Food and Agriculture Organization of the United Nations
General Fisheries Commission for the Mediterranean
BlackSea4Fish

International bottom trawl survey in the Black Sea (iBotS)

Instruction manual

Version 1.1

28 February 2024

2024

The International bottom trawl survey in the Black Sea (iBotS) programme aims to overcome the data gaps and harmonization needs identified by the Subregional Group on Stock Assessment in the Black Sea (SGSABS) by providing resources for the implementation of GFCM 2030 strategy towards the sustainability of Mediterranean and Black Sea fisheries. The iBotS coordinates the fishery-independent data collection for four GFCM Black Sea priority species (turbot, piked dogfish, red mullet, and whiting). This instruction manual was produced by the Black Sea expert group of demersal trawl surveys under the coordination of the BlackSea4Fish Project by adopting MEDITS instruction manual to the Black Sea conditions. In case further details needed, please refer to MEDITS instruction manual available at https://www.sibm.it/SITO%20MEDITS/principaleprogramme.htm

Contents

Preamble

The objective of the coordinated International Bottom Trawl Survey in the Black Sea (iBotS) is to provide statistically sound and high-quality survey data from Black Sea waters by coordinating and supporting standardized sampling methodology. Current priorities are to support the analytical stock assessment of four GFCM Black Sea priority species – turbot (*Scophthalmus maximus*), piked dogfish (*Squalus acanthias*), red mullet (*Mullus barbatus*) and whiting (*Merlangius merlangus*) – as well as monitor the abundance and distribution of other fish, elasmobranch and invertebrate species.

The iBotS instruction manual is an evolution of the Mediterranean area MEDITS Protocols Manual (MEDITS, 2017) adapted to the Black Sea region. While a significant part of the MEDITS protocol is maintained, sampling gear, gear operation, target species, sampling stations and temporal alignment of the surveys for example have been adjusted to the specific regional needs of the Black Sea. The work has been carried out by the Black Sea expert group on demersal trawl surveys under the coordination of the BlackSea4Fish project. The iBotS group initiated the standardized survey programme in autumn 2023 across four riparian countries (Bulgaria, Georgia, Romania and Türkiye). Up to the present, ten workshop meetings have been held to review and discuss data availability and survey methods across project partners:

- A BlackSea4Fish Demersal Surveys workshop meeting was held from 31 May to 1 June 2021 to kick-start the review and discuss data availability and survey methods across riparian countries.
- In 2021, a Technical Report on the Integration of Black Sea Surveys (WGBS, 2021) was prepared.
- An online meeting was held on 4 April 2022 to present and discuss the main outcomes of the Report on the Integration of Black Sea Survey.
- A hybrid meeting was held on 18 June 2022 in Burgas, Bulgaria to discuss target species and temporal alignment.
- A hybrid meeting was held on 17 February 2023 in Trabzon, Türkiye to discuss gear standardization.
- An online meeting was held on 7 March 2023 to discuss and start adaptation of the MEDITS protocols manual to the iBotS instructional manual.
- An online meeting was held on 21 March 2023 to discuss additional species and the data required for each species group, as well as the haul positions.
- An online meeting was held on 4 April 2023 to go through the additional information provided by the experts such as historic/commercial/survey station positions to help with haul localization work.
- On 11 April 2023, the final online meeting was held to go through the Appendices and modify them according to the iBotS requirements.
- Survey experts were given an onboard training on gear check and catch treatment for five days in Trabzon, Türkiye between 29 May and 2 June 2023.
- The group gathered for the last time before the first trials began in Burgas on 17 June 2023 to adopt the new protocol and finalize the number of hauls to be performed in each depth strata.

- On 30 January 2024, an online meeting was organized at which survey experts gathered to evaluate the first standardized demersal trawl survey conducted in Türkiye in line with the iBotS Manual Version 1.0.

Coordination of the iBotS programme (2023)

The iBotS programme is coordinated at the international level by the GFCM Secretariat under the BlackSea4Fish project. Table 1 shows the national and supporting experts of the iBotS standardization group.

Table 1. List of national and supporting experts

Country	Scientist Name	Affiliation	email address
BGR	Elitsa PETROVA	IFR	elitssa@yahoo.com
BGR	Feriha TSERKOVA	IFR	feya1980@gmail.com
GEO	Ramaz MIKELADZE	NEA	rmiqeladze@gmail.com
GEO	Marika MAKHARADZE	NEA	marimakharadze123@gmail.com
ROU	George TIGANOV	NIMRD	gtiganov@alpha.rmri.ro
ROU	Cristian Danilov SORIN	NIMRD	cdanilov@alpha.rmri.ro
UKR	Kostiantyn DEMIANENKO	IFME	s.erinaco@gmail.com
TUR	Murat DAGTEKIN	SUMAE	muratdagtekin998@gmail.com
TUR	Salih ILHAN	SUMAE	salih.ilhan.ktu@gmail.com
	Huseyin OZBILGIN	GFCM	huseyin.ozbilgin@fao.org
	Paolo CARPENTIERI	GFCM	paolo.carpentieri@fao.org
	Gokhan GOKCE	GFCM	gokhan.gokce@fao.org
	Yunus Emre FAKIOGLU	GFCM	emre.fakioglu@fao.org
	David STOKES	MI	david.stokes@marine.ie
	Frankie GRIFFIN	MI	frankiegriff@hotmail.com
	Ali Cemal GUCU	GFCM	gucu@ims.metu.edu.tr

Introduction

A first step in survey planning is to identify the target population to be sampled and to contain, as far as possible, that population within the survey area (Cochran, 2007). In fisheries, the target population is often already defined into geographic management units or stocks, even if these borders are not precisely in line with the true distribution in the water (WGBS, 2021). While it is not always feasible to obtain representative samples of the entire target population, it is important that the demographics of the sampled population match those of the population for which information is needed, and that any gaps are then prioritized for further study.

This first version of the protocols manual is developed as part of the iBotS programme to support standardized sampling for four priority (G1) and thirteen additional (G2) species that are defined within the geographic management units of the Black Sea (Table 2).

Table 2. Priority (G1) and additional species (G2) and the data required to be collected for each species

Group	Species	Common name	3-alpha code	Required data
G1	*Scophthalmus maximus*	Turbot	TUR	TW, N, L, S, MS, IW, A
	Mullus barbatus	Red mullet	MUT	TW, N, L, S, MS, IW, A
	*Squalus acanthias**	Piked dogfish	DGS	TW, N, L, S, MS, IW, A
	Merlangius merlangus	Whiting	WHG	TW, N, L, S, MS, IW, A
G2	*Raja clavata*	Thornback ray	RJC	TW, N, L, S
	Dasyatis pastinaca	Common sting ray	JDP	TW, N, L, S
	*Squalus blainville**	Longnose spurdog	QUB	TW, N, L, S
	Platichthys flesus	European flounder	FLE	TW, N, L
	Mullus surmuletus	Surmullet	MUR	TW, N, L
	Alosa immaculata	Pontic shad	SHC	TW, N, L
	Alosa tanaica	Caspian shad	CUI	TW, N, L
	Neogobius melanostomus	Round goby	NBU	TW, N, L
	*Huso huso**	Beluga	HUH	TW, N, L
	*Acipenser nudiventris**	Ship sturgeon	AAN	TW, N, L
	*Acipenser stellatus**	Stellate sturgeon	APE	TW, N, L
	*Acipenser gueldenstaedti**	Danube sturgeon	APG	TW, N, L
	*Acipenser sturio**	European sea sturgeon	APU	TW, N, L
G3	All other species			TW, N

Notes:

TW = total weight, N = number of individuals, L = length, S = sex, MS = maturity stage, IW = individual weight, A = age

*vulnerable species that should be given priority for data recording and released alive.

The characteristics of the sampling gear (including specification and operation), survey design, sampling methodology and processing of samples are all detailed in the current manual. Given the commitment to progress towards these agreed goals in a timely way, modifications to this manual will be incorporated through consensus of the expert iBotS group as required during this implementation process.

1. Specifications of the sampling gear

The iBotS trawl has been designed as a survey gear to ensure sampling of target populations with as high accuracy as possible in the areas and depths specified in the manual. To ensure that data on recruitment are collected, catch efficiency for juveniles of species like red mullet and whiting has been addressed through the use of a 10 mm mesh side[1] in the codend. This equates to an approximately 20 mm mesh opening. A key consideration here, as for any survey trawl, is that the design should provide for consistent sampling efficiency across the areas, trawlable habitats and depth ranges of the survey to minimize sampling bias.

1.1. Trawl

The revised sampling gear is a four-panel bottom trawl made of polyethylene (PE) with a 10 mm codend, broadly based on the MEDITS GOC73. It has been scaled to suit vessels with an engine power of >224 kW (300 HP) and capable of towing the iBotS gear at a minimum speed of 2.6 knots and 3.5 knots for the last five minutes of the haul before hauling back.

Figure 2 shows a technical drawing of the trawl with mesh sizes indicated in bar length. The mesh numbers in height correspond to well-finished and joined-netting sections; the joining mesh should then be subtracted when cutting. The numbers of meshes in the width do not include the side seams (selvedges), and these five meshes should be added when cutting.

The trawls should be made from good-quality PE netting, with the exception of the codend, which can be made from polyamide, subject to regional availability. It may not be possible for the net manufacturer to always obtain netting exactly as specified in the manual. However, deviation from standard specifications is extremely hard to quantify and coordinate, and therefore every care must be taken to obtain materials as close to agreed specifications as possible. Deviations need to be documented and discussed at the iBotS coordination meeting. Any concerns or recommendations should then be passed on to the assessment group and other stakeholders, as appropriate.

The headline should have 16 floats rated to a minimum 200 m depth and with a diameter of circa 20 cm and buoyancy of 3.45 kgf (± 5 percent). The total buoyancy should be 55.2 kgf (± 5 percent). The 16 floats, 8 on each side, should be symmetrically distributed along the headline at a distance of 2 m, the first float starting from the wing end and leaving a space of 40 cm between the two central floats, as shown in Appendix 13. The distance measurements should be made between the centre of the floats. With this number of floats, the vertical opening of the trawl should be about ≥1.5 m.

Following initial trials in Trabzon, Türkiye in 2023, the ground gear has a total of 93.4 kg of chain (ballast chain), as shown in Figure 3. It is symmetrically fixed to the footrope at 17 cm intervals (with a hanging height of at most 8 cm), as follows:

1. two pieces of 16.5 kg (33 kg total) on the wings, 10 mm in diameter and with a linear density of 1.05 kg/m.
2. one piece of 50 kg in the centre, 12 mm in diameter and with a linear density of 2 kg/m; and
3. one piece of 9.4 kg in the centre, 14 mm in diameter and with a linear density of 2.7 kg and with

[1] For the report and figures, the mesh side value, or half mesh, will be used to indicate the mesh dimensions. The mesh side is defined by the International Organization for Standardization (**ISO 1107-1974 - Mesh Measurements, definitions**) as “the distance between two sequential knots, measured from center to center when the yarn between those points is fully extended.”

this chain fixed to both parts of the belly (bosom) in the same way as the first one.

Each trawl should have a unique tag or number as described in Appendix 13, so that it can be clearly identified. This is recommended to be a stainless-steel plate attached to the headline on each trawl with a simple identifier for each. This will allow the age and ongoing repairs to be traced back to a specific trawl by the designated gear manager.

1.2. Rigging

Care with the rigging prior to the survey is essential to ensure trawl geometry in the water is maintained as consistently as possible as it directly affects its sampling efficiency. The sweeps should measure 100 m in length and should be measured prior to each survey, with any differences between the sides corrected. The priority here is to ensure symmetry between each side of the trawl, while small deviations from the plan in overall length can then be noted and corrected as soon as possible after the survey. The sweeps are made from combination rope, 32 mm in diameter x 100 m long, and have a weight of 1 kg/m (±10 percent). The general drawing of the rigging is given in Figure 4.

A net recovery system (bag rope, lifeline) allowing the retrieval of the trawl by the codend should be installed. Ropes attached to the codend and terminating with a float must be avoided.

1.3. Doors (otter boards)

The doors are shown in Plate 1 and Figure 5. The doors must weigh 230 kg each. The warp is shackled in the rearmost hole of the bracket sheet (see arrow 1 in Figure 5). The short lengths of the crowfoot (backstrops) are shackled in the rearmost hole of the backside attachment plates, upper and lower (see arrow 2 in Figure 5). The lengths of the backstrops (shackles not included) are as follows:

- long external backstrop: 1.43 m
- short upper and lower backstrops: 0.60-0.57 m (± 10 percent).

