fishers in the area, because large-scale consistently-collected ecological information was limited. This led to identification of areas that were fished at specific times of year for specific target communities in the multispecies fisheries, as well as areas which had been traditionally fished under different environmental conditions or using other methods. With this approach, ~100% coverage of the area is ensured, in a significant time frame considered as normal variability. More detailed information on the history of the design is available in Section 8.4.

3.2.3 Systematic design

North Sea survey conducted by the Netherlands

The Netherlands annually intends to fish 72 stations in the central and western North Sea (ICES areas 4b and c). One haul is carried out in the centre of each ICES rectangle. If fishing is not possible in that area, the best position in the neighbourhood of the centre of the rectangle is chosen. The monitoring in the central and western North Sea started as part of the North Sea International Bottom-trawl Surveys (NS-IBTS), but was changed into a beam trawl survey in 1998.

In the southeastern North Sea (ICES Area 4c), the Netherlands plans 74 stations, distributed over the ICES rectangles based on flatfish catch expectations (historical information). One to four hauls are carried out in a rectangle, depending on the distance to the coast. For 13 stations in 6 rectangles, mostly in coastal areas, the standard haul duration is set to 15 min (see Section 8.1.3). This is done to prevent large catches, especially of starfish, which make catch processing impossible. The minimum distance between two hauls is 10 nmi. All stations are used for the fisheries-independent survey indices.

3.3 Survey gears

3.3.1 Variety of beam trawls

All surveys coordinated by WGBEAM are carried out with a beam trawl. However, the width and rigging of the beam trawls varies depending on local conditions and ship capacity. Most countries have used the same gear for the full sampling period and have not changed the geographical area over time. Operation of the gear can occur from the aft or from the side, depending on ship design.

The setup of the gear is mostly related to seabed conditions. For example, in the Dutch beam-trawl survey the gear is rigged with a flip-up rope in the central and western North Sea to keep boulders out of the net. In the southeastern North Sea, no flip-up rope is used as there are no boulders in that area. As another example, gears with chain mats have to be used in areas with rough seabed, to prevent net damage.

Detailed information on the gears and rigging is listed in Annex 4. If more information on the gears is needed, national manuals are available via the national WGBEAM contact persons.

3.3.2 Overview by country

Belgium

Belgium uses a commercially rigged 4-m beam trawl equipped with a chain mat (since 1993) and 40-mm mesh size in the codend. The gear is trawled from the stern.

Germany

Germany uses a 7.2-m beam trawl, similar to those employed by the shrimping fleet. Five tickler chains are attached. The codend mesh size is 40 mm. The gear is trawled from the side of the vessel.

The Netherlands

The Netherlands uses an 8-m beam trawl, especially designed for the survey in 1985. The beam trawl is fitted with eight chains, of which four are connected to the beam and four to the net. As mentioned in Section 3.3.1, the gear is rigged with a flip-up rope in the central and western North Sea to keep boulders out of the net. In the southeastern North Sea no flip-up rope is used as there are no boulders in that area. The codend mesh size is 40 mm.

UK

The UK (Cefas) Ecosystem survey in the western English Channel and Celtic Sea (Q1SWECOS), uses a more modern version of the traditional commercial gear used on the other surveys. The main differences are the use of polypropylene for the netting, and a 3-m extension to the codend for easier catch retrieval on the RV. Two gears are deployed per haul and recorded separately. One gear is fitted with a 40-mm liner, the other uses only the commercial 80-mm codend. Detailed schematics and information on the net and the beam are available in the national manual.

The other UK (Cefas) beam trawl surveys use a commercially rigged (1989-style) 4-m beam trawl (as measured between the inside edges of the shoes), fitted with a chain mat and flip-up ropes in all areas, and with a 40-mm liner. The liner needs to be long enough that, when it is attached to the forward end of the codend, it extends to about 1 m below the codline. Detailed schematics and information on the net and the beam are available and maintained in the national manual.

Iceland

Iceland uses a commercially rigged (1989-style) 4-m beam trawl (as measured between the inside edges of the shoes) fitted with a chain mat and flip-up ropes. The liner needs to be long enough that, when it is attached to the forward end of the codend, it extends to about 1 m below the codline. Detailed schematics and information on the net and the beam are available and maintained at the Icelandic marine and freshwater institute.

France

France uses a 4-m beam trawl gear with ten ticklers, derived from a commercial beam trawl used by the Belgian fleet in the Bay of Biscay on soft grounds. Four chains are connected to the beam and six to the net. On the survey running from 2007 to 2013 on board RV Gwen Drez, the beam trawl was towed on two warps, each of which was connected to one of the shoes. On from 2014, the beam trawl has been towed on one warp, because of a change of vessel. The codend mesh size is 40 mm. Detailed schematics and information on the net and the beam are available in the national manual.

Italian-Sloveninan-Croatian survey

The Italian-Slovenian-Croatian survey is carried out with two or four modified 3.5-m beam trawls, named "rapido" trawl by Italian fishers. The gear was specifically designed to work on different types of seabed bottoms, and consists of a modified beam trawl with a rigid mouth. The frame is rigged with iron teeth along the lower leading edge. To protect the polyamide net bag tied to the iron frame, there are four skids joined to the iron frame and a reinforced rubber diamond-mesh net in the lower part. The codend mesh size is 40 mm. Detailed schematics and information on the net and the beam are available and maintained in the national manual (Anon., 2019).

4 Observation methodologies

4.1 Haul procedures

The fishing methodology for the offshore beam trawl surveys is similar for most of the surveys.

In general, the offshore beam trawl survey is a daytime survey, which means that fishing occurs between 15 minutes prior to sunrise and 15 minutes after sunset. The beginning and ending of the daylight period hauls is set according to the astronomic sunset and sunrise. If a tow is conducted outside these hours, it must be reported as an additional tow and a valid tow should be attempted where practicable. In the Iceland Sea, a day and a night haul are conducted at every station, but no analysis of catchability has been conducted until now. In the Bay of Biscay, day and a night hauls were conducted at every station in 2011 and 2012. CPUE computed with day and night hauls were similar, and, consequently, only day hauls have been carried out since 2013 (ICES, 2013). For UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea, there are no formal daylight sampling restrictions, but the time of day is recorded. 24-h sampling has been carried out at times to facilitate efficient vessel usage. The different catchability between day and night is not analysed by species. From the outset, this survey was not setup to be a daylight-only fishing survey. With the somewhat limited daylight available at the time of year the survey is conducted (March), fishing during both day and night is necessary in order to get the survey work completed within the available ship days.

Most countries operate one beam trawl during the survey. In the North Sea, only the survey conducted by the Netherlands operates two beam trawls simultaneously. In the UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea two beam trawls are also deployed simultaneously, one with and one without a liner.

Hauls can be marked as invalid by the scientist in charge, e.g. if net damage occurs, or if the tension on the wires is higher than the maximum allowed value. Depending on the situation, the station can be resampled (preferred option), resampled with a shorter tow duration, slightly moved (in the case of a bad quality fishing ground), or skipped.

4.1.1 Haul duration

The start of the haul is the moment the full length of line has been set according to the standard warp–depth ratio (Section 4.1.3). In addition, some countries use systems to view depth, warp length, and tension on the wires during trawling:

- Belgium, the Netherlands and UK (Cefas) employ the Marelec trawl control system to detect the line length and tension during towing, which indicates if the net is set to the ground and/or is blocked in any way.
- In the Adriatic Sea survey (Italy-Slovenia-Croatia) a minilog (Star Oddi) is attached to each gear and provides real-time depth and temperature.
- Iceland has a SCANMAR trawl-depth sensor attached to the net in all hauls.
- Germany uses a system to view the tension on the wires during trawling.

Haul duration is set to 30 min for all surveys except UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea (see following paragraph). The start of the trawl should be given as the time when the gear has settled on the bottom, and the end of the trawl as the time when hauling commenced. In cases where there is an increased risk to net damage, substrata known to be difficult (e.g. sand, stones, or shells), and/or large benthic bycatches, fishing duration is reduced *a priori* to 15 min, which is half of the standard tow duration. These stations can be

marked as valid tows. In principle, the duration for a valid tow should at least be 15 min, but the final decision on tow validity belongs to the scientist in charge on board. As a consequence, tows with a shorter duration may also incidentally be qualified as valid tows if the scientist in charge has decided that the tow technically has been conducted in a valid manner and the catch is assumed to be representative. The important factor is if the gear has had ground contact, which can be evaluated based on sensors connected to the gear or by looking at the gear's shoes.

UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea differs in its setup, as tow length is standardized as a set distance of 2 nmi, instead of a set time period. This difference is due to the strong variations in tide and environmental conditions in this area, which require some flexibility in towing speed. However, 2 nmi at a speed of 4 knots is closely equivalent to the 30 min used in the other beam trawl surveys. Tow length can be shortened if the ground conditions require it, but tows are only considered valid if fished for a minimum of 1 nmi, which is half of the recommended tow length.

For the other UK surveys the following rule applies: if, for any reason, a tow has a duration of less than 15 min or more than 40 min, then the catch should still be fully processed, but the tow should be classified as an additional tow and a valid tow should be attempted where practicable.

In the Adriatic Sea survey (Italy-Slovenia-Croatia), a shorter tow is allowed under certain circumstances, as long as it remains above 10 min. If the duration is less than 10 min, the haul is repeated and the catches are pooled together.

4.1.2 Fishing speed

Fishing speed is 4 knots over ground for all surveys, except for the Bay of Biscay survey (France; 5 knots) and the Adriatic Sea survey (Italy-Slovenia-Croatia; 5.5 knots).

Tidal direction is generally not considered *a priori* for the offshore beam trawl surveys, as it is difficult to retrieve detailed tidal information in offshore areas and fishing grounds require a certain towing direction to avoid damage to the gear. As exceptions:

- For the North Sea survey conducted by Belgium and the UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea, the standard fishing procedure is to fish against the tide when time allows it.
- The Netherlands has recently started registering tidal direction in the North Sea survey. When combined with towing direction, this provides information on whether the sampling took place with or against the tide.

4.1.3 Warp length

For all surveys, warp length is generally 3–4 times the water depth when using it as a single line, and 6–7 times the water depth when using it as a double line (North Sea surveys conducted by Belgium and Germany). The exact value depends on the water depth and the local conditions. In the Adriatic Sea survey (Italy-Slovenia-Croatia), warp length is 7 times the water depth. Warp length can be adjusted under specific circumstances. For example, it can be lowered if fishing on hard rocky ground, or increased if fishing into a strong tidal current.

4.2 Catch processing

The detailed process of how the catch is sorted can vary between surveys, as it depends on the size of the vessel and the sorting tools available. The standard procedure is that, wherever possible, the entire catch is sorted. In some cases, representative subsamples can be used

(Section 4.3). The catch is weighed, or an estimate of the weight of the catch is made (e.g. by counting the number of fishing baskets).

In most surveys, only one gear is deployed and, therefore, only the catch of one net is sorted. For surveys with two simultaneously operated beam trawls:

- In the North Sea Dutch beam trawl survey, only one net is sorted for the determination of length distribution and species composition. The catch of the other net is used to collect additional fish for biological information (e.g. age and sex-ratio).
- In the Adriatic Sea survey (Italy-Slovenia-Croatia), the catches of the two gears are pooled together.
- In Q1SWECOS (UK Cefas) survey, the two gears operated have a different selectivity (mainly for small individuals, due to the use of a 40-mm liner in one gear). Samples should be either pooled for analysis, or only a single gear used, as the catches are likely strongly correlated because of the common deployment of the gears. A tow is only considered valid when both gears have fished correctly and have no damage. If this is not the case, tows are repeated to always ensure valid catches from both gears. Both gears are reported separately in the ICES database DATRAS.

4.3 Subsampling

In the case of large catches, a selection of species or size categories of species may be identified as being sufficiently abundant that they can be appropriately subsampled. Subsampling can be based on weight, fraction, volume, or numbers. The method is chosen based on practical considerations, such as the availability of scales on board, catch size, and species. The subsampling methodologies can be applied to all species in the catch. If the entire catch cannot be sorted, the data should be flagged accordingly when submitting them to DATRAS.

The minimum number of fish needed for properly determining length–frequency distributions can vary due to the heterogeneity of the length distribution of the species in a haul. However, in general, 50–100 fish per species should be measured to the cm below (e.g. all specimens measuring 10.0–10.9 cm should be recorded as 10 cm). Consequently, a subsample should at least consist of 50 fish.

Example 1 Subsampling by volume: Small fish and epifauna are collected in multiple baskets. A mixed sample (from different baskets) of one basket is created. The subsample is sorted and, if necessary, subsampled.

Example 2 Subsampling by numbers: For one species more than 50 fish are caught. 50 fish are measured while the remaining fish are only counted.

Example 3 Subsampling by fraction: More than 100 fish are caught for a species. The sample is split into equal fractions until at least 50 fish remain for measurements.

Example 4 Subsampling by weight: More than 100 fish are caught for a species. The whole sample is weighed and at least 50 fish are measured and weighed.

When representative subsampling is not feasible, the species can be further sorted into two or more size grades or categories. As the catches vary, the decision on proper subsampling has to be taken case-by-case. The following examples are used to describe incidences when grading or categorization may be required, but they are by no means exhaustive:

Example 5 A catch element consists of 999 fish in the length range 18–26cm and one fish of 40cm. If a single subsample of 100 fish is used and extrapolated to the whole, either zero or ten 40-cm fish will be estimated. In this case, the correct approach is to remove the one large fish, treat it as category 1, and measure it separately. The remaining 999 fish can be treated as category 2, and a subsample can be taken by splitting based on weight, fraction, volume, or numbers. This approach provides an accurate assessment of the numbers caught at each length for this element of the catch.

Example 6 A catch element of one species consists of 994 fish in the length range 18–26 cm, 3 fish in the length range 10–12 cm, and 3 fish in the length range 38–40 cm. If a single raised subsample of 100 fish is used and extrapolated to the whole, anything between zero and ten fish will be estimated in the length ranges of 10−12 and 38–40 cm. In this case, the correct approach is to remove the small and large fish and measure those six fish as category 1. A subsample can then be taken from the remaining 994 fish (category 2) by splitting based on weight, fraction, volume, or numbers. This approach provides an accurate assessment of the numbers caught in each length group for this element of the catch.

4.4 Species sorting and identification

4.4.1 Finfish and elasmobranch species

All finfish species and elasmobranchs should be identified to the taxonomic species level if possible, using established quality control methods (see Section 7.4). If identification to the species level proves impossible, individuals can be grouped by genus or by larger taxonomic group (e.g. *Pomatoschistus* species or Ammodytidae).

In most surveys, subsampling by species is allowed, as long as a specified minimum number of specimens per species is measured. The measured fraction of the (sub-)sample of the species is weighed. Subsampling of the catch for length frequencies is allowed as long as a proper length distribution is collected (see also Section 4.3).

4.4.2 Other species

A representative (mixed) subsample of the epibenthos is generally sorted and identified to the lowest taxonomic level. Free-living species are at least counted, and often weighed. For attached species, presence is recorded.

Viable (undamaged and not empty) elasmobranch eggs should be identified to the lowest taxonomic level and counted. Guidance for egg identification can be found on the website on egg-capsules of sharks, skates and chimeras from the Natural History Museum of Rotterdam [16], and through the HAROkit identification tools (factsheets in Dutch for species caught in Belgian fisheries) [17].

[16] https://home.planet.nl/~bor00213/. Last accessed 29 of November 2022.

[17] https://www.vliz.be/en/harokit. Last accessed 29 of November 2022.

4.4.3 Exceptions

In the Belgian survey, a closed species list (all finfish species and commercial shellfish) was used for species recordings until 2009 and in 2015 and 2016 (see Table A7.1 for species and registration types).

For the survey conducted by the Netherlands, catch processing slightly differs between the southeastern North Sea and the central/western North Sea. This is due to differences in the density of the station grid and the catch composition, which affect the amount of catch processing time available and needed between hauls. In the southeastern part, where there is a dense sampling grid and the catch composition consists of lots of young fish and few species, larger and rare fish and larger or rare epifauna species are sorted. Small fish and other epifauna are collected in baskets, from which a mixed sample (from different baskets) of one basket is created. This sample is sorted and, if necessary, subsampled. In the central/western North Sea, where the sample grid is less dense, the average fish size bigger, and the species diversity higher, all fish are sorted as well as large or rare epifauna species. The remainder of the epifauna are collected in baskets. If the quantity of epifauna exceeds one fishing basket, a mixed sample (from different baskets) of one basket is created. This sample is sorted and, if necessary, subsampled.

UK (Cefas) North Sea beam trawl survey and Irish Sea and Bristol Channel beam trawl survey, quantify benthic bycatch at selected prime stations (generally one per ICES rectangle). At the all other prime stations, a closed list of species is always picked out and quantified (Table A7.2).