1.4. Towing depth and warp length

After taking the characteristics of the trawl and the rigging into account, the recommended warp should have a minimum diameter of 12 mm.

The length of warp to be shot is determined by the operating depth. The recommended depth to warp ratio (scope) is given in Table 3. It is also recommended that the warp length should not be less than 150 m in shallow water, as it will decrease the spread and stability of the doors considerably. It is strongly recommended to have both warps stretched and marked at the relevant lengths prior to the survey. Alternatively, there should be some other method of ensuring that the warps are absolutely correct and equal just prior to the trawl lands on the seabed and starts fishing.

Table 3. Relationship between depth (m) and warp length (m) to be used in each stratum.

Depth (m)	Warp length (m)
10 to < 25	150
25 to < 50	150
50 to <75	225
75 to <100	300
100 to 125	375

This warp–depth relationship is based on the recommended net, warps and doors, which may not be exactly replicable in all situations. In particular, doors will have a significant impact if not as specified. The key overall measure of geometry, however, should be the sweep angle, which directly affects herding efficiency (catchability), the key attribute to fix on standardized surveys. Having data for door spread is a useful initial guide for monitoring sweep angle and, if necessary, the warp should be adjusted to maintain the sweep angle and the trawl data should be checked to ensure operations are consistent and make sense. In selecting the correct warp length for a haul close to a stratum boundary, it is useful to confirm whether the centre of the haul will be in the same strata as the start of the haul. Obviously, it is preferable to allocate the haul to the strata where the haul will spend most time fishing.

Where surveys need to adapt their trawling methods, this should be discussed and documented by iBotS. For quality control and to avoid a drift or bias in operations, the basic trawl geometry data should be plotted and reported annually to compare between surveys and between years within a survey. Again, standardizing catchability is the key objective, so any adjustments need to make sense in the first place, but ultimately ensure that ground contact and sweep angle are as expected. If other parameters such as headline height do not follow as predicted, there is something wrong and the gear needs to be thoroughly checked. This, of course, is impossible to monitor without net telemetry (trawl sensors).

1.5. Net telemetry equipment and monitoring systems

Once a trawl is deployed, its location and sampling efficiency on the species below cannot be directly observed. As with many scientific and medical endeavours, modern specialist equipment is required to view what cannot be seen with the human eye. In fact, very few important daily decisions do not rely now on modern technology. Standardized trawl surveys produce relative indices of abundance and therefore assume control over catchability. This source of uncertainty can be broken down into two components:

i) the time between deployment and recovery when the trawl is in the water column, catching fish, but still not fishing on the bottom in a standardized way (Battaglia et al., 2006); and

ii) the time during the haul when ground contact or trawl geometry is not as expected (for general discussion see Godo *et al*., 1994).

Given the relatively short haul time with scientific surveys (e.g., iBotS ≈ 30 min), delays or ambiguity surrounding the exact time a haul starts and stops can have a big impact on the unit of effort used (Bertrand *et al.*, 2002). Likewise, sampling efficiency before the trawl establishes good contact with the seabed and achieves stable geometry is extremely difficult to confirm without net sensors. Thus, the proportion of uncertainty in a survey can be high and continues to rise with increasing depth, changes in skipper behaviour, and local currents, among other factors.

It is highly recommended, therefore, that trawl telemetry be used (SCANMAR, SIMRAD, MARPORT, NOTUS or other acoustic sensors) to monitor the trawl geometry. At a minimum, vertical and horizontal opening, as well as contact with the bottom, are considered a minimum dataset to confirm standardized catchability.

If trawl sensors are not available, measurements of the warp geometry at the stern should be taken at various depths on board each vessel at the beginning of the survey series to establish the relationship between the horizontal and vertical openings with depth. This should be available during the survey in graph and table format for quick reference and monitored annually. A conversion from door spread to sweep angle should also be included in the door spread at depth table.

When available, sensors should be positioned on the otter boards to give door spread. On the headline, additional floats should be incorporated to compensate for the headline sensor to ensure that the sensor is neutrally buoyant at the surface. This can simply be done by attaching floats to the sensor in a tank until the sensor just begins to float but can easily be pushed under the water as well. Whichever headline sensor is employed, it should give a good indication of ground contact in real time, as well as the height of the headline above the seabed.

Data for the net horizontal and vertical openings measured *in situ* (or estimated for each haul), will be included in the TA data file, as specified further on in this manual. Reliable equations for horizontal and vertical net openings will be agreed upon by iBotS and used to estimate values of net openings and applied when necessary.

2. Sampling Methodology

2.1. Vessel characteristics

The vessels used for the iBotS surveys should be equipped with an engine power of ≥224 kW (300 HP) and able to tow the standard sampling gear at a speed of 2.6 knots. For the last five minutes of the haul, 3.5 knots is recommended in order to secure fish still swimming ahead of the trawl. It is strongly recommended that, as far as possible, the same vessel and crew be used each year in each area so as to reduce variations between years due to a vessel and/or skipper effect. Documenting and discussing detailed operating procedures with the skipper and crew ("toolbox talk") at the beginning of the survey is also useful in this regard, particularly in relation to i) the speed of haul back at the end of the tow; ii) the handling of larger or rarer species in the catch; iii) cleaning the net completely of any catch/litter items; iv) working with the plans for any trawl repairs; and v) charging and checking trawl sensors regularly when available. The skipper and crew are critical to the effectiveness of trawl sampling and need to be considered integral to the scientific team and discussions.

2.2. Period of the survey

The period of the iBotS surveys is during the months of May–June[2] and 15 October–15 December, depending on the weather conditions. The timing of the surveys will be coordinated and reviewed annually by the group. It is strongly recommended to keep the sampling period consistent between years in order to reduce any temporal effects on the time series.

2.3. Haul localization

Survey stratification for the Black Sea is by depth and country boundary and analogous to that of the MEDITS programme, as well as many other coordinated surveys elsewhere. As a first approximation, national waters have been divided according to a number of depths contours agreed upon by the expert group to broadly reflect the distribution patterns of target species in Table 1. These strata were agreed to start at –10 m and be further divided at –25 m, –50 m, –75 m, –100 m, ending at the –125 m contour, where the waters of the Black Sea become largely anoxic (Table 4).

Table 4. The depths fixed in all areas as strata limits

Depth (m)
10 to < 25
25 to < 50
50 to <75

[2] If the Georgian research institute cannot obtain permission for the spring survey in that period, the survey can start on 15 April.

75 to <100
100 to 125

The initial target number of hauls for each country has been taken as the average number of hauls carried out historically in good survey years, with two exceptions. Romania has a large shelf area to survey with the increased depth range proposed here, so some additional hauls have been added above the historic haul count to account for that. This higher count keeps national sampling levels above the density seen in MEDITS programme of c.1haul/500 km2 and is seen as a reasonable minimum target until the new time series can be evaluated.

The hauls should be positioned according to the agreed depth-stratified sampling scheme, with the total number of stations allocated across strata proportional to the area of those strata. Within each stratum, hauls should be located randomly, with a minimum of 5 nautical miles between hauls. This 5 nautical mile buffer is to ensure that hauls are dispersed across the strata and to minimize repeat sampling (autocorrelation). Random selection of known historic tows can be used for much of the station selection, but 1–2 tows per strata should be at new locations where additional data are sought to expand the database of possible sample locations. Data from the commercial fishery, seabed mapping or other sources can be used, but it is important that all trawlable areas within a stratum can be sampled, including areas not previously surveyed. This will be a particular challenge in the deeper water strata. Estimation of the index using the proposed formulae also assumes a level of randomness in the survey design.

As no single approach has been adopted, the practical approach for each survey needs to be well documented and included in future versions of the manual.

The adopted strata and the target number of hauls by strata are given in Appendix 1.

The decision to carry out a haul in a given location should not be influenced by the presence or lack of fish. Over time, haul positions often start to form a cluster of positions on the ships plotter and the target (nominal) position can start to drift away into previously untrawled ground. It is recommended that a database or table of fixed nominal tow positions be maintained where a single clear fishing track is used each time, not simply a historic tow close to the target haul. This information is given to the captain as the target line, and it should be easily viewable on the plotter that the vessel is within 0.5 nautical miles or less of the target line, given that the trawl will still be a few hundred metres behind the vessel and possibly to one side. The nominal positions will still be selected at random of course.

Likewise, it is critical that damage be recorded as precisely as possible to avoid the location in the future if damage is likely to occur again. Vulnerable marine ecosystems such as *Zostera* sp. meadows, *Philophora* sp. and mussel beds should be excluded from the sampling scheme and should also be avoided and not trawled.

2.4. Operating the gear

2.4.1. Sampling period in the day

To avoid catchability issues due to diurnal vertical migration of some species, hauls are performed during daylight only. The daylight period is defined as the trawl not being on bottom within 30 minutes after sunrise or 30 minutes before sunset.

2.4.2. Haul speed and duration

The standard fishing speed is 2.6 knots over the ground. This recommended speed is very important in order to maintain the trawl geometry (i.e. catchability) across survey years and countries. The actual speed, as well as the covered distance, should be monitored and recorded. Time and ship speed should be recorded every ten minutes during the operation and, where the tow is not a straight line, the position should also be recorded to provide an accurate distance. It is highlighted that a speed lower than 2.4 knots may have a negative effect on the stability of the doors, which could fall over and even get stuck in softer seabed.

The haul duration is fixed at 30 minutes for all depths. In cases where the fishing operation is stopped before the completion of the standard duration, the haul can be considered valid as long as at least two thirds of the time or distance has been successfully attained.

2.4.3. Haul start and end definition

The start of the haul is defined as the moment at which the footrope is in good contact with the seabed (touch-down). The end of the haul is defined as the moment at which the footrope leaves the seabed (lift-off). In practical terms, this is impossible to determine without the use of trawl sensors, and therefore an alternative standardized method is recommended for each survey. Commonly, in this scenario the point at which the winches stop paying out warp is considered as the start of the haul. Likewise, when the winches start to haul back the warp can be considered as the end of the haul. These definitions are far from accurate, but they are simple to keep consistent, at least until precise information from trawl telemetry is available to the survey and can then be used to correct the haul duration retrospectively.

The haul starting and end times should be recorded in UTC time and not in local time. The clock used should always be the GPS, not local devices or personal computers.

2.4.4. Haul orientation

In general, hauls should be performed at constant depth. The depth variations during the haul should not exceed ± 5 percent relative to the initial depth. Discrepancies with regard to this target should be recorded.

As far as possible, the hauls should be rectilinear. If, for some reason, that is not possible, the turning circle must be as wide as possible so as not to disrupt the trawl geometry. In all cases the fields "course" and "distance" of the TA data file should be precisely documented.

2.4.5. Managing the end of shooting operations and the start of the haul

It is important that the gear stays in good contact with the seabed during the entire haul. This should be regularly checked either by an acoustic device during the haul, a footrope-mounted contact/tilt sensor or by regular observation of wear on the ground gear chains. Observation of benthic organisms in the catches for the area is also a useful metric. For the last five minutes of the haul, the speed should be increased to 3.5 knots.

2.4.6. Trawl geometry while fishing

When sensors are available, the vertical and horizontal openings (between the doors) should be monitored as often as possible once the trawl is stabilized. The values of these two parameters (disregarding the obviously aberrant values) should be noted every ten minutes and reported as an average or median value in the data file for each haul.

When telemetry is not used, reliable models of horizontal and vertical net opening related to other available parameters (warp length, depth, etc.) should be recorded for the haul so that effort in terms of area fished can be estimated. Nevertheless, the use of trawl sensors is highly recommended because they give exact information on the gear's behaviour, as well as inform, in real-time, if an issue has occurred so that fishing time is not wasted or inaccurate.

All survey leaders should follow a common standardization for data processing and quality control of the technological parameters (haul duration, average or median horizontal and vertical net openings). The data collection process must be consistent over the years.

2.4.7. Ongoing checks of the trawl

The trawl should be inspected during the hauling procedure on every tow for holes and other damage, especially along the lower wings and belly sections. These issues should be repaired after the catch has been emptied from the trawl, and the repairs should be completed before the trawl is used again. Any significant repairs should be logged and available to the designated gear person for the survey. This helps to provide information on the performance and overall health of specific trawls when it comes to managing the maintenance schedule.

Since no system has been integrated to prevent the bosom of the trawl from chafing against the seabed, it is recommended that affected sections of the trawl (in particular the lower net panel) be replaced as needed, particularly when they have lost their initial characteristics. Likewise, when knots are wearing through, or when significant repairs have been made to a panel during the previous survey, consideration should be given to replacing panels.

2.4.8. Annual checks of the trawl

Though the net may eventually stretch under normal fishing conditions, meshes and panels will initially shrink as sediment enters the twines and the twines swell. Therefore, to retain the critical difference in tension between the top and lower belly panels, the net should be checked at least annually. Every year, a detailed check should be made of all net and rope dimensions. The trawl gear check list provided in Appendix 13 should be used as a guide for this process for each individual trawl, and trawls themselves should be individually identifiable.

The aims are:

- to have a clear, commented and documented checklist for the quality control of the technical characteristics of the iBotS gear in order to avoid a gradual change in rigging or materials over time (technical creep/drift);
- to have a clear and standard procedure that is easy to apply in the field, even by non-technologists, for the monitoring and quality control of repairs at sea; and
- to make available tools ensuring that the technical aspects of the sampling trawl that affect sampling efficiency are easily checked and implemented across years and national surveys. As a standardized catch to calibrate sampling trawls cannot be provided, attention must be paid to any aspects that may affect a change in catchability. In turn, this allows surveys to rely on the assumption that catchability is standardized and does not need to be quantified and corrected for in the data.

3. Treatment of the catches

3.1. Handling the catch on board

The objective of the survey is to provide a representative sample of the population. Therefore, where the catch is too large to be measured or counted completely, the samples selected for processing must likewise be representative of the catch. It is likely that fish at the minimum and maximum of the length distribution (juveniles and "old fish", respectively) will be less abundant. More abundant lengths may need to be sub-sampled and a raising factor then used to multiply the measured fish to estimate the total number that would have been in the catch. When sub-sampling and removing parts of the catch, it is very important how these tails of the distribution are treated. Categories are a useful way to ensure that the probability of less common lengths appearing in the measured sample reflects their abundance in the catch, not just the chance that it ended up in that sample (see Appendix 14).

A generalized catch processing workflow is shown in Figure 1. Once on the deck, the catch should be sorted following the eight steps listed below:

1. The catch and a plate indicating the station code and date are photographed.
2. All rare, vulnerable, and threatened species, such as sturgeons, dogfish, or other specimens subject to conservation measures, are picked out immediately. Efforts should be made to obtain length, weight and sex data before returning the specimens to the sea unharmed, giving them a chance for survival. Such specimens should be returned to the sea within 4–5 minutes. The specimens may be held in a tank with running water temporarily to allow catch processing to continue while optimizing survival.
3. Next, large species, such as rays and skates, are removed from the catch. Their weight, size, and sex (whenever possible) are recorded. If the remaining catch weighs more than can reasonably be processed (20 kg), a sub-sample of one bucket (around 20 kg) is taken following random sub-sampling rules (Holden and Reith, 1974). The weight of this catch and of the sampled catch must be recorded to raise all sampling back to this original total catch weight.
4. The sampled fraction of the catch (CF) is then sorted out to the lowest taxonomic level possible.
5. If a sorted species component weighs too much to be worked through *in extenso*, a sub-sample of around 1500 gr (but not less than 100 individuals) is taken for length measurement. However, as with the original catch sorting, any rare lengths (very large or small fish) should be separated out as separate categories and not sub-sampled to the same degree.
6. The weight of each category should be recorded separately. This sub-sample should not be less than 100 individuals, except for in the case of thornback ray (*Raja clavata*), for which 50 individuals are sufficient.
7. iBotS has four priority species: turbot, red mullet, whiting, and piked dogfish (Group 1, Table 2). The total weight, number of individuals, and length–frequency distributions (LFD) are recorded for these species. For this group of species, a part of the catch is retained and stored following the rules given in Section 3.3 for the estimation of the biological parameters, including sex, maturity, individual length, individual weight and age. As dogfish is a protected species in some of the Black Sea countries due to its critical status, the individuals of this species should be treated with great care if the fish is alive. In such cases, the length, weight, and sex should be determined externally, and the fish should be released back into the sea. According to the group decision taken during the "Workshop on age reading of Black Sea piked dogfish (*Squalus acanthias*)" in Istanbul, Türkiye, on 11-14 December 2023, age reading was decided to be done only for the individuals whose vitality condition at capture is dead until further research verifies that cutting the spine is not affecting the survival of the individuals as the spine removing procedure is considered an invasive way.
8. Of the thirteen additional species included under iBotS (Group 2), only the total number of individuals, total weight and length–frequency distribution are recorded. For thornback ray, common stingray (*Dasyatis pastinaca)* and longnose spurdog (*Squalus blainville*), sex data should also be determined externally and recorded.

If time allows, biological data collected for priority species should also be collected for the additional and other species (Groups 2 and 3).

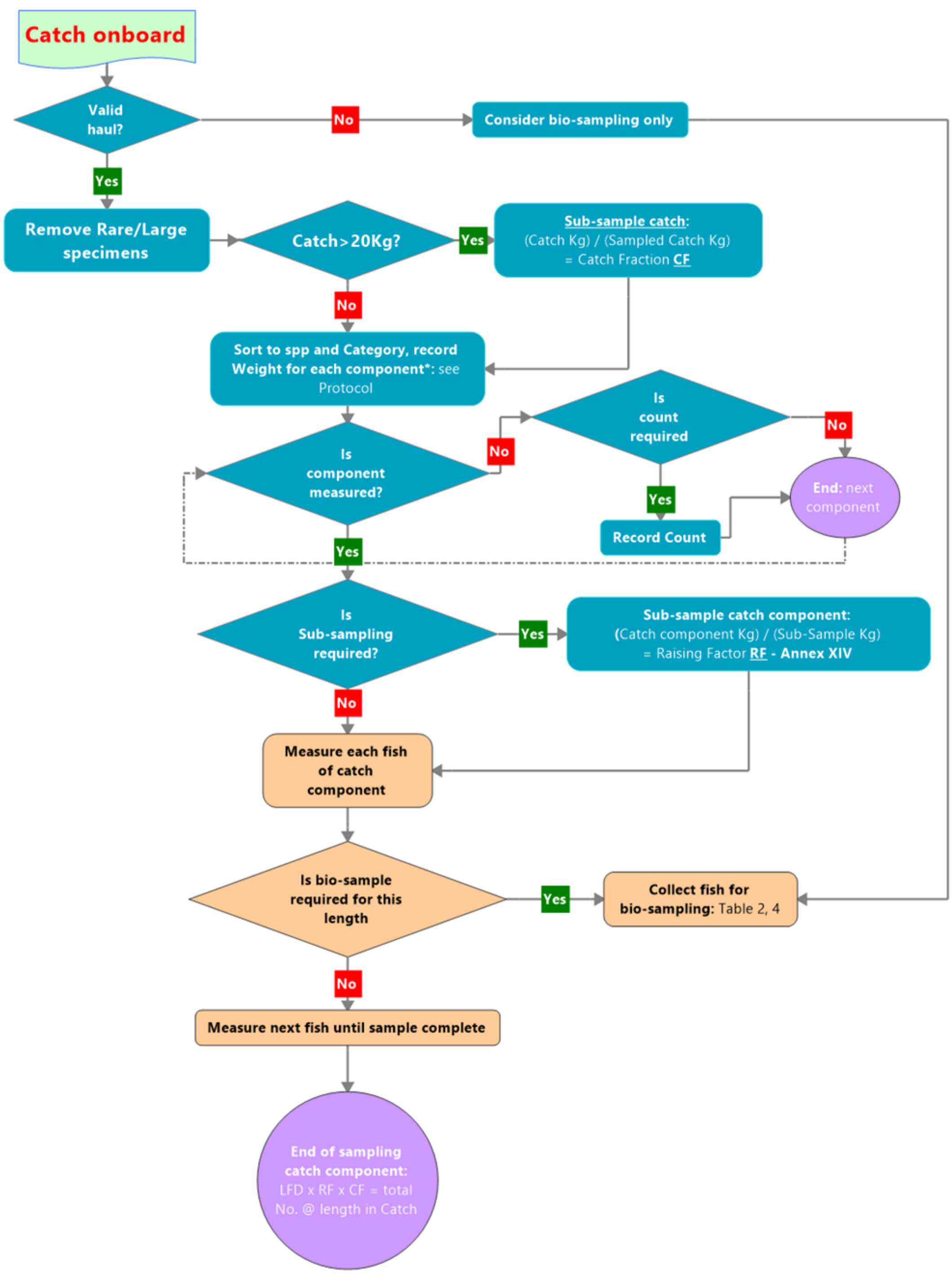

Figure 1. Generalized catch processing workflow.

Notes: Catch should be sorted to the species level, where possible, and by sex, as indicated in the protocols. Sorting further into categories (Cat) will be determined by each specific catch. The combination of Spp\Sex\Cat combines to define a single catch component for sampling. This component has a specific raising factor to estimate the category numbers at length in the sampled catch. All categories of this species must then be combined to gain the raised number in the sampled catch. Finally, the raised numbers must be raised again by the catch fraction if the catch itself was also sub-sampled.

3.2. Length–frequency distribution

The length–frequency distribution of the catch should be measured based on the total length (TL) of the samples with the tail fully extended (Figures 1 and 2, Appendix 4). The measurement unit is the lower half centimetre for red mullet, whiting, surmullet, Pontic shad, Caspian shad and round goby, and the lower one centimetre for the rest of the species in Table 2.

The length measurements for LFDs should be made on fresh fish on board whenever possible. If the samples are frozen for later examination, a conversion factor should be established and applied to ensure consistency between the measurements.

3.3. Selection of individuals for biological parameters

When measuring the fish for LFD, the number of fish from each size class specified in Table 5 is retained for the determination of the biological parameters in the laboratory. Biological sampling should ideally be carried out at every haul. This avoids the need to apply length-at-age data from one area to lengths in a separate area where growth rates may be different (Gerritsen, 2006; Berg, 2012).

If sampling at each haul is problematic, strata area could be divided broadly into sectors (e.g. East-Central-West or North-Central-South) and sampled to ensure the best spatial coverage possible over the survey area. It is estimated a total of about 300 age-stratified individuals will be selected for biological sampling based on the criteria given above, per species per survey.

Table 5. Sample size by length class proposed for otoliths, individual length and weight, and maturity stages for the priority species (Group 1)*

Length classes	Implied limits (cm)	Target number of samples to be collected for age reading per survey	Sector 1 (East or North)	Sector 2 (Central)	Sector 3 (West or South)
			Whiting		
8.0 m >	min - 8.00	15	A total of 5 individuals	A total of 5 individuals	A total of 5 individuals
8.0 – 17.0 cm (With 0.5 cm class interval)	8.01 – 17.00	270	5 individuals from each length of class	5 individuals from each length of class	5 individuals from each length of class
17.0 cm < **	17.01 – max	15* +	All individuals	All individuals	All individuals
Total sample (Approx.)		~300	~100	~100	~100
			Red mullet		
6.5 cm >	min - 6.50	15	A total of 5 individuals	A total of 5 individuals	A total of 5 individuals
6.5 – 15.0 cm (With 0.5 cm	6.51 – 15.00	210	5 individuals from each length of class	5 individuals from each length of class	5 individuals from each length of class

class interval)					
15.0 cm < **	15.01 - max	50* +	All individuals	All individuals	All individuals
Total sample (Approx.)		~300	~100	~100	~100

*Estimated based on available data

**reference length of Category II fish

3.4. Individual length and weight

The length of the individuals selected for the estimation of biological parameters should be measured to the lower milimetre but recoded in centimetres. The weight should be measured with at least ± 0.01 g precision and recorded in grams.

3.5. Age and maturity

The otolith pairs for the sample fish selected for biological parameter estimation should be examined according to the appropriate protocols (Carbonara and Follesa, 2019; Carbonara, 2014; GFCM, 2019). For species under protection, and for those fishes for whom age cannot be read from otoliths, other relevant body parts (spines, scales, etc.) should be sampled (Table 6). The maturity stages of the same set of fish should be determined according to the *GFCM Atlas of the Maturity Stages of Mediterranean Fishery Resources* (Follesa and Carbonara, 2019).

If the survey team would like to collect biological parameters also for species other than those defined in Table 2, they are invited to follow the common protocol both for data collection and data storage.