On the UK (Cefas) ecosystem survey in the western English Channel and Celtic Sea, the benthic bycatch is fully identified to species level, where possible, and, as a minimum, their presence/absence is recorded. The sample taken from the trawl with the liner is fully sorted for fish and epibenthos. Over time there have been increasing efforts to also fully enumerate the benthic bycatch from the sample with the liner. Data for epibenthic species caught only in the trawl without the liner, and not seen in the trawl with the liner, are captured as observations against the trawl with the liner. As these are the only species flagged as "observed" (all other species being quantified in some manner) they can always be identified at a later date as coming from the gear without the liner. As a consequence, time-series can only be used consistently at the observation level. A full internal protocol is available at Cefas [18].

The survey conducted by France has sorted non-commercial epibenthos in three groups from 2007 to 2013: starfish, crabs, and shrimps (Table A7.3). These are weighed (total weight) and counted (eventually by subsample). On from 2014, all the non-commercial epibenthos has been sorted by the lowest taxon to which they can be attributed on board, counted, and weighed (total weight).

In the Icelandic survey, all fish, crabs, *Nephrops* species, and seacucumbers are separated from other catch on a conveyor belt. Benthos, debris, seaweed, kelp, rocks, and shell hash are left on the conveyor belt. The conveyor belt has a tray beneath it which is checked after each station in case anything fell off. A flow scale is not used. From 2018 until 2020 an extended protocol applied, where a more detailed species identification took place, and the weight of all benthos species was recorded for daytime hauls (approx. half of the hauls).

[18] Available upon request via https://www.cefas.co.uk/contact/, choose Monitoring.

4.5 Length measurements

4.5.1 Finfish and elasmobranch species

All fish species should be measured to the cm below (e.g. all specimens measuring 10.0–10.9 cm should be recorded as 10 cm), and counted. Length is defined as total length, measured from the tip of the snout to the tip of the caudal fin. In most surveys, subsampling by species is allowed, as long as a specified minimum number of specimens per species is measured. The (sub-)sample of the species is weighed (only exception: for the Netherland survey in the southeastern North Sea, no weight by species recorded until 2016).

Subsampling of the catch for length frequencies is allowed, as long as a representative length distribution is collected. The minimum number of specimens required to obtain a representative length–frequency distribution can vary, due to the heterogeneity of the length distribution of the species in a haul. In general, 50–100 specimens should be measured to the cm below for a representative length–frequency distribution.

Elasmobranch species are measured by sex to the cm below, from the tip of the nose till the tip of the tail, and are treated the same as the finfish species.

4.5.2 Other species

The shellfish species *Nephrops novegicus* and *Cancer pagurus*, and other commercially important shellfish species, are measured to the mm below by sex, as indicated in Figure 4.1, and treated the same as the finfish species. Berried (bearing eggs) females may be treated separately.

For Cephalopod species, the mantle length is measured. The Netherlands, Italy-Slovenia-Croatia, and Iceland record length to the mm below. UK (Cefas) and France (Ifremer) measure cephalopods to the cm below. Belgium and Germany measure cephalopods to the 1/2 cm below.

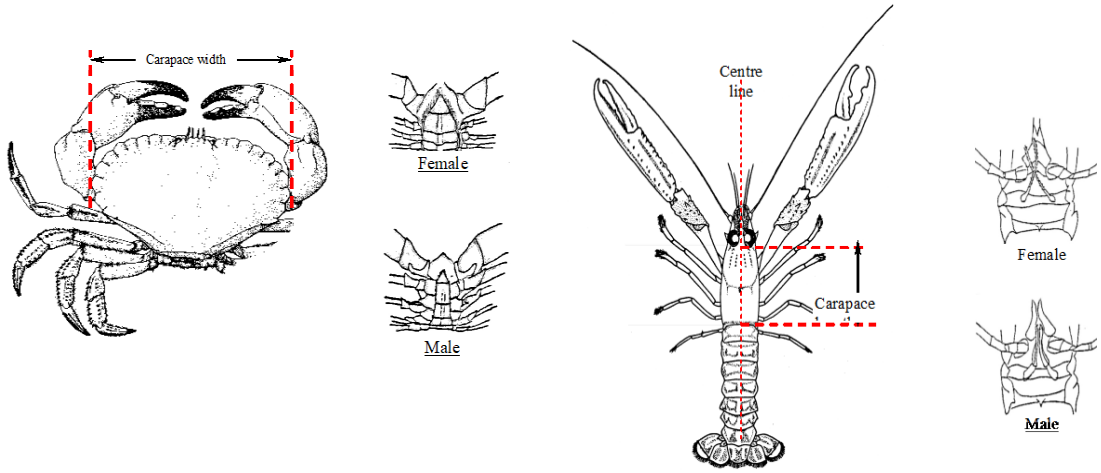

Figure 4.1. Measurement of *Cancer pagurus* (left, carapax width) and *Nephrops norvegicus* (right, carapax length). Drawings reproduced with permission from Hayward and Ryland (1994).

4.5.3 Exceptions

The survey conducted by Belgium does not measure all cephalopod species, focusing instead on the commercially important ones (e.g. *Loligo vulgaris*, *L. forbesii*, and *Sepia officinalis*). *Alloteuthis* and *Sepiola* species are counted and weighed. For some earlier years, the width of rays and skates (from wing to wing) was also measured, but, since 2017, only total length is recorded for those species (from the tip of the nose till the tip of the tail, in line with other

countries). A closed species list was used until 2009 and in 2015 and 2016 (see Annex 7 for species and registration types).

The survey conducted by the Netherlands records minimum and maximum length for epifauna (to the mm below) per species and per sample in the central and western North Sea.

For length frequencies, UK (Cefas) surveys require doubling of the minimum sampling size (75 specimens) in the case of large catches (n > 1000) of any species. This is historically defined.

For measurements by sex, UK (Cefas), the Netherlands, and Germany distinguish female egg-bearing shellfish.

In the Adriatic Sea survey (Italy-Slovenia-Croatia), all finfish species, rays, sharks, cephalopods, and commercially important shellfish and crustaceans are measured to the mm below except for *Bolinus brandaris*, *Hexaplex trunculus* and *Ostrea* sp. All the specimens of sole, brill, turbot, spottail mantis shrimp, caramote prawn, deep-water rose shrimps, Norwegian lobsters, cuttlefish, skates, and sharks are sexed.

In the Icelandic survey, all crabs, lobsters, sea cucumbers, scallops, cyprines, and shrimps are counted. 50 individuals per species are measured and the remaining specimens are counted to speed up processing.

4.6 Biological Information (age, sex, maturity)

4.6.1 Biological information collected

All countries collect biological information for a number of species, including at least sole and/or plaice. The stratification is described in Section 4.6.2. This section only describes data collected in such a way that the information can be traced back to an individual fish.

During all surveys, otoliths (or illiciums for *Lophius* species) are collected to provide information on age. Generally, fish are measured to the mm below, sex is defined if possible, and the fish is weighed. On from 2010, macroscopic maturity information has been collected from two months prior to and until the end of the spawning season, following recommendation from ICES Workshop on Maturity Staging of Sole, Plaice, Dab, and Flounder (WKMSSPDF; ICES, 2010). For autumn surveys, this meant that maturity information was no longer systematically collected for plaice, sole, turbot, and brill. In 2018, WGBEAM decided that, due to a presumed change in spawning season, on from 2019 the macroscopic maturity stage will be recorded for the biologically sampled individuals. Macroscopic maturity classification follows internationally agreed criteria as reported by ICES Workshop for Advancing Sexual Maturity Staging in Fish (WKASMSF; ICES, 2018).

The UK (Cefas) and France (Ifremer) surveys measure biologically sampled individuals to the usual measuring interval for each type of species (i.e. demersal species to the cm below, herring and sprat to the 1/2 cm below), but usually only for the first 50 individuals per species and haul. The remaining individuals of that species in the haul are counted.

There are variations among species in which biological information is collected or which measurements are taken and recorded individually. Parts A–F of Table 4.1 show biological information data collection for different species and countries. The maturity stage keys used for skates and rays are in Annex 8, the maturity scales for finfish follow the 2018 WKASMSF guidelines (ICES, 2018). In the Bay of Biscay, no individual weights are collected for the target species (Part D of Table 4.1).

Table 4.1. Biological information currently collected on a routine basis by country and area in the offshore beam trawl surveys. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia; UK: UK (Cefas). Blank fields indicate that no information is collected.

Part A - North Sea and eastern channel, ICES areas 4 and 7d (BE, DE, NL, and UK)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Arnoglossus laterna [1]	NL	NL	NL	
Aspitrigla cuculus	UK	UK	UK	UK
Buglossidium luteum [1]	NL	NL	NL	
Conger conger	UK	UK		UK
Dicentrarchus labrax	UK	UK	UK	UK
Eutrigla gurnardus	UK	UK	UK	UK
Gadus morhua	BE, NL, UK	BE, NL, UK	BE, NL, UK	UK
Hippoglossoides platessoides	NL	NL	NL	
Hippoglossus hippoglossus [2]	NL	NL	NL	
Lepidorhombus whiffiagonis	UK	UK	UK	UK
Leucoraja naevus	UK	UK		UK
Limanda limanda	BE, DE, NL, UK	BE, DE, NL, UK	BE, DE, NL, UK	UK
Lophius piscatorius	UK	UK	UK	UK
Melanogrammus aeglefinus	UK	UK	UK	UK
Merlangius merlangus	UK	UK	UK	UK
Merluccius merluccius	UK	UK	UK	UK
Microstomus kitt	BE, NL, UK	BE, NL, UK	BE, NL, UK	BE, NL, UK
Mullus surmuletus	UK	UK	UK	UK
Mustelus asterias	UK	UK		UK
Platichthys flesus [3]	NL,UK	NL,UK	NL,UK	NL,UK
Phrynorhombus norvegicus [1]	NL	NL	NL	NL
Pleuronectes platessa [3]	BE, DE, NL, UK	BE, DE, NL, UK	BE, DE, NL, UK	BE, DE, NL, UK
Raja brachyura	UK	UK		UK
Raja clavata	UK	UK		UK
Raja microocellata	UK	UK		UK
Raja montagui	UK	UK		UK
Scophthalmus maximus [3]	BE, NL, UK	BE, NL, UK	BE, NL, UK	BE, NL, UK
Scophthalmus rhombus [3]	BE, NL, UK	BE, NL, UK	BE, NL, UK	BE, NL, UK
Solea solea [3]	BE, DE, NL, UK	BE, DE, NL, UK	BE, DE, NL, UK	BE, DE, NL, UK
Trigla lucerna	UK	UK	UK	UK
Trigloporus lastoviza	UK	UK	UK	UK
Zeus faber	UK	UK	UK	UK

[1] Approx. 25 per year.

[2] Max. 5 per year.

[3] Maturity data collection ceased in 2011 and restarted on from 2019.

Table 4.1 (cont.)

Part B - Western channel and Celtic Sea, ICES areas 7e, f, g, h, and j (UK)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Aspitrigla cuculus	UK	UK	UK	UK
Conger conger	UK	UK		UK
Dicentrarchus labrax	UK	UK	UK	UK
Dipturus batis	UK	UK		UK
Eutrigla gurnardus	UK	UK	UK	UK
Gadus morhua	UK	UK	UK	UK
Glyptocephalus cynoglossus	UK	UK	UK	UK
Lepidorhombus whiffiagonis	UK	UK	UK	UK
Leucoraja naevus	UK	UK		UK
Lophius piscatorius	UK	UK	UK	UK
Lophius budegassa	UK	UK	UK	UK
Melanogrammus aeglefinus	UK	UK	UK	UK
Merlangius merlangus	UK	UK	UK	UK
Merluccius merluccius	UK	UK	UK	UK
Microstomus kitt	UK	UK	UK	UK
Molva molva	UK	UK		UK
Mullus surmuletus	UK	UK	UK	UK
Mustelus asterias	UK	UK		UK
Pleuronectes platessa	UK	UK	UK	UK
Raja brachyura	UK	UK		UK
Raja clavata	UK	UK		UK
Raja fullonica	UK	UK		UK
Raja microocellata	UK	UK		UK
Raja montagui	UK	UK		UK
Raja undulata	UK	UK		UK
Scophthalmus maximus	UK	UK	UK	UK
Scophthalmus rhombus	UK	UK	UK	UK
Scyliorhinus stellaris	UK	UK		UK
Solea solea	UK	UK	UK	UK
Squalus acanthias	UK	UK		UK
Torpedo marmorata	UK	UK		UK
Trigla lucerna	UK	UK	UK	UK
Trigloporus lastoviza	UK	UK	UK	UK
Zeus faber	UK	UK	UK	UK

Table 4.1 (cont.)

Part C - Irish Sea and Bristol channel, ICES areas 7a, f, and g (UK)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Aspitrigla cuculus	UK	UK	UK	UK
Conger conger	UK	UK		UK
Dicentrarchus labrax	UK	UK	UK	UK
Eutrigla gurnardus	UK	UK	UK	UK
Gadus morhua	UK	UK	UK	UK
Leucoraja naevus	UK	UK		UK
Limanda limanda	UK	UK	UK	UK
Lophius piscatorius	UK	UK	UK	UK
Melanogrammus aeglefinus	UK	UK	UK	UK
Merlangius merlangus	UK	UK	UK	UK
Merluccius merluccius	UK	UK	UK	UK
Microstomus kitt	UK	UK	UK	UK
Molva molva	UK	UK		UK
Mullus surmuletus	UK	UK	UK	UK
Mustelus asterias	UK	UK		UK
Pleuronectes platessa	UK	UK	UK	UK
Raja brachyura	UK	UK		UK
Raja clavata	UK	UK		UK
Raja microocellata	UK	UK		UK
Raja montagui	UK	UK		UK
Scophthalmus maximus	UK	UK	UK	UK
Scophthalmus rhombus	UK	UK	UK	UK
Scyliorhinus stellaris	UK	UK	UK	UK
Solea solea	UK	UK	UK	UK
Trigla lucerna	UK	UK	UK	UK
Trigloporus lastoviza	UK	UK	UK	UK
Zeus faber	UK	UK	UK	UK

Part D - Bay of Biscay, ICES Area 8 (FR)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Arnoglossus laterna	FR			
Aspitrigla cuculus	FR		FR	
Buglossidium luteum	FR			
Conger conger	FR			
Dicentrarchus labrax [4]	FR		FR	FR
Dipturus batis	FR			
Eutrigla gurnardus	FR		FR	
Lepidorhombus whiffiagonis	FR		FR	FR

Table 4.1 – Part D (cont.)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Leucoraja naevus	FR			
Limanda limanda	FR			
Lophius piscatorious [5]	FR		FR	FR
Lophius budegassa [5]	FR		FR	FR
Merlangius merlangus	FR		FR	FR
Merluccius merluccius	FR		FR	FR
Microstomus kitt	FR			
Molva molva	FR			
Mullus surmuletus	FR		FR	FR
Mustelus asterias	FR			
Platichthys flesus	FR			
Phrynorhombus norvegicus	FR			
Pleuronectes platessa	FR			
Raja brachyura	FR			
Raja clavata	FR			
Raja microocellata	FR			
Raja montagui	FR			
Raja undulata	FR			
Scophthalmus maximus	FR			
Scophthalmus rhombus	FR			
Solea solea	FR		FR	FR
Torpedo marmorata	FR			
Trigla lucerna	FR			
Trigloporus lastoviza	FR			
Zeus faber	FR			

[4] Scales collected, no otoliths;

[5] Illiciums collected, no otoliths

Part E - Iceland Sea, ICES Area 5 (IS)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Agonus cataphractus	IS			
Amblyraja radiata	IS			
Ammodytes marinus	IS			
Anarhichas lupus	IS			
Clupea harengus	IS			
Cyclopterus lumpus	IS			
Dipturus batis	IS			
Enchelyopus cimbrius	IS			
Eutrigla gurnardus	IS			
Gadus morhua	IS			

Table 4.1 – Part E (cont.)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Glyptocephalus cynoglossus	IS	IS	IS	IS
Hippoglossoides platessoides	IS	IS	IS	IS
Hippoglossus hippoglossus	IS	IS	IS	IS
Hyperoplus lanceolatus	IS			
Lepidorhombus whiffiagonis	IS	IS	IS	IS
Leptoclinus maculatus	IS			
Limanda limanda	IS	IS	IS	IS
Lophius piscatorius	IS			
Lumpenus lampretaeformis	IS			
Lycodes gracilis	IS			
Melanogrammus aeglefinus	IS			
Merlangius merlangus	IS			
Microstomus kitt	IS	IS	IS	IS
Molva molva	IS			
Myoxocephalus scorpius	IS			
Platichthys flesus	IS			
Pleuronectes platessa	IS	IS	IS	IS
Pollachius virens	IS			
Scomber scombrus	IS			
Sebastes norvegicus	IS			
Sebastes viviparus	IS			
Squalus acanthias	IS			
Triglops murrayi	IS			
Trisopterus esmarkii	IS			

Part F - Adriatic Sea, GSA17 (IT/SI/HR)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Arnoglossus laterna	IT-SI-HR			
Buglossidium luteum	IT-SI-HR			
Conger conger	IT-SI-HR			
Eutrigla gurnardus	IT-SI-HR			
Lophius piscatorious	IT-SI-HR			
Lophius budegassa	IT-SI-HR			
Merluccius merluccius	IT-SI-HR	IT-SI-HR		IT-SI-HR
Platichthys flesus	IT-SI-HR	IT-SI-HR		IT-SI-HR
Raja clavata	IT-SI-HR	IT-SI-HR		IT-SI-HR
Scophthalmus maximus	IT-SI-HR	IT-SI-HR	IT-SI-HR	IT-SI-HR
Scophthalmus rhombus	IT-SI-HR	IT-SI-HR	IT-SI-HR	IT-SI-HR
Solea solea	IT-SI-HR	IT-SI-HR	IT-SI-HR	IT-SI-HR

Table 4.1 – Part F (cont.)