Table 6. Reference sheet for biological sampling (M/F: for males and females separately)

	TW	N	L	S	Bio Sampling IW+IL+MS	A	Length interval (cm)	Category 1	Category 2	Category 3
TUR	M/F	M/F	M/F	Yes	Yes	Yes	1	All		
MUT	Yes	Yes	Yes	Yes	Yes	Yes	0.5	6.50 cm<=	6.51-17.00	>17.01
DGS	M/F	M/F	M/F	Yes	Yes	Yes	1	All		
WHG	Yes	Yes	Yes	Yes	Yes	Yes	0.5	<=8.00	8.01-15.00	>15.01
RJC	Yes	Yes	Yes	Yes	No	No	1			
JDP	Yes	Yes	Yes	Yes	No	No	1			
FLE	Yes	Yes	Yes	No	No	No	1			
QUB	Yes	Yes	Yes	No	No	No	1			
MUR	Yes	Yes	Yes	No	No	No	0.5			
SHC	Yes	Yes	Yes	No	No	No	0.5			
NBU	Yes	Yes	Yes	No	No	No	0.5			
HUH	Yes	Yes	Yes	No	No	No	1			
AAN	Yes	Yes	Yes	No	No	No	1			
APE	Yes	Yes	Yes	No	No	No	1			
APG	Yes	Yes	Yes	No	No	No	1			

APU	Yes	Yes	Yes	No	No	No	1			
Others	Yes	Yes	No	No	No	No				

4. Calibration of the survey at sea

To quality-assure the standardization of iBotS surveys on an ongoing basis, an exchange of scientists between the vessels is recommended. For this purpose, one place will be reserved on board each vessel to facilitate the boarding of a scientist from another survey team. In addition, each national survey group will do its best to send an experienced survey scientist from their own team on board other vessels participating in the project. It is expected that the reports of these trips will help to identify differences in the working methodology that may not be detailed in the manual.

It is recommended that surveys strive to coordinate some hauls as close (in terms of timing and location) to a neighbouring survey as possible, annually. This allows differences in survey catch rates to be monitored on an ongoing basis, assuming that vessels were fishing on similar local fish abundance. Further, should a vessel have difficulties completing a particular survey, it can provide managers some confidence to infer from the intercalibrated neighbouring survey what trends might be happening within a data gap.

Using a similar approach, where a survey needs to make a significant change that may impact catchability, it is recommended to carry out a small number of hauls annually to build a comparative data set. Again, these comparative hauls should be conducted as close in space and time, using the new system (e.g. new trawl, vessel), as possible to the regular hauls (for discussion, see ICES, 2004; ICES 2005a, 2005b, 2009).

5. Data exchange formats

5.1. General information

Standard formats are defined for data storage and to facilitate the exchange of the data produced by the iBotS surveys. The exchange files are in .csv format, using a semicolon as a field separator.

5.2. File types

Five file types are defined in order to store and exchange the data (Table 7):

- Type A: Characteristics of the haul (Appendix 6): this file includes the data on bottom temperature and stratification
- Type B: Catches by haul (Appendix 8)
- Type C: Length, sex, and maturity at aggregated level (Appendix 9);
- Type E: Age, weight and maturity by length at individual level (Appendix 10); and
- Type L: Marine litter data (Appendix 11)

Table 7. The file names defined to facilitate the exchange of data

Position	Variable	Possible values
Character 1–2	Files type	TA (haul characteristics) TB (catch by haul) TC (biological parameters at aggregated level) TE (biological parameters at individual level); TL (litter categories)
Character 3–5	Country	BGR, GEO, ROU, RUS, TUR, UKR

Character 6–7	GSA	29
Character 8–11	Year	2023, 2024, etc.
Character 12	Separator	. (point)
Character 13–15	Extension	csv

Note: example = TATUR292023.csv

5.3. File structure and information coding

The exchange files format is described in Appendices 6–11.

Complementary coding tables used to fill in the data files are given in the Appendices referred to above.

6. Protocol for monitoring marine litter

A common protocol for the voluntary collection of data on marine litter is as follows:

On board the vessel, the total litter collected is weighed and split into the categories and subcategories as reported in the template in Appendix 11. Once the litter is collected, it is mandatory to record or estimate the total weight of marine litter data, regardless of the categories and subcategories, and the number of items in each main category. It is facultative to register weight by category and number of items by subcategory. In cases of large amounts of litter in the catch, all large-sized objects of litter must be recorded, while a sub-sample could be analyzed for small-sized litter (e.g. lids). Litter should be coded as total, by category and subcategory. Detailed data on total weight and litter composition must be reported in the specific form on litter (Appendix 11).

Qualitative and quantitative data on litter must be connected to data regarding the characteristics of the haul contained in file TA. Data related to the fishing set and gear performance allows for calculating the sampled surfaces for each haul and estimating a standardized index of total and categorically defined litter abundance per square kilometre. A photograph of the total litter separated from the fish catch in a haul, including a label with the main haul data, is recommended, as it might be used for future analysis of litter composition by image analysis tools. Organisms attached to litter might be also noted.

7. Gear specifications

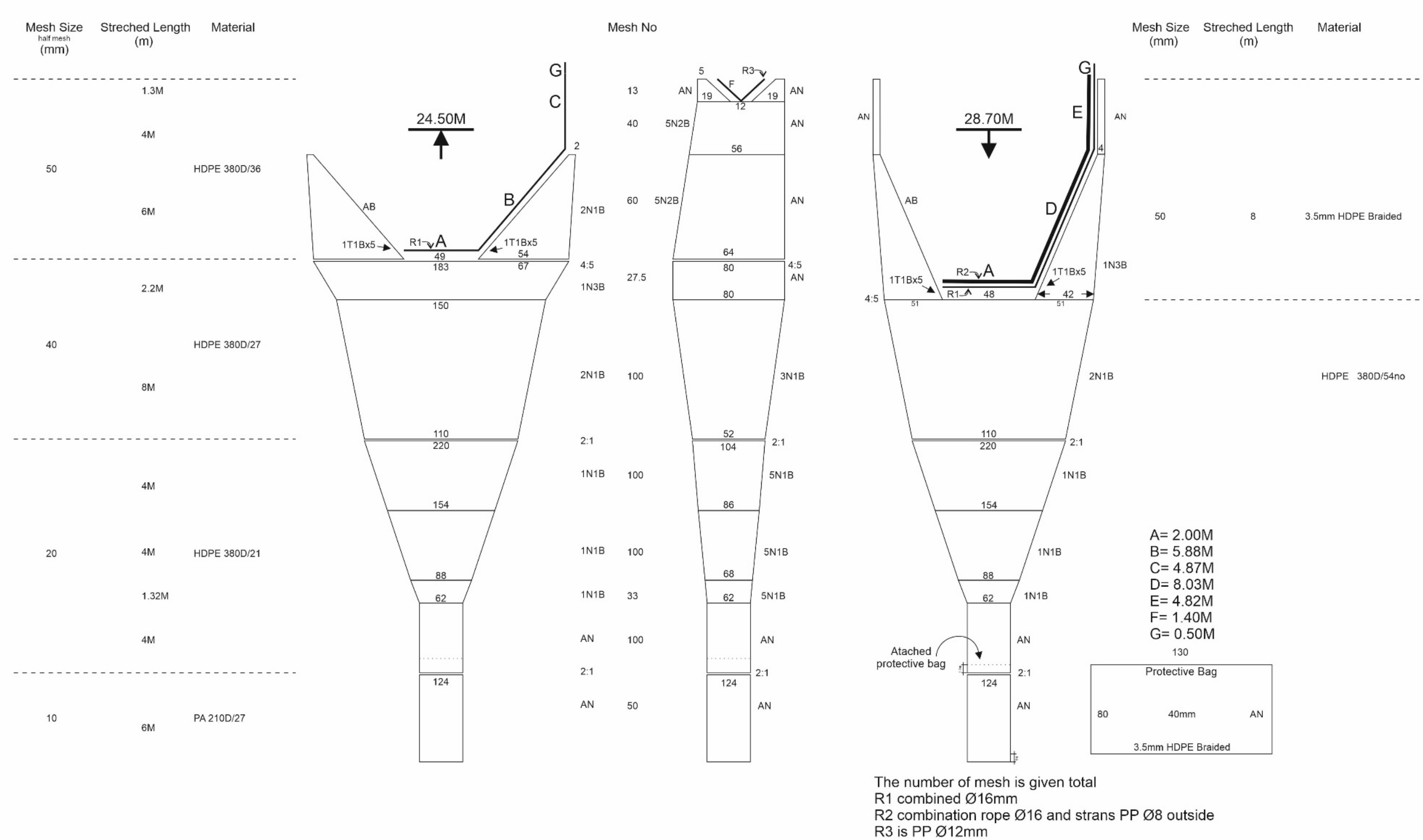

Figure 2. Design of the sampling trawl used for the iBotS survey.

Notes: It is very important to maintain the original relationship (hanging ratio, difference in length) between the netting lengths and the frame ropes along the headline and footrope. Note to netmakers: The numbers of meshes shown for netting panel widths do not include selvedge meshes. Five meshes (six knots) per selvedge must be added where indicated. Conversely, to obtain panel depths, one row (1/2 mesh) must be subtracted from each panel, as the joining row is included in the number of meshes deep.

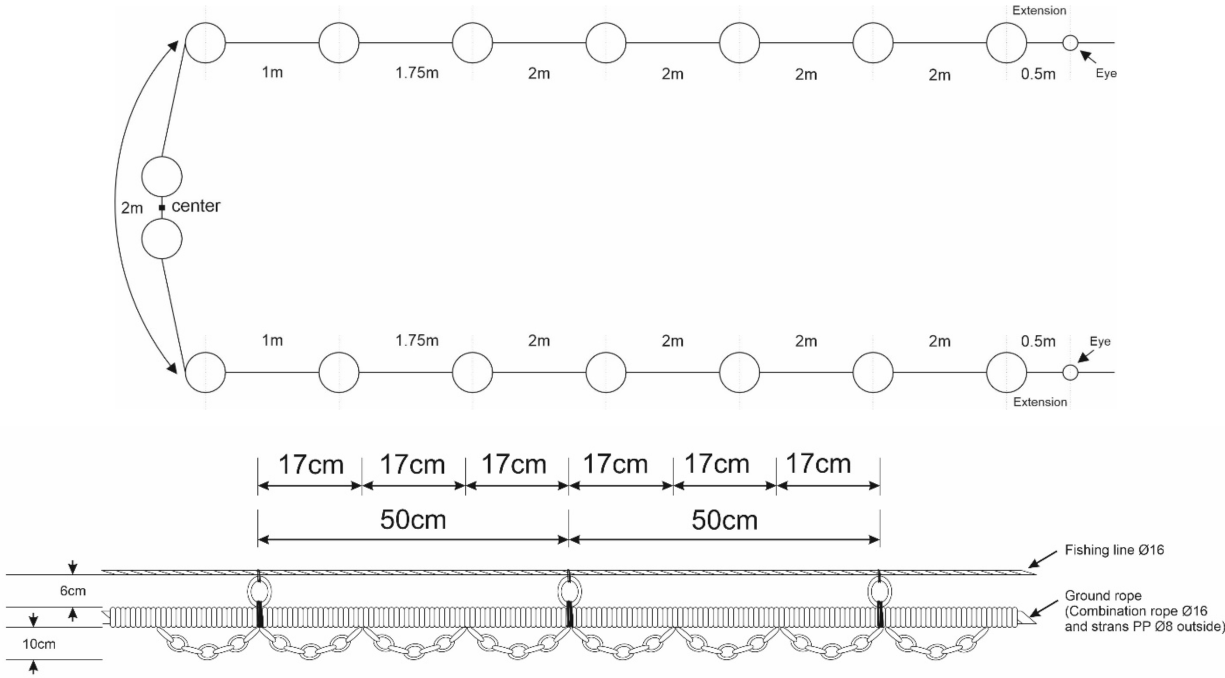

Figure 3. Rigging details of the headline (top)and ground gear (bottom)

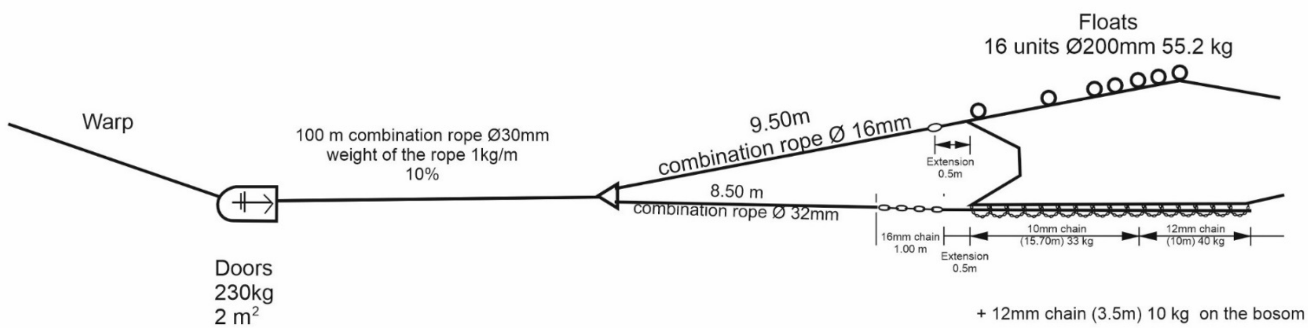

Figure 4. Gear rigging details adopted for the iBotS trawl. The length of the 1 m chain must be adjusted in order to obtain the upper (steel) and the lower bridles (combination rope + chain) of the same length.