Species	Individual length	Individual weight	Age structure	Sexual maturity
Torpedo marmorata	IT-SI-HR			
Trigla lucerna	IT-SI-HR			
Trigloporus lastoviza	IT-SI-HR			
Zeus faber	IT-SI-HR			
Sepia officinalis	IT-SI-HR	IT-SI-HR		IT-SI-HR

4.6.2 Stratification of biological samples

The stratification of the biological sampling varies over the different surveys. Maps for biological stratification are provided in Annex 6.

The biological data collection by Belgium, Germany, and the Netherlands in the North Sea, and by France in the Bay of Biscay, follows a fixed stratification by area and length class: a fixed number of otoliths by cm-class and area is collected for different species (Table 4.2). The collection of otoliths is spread, as much as possible, over the flatfish and roundfish areas. Registration of biological data are always done on a per haul basis. As a consequence of optimization exercises conducted over the years, the numbers of otoliths that have been collected may have changed.

4.6.3 Processing of age material

In general, otoliths or illiciums are returned to the lab for appropriate processing by a dedicated otolith processing team and skilled age readers, who participate in ICES age reading exchanges and/or workshops initiated by ICES Working Group on Biological Parameters (WGBIOP). There are variations per institute and/or species in the form in which the year-class information is identified from otoliths or illiciums. The information on the age structure used, as well as the preparation method of the age structure, can be found in the data file on DATRAS (CA record, columns AgeSource and AgePrepMet).

Age reading can take place from the otolith or illicium itself by using a microscope. It is also possible to identify the age from pictures of the otolith or illicium.

For the Netherlands and Belgian surveys, the software SmartDots [19] is being used for age reading since 2020 and 2016, respectively. Along with the year-class information, this software also provides otolith growth per year. This latter information is not submitted to DATRAS, but can be made available for specific purposes.

[19] https://www.ices.dk/data/tools/Pages/smartdots.aspx. Last accessed 29 November 2022.

Table 4.2. Stratification of biological data collection.

Country	Species	Number of fish	Spatial stratification unit(s)	Stratification applied since (–until)	Comment
North Sea and Eastern Channel, ICES areas 4 and 7d					
Belgium	Plaice and sole	2 per cm class	ICES rectangle	2018	
		3 per cm class	ICES rectangle	2017	
		5 per cm class	ICES rectangle	1992–2016	only ≥ 15 cm
	Turbot, brill, and cod	3 per cm class	ICES rectangle	2017	
		5 per cm class	ICES rectangle	1992–2016	only ≥ 15 cm
	Dab and lemon sole	3 per cm class	ICES rectangle	2018	
Germany	Plaice and dab	1 per cm class per sex	ICES rectangle	2014	
		3 per cm class per sex	ICES rectangle	1997–2013	
	Sole	All caught	No stratification	1997	
The Netherlands	Plaice	1 per cm class	ICES rectangle	2001	< 40 cm Haul-based registration since 2001 Collection in all survey years
	Plaice	2 per cm class	ICES rectangle	2001	≥ 40 cm Haul-based registration since 2001 Collection in all survey years
	Sole	2 per cm class	ICES rectangle	2001	Haul-based registration since 2001 Collection in all survey years
	Plaice and sole	5 per cm class	Flatfish area or roundfish area	1985–2000	
	Turbot, brill, dab, flounder, lemon sole, and cod	4–5 per cm class	Flatfish area or roundfish area	1985	Haul-based registration since 2001 Collection in all survey years
	Other species	3–5 per cm class	Roundfish area	1998	Species listed in Part A of Table 4.1 Only central and western North Sea Haul-based registration since 2001 Collection in all survey years

Table 4.2 (cont.)

Country	Species	Number of fish	Spatial stratification unit(s)	Stratification applied since (–until)	Comment
North Sea and Eastern Channel, ICES areas 4 and 7d (cont.)					
UK-Cefas	Plaice	2 per cm class per sex	Station	1988	
	Sole	10 per cm class	Stratum	2010	
		11 per cm class per sex	Survey	1988–2009	
	Dab	5 per cm class	Survey	2014	
		4 per cm class < 13 cm 8 per cm class 13–49 cm 50 per cm class > 50 cm	Survey 1988–2013		
	Lemon sole	5 per cm class	Survey	1988	
	Turbot and brill	50 per cm class	Survey	1988	Effectively this means that all fish are collected
	Other species	All	Survey	1988	Species listed in Part A of Table 4.1
Western channel and Celtic Sea, ICES areas 7efghj (Q1SWECOS)					
UK-Cefas	Plaice (female)	1 per cm < 11 cm 10 per cm 11–35 cm 20 per cm 36–51 cm 10 per cm > 51 cm	Stratum	2006	Historically, virtually all individuals were sampled for age, but, due to the increase of the plaice stock, this is not the case anymore
	Plaice (male)	1 per cm < 11 cm 10 per cm 11–26 cm 20 per cm 26–41 cm 10 per cm > 41 cm	Stratum	2006	Historically, virtually all individuals were sampled for age, but, due to the increase of the plaice stock, this is not the case anymore
	Sole	100 per cm class per sex	Stratum	2014	Virtually all individuals are sampled for age
		20 per cm class	Stratum	2006-2013	Virtually all individuals are sampled for age
	Megrim	20 per cm class per sex	Stratum	2006	
	Other species	All	Survey	2006	Species listed in Part B of Table 4.1

Table 4.2 (cont.)

Country	Species	Number of fish	Spatial stratification unit(s)	Stratification applied since (–until)	Comment
Irish Sea and Bristol channel, ICES areas 7afg					
UK-Cefas	Plaice	1 per cm class < 5 cm 4 per cm class 5–19 cm 8 per cm class 20–59 cm 1 per cm class > 59 cm	Stratum and depth band (< 20, 20+ m)	2001	
	Sole	2 per cm class <5 cm 6 per cm class 5–19 cm 12 per cm class 20–59 cm 1 per cm class > 59 cm	Stratum and depth band (< 20, 20+ m)	2010	
		1 per cm class per sex < 5 cm 4 per cm per sex 5–19 cm 8 per cm class per sex 20–59 cm 1 per cm class per sex > 59 cm	Depth band (< 20, 20+ m)	1988- 2009	
	Dab	1 per cm class < 7 cm 4 per cm class 7–14 cm 8 per cm class 15–29 cm 4 per cm class > 29 cm	ICES area (7a, 7fg)	2014	
		1 per cm class per sex < 7 cm 4 per cm class per sex 7–14 cm 8 per cm class per sex 15–29 cm 4 per cm class per sex >29 cm	Depth band (< 20, 20+ m)	1988-2013	
	Lemon sole	2 per cm class <10 cm 5 per cm class 10-34 cm 2 per cm class >34 cm	Depth band (< 20, 20+ m)	1988	
	Turbot and brill	50	Depth band (< 20, 20+ m)	1988	

Table 4.2 (cont.)

Country	Species	Number of fish	Spatial stratification unit(s)	Stratification applied since (–until)	Comment
Bay of Biscay, ICES Area 8					
France	Sole	min. 5 per cm class per sex	Area (north resp. south of 46°30′)	2007	
Iceland sea, ICES Area 5					
Iceland	All species	10	Station	2016	Species listed in Part E of Table 4.1 No length stratification
Adriatic Sea GSA 17					
Italy Slovenia Croatia	Sole, turbot, brill, and European flounder	10 per cm class	Area (south resp. north of Ancona, and international waters)	2005	

5 Additional data

5.1 Environmental data

Temperature and salinity data are collected during all surveys. In some cases oxygen content is also measured. Most surveys use a CTD for data collection, with the exception of the Bay of Biscay survey, which uses SCANMAR temperature unit.

- Vertical downcast profiles are collected during the surveys conducted by Germany, the Netherlands, and UK (Cefas), and during the Adriatic Sea survey (Italy-Slovenia-Croatia). Detailed information on the instruments used is available at the respective national institutes.
- Continuous CTD data collection during the tow is carried out during the surveys conducted by Belgium, France, Iceland, UK (Cefas), and Italy-Slovenia-Croatia.

Germany and UK (Cefas) collect water samples, in addition to the use of a CTD. The samples are used to exactly determine the salinity at a station.

No parameters have been set for determining the accuracy of CTD measurements, as these are additional data. It is assumed that all countries use instruments that fit their needs, and that guidelines for their use are available from the respective institutes.

5.2 Marine litter

Macrolitter from the catch is collected during all offshore surveys. UK (Cefas) records information on litter caught during the surveys since 2009, Belgium, Germany, and the Netherlands (only RV Tridens II) since 2011, Italy-Slovenia-Croatia since 2013, France since 2014, and Iceland since the start of the survey in 2016. The data collection procedure followed is consistent with the guidelines described by the ICES Working Group on Marine Litter (WGML; ICES, 2022). It should be noted that the guidelines have slightly changed over the years.

6 Data recording and storage

6.1 Recording trawl information

All information related to the beam trawl surveys coordinated by WGBEAM is stored on DATRAS.

For the North Sea survey conducted by Belgium, haul time and positions (shoot and haul) and abiotic data, such as depth, windspeed, wind direction, surface temperature and surface salinity, are retrieved from the ship's system. Bottom temperature and bottom salinity are acquired from the CTD that is attached to the beam. The haul metadata are stored in a standard format that is later read into the institute's database Smartfish by means of an import software.

The Netherlands and Germany retrieve data on e.g. hauling position, depth, and time, directly from the ship's system. The information is stored in a standard format that can be read by the input software of the institute's database. CTD data are added from downcasts.

During the other surveys, the haul information is manually collected from various sources and entered into the database.

6.2 Recording catch and biological information

For measuring the length of individuals, calibrated measuring boards are used. Measurement accuracy is registered along with the length information. For weighing, motion compensated marine scales are used. The measuring accuracy and precision varies per ship, but is available in national manuals (see Section 7.1).

The survey conducted by Belgium uses digital measuring boards for length measurements and the electronic registration of biological fish and shellfish data. For individual fish weights, the balance is directly synchronized with the measuring board. During the survey, data that are recorded with the measuring boards are automatically saved in Smartfish, the institute's database. Age data are added automatically via SmartDots (used since 2016).

On the survey conducted by Germany, the catch and length information are registered on paper, and the information entered into the database after the haul processing on board. Data from biological samples are written down and entered later in the same file. Otoliths are returned to the institute for appropriate processing and age reading by a dedicated otolith processing team, after which the information is added to the file.

On the survey conducted by the Netherlands, the haul information is read from the vessel's information system, and catch information is added by means of a home-developed data entry programme, using a standardized species list to prevent typing errors, and defined length ranges for most species that are based on database recordings. Data on length measurements are entered directly into the computer. After the haul, the scientist in charge checks the information in the file for completeness and obvious mistakes. Data from biological samples are written down on paper and entered later in the same file. Otoliths are returned to the institute for appropriate processing and age reading by a dedicated otolith processing team, after which the information is added to the file. Since 2020, this happens automatically via SmartDots.

The surveys conducted by UK (Cefas) use the Electronic Data Capture (EDC) system to collect data, which has in-built quality checks for min/max lengths and length–weight for every length sample collected and every biologically sampled individual.

The survey conducted by Iceland uses an electronic system (Hafvog) to collect length data.

On the survey conducted by France data are entered into the computer on board.

On the Adriatic Sea survey (Italy-Slovenia-Croatia) the catch and haul information is registered on paper on board, and entered into the database once ashore.

6.3 Data storage

6.3.1 Trawl, catch, and biological information

National offshore beam trawl survey data are stored on institutional databases. Data are transmitted to DATRAS.

6.3.2 Environmental data

The Netherlands and Germany store the CTD data on institutional databases, after checking for outliers, together with the other survey data. Vertical CTD profile information is supplied to ICES Oceanography database [20]. Belgium stores the continuous CTD data in Smartfish, the institute's database. Average bottom temperature and salinity are supplied with the other data in the DATRAS HH file.

6.3.3 Litter data

Germany, Iceland, France, UK (Cefas), and Italy store the data on an institutional litter database. Belgium and the Netherlands store Excel sheets with litter information on an internal server (with automated backup). All countries deliver the information to ICES Litter Database related to DATRAS. The litter reference coding follows ICES vocabulary [21] .

[20] https://www.ices.dk/data/data-portals/Pages/ocean.aspx. Last accessed 30 of November 2022.

[21] https://vocab.ices.dk/?ref=1381. Last accessed 30 of November 2022.

7 Quality assurance

7.1 National manuals

For most surveys, extensive manuals are available at the institutes conducting the surveys. Mostly, those manuals are not written in English, as the national personnel has to be able to work with them. They often contain more information than only on the offshore beam trawl surveys, and, in some cases, they are considered sensitive. The manuals may contain detailed information on, for example, responsibilities and administrative institutional procedures, that are not of direct interest for the offshore beam trawl surveys. Parts of the national manuals may be made available upon request (author contact details in Annex 1), with a clear argumentation on why the present manual is not sufficient, and a clear description of the purpose of the request.

Table 7.1. Overview of national offshore beam trawl survey manuals.

Country	Area	Manual available	Update frequency	Comment
Belgium	North Sea	Yes	When relevant	Available on internal server (automated backup)
France	Bay of Biscay	Yes	Annual	
Germany	North Sea	No	Not applicable	Manual is under development
Iceland	Iceland Sea	Yes	Annual	
Italy Slovenia Croatia	Adriatic Sea	Yes	When relevant	The manual also contains detailed gear descriptions
The Netherlands	North Sea	Yes	Reviewed annually, updated when relevant	The manual also contains: (i) a quality assurance table, describing risks, potential measures, critical moments, limit values; and (ii) detailed gear descriptions
UK (Cefas)	All areas	Yes	Reviewed annually, updated when relevant	Draft manuals available for all three UK beam trawl surveys

7.2 Gear

In general, gear is maintained in accordance with standardized gear descriptions. Before the survey, a check is done (by the fishing skipper, other crew, and/or the institutes' gear technicians) on major parameters, such as mesh size, number of meshes, and net damage, and the gear is repaired when necessary. If the gear does not match the description, the gear technicians overhaul the gear. If the gear is damaged during the survey, the net is replaced or repaired by the crew based on the net drawings, using pre-made net pieces or repairs by hand.

In case of repairs, the gear must be checked immediately after the survey, as it is not possible to properly hang out the net on board while at sea.

In the Adriatic Sea beam trawl survey, a check against a standard is done before or after each sampling day. If the gear has suffered damage, it is replaced or repaired.

The German institute does not have a standard gear description after which the gear is checked, because the crew carries out the maintenance. They conduct regular checks using the net drawing.

7.3 Subsampling

The survey conducted by the Netherlands in the North Sea has a defined quality assurance procedure for the fraction and numbers subsampled. At least three times during a survey, checks are carried out to ensure that the last two fractions in the subsample are equal.

The Adriatic Sea (Italy-Slovenia-Croatia) survey has a defined quality assurance process for the fraction subsampled.

Other countries do not have a defined quality assurance process for subsampling.

7.4 Species identification

Generally, literature is used on board to identify species. All countries' sampling procedures allow for continuous feedback on species identification on board (e.g. by having identification keys, multiple experts on board, and contact experts ashore). For problem taxa, WGBEAM follows the recommendations of ICES Workshop on Taxonomic Quality Issues in the DATRAS Database (WKTQD; ICES, 2007b). Species that cannot be identified at sea are conserved (mostly frozen) and returned to the lab for identification by experts.

In the North Sea surveys conducted by the Netherlands and Belgium, quality assurance of species identification is carried out by annual internal identification tests and workshops for personnel (on demersal fish and epifauna, pelagic fish species, freshwater fish species, and marine shellfish species). Employees responsible for offshore beam trawl surveys (e.g. scientists in charge) must obtain a minimum score on the demersal fish and epifauna identification test.

In the surveys conducted by UK (Cefas), fish species identification is to species level using identification guides compiled with the help of taxonomic experts. To ensure quality control, staff are specifically trained for the different surveys, and fish identification tests are randomly carried out on surveys.

For the Adriatic Sea survey (Italy-Slovenia-Croatia), an identification workshop was carried out in 2011 for the personnel involved in the survey, and a list of species, checked for synonyms and mistakes, has been finalized. Since 2010, increasing efforts are being been made to identify, sort, count, and weigh epibenthos/benthos species and debris items onboard.

Suggestions for identification literature are Fisher (1973), Hayward and Ryland (1994), Wheeler (1978), and HAROKIT [22] (sharks, skates and rays).

[22] https://www.vliz.be/en/harokit. Last accessed 05 January 2023.