Plate 1. iBotS otter board ©GFCM/Tamer Günal

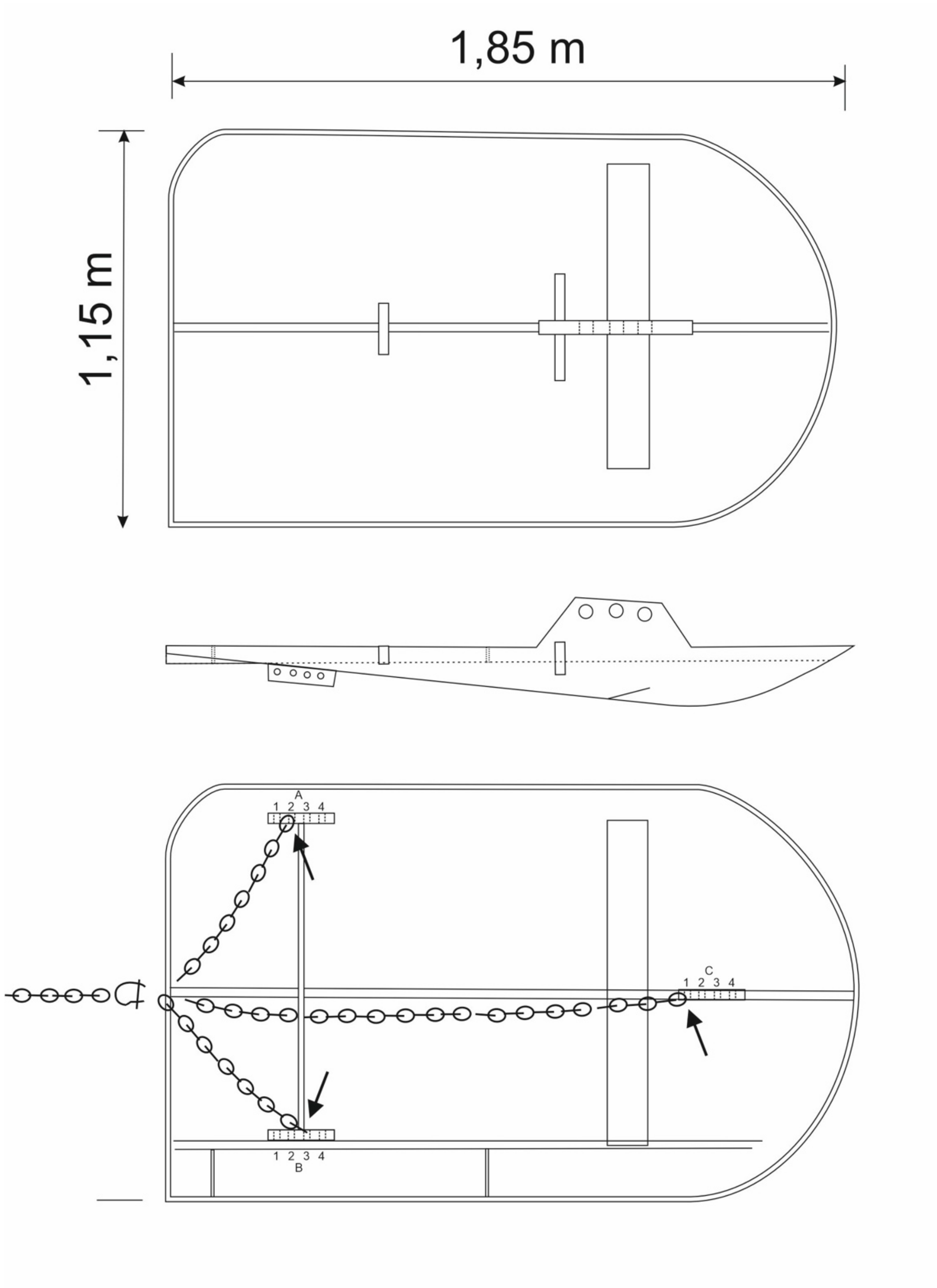

Figure 5. iBotS otter boards (230 kg; 2.1 m^2).

Notes: The lengths of the backstrop chains are indicated without the shackles. The warp is shackled in the first hole (C) of the bracket sheet. The short parts of the external crowfoot are shackled in the second and third hole (A and B, respectively) of the attachment plate.

8. References

Battaglia, A., Trenkel, V. M. & Rochet, M.-J. 2006. Estimating end effects in trawl catches. *ICES Journal of Marine Science*, 63: 956–959.

Berg, C. W. & Kristensen, K. 2012. Spatial age-length key modelling using continuation ratio logits. *Fisheries Research*, 129–130: 119–126.

Bertrand, J. A., Leonori, I., Dremiere, P. Y. & Cosimi, G. 2002. Depth trajectory and performance of a trawl used for an international bottom trawl survey in the Mediterranean. *Sci. Mar. (Barc.)*, 66, suppl. 2: 169–182.

Campana, S.E. 2014. *Age determination of elasmobranchs, with special reference to Mediterranean species: a technical manual.* Studies and Reviews, No. 94. General Fisheries Commission for the Mediterranean. Rome, FAO.

Carbonara, P. & Follesa, M.C., eds. 2019. *Handbook on fish age determination: a Mediterranean experience*. Studies and Reviews, No. 98. General Fisheries Commission for the Mediterranean. Rome, FAO.

Cochran, W.G. 2007. *Sampling Techniques*. Hoboken, USA, John Wiley & Sons.

Follesa, M.C. & Carbonara, P., eds. 2019. *Atlas of the maturity stages of Mediterranean fishery resources*. Studies and Reviews, No. 99. Rome, FAO.

Gerritsen, H. D., McGrath, D. & Lordan, C. 2006. A simple method for comparing age–length keys reveals significant regional differences within a single stock of haddock (Melanogrammus aeglefinus). *ICES Journal of Marine Science: Journal du Conseil*, 63: 1096–1100.

Gerritsen, H. D. & McGrath, D. 2007. Precision estimates and suggested sample sizes for length–frequency data. *Fishery Bulletin*, 105: 116–120.

GFCM. 2019. *Report of the Workshop on Age Reading of Select Black Sea Species (Anchovy and Rapa whelk), 28 January–01 February 2019, Trabzon, Turkey*.

GFCM. 2021. *Review of the integration of Black Sea demersal surveys.* BlackSea4Fish Project. Technical Report. Version 1.0. 35 pp.

Godø, O. R. 1994. Factors affecting the reliability of groundfish abundance estimates from bottom trawl surveys. In: A. Fernö & S. Olsen, eds. *Marine fish behaviour in capture and abundance estimation*, pp. 166–199. Hoboken, USA, Wiley.

Holden, M.J & Raitt, D.F.S. 1974. *Manual of Fisheries Science Part 2 – Methods of Resource Investigation and their Application*. Rome, FAO.

ICES. 2004. *Report of the Workshop on Survey Design and Data Analysis (WKSAD).*

ICES. 2005a. *Report of the Workshop on Survey Design and Data Analysis (WKSAD).*

ICES. 2005b. *Report of the Study Group on Survey Trawl Standardization (SGSTS).*

ICES. 2009. *Report of the Study Group on Survey Trawl Standardization (SGSTS).*

MEDITS. 2017. *MEDITS-Handbook. Version n. 9, 2017, MEDITS Working Group.*

Appendix 1

Stratification scheme with target number of hauls by each country (by stratum number)

Table 1. Stratification scheme with target number of hauls by each country

Strata	Stratum number	National Area Km²	Strata proportion	Depth (m)	Strata Area (Km²)	Hauls by country	Hauls by strata
BGR_Coast	TBD	11032	0.12	10-25	1295	40	5
BGR_Shallow	TBD	11032	0.24	26-50	2661	40	10
BGR_Medium	TBD	11032	0.29	51-75	3211	40	12
BGR_Deep	TBD	11032	0.30	76-100	3263	40	12
BGR_Slope	TBD	11032	0.05	101-125	602	40	3
GEO_Coast	TBD	1646	0.17	10-25	288	20	4
GEO_Shallow	TBD	1646	0.20	26-50	329	20	4
GEO_Medium	TBD	1646	0.23	51-75	384	20	5
GEO_Deep	TBD	1646	0.24	76-100	399	20	5
GEO_Slope	TBD	1646	0.15	101-125	246	20	3
ROM_Coast	TBD	21113	0.06	10-25	1345	52	3
ROM_Shallow	TBD	21113	0.26	26-50	5445	52	14
ROM_Medium	TBD	21113	0.43	51-75	8987	52	22
ROM_Deep	TBD	21113	0.17	76-100	3592	52	9
ROM_Slope	TBD	21113	0.08	101-125	1743	52	4
TUE_Coast	TBD	4432	0.17	10-25	733	30	5
TUE_Shallow	TBD	4432	0.20	26-50	874	30	6
TUE_Medium	TBD	4432	0.22	51-75	976	30	7
TUE_Deep	TBD	4432	0.30	76-100	1351	30	10
TUE_Slope	TBD	4432	0.15	101-125	658	30	5
TUW_Coast	TBD	11386	0.06	10-25	690	30	2
TUW_Shallow	TBD	11386	0.13	26-50	1525	30	5
TUW_Medium	TBD	11386	0.27	51-75	3082	30	9
TUW_Deep	TBD	11386	0.40	76-100	4574	30	13
TUW_Slope	TBD	11386	0.12	101-125	1353	30	4

Notes:

Stratum: Position 125–129 in the file A, to be decided (TBD) prior to the first survey implementation.

Hauls per strata are the total per country multiplied by the proportion for each stratum.

Appendix 2

Coding of recorded species, general observations on hauls and quadrants

Table 1. Coding of recorded species (Position 85 in the file A)

iBotS code	Nature	Comments
0	No standard species recorded	
1	Only the species of the reference list are recorded	See AppendixAppendix 6
2	The species of the reference list plus some others are recorded	
3	All the caught species are recorded	See Appendix XV
4	Species from a national list	

Table 2. Coding of general observations (Position 112 in the file A)

iBotS code	Nature	Comments
0	No problem	
1	Slight plugging of the net	
2	Heavy plugging of the net	
3	High abundance of jellyfish	
4	High abundance of plants in the net	
5	Tears of the net	
6	High abundance of benthos	
7		
8		
9	Other	

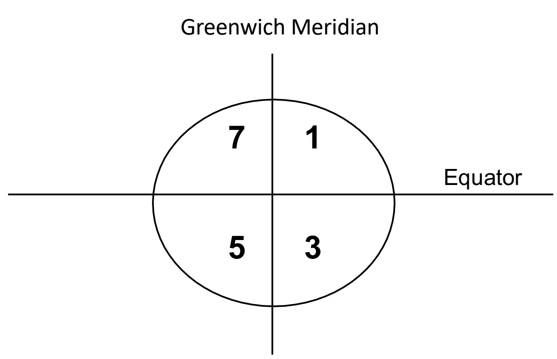

Figure 1. Coding of quadrants (Positions 41 and 63 in the file A)

Appendix 3

Codes of taxonomic categories and form to introduce new species codes

Table 1. Codes of taxonomic categories (Position 24 in the file B)

iBotS code	Nature
A	Fish
Aa	Fish Agnatha
Ae	Fish Chondrichthyes
Ao	Fish Osteichthyes
B	Crustaceans (Decapoda)
Bam	Amphipoda
Bci	Cirripeda
D	Other commercial (edible) species
Dec	Echinodermata
Dmb	Mollusca Bivalvia
E	Other animal species but not commercial (not edible)
Ean	Annellida
Eba	Brachiopoda
Ebr	Bryozoa
Ech	Echiura
Ecn	Cnidaria
Ect	Ctenophora
Eec	Echinodermata
Ehi	Hirudinea
Emb	Mollusca Bivalvia
Emg	Mollusca Gastropoda
Emo	Mollusca Opistobranchia
Emp	Mollusca Polyplacophora
Ene	Nemertea
Epo	Polychaeta
Epr	Priapulida
Esi	Sipuncula
Esc	Scaphopoda
Etu	Tunicata (Ascidiacea)
G	portions or products of animal species (shell debris, eggs of gastropods, selachians, etc.)
H	portions or products of vegetal species (e.g. leaves of sea grasses, of terrestrial plants, etc.)