7.5 Data quality

There is no commonly-agreed-on standard checking procedure for the national databases. However, there is a common description of checks that need to be conducted before uploading the survey data to DATRAS. Prior to uploading, the files are screened. The allowed ranges, mandatory fields, and checks that need to be carried out were updated in 2013 by ICES Workshop on DATRAS data Review Priorities and checking Procedures (WKDATR; ICES, 2013b) with approval from WGBEAM (ICES, 2013a), and are available at the ICES data submission checking portal [23]. Each country is responsible for the quality assurance of their respective data in DATRAS.

Quality checks of the Belgian survey data occur in three stages: 1) data quality checks at the software and database level, 2) data exploration quality checks in Power-bi, and 3) additional quality checks in R studio on the converted DATRAS datasets). A series of checks are done at the trip level (e.g. dates), haul level (e.g. timing, positions, haul duration, and distance), sample level (e.g. number of lengths and CPUE per ICES division), and individual fish level (e.g. number of otoliths). The checks cover whether lengths and weights recordings are within realistic ranges, and whether there are outliers in length-weight and age-length relationships of the individual fish measurements.

The data from the survey conducted by Germany undergoes numerous quality checks through a self-developed data entry software. Further checks are carried out before uploading the data to the database. Age determinations are confirmed by a second age reader.

The data from the survey conducted by the Netherlands undergoes standard checks for all parameters (detects outliers and/or missing values), using a standard SAS script, before the data are uploaded to an institutional database.

During and after UK (Cefas) surveys, a suite of quality checks are performed on the collected data to ensure accuracy and quality. Further checks are carried out on the data before the data are uploaded to the database. To ensure consistency in maturity identification, both within and between surveys in the series, staff inexperienced with the particular survey are supervised until they attain the required quality level and confidence.

The electronic system (Hafvog) Iceland uses for data recording has a built-in quality control for realistic minimum and maximum lengths and length-weight distributions, to detect outliers. Further checks are carried out when the data are uploaded to the national database.

During or after the survey conducted by France, a check is performed on the collected data for typing errors and obvious mistakes. A suite of checks is later carried out on the data before it is uploaded to the national database.

For the Adriatic Sea survey (conducted by Italy, Slovenia, and Croatia), Italy performs data quality procedures before entering data in the national database.

[23] https://datsu.ices.dk/web/selRep.aspx. Last accessed 05 January 2023.

8 History of the surveys by area

The offshore beam trawl surveys did not start as a combined survey. Over time, the beam trawl survey area as well as the data collection has expanded. Despite the ambition to keep the time-series as coherent as possible, vessel changes or modification of station grids do happen. This chapter provides a detailed overview of the history of the different surveys, and a summary of the changes over time in tabular form (Table 8.1). The table also highlights the presumed effect of the change on the data use.

8.1 North Sea and eastern English Channel [surveys conducted by Belgium, Germany, Netherlands, and UK (Cefas)]

8.1.1 Belgian offshore beam trawl survey

The Belgian offshore beam trawl survey started in 1992, collecting fisheries-independent data in the southwestern North Sea, primarily for plaice and sole. The survey has always been planned at the end of August / beginning of September. For the entire period from 1992 to 2021, the survey has been carried out on board of RV Belgica, except in 2015 and 2016, when the RV Belgica broke down and the commercial fishing vessel FV the Ramblers (Z.279) was used instead. From 2022 onwards, the new RV Belgica has been used to conduct the survey. The continuous time-series, using as the standard gear a 4-m beam trawl with chain mats and a 40-mm mesh in the codend, started in 1993. The survey covers ICES areas 4b and c (southern and central North Sea). 62 fixed stations are fished for 30 min at 4 knots. Although the target species are plaice and sole, all fish species and commercially important crustaceans and cephalopod species are measured since 2010 [from 1992 until 2010 only numbers were recorded for a closed list of species (Table A7.1)]. Otoliths are collected for plaice, sole, and other species, such as cod, brill, turbot, dab, and lemon sole. All (epi)benthic species are recorded (numbers and/or weights) since 2009. Litter has been collected since 2011.

8.1.2 German survey

The German survey started in 1991, covering areas off the Jutland coast (ICES statistical rectangles 40F4-43F7) which were not sampled by the then existing international surveys. In 2009 and 2013, the area was extended to ICES statistical rectangles 39F4–7 and 43F8–9, respectively. Since 1992, the survey gear is a 7-m beam trawl. The codend liner used was an 80-mm mesh in 1992 and a 40 mm mesh on from 1993. Some years (1996 and 2006) are missing in the series as a result of technical failures. The survey was originally carried out on board the RV Solea (A), which was replaced in 2004 with the newly built RV Solea (B).

8.1.3 Dutch offshore beam trawl survey

The Dutch offshore beam trawl survey started in 1985 on board the RV Isis. The original target species were plaice and sole, because those species were (and are) commercially exploited by the Dutch fisheries. The main goal of the survey was to create fisheries independent indices for plaice and sole in the southeastern North Sea, to be used by ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). Although the main focus was on the target species, all fish species were measured since the start of the survey, and all epifauna species numbers were recorded. Otoliths have been collected for plaice, sole, dab, brill, turbot, and cod since 1985.

Table 8.1. Overview of changes for offshore beam trawl surveys. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia; UK: UK (Cefas).

Year	Geographic region	Type of change	Description of change	Effect of change on data-use
2021	All areas	Data reporting	All countries: If the catch of two nets has been sorted as one sample, GearExp=DB (double beam) should be entered, otherwise SB. −9 can assumed to be SB.	Data from NL BTS < 2002 have been affected. For CPUE calculation, methodology in Section 2.3.1 should be used
2021	North Sea	Vessel	BE: Vessel change	None. Gear and sampling procedures remained identical, working conditions on board improved
2021	North Sea	Net protection	NL: Net protection changed from monofilament plastics (pluis) to leather in ICES Area 4c	None. Comparative fishing conducted in 2020 (new net protection installed on a net not used for sampling).
2020	North Sea	Data collection	NL: Use of SmartDots for age reading	Otolith growth per year provided in addition to yearclass information. This information is not submitted to DATRAS, but can be made available for specific purposes.
2019	All areas	Data collection	All countries: Maturity information is collected for most species, despite the recommendation from ICES (2010)	Maturity information available for most species (except dab). Macroscopic maturity information collected outside the optimal period (two months prior to and until the end of the spawning period) should be treated with care
2019	North Sea	Sampling design	NL: Reduction of number of stations in ICES Area 4c	Limited. Spatial coverage remained the same
2017	North Sea	Vessel	NL: Vessel change in ICES Area 4c	Limited. The other part of the survey was already conducted with the new vessel
2017	North Sea	Data collection	NL: Litter collection in ICES Area 4c	Litter data available
			NL: Registration of sampled weight by species in ICES Area 4c	Weight data by species available
2017	North Sea	Data collection	BE: Vessel change	Full sampling possible (comparable with 2011–2014)
2016	Iceland sea	Spatial coverage	IS: Start of beam trawl survey time-series in ICES Area 5a	Expansion of spatial coverage

Table 8.1 (cont.)

Year	Geographic region	Type of change	Description of change	Effect of change on data-use
2016	Western English Channel, Celtic Sea	Sampling design	UK: Change of sampling design for Q1SWECOS	Area of strata modified. Strata A dropped
2016	North Sea	Data collection	BE: Vessel change	Only absolute minimum sampling possible. Sampling carried out as before 2010
2016	North Sea	Data collection	BE: Use of SmartDots for age reading	Otolith growth per year provided in addition to yearclass information. This information is not submitted to DATRAS, but can be made available for specific purposes
2015	North Sea	Data collection	BE: Vessel change	Only absolute minimum sampling possible. Sampling carried out as before 2010
2015	Bay of Biscay	Vessel	FR: Vessel change	None. Gear remained identical, working conditions on board improved
2014	Bay of Biscay	Vessel	FR: Vessel change	None. Gear remained identical, working conditions on board improved
2013	Western English Channel, Celtic Sea	Sampling design	UK: Change of sampling design for Q1SWECOS	Area of strata modified
2013	North Sea	Spatial coverage	DE: Area coverage extended to the rectangles 43F8, F9 (based on a request from WGNSSK)	Expansion of spatial coverage
2012	Western English Channel, Celtic Sea	Spatial coverage	UK: Expansion of western channel survey to wider Celtic Sea	Expansion of spatial coverage
2011	North Sea	Data collection	BE, DE, and NL (central North sea): litter data collection started	Litter data available
2011	North Sea	Gear	NL: Slight net modification in southeastern North Sea survey	None. Modification effect was tested before implementation (no significant effect).
2010	North Sea	Data collection	BE: Length information recorded for all fish species	Length data on other fish species than plaice and sole available

Table 8.1 (cont.)

Year	Geographic region	Type of change	Description of change	Effect of change on data-use
2010	All areas	Data collection	All countries: Maturity information is only collected from two months prior to and until the end of the spawning season (following ICES, 2010)	Limited information on maturity (e.g. in Q3 surveys unavailable for plaice, sole, dab, turbot, brill).
2010	North Sea	Gear	NL: Slight net modification in central North Sea survey	None. Modification effect was tested before implementation (no significant effect)
2009	North Sea	Spatial coverage	DE: Area coverage extended to the rectangles 39F4, F5, F6, F7	Expansion of spatial coverage
2009	North Sea, eastern English Channel	Data collection	UK: Litter data collection started	Litter data available
2009	North Sea	Data collection	BE: Epibenthos registered	Data on epibenthos available
2009	Irish Sea, Bristol Channel	Vessel	UK: Vessel change	None
2008	North Sea, eastern English Channel	Vessel	UK: Vessel change	None
2007	Adriatic Sea	Spatial coverage	IT-SI-HR: Start of beam trawl survey time-series Solemon in GSA17	Expansion of spatial coverage
2007	Bay of Biscay	Spatial coverage	FR: Start of beam trawl survey time-series in ICES Area 8	Expansion of spatial coverage
2006	Western English Channel, Celtic Sea	Spatial coverage	UK: Start of southwest channel survey	Expansion of spatial coverage
2004	North Sea	Vessel	DE: Vessel change	None. Gear remained identical, working conditions on board improved
1998	North Sea	Spatial coverage	NL: Spatial expansion to central North Sea (ICES Area 4b)	Start of time-series with full North Sea coverage

Table 8.1 (cont.)

Year	Geographic region	Type of change	Description of change	Effect of change on data-use
1995	North Sea (4c)	Spatial coverage	UK: Spatial expansion of eastern channel survey to North Sea (ICES Area 4c)	Expansion of spatial coverage
1993	Irish Sea, Bristol Channel	Spatial coverage	UK: Spatial expansion of survey into ICES areas 7afg	Expansion of spatial coverage
1993	North Sea (4c)	Spatial coverage	BE: Start of beam trawl survey time-series in ICES Area 4c	Expansion of spatial coverage
1992	North Sea	Spatial coverage	DE: Start of beam trawl survey time-series in ICES areas 4bc	Expansion of spatial coverage
1989	Eastern English Channel	Vessel	UK: Vessel and gear change	Data prior to 1989 cannot be used for indices calculations
1988	Irish Sea, Bristol Channel	Spatial coverage	UK: Start of beam trawl survey time-series in ICES areas 7afg	Expansion of spatial coverage
1988	Eastern English Channel	Spatial coverage	UK: Start of beam trawl survey time-series in ICES Area 7d	Expansion of spatial coverage
1985	North Sea		NL: Start of beam trawl survey in southeastern North Sea (ICES Area 4c)	Start of offshore beam trawl survey timeseries

In 1996, the Netherlands started a beam trawl survey in the central North Sea using RV Tridens II. Originally, this survey was the Q3 IBTS, but because Dutch fisheries were increasingly concentrated on flatfish species, it was more appropriate to change the gear from the IBTS standard gear (Grand Ouverture Verticale, GOV) to a beam trawl, in order to obtain more information on those species in the central North Sea. As a consequence, in 1996 and 1997, part of the IBTS Q3 was replaced by a beam trawl survey, and, since 1998, the complete survey has been carried out as a beam trawl survey.

Since 2017, the complete survey (areas formerly covered by RV Isis and RV Tridens II) has been conducted using the RV Tridens II. Originally, the target species were plaice and sole, but catches have always been completely sorted, and otoliths have been collected for more species than plaice and sole throughout the years.

Until 2018, in the southeastern North Sea and German Bight (originally sampled by RV Isis), 82 priority stations and 12 additional stations were planned, divided over 20 ICES statistical rectangles (left panel in Figure 8.1). In 2019, the number of stations was reduced and, for some stations, the towing duration was set to 15 min (left panel in Figure 8.1). The main reasons for this change were to get an achievable sampling programme and to prevent extremely large catches of, especially, starfish (ICES, 2020b). The changes were based on an evaluation of the survey data from the prior 10 years, with focus on the number of invalid tows, the number of tows with large catches (5–10 baskets, 10–20 baskets, and > 20 baskets), and the number of tows with reduced haul duration. The geographical coverage stayed the same, and the presumed effect is minimal. The reduction of the haul duration produces a more constant gear efficiency and more thorough catch processing, since extremely large catches negatively affect both gear efficiency and catch processing.

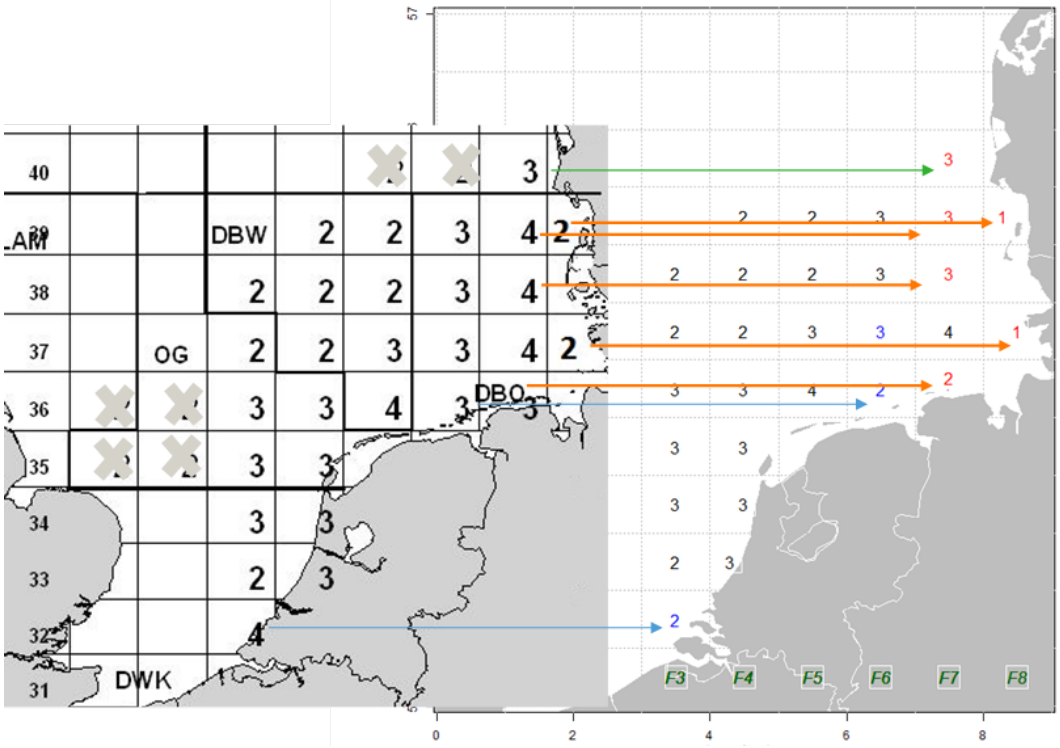

Figure 8.1. Changes to the number of stations and towing duration for part of the Dutch beam trawl survey (left panel: stations used until 2018, right panel: stations used on from 2019). Orange lines: reduction of number of stations and haul towing duration per rectangle; blue lines: reduction of number of stations per rectangle; numbers in red font: 15 min tows; numbers in blue font: high chance on extremely large catches; numbers in black font: 30 min tows.

In 2020 (Figure 8.2), an additional station was added to the central North Sea survey on the Scottish coast (in ICES statistical rectangle 43E8). The station is in a shallow sandy area, where mainly young flatfish are caught. In addition, on from 2020, the tow duration at a number of stations has been reduced to 15 min, due to substrate characteristics and the risk of net damage.

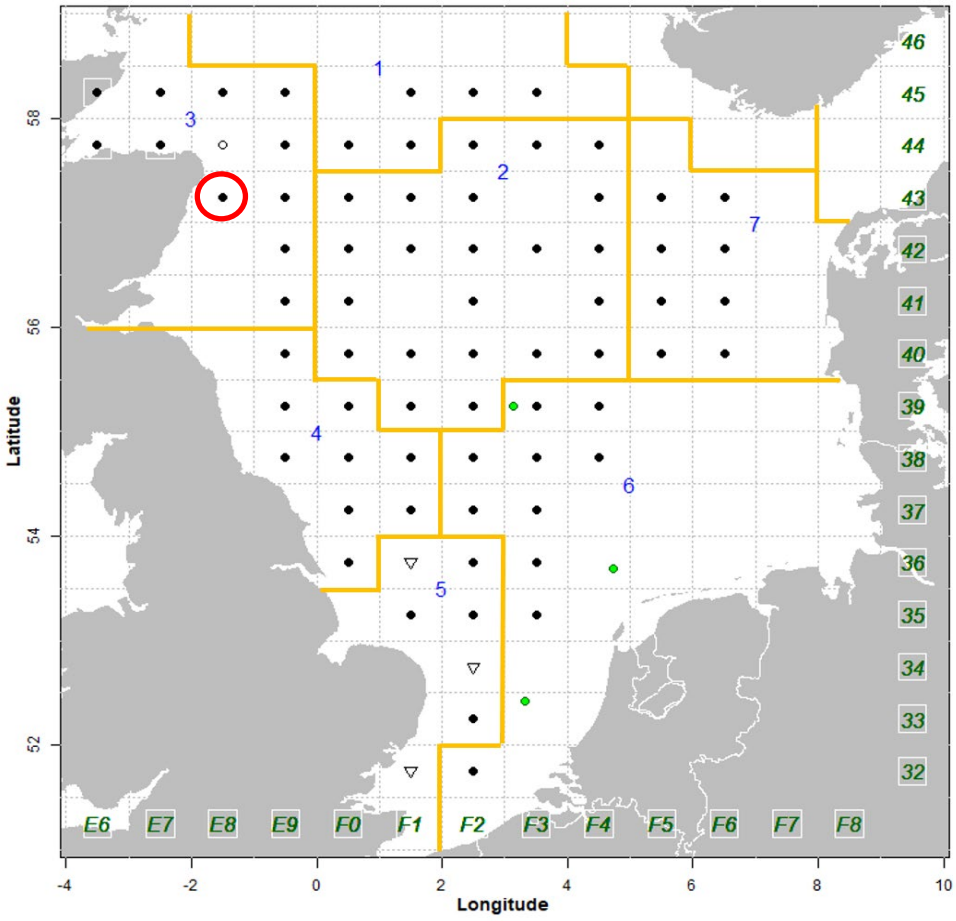

Figure 8.2. Location of the added station (in the red circle) for part of the Dutch beam trawl survey, fished since 2020. Black dots: stations with 30 min tows; open triangles: stations with 15 min tows due to rough substrate; open circle (44E8): station to be aware of due to the potential for extreme catches; green circles: stations with no beam trawl survey (Netherlands Joint Assessment Monitoring Programme); yellow lines and blue numbers: roundfish areas.

8.1.4 Eastern English Channel survey [UK (Cefas)]

UK (Cefas) has carried out an annual July/August beam trawl survey since 1988, using a commercial 4-m beam trawl, which has provided a commercially independent dataset used by WGNSSK. The survey has used FV Susanna in 1988, RV Corystes during 1989–2007, and RV Cefas Endeavour on from 2008. The original primary aim was to assess the relative abundance of prerecruit plaice and sole in ICES Division 7d. Consequently, most of the sampling was carried out in areas that are nursery grounds for these species. In 1995, the survey was extended to include the southern North Sea, in order to sample the whole population of plaice and sole. Since 2008, additional stations have been fished off the coast of Belgium, in order to have a time-series of stations for comparison purposes. These additional stations have been surveyed in most years since 2008.

In the eastern English Channel, tows are carried out in two ICES subareas: originally 79 tows in 7d and 29 in 4c. Initially, all tows in 7d had equal priority and the tows in 4c were worked time permitting. Since 1999, the number of tows worked has been reduced to 75 in 7d and 16 in 4c, as a result of a reduction in cruise time, and all of the tows now have equal priority. Further reductions in the numbers of tows were made in 2011, to account for a reduction in survey days and to remove locations where unmanageable benthic and substrate bycatches were observed.

8.2 Irish Sea and Bristol Channel survey [UK (Cefas)]

An autumn Irish Sea groundfish survey has been carried out annually since 1979. A Granton otter trawl was used until 1987, and, in 1988, the commercial 4-m beam trawl that is currently used was introduced. Concurrent to this survey, a limited beam-trawl survey was carried out in the Bristol Channel. From 1988 to 1992, the main survey effort was concentrated in the northeast Irish Sea and the Bristol Channel, and, since 1993, a standard survey has been undertaken covering the whole of ICES divisions 7a, f, and g. In 2002, the survey was extended to cover the survey area in ICES Division 7e, previously undertaken by the charter vessel FV Carhelmar that had been used since 1988. In 2005, the 7e survey was moved back to the FV Carhelmar, and this area is no long covered by a research vessel.

In the early years of the survey series (1988–-1991), the tow duration was mainly 15 min, but there was a growing number of 30 min tows. Since 1992, the default tow duration became 30 min. The rationale for these changes was not documented, but it is assumed that, in the early years, many more sites were fished within a similar number of working days. As the survey evolved, it must have become clear that this strategy was unsustainable, and a much more reduced coverage was adopted. Subsequently, the available time allowed for a longer tow duration to be adopted, probably in line with other Cefas and international surveys.

The number of primary survey stations within each sector are: Irish Sea South (18 stations), Irish Sea North (16 stations), Irish Sea West (15 stations), Saint George Channel (16 stations), Bristol Channel Inshore (32 stations), and Bristol Channel Offshore (11 stations). Historically, there was another sector, SEI (11 stations) that was dropped approximately 20 years ago, and which now receives occasional opportunistic visits. The 11 Bristol Channel Offshore stations are considered the lowest priority, as the data currently do not contribute to the VPA tuning and recruitment indices by the respective ICES working groups. Three depth bands were used in the survey until 2000: 0–20 m, 20–40 m, and 40+ m; which in 2001 were reduced to two depth bands: 0–20 m and 20+ m.

8.3 Western English Channel, Celtic Sea, and southwest of Ireland [UK (Cefas)]

UK (Cefas) initiated and conducted the Quarter 1 southwest beam trawl survey in the western English Channel annually mid-February to mid-April for two weeks from 2006. Since 2013, the survey area has been extended to include the wider Celtic Sea, and the survey has been renamed the Quarter 1 southwest ecosystem survey after obtaining DCF status (4 weeks total time). The survey has always mainly focused on delivering age-based indices for sole and plaice in the area, but also provides information on a much wider range of demersal species, such as lemon sole, monkfish, and cuttlefish. From 2016 to 2018, Ireland joined the existing survey, covering the shelf area from roughly 9°W to the 200 m isobath on the shelf break, which made the survey an internationally coordinated effort.

A stratified random survey design was chosen as the best possible survey design for the area. The strong environmental gradients associated with the biogeographic transition in the area would require that a systematic or fixed station design be performed at a very high resolution in order to not be subject to biases caused by annual variations in environmental conditions. When environmental conditions vary and these changes can be quantitatively accounted for, a stratified random survey design commonly outperforms systematic and fixed station designs, with a lower bias and only a small increase in variance for species with a broad distribution. Moreover, the survey area is a biogeographic transition zone, and, as a consequence, traditional survey methods, such as fixed station designs or rectangle based systematic designs, were not considered suitable for providing unbiased estimates of the state of the principal stocks. The understanding of the stock dynamics in the survey area, in terms of distribution and recruitment variability, is comparatively poor, but they are thought to be heavily influenced by temporally variable environmental and ecological conditions. In order to address these gaps in the understanding of the principal commercial fish stocks, provide information on a wider range of commercial species, and address the ever-increasing need for ecosystem information, this survey has been designed as an ecosystem survey, able to deliver holistic ecosystem information at different levels of precision for the various reporting requirements.

As the physical conditions of the surveyed habitats are variable, the survey areas were defined based on the communities present and biological conditions were *post-facto* assigned. Given the relative paucity of large-scale, consistently collected ecological information, the starting point used was the long-term experience and knowledge of fishers and ex-fishers in the area. Areas were identified that were fished at specific times of year for specific target communities in the largely multispecies fisheries, or that had been traditionally fished under different environmental conditions or using other methods. The major advantage of this approach is that it ensured an almost 100% coverage of the area, and included a significant enough time frame to account for what one might consider normal variability. Spatial commonality in the information provided by individual fishers was identified, and aggregated to rough areas based on the available information and subjective weighting due to the information requirements of the policy customer.

Although the information provided by the industry covered virtually the entire area of the original survey, the level of detail varied considerably. The information provided was highly consistent with respect to the centre of community distribution. However, fishers found it much harder to agree on the most appropriate boundary between communities, suggesting that these are natural gradients rather than the hard boundaries considered in stratified designs. Presumably, the environmental conditions have been variable over time and/or individual fishers had unique drivers and gears for targeting specific species. Consequently, fishers exploited the same species over common areas, but with different spatial extents.

8.3.1 Sampling design 2006–2012

The western English Channel was stratified into 13 strata. Five of these were located along the English coast and three slightly larger strata covered the French coastal zone. The remaining five were considered offshore stations based on oceanographic conditions. One stratum (in the Hurd deep) contained the deepest part of the survey area, at around 200 m, although this depth is limited to a very small part of the stratum. Each stratum was subdivided into roughly 10–15 hand-drawn polygons, from which samples were picked randomly without replacement, and proportional to the area of each polygon. Polygons were designed to be perpendicular to the expected environmental gradients, i.e. for most of the channel strata, the inshore-offshore gradient is steeper than the east-west gradient, and, therefore, polygons were generally wider than tall.

Sampling locations were randomly selected each year within each stratum. The number selected was variable in order to minimize variance in abundance estimates. Each sampling location was given a priority number, and several priority spares were also selected. The priority locations must be targeted for fishing, but if one proved unworkable, the next priority spare location in numerical order was sampled instead. In order to maintain the survey integrity and validity, it was important that the numerical sequence was maintained. Any gaps in the sequence could only be due to locations that could not be fished, and should never be due to other logistical and operational reasons. A total of 81 sampling locations were targeted. Operationally, this survey protocol was used in every survey year.

8.3.2 Sampling design 2013–2015

The western channel remained stratified into 13 numerically identified strata. All strata remained the same, except stratum 1, which was extended northwards into the Celtic Sea. The decision to extend stratum 1, rather than create an additional stratum, was based on the ecological information available. New polygons (grids) were developed based on a systematic hexagon design (grid), with the hexagon area equalling 1/15th of the respective stratum area. This change had no statistical implications, since the probability of site selection was always inversely related to the size of the polygon (grid). The change to a hexagon grid design was mainly done for consistency with the Celtic Sea strata, where it was difficult to determine the major axis of the environmental gradients, and because the inshore–offshore assumed gradient was found to be less influential than originally thought.

The initial intent was to follow the same design principles that had been used to identify the original western English Channel strata when extending the survey into the Celtic Sea. However, it became apparent that fishers knowledge was poorer. As an example, individual gillnetters have very specific areas that they target repeatedly, but these areas differ between netters, so it is difficult to combine their knowledge. Mobile gear fishers are spatially more coherent, but there are large areas of the Celtic Seas where little fishing effort was exerted by surveyed fishers. In contrast, the area is richer in scientific information, such as data from historic surveys and the more recently available data on international fishing activity, in the form of landings, on-board observer programs, and VMS data. These sources provided an acceptable alternative to more general fishers knowledge. However, it limited the ecological view to the recent past, whereas fishers knowledge had included elements stretching over decades in the western English Channel. The Celtic Sea strata were given letter codes rather than numbers in order to be able to distinguish the original strata when calculating the original indices. The survey extension included a large part of the Celtic Sea (ICES areas 7f–j), with 11 additional strata initially (strata A–K) within each of which five locations were targeted. This meant that a total of 136 locations were targeted by the survey, including the original 81 in the western English Channel.

8.3.3 Sampling design since 2016

Following work done by WGISUR and WGMSFDemo, there was an international interest to move towards a more ecosystem-based monitoring and to develop a more coherent monitoring effort in the Celtic Sea. A UK government funded project, ”It’s TIME for Truly Integrated Monitoring for Ecosystems” (MF 1231), provided funds to the Marine Institute (Ireland), Ifremer (France), and Cefas (UK) to develop the scientific basis for this effort. Subsequently, Ireland extended the survey further west, using the modified set of strata for the Celtic Sea agreed on at WGMSFDemo. The design principles of these strata remained the same, but newly collected Q1SWECOS data and additional information that became available through cooperation in the project, suggested that some changes were appropriate. Stratum A was the most heavily modified, as large areas were impractical to sample for technical reasons (areas of

very hard ground that were now excluded from the survey), and it was far more variable than originally expected, covering communities that were similar to those in the Bristol Channel and those on the west coast of Ireland. The changes to the southern boundary of Strata A meant that the northern extent of strata B, F, and G were also changed. The change reduced the total numbers of targeted locations to 131. Other major changes were altering the straight line that formed the western extent of the 2013–2015 design into something more ecologically meaningful, and ensuring coherence with the ecological strata of the French EVHOE survey design at the transition to the Bay of Biscay. As in the previous design, the new strata were subdivided into hexagons 1/15th the size of the strata.

8.4 Ceased survey: Western English Channel survey [UK (Cefas)]

The UK (Cefas) western English Channel commercial beam trawl survey operated from 1989 to 2013 (series now terminated) using the FV Carhelmar for all years, except 2002 and 2004 where the RV Corystes was used. The survey remained relatively unchanged, apart from small adjustments made to the position of individual hauls to provide an improved grid spacing. Station positions were fixed and each station had a unique prime number (station number in DATRAS). The prime station number consisted of a letter and number. The survey was originally divided into 16 blocks all identified by a letter (A–P), and within each block there were a number of stations, from 1 to 6. A full block of 6 stations equates to 15′ of Longitude and 30′ of Latitude. The full survey of 58 tows was completed annually in October.

The biological data collection was stratified by bands based on distance to the coast. This contrasts to the ICES areas 7a, f, and g survey, where otolith strata are based on depth bands. The reason for this is that the coastal shelf with water depth < 40 m is relatively narrow and is often fished with fixed gear. The survey bands (in miles) were 0–3, 3–6, 6–12, 12+ inshore, and 12+ offshore.

The survey operated using two Cefas 4-m beam trawls towed for 30 minutes at 4 knots over the ground using a warp/water depth ratio of 3.5: 1. When carried out on the FV Carhelmar, two beam trawls were deployed, but otoliths were sampled from both gears combined. In many cases, age information (CA records in DATRAS) was retrospectively assigned to the two different gears to match the length distributions. In 2002 and 2004, when the survey was carried out on the RV Corystes, only one gear was deployed, and the abundance information was doubled to equal the survey effort from the other surveys. However, variance estimates for these surveys must be treated as more uncertain, due to the reduced effective sample size.

8.5 Bay of Biscay survey (France)

The Bay of Biscay offshore beam trawl survey was started in 2007 by France, and is carried out by Ifremer in November/December. From 2007 to 2013, the RV Gwen Drez, a 24-m trawler, was used. In 2014, the RV Gwen Drez was withdrawn from the French research fleet, and the survey was carried out on the FV Antea, a 35-m trawler that is usually based overseas. Since 2015, the survey is carried out by the RV Cotes de la Manche, a 25-m research vessel, which is similar to the RV Gwen Drez but can fish only with one warp.

The main goal of the survey is to get a fisheries independent index for sole in the Bay of Biscay. Consequently, the survey covers the whole Bay of Biscay sole habitat, from the coast to 100 m depth. Although the target species is sole, all fish species are measured, weighed, and counted, and benthos species are sorted (by group from 2007 to 2013 and by the lowest taxon to which they can be attributed on board on from 2014), weighed, and counted.

8.6 Adriatic Sea survey (Italy, Slovenia, and Croatia)

The Adriatic beam trawl survey started in 2005 in the framework of the SoleMon project, funded by the Italian Ministry of Agriculture. Initially, it involved two Italian institutes, Istituto di scienze marine (ISMAR–CNR; Ancona) and the Istituto Centrale per la Ricerca scientifica e tecnologica Applicata al Mare (ICRAM; Chioggia), and one Croatian Unit, Institute of oceanography and fisheries (IOF; Split). Two surveys were carried out in 2005 and 2006, with chartered fishing vessels, in the north Adriatic Sea (Italian and Croatian waters).

Following an appraisal of the work carried out and the results obtained, extending the survey to the whole east Adriatic Sea through the SoleMon Project was discussed and agreed on during the 8th AdriaMed Coordination Committee (Tirana, December 2006). The execution of surveys for the appraisal of sole (*Solea solea*) in both GSA 17 and 18 (Albania, Croatia, Montenegro, and Slovenia), supported by the AdriaMed Project, was included in the Project workplan for 2007. In addition, as a follow up of the work carried out, the results of the two surveys in 2005 and 2006 were presented during the GFCM-SAC Sub Committees meetings held in Kavala, Greece (September 2007). In autumn 2007, the survey was carried out on RV Dallaporta in GSA 17 and 18. In May 2008, an *ad-hoc* meeting was organized to jointly analyse the data on the spatial distribution and abundance of sole in the Adriatic Sea (on the basis of the surveys carried out in 2007 and covering the survey data from spring 2005 to autumn 2007). It was agreed to continue the survey in the same manner.

Since 2007 the surveys have been regularly performed only in GSA 17 on board the RV Dallaporta. In 2017 the survey was endorsed by the Italian Fishery Data Collection Programme (Programma Nazionale Raccolta Dati Alieutici), and passed from being a stand-alone project to an integral part of the DCF Programme.