M O	Mammalia (mammals) Aves (birds)
R V	Reptilia (Turtles) Plantae (vegetals)

Table 2. Form to introduce new species codes

Name of scientist:				Date:	
GSA:29					
Proposed Code		Scientific name	Reference for scientific name description	Geographical position	Stratum
Genus	Species				

Sheet to be sent to the GFCM Secretariat (GFCM-Secretariat@fao.org)

Appendix 4

Standard length measurements for fish

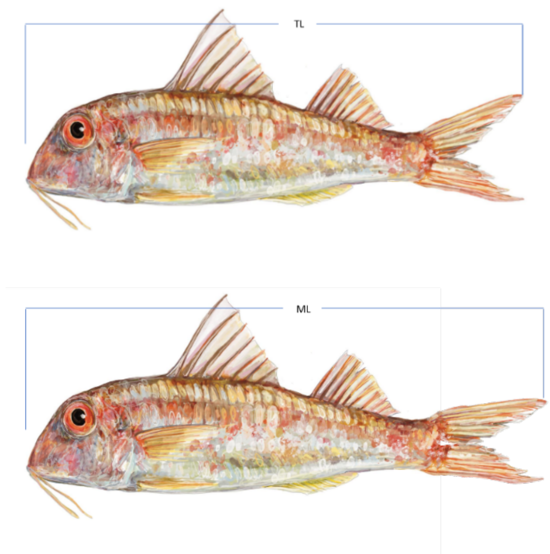

Figure 1. Difference between the total length (TL) and the maximum length (ML) (note the distance between tip of the upper and lower caudal fins)

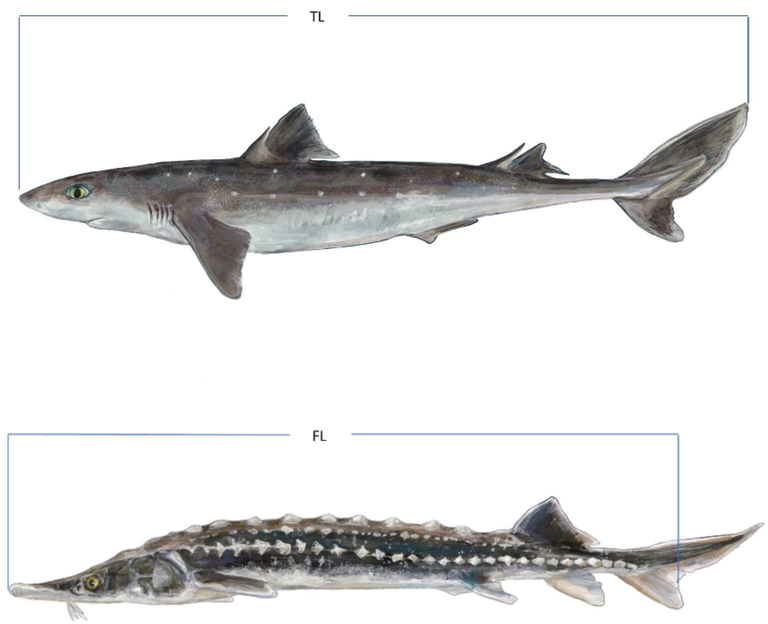

Figure 2. TL = total length

FL = fork length, used in case TL cannot be taken, e.g. with damaged fins.

Note: Rule to take TL of elasmobranchs also applies to bony fish.

For the same reason, in Rajidae, Myliobatidae, Dasyatidae and Rhinopteridae, the length of disc can be taken.

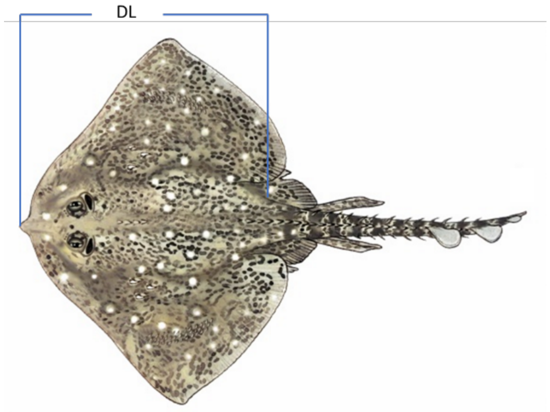

Figure 3. Length of disc in the Rajidae Myliobatidae, Dasyatidae and Rhinopteridae species.

Appendix 5

Codes of sexual maturity for fish

Table 1. Codes of sexual maturity for bony fish

Sex	Gonad aspect	Maturation state	Stage
I	Sex not distinguished by naked eye. Gonads very small and translucid, almost transparent. Sex undetermined.	UNDETERMINED	**0**
F	Small pinkish and translucent ovary shorter than 1/3 of the body cavity. Eggs not visible by naked eye.	IMMATURE/VIRGIN	**1**
M	Thin and whitish testis shorter than 1/3 of the body cavity.		
F	Small pinkish/reddish ovary shorter than ½ of e body cavity. Eggs not visible by naked eye.	VIRGIN–DEVELOPING*	**2a**
M	Thin whitish testis shorter than 1/2 of the body cavity.		
F	Pinkish reddish/ reddish-orange and translucent ovary long about ½ of the body cavity. Blood vessels visible. Eggs not visible by naked eye.	RECOVERING*	**2b**
M	Whitish/pinkish testis, more or less symmetrical, long about ½ of the body cavity		
F	Ovary pinkish yellow in color with granular appearance, long about 2/3 of the body cavity. Eggs are visible by naked eye trough the ovaric tunica, which is not yet translucent. Under light pressure eggs are not expelled.	MATURING	**2c**
M	Whitish to creamy testis long about 2/3 of the body cavity. Under light pressure sperm is not expelled.		
F	Ovary orange pink in color, with conspicuous superficial blood vessels, long from 2/3 to full length of the body cavity. Large transparent, ripe eggs are clearly visible and could be expelled under light pressure. In more advanced conditions, eggs escape freely.	MATURE/SPAWN ER	**3**
M	Whitish-creamy soft testis long from 2/3 to full length of the body cavity. Under light pressure, sperm could be expelled. In more advanced conditions, sperm escapes freely.		
F	Reddish ovary shrunken to about 1/2 length of the body cavity. Flaccid ovaric walls; ovary may contain remnants of disintegrating opaque and/or translucent eggs.	SPENT	**4a**
M	Bloodshot and flabby testis shrunken to about ½ length of the body cavity		
F	Pinkish and translucent ovary long about 1/3 of the body cavity. Eggs not visible by naked eye.	RESTING*	**4b**
M	**Whitish/pinkish testis, more or less symmetrical, long about 1/3 of the body cavity.**		

Table 2. Codes of sexual maturity for oviparous elasmobranchs

Sex	Gonad aspect	Maturation state	Stage
I	Sex not distinguished by naked eye.	UNDETERMINED	**0**
F	Ovary is barely discernible with small isodiametric eggs. Distal part of oviducts is thick-walled and whitish. The nidamental glands are less evident.	IMMATURE/VIRGIN	**1**
M	Claspers are small and flaccid and do not reach the posterior edge of the pelvic fins. Sperm ducts not differentiated. Testis small and narrow.		
F	Whitish and/or few yellow maturing eggs are visible in the ovary. The distal part of oviducts (uterus) is well developed but empty. The nidamental glands are small.	MATURING*	**2**
M	Claspers are larger, but skeleton still flexible. They extend to the posterior edge of the pelvic fins. Spermducts well developed eventually beginning to meander.		
F	Ovaries contain yellow eggs (large yolk eggs). The nidamental glands are enlarged and oviducts are distended.	MATURE	**3a**
M	Claspers extends well beyond the posterior edge of the pelvic fin and their internal structure is generally hard and ossified. Testis greatly enlarged. Spermducts meandering over almost their entire length.		
F	Ovary walls transparent. Oocytes of different sizes, white or yellow. Nidamental glands large. Egg-cases more or less formed in the oviducts (Extruding Stage).	MATURE/EXTRUDING- ACTIVE	**3b**
M	Clasper longer than tips of posterior pelvic fin lobes, skeleton hardened with axial cartilages hardened and pointed. Spermducts largely. Sperm flowing on pressure from cloaca (Active Stage).		
F	Ovary walls transparent. Oocytes of different sizes, white or yellow. Oviducts appear much enlarged, collapsed and empty. The nidamental glands diameter are reducing.	RESTING	**4a**
M	Clasper longer than tips of posterior pelvic fin lobes, skeleton hardened with axial cartilages still hardened. Spermducts empty and flaccid.		
F	**Ovaries full of small follicles similar to stage 2, enlarged oviducal glands and uterus**	**REGENERATING***	**4b**

Table 3. Codes of sexual maturity for viviparous elasmobranchs

Sex	Gonad aspect	Maturation state	Maturity	Stage
I	Sex not distinguished by naked eye.	UNDETERMINED	IMMATURE	**0**
M	Claspers flexible and shorter than pelvic fins. Testes small (in rays, sometimes with visible lobules). Sperm ducts straight and thread-like.	IMMATURE	IMMATURE	**1**
F	Ovaries barely visible or small, whitish; undistinguishable ovarian follicles. Oviducal (nidamental) gland may be slightly visible. Uterus is thread-like and narrow.			
M	Claspers slightly more robust but still flexible. Claspers as long as or longer than pelvic fins. Testes enlarged; in sharks testes start to segment; in rays lobules clearly visible but do not occupy the whole surface. Sperm ducts developing and beginning to coil (meander).	DEVELOPING	IMMATURE *	**2**
F	Ovaries enlarged with small follicles (oocytes) of different size. Some relatively larger yellow follicles may be present. Ovaries lack atretic follicles. Developing oviducal gland and uterus.			
M	Claspers fully formed, skeleton hardened, rigid and generally longer than pelvic fins. Testes greatly enlarged; in sharks testes are fully segmented; in rays filled with developed lobules. Sperm ducts tightly coiled and filled with sperm.	SPAWNING CAPABLE	MATURE	**3a**
F	Large ovaries with enlarged yolk follicles all of about the same size so that they can be easily distinguished. Oviducal gland and uterus developed without yolky matter, embryos and not dilated.	CAPABLE OF REPRODUCING		
M	Description similar to stage 3a, however with clasper glands dilated, often swollen and reddish (occasion-ally open). Sperm often present in clasper groove or glans. On pressure sperm is observed flowing out of the cloaca or in the sperm ducts.	ACTIVELY SPAWNING	MATURE	**3b**
F	Uteri well filled and rounded with yolk content (usually candle shape). In general segments cannot be distinguished and embryos cannot be observed.	EARLY PREGNANCY	MATERNAL	
F	Uteri well filled and rounded, often with visible segments. Embryos are always visible, small and with a relatively large yolk sac.	MID PREGNANCY	MATERNAL	**3c**
F	Embryos fully formed, yolk sacs reduced or absent. Embryos can be easily measured and sexed.	LATE PREGNANCY	MATERNAL	**3d**
M	Claspers fully formed, similar to stage 3. Testes and spermducts shrunken and flaccid.	REGRESSING	MATURE	**4**
F	Ovaries shrunken without follicle development and with atretic (degenerating) follicles. The oviducal glands diameter may be reducing. Uterus appears much enlarged, collapsed, empty and reddish.	REGRESSING	MATURE	**4a**
F	Ovary with small follicles in different stages of development with the presence of atretic ones. Uterus enlarged with flaccid walls. Oviducal gland distinguishable.	REGENERATING (mature)	MATURE *	**4b**

Appendix 6

Format of type A files (data on hauls)

Data collection template of the type A files (Data on hauls)													
Country				Survey									
GSA				Year									
Gear		Avg. net horizontal opening					Avg. net vertical opening						
Hauls	Haul identification code	Date	Coordinates				Depth (m)		Time		Avg. speed (knots)	Warp length (m)	Remarks
			Start		End								
			Lat	Lon	Lat	Lon	Start	End	start	end			

Instructions

- Survey: insert the name of the survey.
- GSA: insert the code of the Geographical subarea (GSA)
- Gear: insert the type of the gear as iBotS.
- Avg. net horizontal opening: The distance between wing ends.
- Hauls Number: identification number which shall be assigned to each fishing haul (e.g., progressive numbers from 1 to 30). Fishing hauls are made in the same position from year to year, the same number should be associated with a fishing haul every year.
- Hauls Identification Code: identification code which shall be assigned yearly to each fishing haul (unique).
- Coordinates: Latitude (start and end) - insert the latitude at the beginning and at the end of each fishing haul. Data should be inserted in degree, minutes and seconds (e.g., 40°51'59"N). Longitude (start and end) - insert the longitude at the beginning and at the end of each fishing haul. Data should be inserted in degree, minutes and seconds (e.g., 124°4'58"W).
- Depth (m): insert the depth in metres, at the beginning and at the end, of each fishing haul.
- Time: insert the time, at the beginning and at the end, of each fishing haul.
- Av. Speed: insert the average speed maintained during the fishing haul.
- Warp length: The distance between towing blocks and the otter boards should be inserted.
- Remarks: Additional information such as weather conditions, observations, and interval coordinates.