The main goal of the SoleMon surveys is to collect biological data and information on the distribution and relative abundance of commercially important marine species in GSA 17 for use in stock assessment and fishery management (STECF and GFCM-SAC meetings). The primary target species is the common sole (*Solea solea*). Further target species include spottail mantis squillid (*Squilla mantis*), common cuttlefish (*Sepia officinalis*), great Mediterranean scallop (*Pecten jacobaeus*), queen scallop (*Aequipecten opercularis*), turbot (*Scophthalmus maximus*), brill (*Scophthalmus rhombus*), european hake (*Merluccius merluccius*), red mullet (*Mullus barbatus*), skates (Rajdae), and caramote prawn (*Penaeus kerathurus*). Since 2007, the SoleMon surveys have been increasingly moving towards an integrated-ecosystem approach, and further tasks (e.g. seabed litter and megazoobenthos monitoring) have been added to the original goals, which are still the priority objectives.

Seventeen beam-trawl fishing surveys were carried out in GSA 17 from 2005 to 2019: two systematic pre-surveys (spring and autumn 2005) and fifteen random surveys (spring and autumn 2006, and autumn 2007–2019) stratified on the basis of depth (0–30 m, 30–50 m, and 50−100 m). Hauls were carried out during daytime using two or four gears simultaneously for 30 min (when possible) at 5.5 knots. A total of 68 fixed stations were sampled in spring 2005, 62 in autumn 2005, 42 in spring 2006, and 67 in autumn 2006–2019.

8.7 Iceland Sea survey (Iceland)

The Icelandic beam trawl survey started in 2016, after both fishers and scientists had requested a dedicated flatfish survey for over a decade. It is organized by the Marine and Freshwater Research Institute in Reykjavik, Iceland. In the first year, a pilot study with 31 stations on the west coast was conducted on the former RV and current shrimp trawler FV Dröfn RE-35. In

2017, the survey was expanded to include the south and north coasts, and 81 stations were surveyed in total with RV Bjarni Sæmundsson RE-30. The survey targets plaice, dab, and lemon sole, but also collects biological information on other flatfish species.

8.8 History and developments of the survey gears

Most surveys have been carried out using the same gear for a reasonable period. However, most surveys had major gear changes at the start of the survey. Only data taken after the gear was standardized are considered for index calculations. Therefore, there are no major gear changes in the time-series, unless comparative fishing took place before the change. The description of the gears used currently can be found in Section 4.1 and in Annex 4.

The Belgian survey runs since 1992, but the continuous time-series using a 4-m beam trawl with a 40-mm mesh in the codend as the standard gear started in 1993.

The German survey started in 1991 using a 80-mm mesh in the codend, which was changed to a 40-mm mesh in 1992. The series taken into account starts in 1992.

For the Dutch survey, the nets were slightly modified in 2010 for the RV Tridens II and in 2011 for the RV Isis. Fifteen hangers of two 1T2B were replaced by ten 1T2B and five AB. Therefore, the number of meshes decreased from 55 to 45 (originally 37) and from 45 to 36 (originally 26). The effect of this modification was tested before the survey was carried out with the new net. The results of the comparison were reported to WGBEAM (ICES, 2011). As there was no significant effect, it is assumed that this modification does not have any effect on the data collected.

In 2020, the portside net was laid out with a leather net protection instead of synthetic filaments, to minimize the amount of plastics released into the sea. During the survey in the southeast North Sea the catch volumes of the starboard net (still equipped with synthetic fibres and used for sampling that survey) and the portside net were compared, and no difference could be found. From 2021, both nets were laid out with the leather protection during the survey in the southeast North Sea. On from 2022, the leather protection has also been attached to the nets used in the central North Sea.

In the western English Channel surveys [UK (Cefas)], during 1984–1988, the vessel was equipped with two 6-m chain-mat beam trawls with 75-mm codends. For the survey hauls, one of the codends was fitted with a 60-mm liner. In 1989, when the RV Bogey 1 was replaced, two commercial chain-mat 4-m beam trawls (measured inside the shoe plates) were purchased as dedicated survey gear. Both beams were fitted with the standard flip-up ropes and 75-mm codend. In 1989 and 1990, only one codend was fished with a 40-mm liner, but on from 1991, with the introduction of 80-mm codends, both were fitted with 40-mm liners. The gear has remained unchanged since 1991. The skipper initiated the bridle length extension when the Cefas beams where first used to improve the towing stability of the beams when used on RV Carhelmar.

France carried out a first survey in the Bay of Biscay in 2006 using a twin otter trawl. The survey was presented at the 2007 meeting of ICES International Bottom Trawl Survey Working Group (IBTSWG). Because the survey aimed to collect data for flatfish indices, IBTSWG advised that this survey should be presented to WGBEAM. WGBEAM recommended the use of a beam trawl, which is considered more suitable for collecting data for flatfish abundance indices. Consequently, the gear was changed to a 4-meter beam trawl in 2007. The gear has remained unchanged since then, but it was towed on two warps from 2007 to 2013 and on one warp later, due to vessel changes.

References

Anonymous. 2019. SoleMon - Rapido trawl surveys in the Northern Adriatic Sea. SoleMon Handbook. Version 4, July 2019. Available at: https://podaci.ribarstvo.hr/files/SOLEMON-Handbook_2019_Ver_4.pdf

Beier, U., Haslob, H., Raat, H., and de Boois, I. J. In perparation. ICES Survey Protocols – Inshore beam trawl surveys, coordinated by Working group on Beam Trawl Surveys (WGBEAM). ICES Techniques in Marine Environmental Sciences.

Damme C. van, Beier, U., Blom, E., Boois, I. de, Burggraaf, D., Couperus, B., Hal, R. van, Pasterkamp, Th., and Vrooman, J. 2023. CVO Handboek en protocollen voor bestandsopnamen en routinematige bemonsteringen op zee en in estuaria. Versie 17. CVO report.

Fischer, W. (Ed.). 1973. FAO species identification sheets for fisheries purposes. Mediterranean and Black Sea (fishing area 37). Food and Agriculture Organization of the United Nations, Rome, Italy.

Hayward, P.J., and Ryland, J.S. 1994. The marine fauna or the British Isles and north-west Europe. 688 pp. Oxford University Press, Oxford, UK.

ICES. 2007. Report of the Workshop on Taxonomic Quality Issues in the DATRAS Database (WKTQD), 23-25 January 2007, Copenhagen, Denmark. ICES CM 2007 / RMC: 10. 45 pp. https://doi.org/10.17895/ices.pub.19268408

ICES. 2010. Report of the Workshop on Sexual Maturity Staging of Sole, Plaice, Dab and Flounder (WKMSSPDF). 22–26 February 2010, Ijmuiden, The Netherlands. ICES CM 2010 / ACOM: 50. 96 pp. https://doi.org/10.17895/ices.pub.19280735

ICES. 2011. Report of the Working Group on Beam Trawl Surveys (WGBEAM). 7–10 June 2011, Hamburg, Germany. ICES CM 2011 / SSGESST: 14. 225 pp. https://doi.org/10.17895/ices.pub.19419482

ICES. 2013a. Report of the Working Group on Beam Trawl Surveys (WGBEAM). 23–26 April 2013, Ancona, Italy. ICES CM 2013 / SSGESST: 12. 260 pp. https://doi.org/10.17895/ices.pub.19419476

ICES. 2013b. Report of the Workshop on DATRAS data Review Priorities and checking Procedures (WKDATR), 29–31 January 2013, Copenhagen, Denmark. ICES CM 2013 / SSGESST: 05. 45 pp. https://doi.org/10.17895/ices.pub.21655439

ICES. 2017. Report of the Benchmark Workshop on North Sea Stocks (WKNSEA). 6–10 February 2017, Copenhagen, Denmark. ICES CM 2017 / ACOM: 34. 673 pp. https://doi.org/10.17895/ices.pub.5339

ICES. 2018. Report of the Workshop for Advancing Sexual Maturity Staging in Fish (WKASMSF). 30 April – 4 May 2018, Copenhagen, Denmark. ICES CM / EOSG: 38. 75 pp. https://doi.org/10.17895/ices.pub.19212915

ICES. 2019. Manual for the Offshore Beam Trawl Surveys. Version 3.4. Series of ICES Survey Protocols 14 (SISP 14). 54 pp. http://doi.org/10.17895/ices.pub.5353

ICES. 2020a. Benchmark Workshop for Flatfish stocks in the North Sea and Celtic Sea (WKFlatNSCS). ICES Scientific Reports. 2: 23. 975 pp. http://doi.org/10.17895/ices.pub.5976

ICES. 2020b. Working Group on Beam Trawl Surveys (WGBEAM). ICES Scientific Reports, 2: 48. 86 pp. http://doi.org/10.17895/ices.pub.6028

ICES. 2022. ICES Manual for seafloor litter data collection and reporting from demersal trawl samples. ICES Techniques in Marine Environmental Sciences, Vol. 67. 16 pp. https://doi.org/10.17895/ices.pub.21435771

ICES Database of Trawl Surveys (DATRAS). 2022. ICES, Copenhagen, Denmark. https://www.ices.dk/data/data-portals/Pages/DATRAS.aspx

Sigurðsson, G.M., Pálsson, J. 2016. Icelandic Beam Trawl Survey – Pilot study of 2016. Marine and Freshwater Research in Iceland, HV 2016-004. 14 pp. Available at: https://dx.doi.org/10.13140/RG.2.2.36712.06407

Wheeler, A. 1978. Key to the fishes of Northern Europe. A guide to the identification of more than 350 species. Frederick Warne, London, UK. 380 pp.

Annex 1: Author contact information

Name	Institution	Email	Contributed to
Ingeborg J. de Boois	Wageningen Marine Research P.O. Box 68, 1970 AB Ijmuiden, The Netherlands	Ingeborg.deboois@wur.nl	North Sea (the Netherlands)
Gary Burt	Centre for Environment, Fisheries and Aquaculture Science (Cefas) Pakefield Road, Lowestoft, Suffolk NR33 0HT, UK	Gary.burt@cefas.co.uk	North Sea, Irish Sea and Bristol Channel, western English Channel, and Celtic Sea (UK)
Jean-Baptiste Lecomte	French Research Institute for Exploitation of the Sea (Ifremer) Rue de l'Ile d'Yeu, BP 21105, 44311 Nantes Cedex 03, France	Jean.baptiste.le-comte@ifremer.fr	Bay of Biscay
Francesco Masnadi	National Research Council, Institute for Marine Biological Resources and Biotechnology (CNR IRBIM) Largo Fiera della Pesca, 2, 60125 Ancona AN, Italy	francesco.masnadi@irbim.cnr.it	Adriatic Sea
Kay Panten	Thuenen-Institut for Seafisheries Herwigstrasse 31, 27572 Bremerhaven, Germany	kay.panten@thuenen.de	North Sea (Germany)
Heleen Raat	Flanders Research Institute for Agriculture, Fisheries and Food (ILVO) Jacobsenstraat 1, 8400 Oostende, Belgium	heleen.raat@ilvo.vlaanderen.be	North Sea (Belgium)
Gudjon M. Sigurdsson Magnús Thorlacius	Marine and Freshwater Research Institute (MFRI) Fornubúðir 5, 220 Hafnarfjörður, Iceland	gudjon.mar.sigurdsson@hafogvatn.is magnus.thorlacius@hafogvatn.is	Iceland sea

Annex 2: List of abbreviations and acronyms

ALK	Age–length key
BTS	Beam trawl survey
CTD	Instrument to measure conductivity and temperature at different water depths
CPUE	Catch-per-unit-effort
DATRAS	ICES database of trawl surveys
DCF	EU Data Collection Framework
EC	European Commission
EU	European Union
GFCM-SAC	General Fisheries Commission for the Mediterranean Scientific Advisory Committees
IBTSWG	ICES International Bottom Trawl Survey Working Group
ICES	International Council for Exploration of the Sea
LFI	Large fish indicator (MSFD)
MSFD	EU Marine Strategy Framework Directive
OSPAR	OSPAR is the mechanism by which 15 Governments and the EU cooperate to protect the marine environment of the northeast Atlantic. The fifteen Governments are Belgium, Denmark, Finland, France, Germany, Iceland, Ireland, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and UK.
RV	Research vessel
SA	Swept area
SISP	Series of ICES Survey Protocols
SMALK	Smoothed age–length key
STECF	EC Scientific, Technical and Economic Committee for Fisheries
TIMES	ICES Techniques in Marine Environmental Sciences
WGBEAM	ICES Working Group on Beam Trawl Surveys
WGDG	ICES Working Group on DATRAS Governance
WGBIOP	ICES Working Group on Biological Parameters
WGISUR	ICES Working Group on Integrating Surveys for the Ecosystem Approach
WGML	ICES Working Group on Marine Litter
WGMSFDemo	ICES Working Group to Demonstrate a Celtic Seas wide approach to the application of fisheries related science to the implementation of the Marine Strategy Framework Directive
WGNSSK	ICES Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak
WKASMSF	ICES Workshop for Advancing Sexual Maturity Staging in Fish
WKMSSPDF	ICES Workshop on Maturity Staging of Sole, Plaice, Dab and Flounder

Annex 3: Overview of WGBEAM offshore surveys (current situation)

Table A3.2. Overview for all surveys of survey area, time-series, sampling period, sampling design, and vessel used. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia.

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Survey name	**BTS**	**BTS**	**BTS**	**BTS**	**BTS**	**Q1SWECOS**	**ISBCBTS**			
Survey area	4bc [a] west	4b [a] east	4bc [a] east	4bc [a]	7d [a], 4c [a]	7efghj [a]	7afg [a]	8ab [a]	GSA17	5a [a]
Survey start	1992	1991	1985	1996	1988	2006 (7e) 2013 (7fghj)	1988	2007	2005	2016
Benthos sampling start	2009	1992	1985	1996	1991 [b]	2006	1992 [b]	2014 [c]	2005	2018–2020
Survey period	Aug/Sep	Aug/Sep	Aug/Sep	Aug/Sep	July	Feb–April	Sep	Nov/Dec	Nov/Dec	Aug/Sep
Start (week num.)	35	32/33	31	34	30	11–14	36/37	45	45	34
Num. survey days	10	11	15	20	14	30	21	22–27	15–20	Total: 21; beam trawl activities: 16
Station positions	Fixed	Fixed	Systematic	Systematic	Fixed	Random	Fixed	Fixed	Fixed	Fixed
Num. stations	62	63	74	72	79	131	108	45-55	67	81
Ship (RV)	Belgica	Solea	Tridens	Tridens	Endeavour	Endeavour	Endeavour	Cotes de la Manche	G. Dallaporta	Bjarni Sæmundsson
Ship length (m)	50.9	42	74	74	72	72	72	25	35.7	56

[a] ICES area; [b] at selected prime stations; [c] 2007–2013 closed list

Table A3.3. Sampling characteristics. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia; elasmo: elasmobranchs; cont: continuous.

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Survey name	**BTS**	**BTS**	**BTS**	**BTS**	**BTS**	**Q1SWECOS**	**ISBCBTS**			
Survey area	4bc [a] west	4b [a] east	4bc [a] east	4bc [a]	7d [a], 4c [a]	7efghj [a]	7afg [a]	8ab [a]	GSA17	5a [a]
Trawl duration (min)	30	30	30	30	30	2nmi (~30 min)	30	30	30	30
Day/night sampling	Day	Day	Day	Day	Day	Day and night	Day	Day	Day	Day and night
Speed over ground (knots)	4	4	4	4	4	4	4	5	5.5	4
Beam width (m)	4	7	8	8	4	4	4	4	3.5	4
Num. beams fished	1	1	2	2	1	2	1	1	2	1
Num. beams sorted	1	1	1	1	1	2	1	1	2	1
Operation from	Aft	Side	Side	Side	Aft	Side	Aft	Aft	Side	Aft

Table A3.3 (cont.)

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Survey name	**BTS**	**BTS**	**BTS**	**BTS**	**BTS**	**Q1SWECOS**	**ISBCBTS**			
Survey area	4bc [a] west	4b [a] east	4bc [a] east	4bc [a]	7d [a], 4c [a]	7efghj [a]	7afg [a]	8ab [a]	GSA17	5a [a]
Length data	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish	Fish, elasmo, shellfish
Catch weight per species	Yes	Yes	Yes (since 2017)	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Epibenthos data	All species [a]	All species	All species	All species	All at selected prime stations, otherwise closed list [b],	All species	All at selected prime stations, otherwise closed list [b]	2007–2013: closed list [b] From 2014: all	All species	Only for daytime hauls (approx. 50%) 2018–2020
Biological data	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1	Table 4.1
Environmental data	Cont	Downcast	Downcast (since 2017)	Downcast	Cont and downcast	Cont and downcast	Cont and downcast	Cont	Cont and downcast	Cont
Litter data since	2011	2011	2011	2011	2009	2009	2009	2014	2013	2016

[a] For 1992–2009, 2015, and 2016 - closed list; see Section 4.4.3 and Table A7.1

[b] See Section 4.4.3 and Table A7.2

Annex 4: Beam trawl dimensions

Table A4.1. Dimensions of gear components. BE: Belgium; FR: France; DE: Germany; HR: Croatia; IS: Iceland; IT: Italy; NL: The Netherlands; SI: Slovenia

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Survey name	BTS	BTS	BTS	BTS	BTS	Q1SWECOS	ISBCBTS			
Survey area	4bc [a] west	4b [a] east	4bc [a] east	4bc [a]	7d [a], 4c [a]	7efghj [a]	7afg [a]	8ab [a]	GSA17	5a [a]
Full gear										
Weight (kg)			2200 (net incl.) 1800 (net excl.)	2200 (net incl.) 1800 (net excl.)	2500		2500		225	2500
Beam										
Width inside shoes (m)	4	7	8	8	4	4	4	4	3.5	4
Num. of components (pipes)			Small: 2 Large: 1	Small: 2 Large: 1						
Pipe length (m)			Small: 3 Large: 5	Small: 3 Large: 5						
Pipe diameter (mm)			Small: 150 Large: 200	Small: 150 Large: 200						

Table A4.1 (cont.)

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Pipe thickness (mm)			Small: 15 Large: 20	Small: 15 Large: 20						
Skids										
Num. of skids	2	2	2	2	2	2	2	2	4	2
Height (cm)		60	80	80						
Width (cm)			40	40					12	
Length (cm)			100	100						
Weight per shoe (kg)			500	500						
Chains										
Num of ticklers	0	5	4 ticklers 4 net chains	4 ticklers 4 net chains	0	0	0	10	0	0
Tickler length (mm)			1520,1420 1320,1220	1520,1420 1320,1220						
Tickler diameter (mm)			24	24						
Chain mat	Yes	No	No	No	Yes		Yes	No	No	Yes
Bridle length (mm)					2900		2900			2900

Table A4.1 (cont.)

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Bridle material					5/8" grade 40 drag alloy chain		5/8" grade 40 drag alloy chain			5/8" grade 40 drag alloy chain
Net										
Flip-up rope	No	No	No	Yes	Yes	Yes	Yes	No	No	Yes
Length flip-up rope (mm)					1040	1120	1040			1040
Material flip-up rope			Braided nylon	Braided nylon	Rubber on 22 mm corlene rope	Rubber on 16 mm wire	Rubber on 22 mm corlene rope	n/a	n/a	Rubber on 22 mm corlene rope
Length headline (mm)			780	780	400	1146	400			400
Material headline			28-mm braided nylon	28-mm braided nylon	22-mm combination wire rope	32-mm Atlas rope	22-mm combination wire rope			22-mm combination wire rope
Length groundrope (mm)			1900	1900	1080	1100	1080			1080
Material groundrope			16″-chain	16″-chain	22-mm 6/19 construction wire rope	26-mm PIR wire	22-mm 6/19 construction wire rope			22-mm 6/19 construction wire rope
Netting material			Braided nylon	Braided nylon		Nylon, with euroline belly/codend				

Table A4.1 (cont.)

	North Sea and eastern English Channel					Western English Channel and Celtic Sea	Irish Sea and Bristol Channel	Bay of Biscay	Adriatic Sea	Iceland Sea
Country	**BE**	**DE**	**NL**	**NL**	**UK**	**UK**	**UK**	**FR**	**IT-SI-HR**	**IS**
Codend meshsize (mm), stretched	40	40	40	40	40	40	40	40	40	40
Mesh sizes net	Figure A4.1	Figure A4.3	Figure A4.2	Figure A4.2						

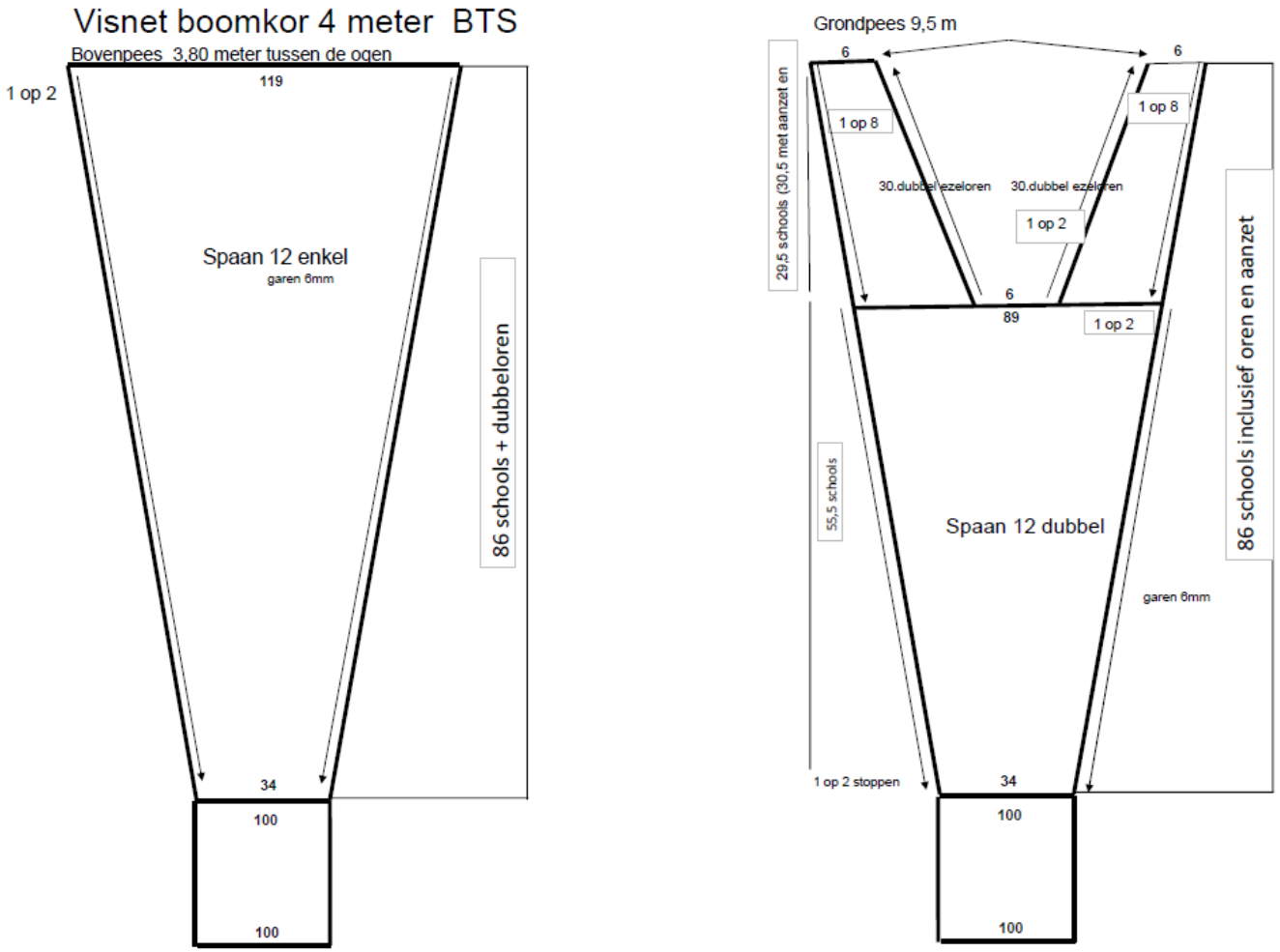

Figure A4.3. Dimensions of the Belgian survey beam trawlnet.

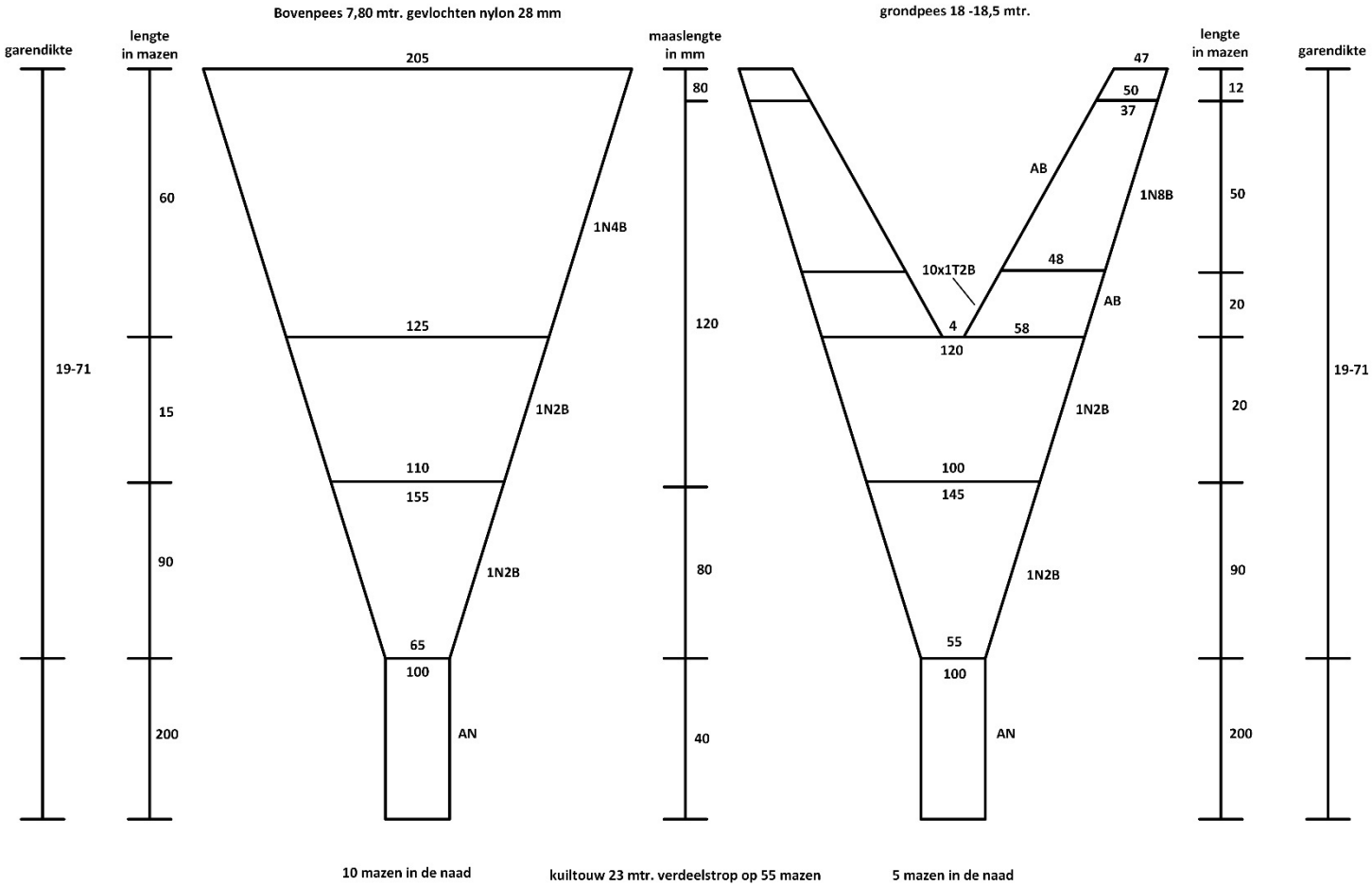

Figure A4.4. Dimensions of the Dutch survey beam trawlnet. Reproduced with permission from Damme *et al*. (2023).

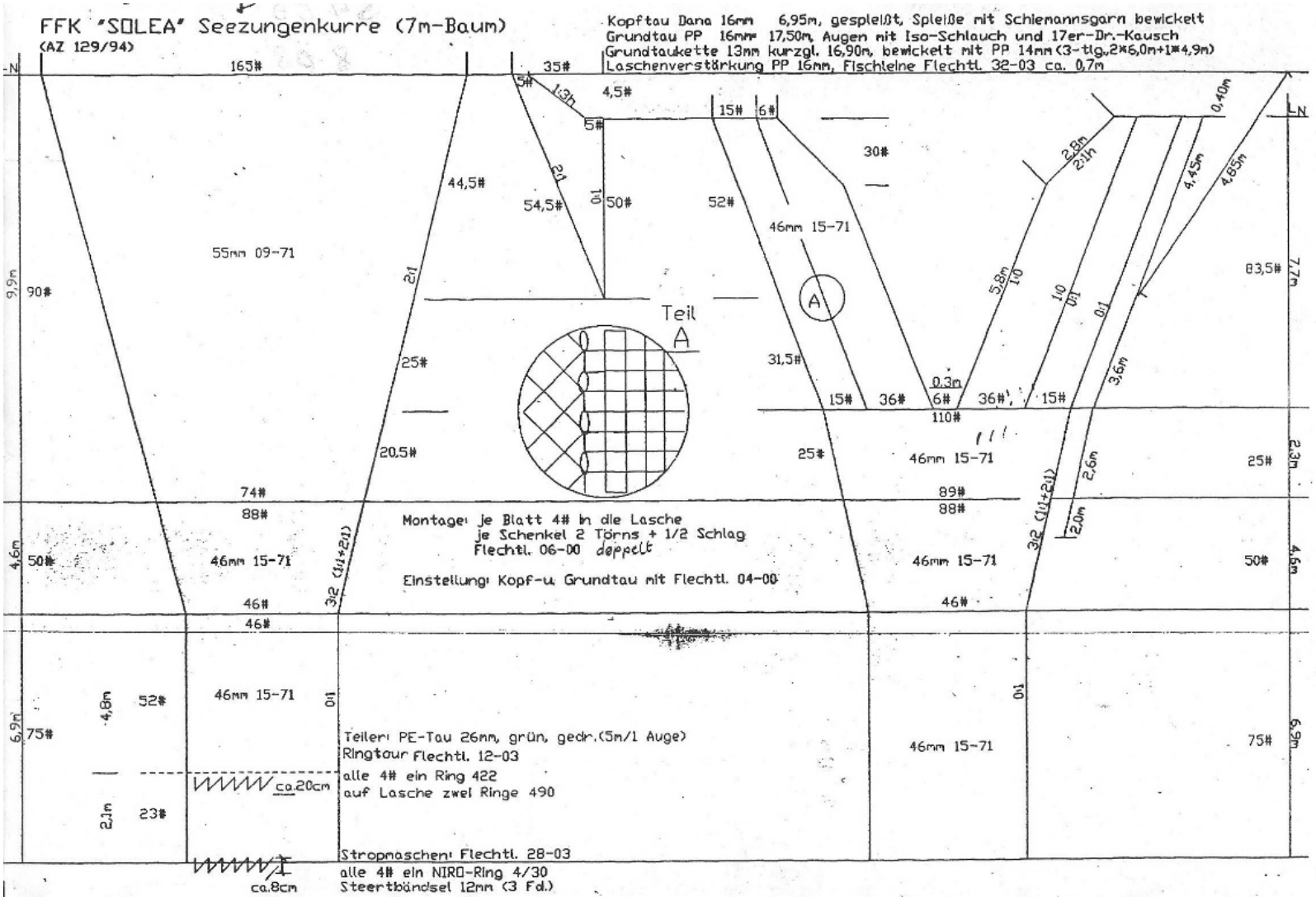

Figure A4.5. Dimensions of the German survey 7-m beam trawlnet. Reproduced with permission from national institutes own drawings (1989).