Appendix 7a

Oceanographic characteristics (when available) of each fishing haul

Data collection template for oceanographic characteristics of each fishing haul											
Country				Survey							
GSA				Year							
Hauls	Haul identification code	Date	Sea Surface				Sea Bottom				Comments
			Temperature	Salinity	Other parameters		Temperature	Salinity	Other parameters		

Instructions

- Survey: insert the name of the survey.
- GSA: insert the code of the Geographical subarea (GSA)
- HAULS Number: insert the identification number which has been assigned to each fishing haul (as in Appendix 1.1.1).
- HAULS Identification CODE: insert the identification code which has been assigned to each fishing haul (as in Appendix 1.1.1).
- Temperature: Insert an average value of the sea temperature (both recorded on the sea surface and on the bottom) in °C with two decimals; NA if not available.
- Salinity: Insert an average value of the salinity (both recorded at the sea surface and on the bottom) in part per thousand ‰; NA if not available.

-

Appendix 7b

Measuring system codes

System	Code
Vemco- Minilog TDR -5 to +35 C°	VA
Star Oddi temperature sensor	SO
XBT	XA
SCANMAR	SA
SIMRAD	SI
CTD probe	CT
SBE 56	SB
CTD probe SBE 37	CD
Other	OT

Appendix 8

Format of type B files (catches by haul)

Data collection template for the type B files (catches by haul)						
Survey						
Country					GSA	
Haul Identification Code					Date	
Species	Size category	Number	Count	Sub-sample W (kg)	Total catch W (kg)	Raising factor

Instructions

- Survey: insert the name of the survey.

- GSA: insert the code of the Geographical subarea (GSA).

- HAUL Identification CODE: insert the identification code which has been assigned to the identified fishing haul (as in Appendix 1.1.1).

- Species: insert the scientific name for all the species present in the catch composition.

- Sub-sample (y/n): for each species caught during the same fishing haul, indicate “Yes” if data (on weight and number) have been collected for a sub-sample, otherwise, indicate “No”.

- Multiplied by: indicate the number for which should be multiplied the sub-sample.

- Number: insert the total number of individuals present in the catch (or in the sub-sample) for the identified species

- Weight (kg): insert the total weight (in kilos) of the individuals present in the catch (or in the sub-sample) for the identified species.

Appendix 9

Format of type C files (length and aggregated biological parameters)

Data collection template for type C files (length and aggregated biological parameters)					
Survey				Haul Code	
Country		GSA		Date	
Haul Sub-sampled Y/N				Catch Raising Factor*	

Species		Cat			Species		Cat	
Catch Kg		Sample Kg			Catch Kg		Sample Kg	
		RF					RF	
TL (cm)	**Freq**	**Bio Sample**			**TL (cm)**	**Freq**	**Bio Sample**	
0					0			
0.5					0.5			
1					1			
1.5					1.5			
2					2			
2.5					2.5			
3					3			
3.5					3.5			
4					4			
4.5					4.5			
5					5			
5.5					5.5			
6					6			
6.5					6.5			
7					7			
7.5					7.5			
8					8			
8.5					8.5			
9					9			
9.5					9.5			
0					0			

0.5		
1		
1.5		
2		
2.5		
3		
3.5		
4		
4.5		
5		
5.5		
6		
6.5		
7		
7.5		
8		
8.5		
9		
9.5		
0		

Total Frequency	
Total Length Classes x10	

0.5		
1		
1.5		
2		
2.5		
3		
3.5		
4		
4.5		
5		
5.5		
6		
6.5		
7		
7.5		
8		
8.5		
9		
9.5		
0		

Total Frequency	
Total Length Classes x10	

** Catch Raising Factor (CF) indicates the entire haul was sub-sampled after rare individuals removed, before sorting into species was done. In this case the any species level RF will need to be multiplied by the Haul RF also, to give the correct RF for the sample.*

Appendix 10

Data collection template for type E files (age, weight and maturity by length at individual level)

Data collection template for age data							
Survey							
Country			GSA				
Haul Identification Code			Date				
Species							
Total weight in the catch			Weight of the sample				
No	Length (cm)	Width (cm)	Age	Sex	Weight	Maturity stage	Remarks
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							

Instructions

- Length: for each identified specimen insert the shell length and width (in mm).
- Sex: if available, insert the sex of the identified specimen (M=male; F=female; U=undetermined; ND=not determined).

Appendix 11

Data collection template for type L files (litter categories)

<table>
<tr><th colspan="5">Data collection template for the type L files (litter categories)</th></tr>
<tr><td colspan="2">Survey</td><td colspan="3"></td></tr>
<tr><td colspan="2">Country</td><td></td><td>GSA</td><td rowspan="2" colspan="2"></td></tr>
<tr><td colspan="2">Haul Identification Code</td><td></td><td>Date</td></tr>
<tr><td colspan="3">Type of Litter</td><td>Weight (kg) (mandatory for category and sub-category)</td><td>Number (facultative for subcategory)</td><td>Number (mandatory for category)</td></tr>
<tr><td>L0</td><td colspan="2">No litter in the net</td><td></td><td></td><td></td></tr>
<tr><td rowspan="10">L1
Plastic</td><td colspan="2">a. Bags</td><td></td><td></td><td rowspan="10"></td></tr>
<tr><td colspan="2">b. Bottles</td><td></td><td></td></tr>
<tr><td colspan="2">c. Food wrappers</td><td></td><td></td></tr>
<tr><td colspan="2">d. Sheets (table covers, etc.)</td><td></td><td></td></tr>
<tr><td colspan="2">e. Hard plastic objects (crates, containers, tubes, ash-trays, lids, etc.)</td><td></td><td></td></tr>
<tr><td colspan="2">f. Fishing nets</td><td></td><td></td></tr>
<tr><td colspan="2">g. Fishing lines</td><td></td><td></td></tr>
<tr><td colspan="2">h. Other fishing related (pots, floats, etc.)</td><td></td><td></td></tr>
<tr><td colspan="2">i. Ropes/strapping bands</td><td></td><td></td></tr>
<tr><td colspan="2">j others</td><td></td><td></td></tr>
<tr><td rowspan="2">L2
Rubber</td><td colspan="2">a. Tyre</td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td colspan="2">b. Other (gloves, boots/shoes, oilskins etc.)</td><td></td><td></td></tr>
<tr><td rowspan="7">L3 Metal</td><td colspan="2">a. Beverage cans</td><td></td><td></td><td rowspan="6"></td></tr>
<tr><td colspan="2">b. Other food cans/wrappers</td><td></td><td></td></tr>
<tr><td colspan="2">c. Middle size containers (of paint, oil, chemicals)</td><td></td><td></td></tr>
<tr><td colspan="2">d. Large metallic objects (barrels, pieces of machinery, electric appliances)</td><td></td><td></td></tr>
<tr><td colspan="2">e. Cables</td><td></td><td></td></tr>
<tr><td colspan="2">f. Fishing related (hooks, spears, etc.)</td><td></td><td></td></tr>
<tr><td colspan="2">g. remnant from the war</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">L4</td><td colspan="2">a. Bottles</td><td></td><td></td><td rowspan="2"></td></tr>
<tr><td colspan="2">b. Pieces of glass</td><td></td><td></td></tr>
</table>

Glass / Ceramic/ Concrete	c. Ceramic jars			
	d. Large objects (specify)			
L5 Cloth (textile)/ natural fibers	a. Clothing (clothes, shoes)			
	b. Large pieces (carpets, mattresses, etc.) (specify)			
	c. Natural ropes			
	d. Sanitarias (diapers, cotton buds, etc.)			
L6 Wood processed (palettes, crates, etc.)				
L7 Paper and cardboard				
L8 Other (specify)				
L9 Unspecified				

Protocol for sampling otoliths, individual weight and maturity stages of iBotS target species

Estimates of abundance indices at age

After the age distribution is allocated to the length distribution, the age-based indices are calculated. The precision of the age–length key can be estimated using the method of Baird (1983) or Oeberst (2000).

In the estimates of the abundance indices at age, it is necessary to compute the average numbers at length and associated variances as a first step.

The mean stratified standardization formulas by Souplet (1996) shall be used for the computation of average numbers at length and associated variances by stratum (formulas 1 and 2 below) and for the total area (formulas 3 and 4 below):

$$\bar{x}_{k,j} = \frac{\sum_{h=1}^{H} x_{h,k,j}}{\sum_{h=1}^{H} A_{h,k}} \qquad 1)$$

$$V(\bar{x}_{k,j}) = \frac{1}{H-1}\sum_{h=1}^{H} A_{h,k}\left(\frac{x_{h,k,j}}{A_{h,k}} - \bar{x}_{k,j}\right)^2 \qquad 2)$$

$$I_j = \sum_{k=1}^{K} W_k * \bar{x}_{k,j} \qquad 3)$$

$$V(I_j) = \sum_{k=1}^{K} \frac{W_k^2 S(\bar{x}_{h,j})^2}{\sum_{h=1}^{H} A_{h,k}}(1-f_k) \qquad 4)$$

where:

$x_{h,k,j}$ is the number of individuals in the haul *h* of the stratum *k* and length class *j*;

$A_{h,k}$ is the swept area of haul *h* in stratum *k*;

$x_{k,j}$ is the average number at length *j* in the stratum *k*;

$V(\bar{x}_{k,j})$ is the variance of the average number at length *j* in the stratum *k*;

W_k is the stratum weight calculated as the area of stratum *k* divided by the GSA area;

I_j is the abundance index of the length class *j*;

$V(I_j)$ is the variance of the abundance index of the length class; and

f_k is the finite population correction factor.

In a second phase, when building the age–length key, the computation of the proportions at age *i* per length class *j* and associated variances is computed as:

$$p_{i,j} = \frac{n_{i,j}}{n_j} \qquad 5)$$

$$V(p_{i,j}) = \frac{p_{i,j}(1-p_{i,j})}{n_j} \qquad 6)$$

where:

$n_{i,j}$ is the number of otoliths of age *i* in the length class *j*;

n_j is the total number of otoliths in the length class *j*; and

$p_{i,j}$ is the proportion of age *i* in the length class *j;*

$V(p_{i,j})$ is the variance of the proportion of age *i* in the length class *j.*

In a third phase, the computation of mean numbers at age and the associated variances are computed. The mean numbers at age are given by:

$$I_i = \sum_{j=1}^{J} I_j * p_{i,j} \tag{7}$$

$$V(I_i) = \sum_{j=1}^{J} \left[V(I_i)p_{i,j}^2 + I_j^2 V(p_{i,j}) + V(p_{i,j})V(I_i)\right] \tag{8}$$

where:

I_i is the abundance index of the age class *i* and $V(I_i)$ is its variance.

These computations are done by sex and the total age composition is given for each age *i* by:

$$Itot_i = Ima_i + Ife_i \tag{9}$$

$$V(Itot_i) = V(Ima_i) + V(Ife_i) \tag{10}$$

With the sampling being independent of sex, the covariance is not considered.

References:

Baird, J.W. 1983. A method to select optimum numbers for aging in a stratified random approach. In Sampling commercial catches of marine fish and invertebrates. W.G. Doubleday and D. Rivard, eds.. *Can. Spec. Publ. Fish. Aquat. Sci.*, 66: 161–164.