Annex 5: Geographic distribution of the surveys

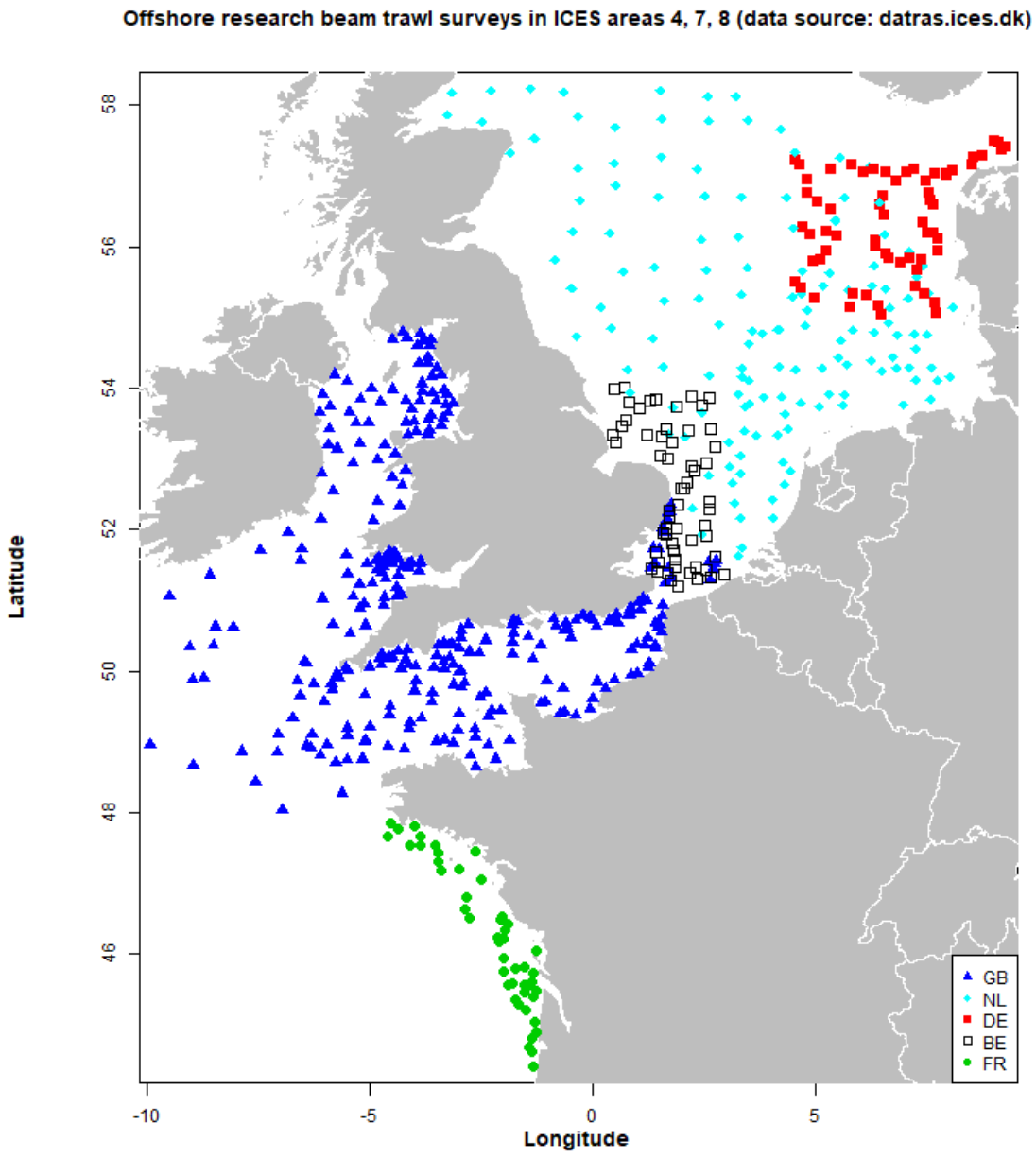

Figure A5.1. Offshore research beam trawl surveys in ICES areas 4, 7, and 8. Based on 2021 data by country. Data source: DATRAS.

For the Offshore research beam trawl survey in ICES Area 5a (Iceland Sea), Iceland, see Figure 2 in Sigurðsson and Pálsson (2016)

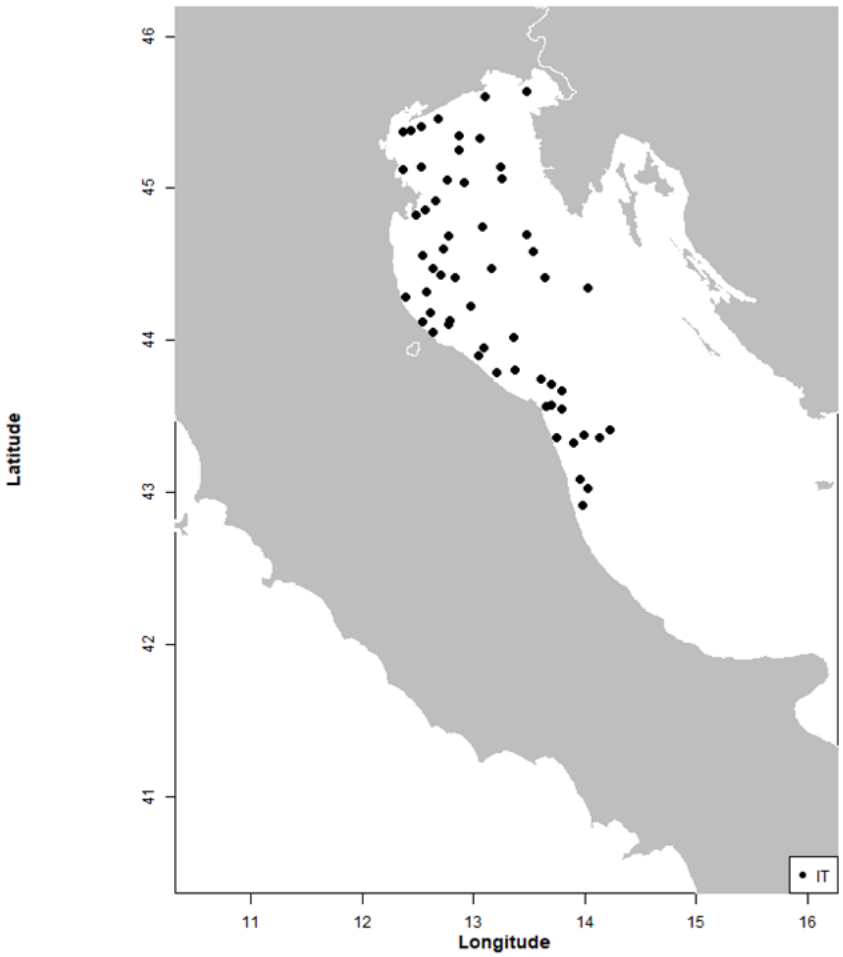

Figure A5.3. Offshore research beam trawl survey in the Adriatic Sea. Based on 2021 data. Data source: DATRAS, Italy-Slovenia-Croatia.

Annex 6: Biological sampling stratification areas

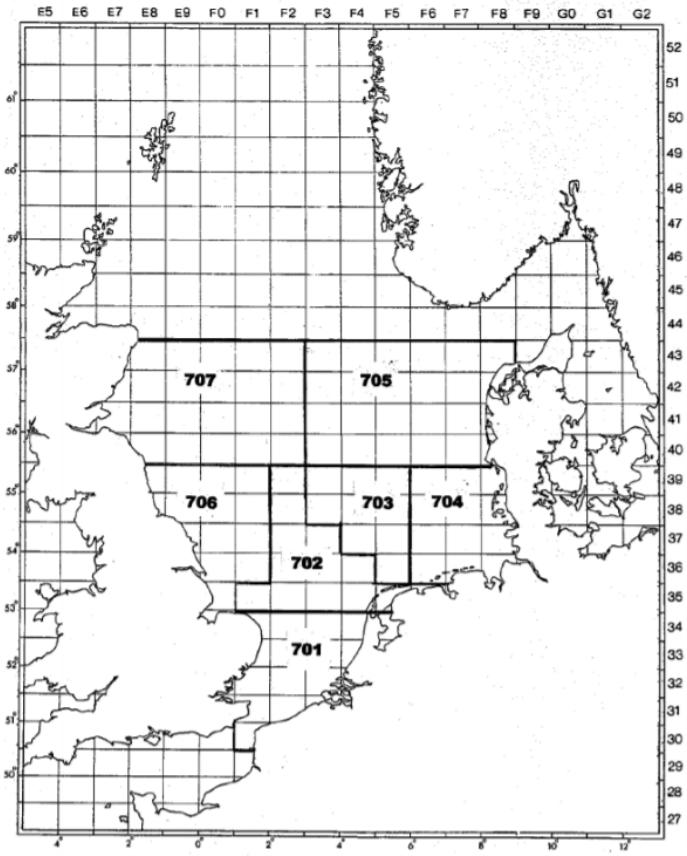

Figure A6.1. North Sea - Belgium: Flatfish areas.

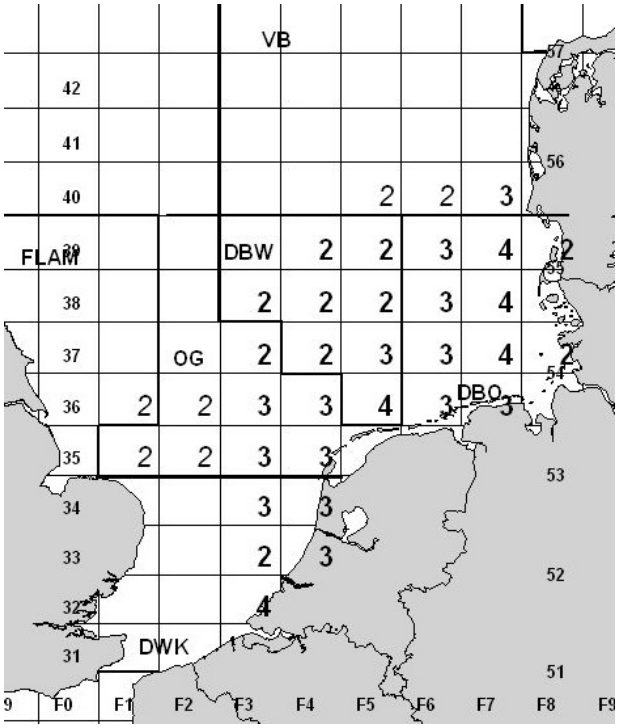

Figure A6.2. North Sea - Netherlands: Flatfish areas.

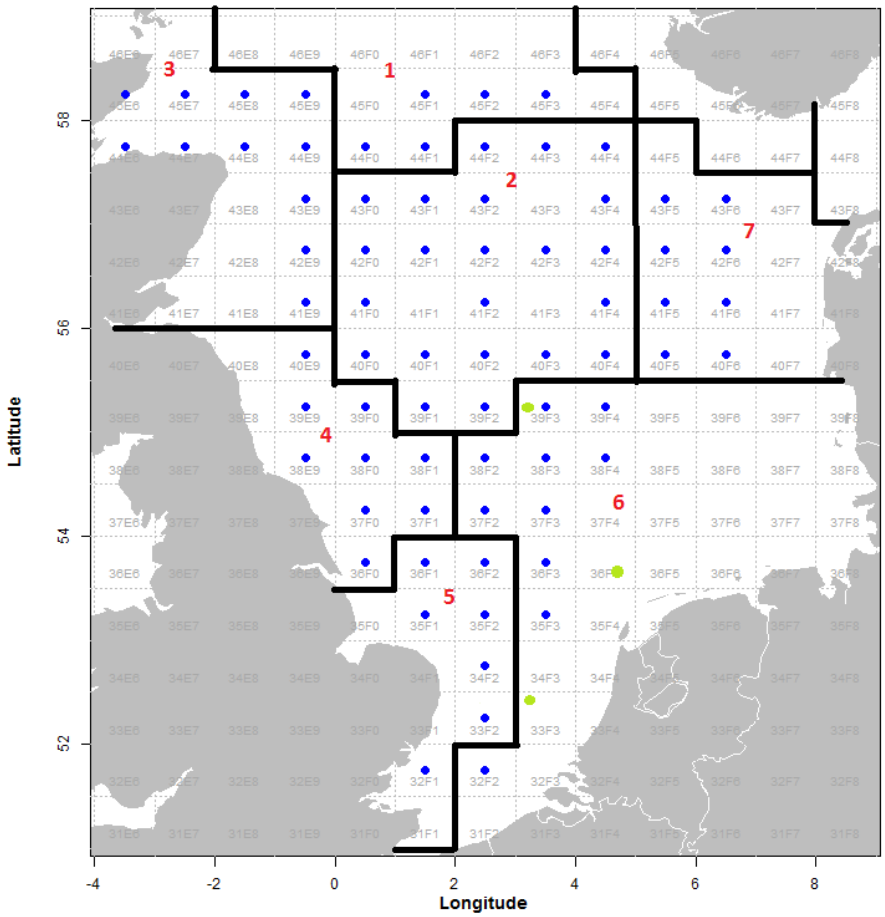

Figure A6.3. North Sea - Netherlands: Roundfish areas.

Annex 7: Closed species lists offshore beam trawl surveys

Table 4. Closed species list used for fish sampling for the survey conducted by Belgium in 1992–2009, 2015, and 2016.

Species	Sample weight	Length measurement
Amblyraja radiata	Yes	Yes
Anguilla anguilla	Yes	Yes
Aspitrigla cuculus	Yes	Yes
Cancer pagurus	Yes	No
Chelidonichthys lucerna	Yes	Yes
Dicentrarchus labrax	Yes	Yes
Eutrigla gurnardus	Yes	Yes
Hippoglossoides platessoides	Yes	Yes
Gadus morhua	Yes	Yes
Glyptocephalus cynoglossus	Yes	Yes
Homarus gammarus	Yes	No
Lepidorhombus whiffiagonis	Yes	Yes
Leucoraja circularis	Yes	Yes
Leucoraja naevus	Yes	Yes
Limanda limanda	Yes	Yes
Loligo vulgaris	Yes	No
Lophius piscatorius	Yes	Yes
Melanogrammus aeglefinus	Yes	Yes
Merlangius merlangus	Yes	Yes
Merluccius merluccius	Yes	Yes
Microstomus kitt	Yes	Yes
Molva molva	Yes	Yes
Mullus surmuletus	Yes	Yes
Mustelus asterias	Yes	Yes
Nephrops norvegicus	Yes	No
Phrynorhombus norvegicus	Yes	Yes
Platichthys flesus	Yes	Yes
Pleuronectes platessa	Yes	Yes
Raja brachyura	Yes	Yes
Raja clavata	Yes	Yes
Raja microocellata	Yes	Yes
Raja montagui	Yes	Yes
Raja undulata	Yes	Yes
Scomber scombrus	Yes	Yes
Scophthalmus maximus	Yes	Yes
Scophthalmus rhombus	Yes	Yes
Scylliorhinus canicula	Yes	Yes
Sepia officinalis	Yes	No

Table A7.1 (cont.)		
Species	**Sample weight**	**Length measurement**
Solea lascaris	Yes	Yes
Solea solea	Yes	Yes
Trachinus draco	Yes	Yes
Trachurus trachurus	Yes	Yes
Trisopterus luscus	Yes	Yes
Zeus faber	Yes	Yes

Table 5. UK closed benthos species list used for stations other than selected prime stations (North Sea, Irish Sea, and Bristol Channel).

Species	Sample weight	Count
Arctica islandica	Yes	Yes
Atrina fragilis	Yes	Yes
Crepidula fornicata	Yes	Yes
Dromia personata	Yes	Yes
Eunicella verrucosa	Yes	Yes
Funiculina quadrangularis	Yes	Yes
Glossus humanus	Yes	Yes
Meiosquilla desmaresti	Yes	Yes
Pennatula phosporea	Yes	Yes
Pentapora foliacea	Yes	Yes
Sabellaria spinulosa	Yes	Yes
Solaster Endeca	Yes	Yes
Styela clava	Yes	Yes
Virgularia mirabilis	Yes	Yes

Table 6. Closed benthos species list used for the survey conducted by France in 2007–2013.

Species	Sample weight	Count
Starfish	Yes	Yes
Crabs	Yes	Yes
Shrimps	Yes	Yes

Annex 8: Maturity key for skates and rays (Rajidae)

Table A8.1. Four stage maturity key for Skates and rays (Rajidae).

Stage	State	Male	Female
A	Immature	Claspers undeveloped, shorter than extreme tips of posterior margin of pelvic fin Testes small and thread-shaped	Ovaries small, their internal structure gelatinous or granulated, and with no differentiated oocytes visible Oviducts small and thread-shaped, width of shell gland not much greater than the width of the oviduct
B	Maturing	Claspers longer than posterior margin of pelvic fin, their tips more structured, but cartilaginous elements are not hardened, and the claspers are soft and flexible. Testes enlarged, sperm ducts beginning to meander	Ovaries enlarged and with more transparent walls. Oocytes differentiated in various small sizes (< 5mm). Oviducts small and thread-shaped, width of the shell gland much greater than the width of the oviduct, but not hardened
C	Fully mature	Claspers longer than posterior margin of pelvic fin, cartilaginous elements hardened and claspers stiff. Testes enlarged, sperm ducts meandering and tightly filled with sperm	Ovary/ovaries large and tight. Oocytes enlarged, with some very large, yolk-filled oocytes (> 5mm). Uteri enlarged and widening, shell gland fully formed
D	Active	Claspers reddish and swollen, sperm present in clasper groove, or flows if pressure exerted on cloaca	Viviparous species (e.g. spurdog, tope, smoothhounds, and stings/electric rays): Distinct yolk-filled eggs with developing embryos present in the oviducts. Oviparous species [e.g. lesser-spotted dogfish and skates (Rajidae)]: Egg capsules beginning to form in shell gland and partially visible in uteri, or egg capsules fully formed and hardened in oviducts/uteri.

Annex 9: Guidelines for starting a new beam trawl survey

One of the remits of WGBEAM is to provide expert advice on beam trawl surveys. Thus, the group is a valuable resource for successfully establishing a new beam trawl survey, whether the beam trawl survey will take place within or outside the ICES area. This manual could be used as a starting point for any institute or body that wishes to start a beam trawl survey that will be used for indices purposes.

Whenever a new survey is commissioned, the suitability of the gear is paramount. Liaising with industry partners and beam trawl survey experts (such those at WGBEAM) is the recommended first step towards establishing the survey.

The following steps should be carried out before any survey is started.

1. Identify the species that are to be targeted.
2. Identify the area to be fished.
3. Identify the most appropriate gear to use.
4. Ensure the gear can be deployed efficiently from your research platform.
5. Ensure that you have competent and expert knowledge to deal with the gear and the sampling.
6. Design the survey to deliver robust data that is representative of your needs.
7. Document the process and ensure that there is repeatability to all of the processes that you carry out.
8. Liaise with experts (such as those at WGBEAM) when designing and carrying out your survey.