Oeberst R. 2000. A universal cost function for the optimization of the number of age readings and length measurements for Age-Length-Key-Tables (ALKT). *Arch. Fish. Mar. Res.*, 48(1): 43–60.

Souplet A. 1996. Calculation of abundance indices and length frequencies in the MEDITS survey. In: J. A. Bertrand *et al.*, eds. *Campagne internationale du chalutage démersal en Méditerraneé.* Campagne. EU Final Report, Vol. III.

Appendix 13

Technical specifications and quality check of the iBotS gear

There should be someone in charge of making sure the sample equipment meets the requirements outlined in this document for each operational unit. This verification needs to be performed upon first arrival of the equipment from the manufacturer and again just before each survey.

Particular care must be taken to preserve the difference in length between the netting segments in the upper and lower panels. Top and bottom sections are of equal length. This consistency in length requires frequent checks of the net. If the top sheet exceeds the length of the corresponding lower sheet by more than one mesh, it should be trimmed to the appropriate size. Additionally, it is necessary to maintain the ratio between the framing ropes and the nets in the wings and arms.

The trawl consists of four panels: top, bottom and side panels. Each panel has several sections. It is necessary to check the relative length of each netting section. They are all compared with the corresponding sections in the other panels in such a way that the top and bottom panel sections are checked against the side panel sections. The best method to compare two sections is to let two persons – one at each end of the section – take around 10 meshes from the centre line of one section in one hand and hold it against 10 meshes from the centre line of the other section in the other hand. The sections must then be stretched and the difference in length observed. The lengths of the side, top and lower panel sections must be equal. The procedure is repeated for each section. In case any difference is detected, a skilled net maker should be consulted to evaluate a possible adjustment.

The lengths of the ground rope and headline must be compared by holding the two together. The length can be adjusted by means of the adjustment chain on the lower bridle.

Plate 1. View of the fishing line and footrope in the iBotS trawl.

a b

Plate 2. Measurement of the distance between the fishing line and the footrope (6 cm) (panel a) and between the bightings on the fishing line (50 cm) (panel b)

a b

Plate 3. Measurement of the distance between ballast chain bights (17 cm) (panel a) and of the inner height of the chain bightings (8 cm) (panel b). With such rigging, the total weight of the chain must be around 94 kg, including the supplementary chain (only one chain) of 9.4 kg.

a b

Plate 4. Measurement of the headline at the bosom level (113 cm).

Trawl netting

The height of a netting (H) is calculated by multiplying the stretched mesh size (MS) of the netting by the number of meshes in height:

(NH): H=MS × NH.

In general, the design of any trawl is conceived to distribute the net drag not homogeneously among the upper (UP), lower (LP) and side panels (SP). In order to guarantee a correct trawl bottom contact, the UP has more drag than the LP, so that during towing, the UP is more stretched while the LP is slacked. Despite the equal longitudinal number of meshes both in the UP and LP, the unequal drag distribution may cause a different stretching of the twines, resulting in a different effective panels length. For this reason, prior to any field cruise, all the nettings need to be measured along the longitudinal axis (N-direction), without considering seams. Normally, the different action of the drag on the three panels will cause the upper nettings to be more likely to become stretched; the lower nettings tend to shrink, and the side nettings are almost in a neutral situation.

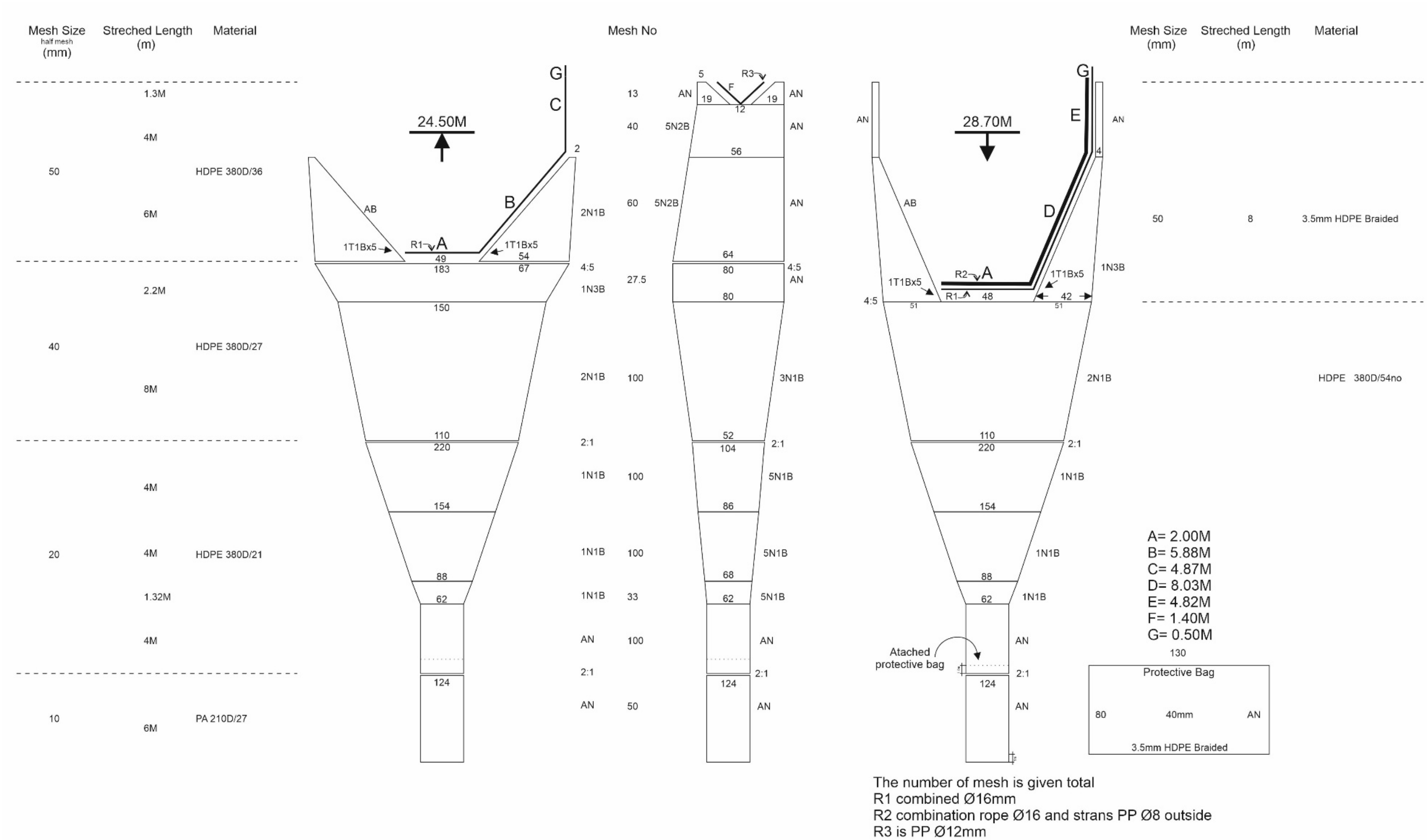

Figure 1. Design of the sampling trawl used for the iBotS survey.

Quality time-0 checks

Time-0 checks are necessary both with a new trawl and when an iBotS gear is measured for the first time (i.e. whenever measured). The overall status for the net should also be periodically checked at the beginning of every cruise. The only difference between time-0 and periodic checks is the measurements of the net width, which are not necessary to make regularly since it is not expected to change over time.

The following templates have been developed in order to be printed out and form a sort of "record book" for the quality certification of each iBotS gear (e.g., netting, otter board, and rigging parts).

It is recommended that each iBotS trawl and otter boards be classified with the following rules of codification:

Trawl: iBotSNET_OUXXX_YYYY_NN

Otter board: iBotSOB_OUXXX_YYYY_NN,

where OUXXX stands for the Operative Unit code; YYYY is the year of trawl purchasing; and NN is a yearly progressive serial number (i.e. reset to 01 each year).

Template for number of meshes and mesh sizes in the top panel, lower panel, side panel (port) and side panel (starboard)

The following templates must be used to gear-check according to the design of the sampling trawl used in the iBotS survey. After the gear check has been completed, the document must be signed by the person in charge of the inspection. The boxes to be filled are defined in Box A

iBotS gear inspection

Operative unit		Inspection No.		Signature
Date of inspection		Name of the control operator		
Sampling trawl code		Otter board code		

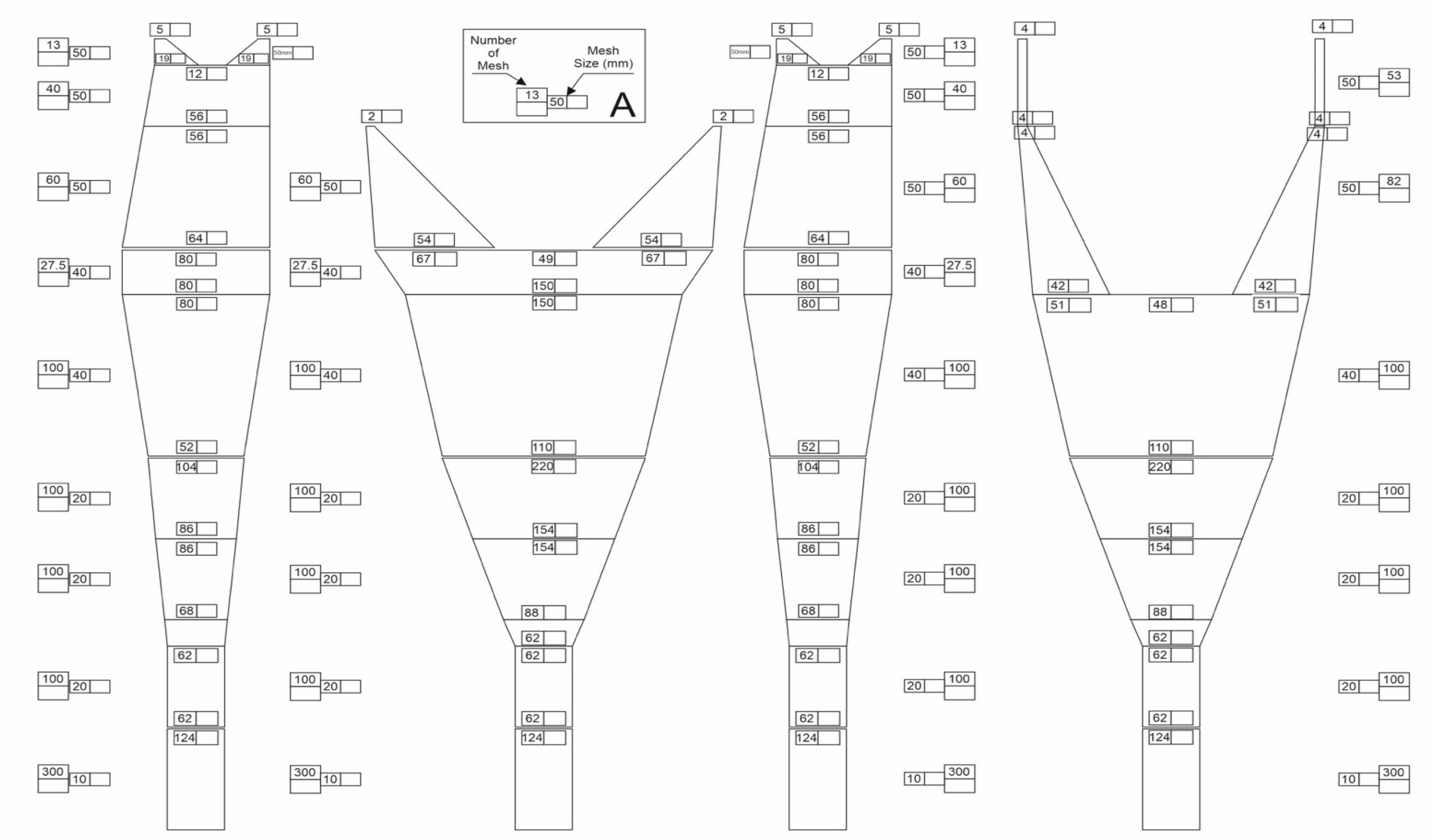

Figure 2. Gear check template for number of the meshes and mesh sizes

Template for the otter boards

The otter boards used in the iBotS survey must be weighed and measured upon their first arrival from the manufacturer. The person in charge of the inspection should also ensure that the overall configuration, such as warps and backstrop chains, meets the requirements outlined in Figure 5 in Section 7 on "Gear Specifications".

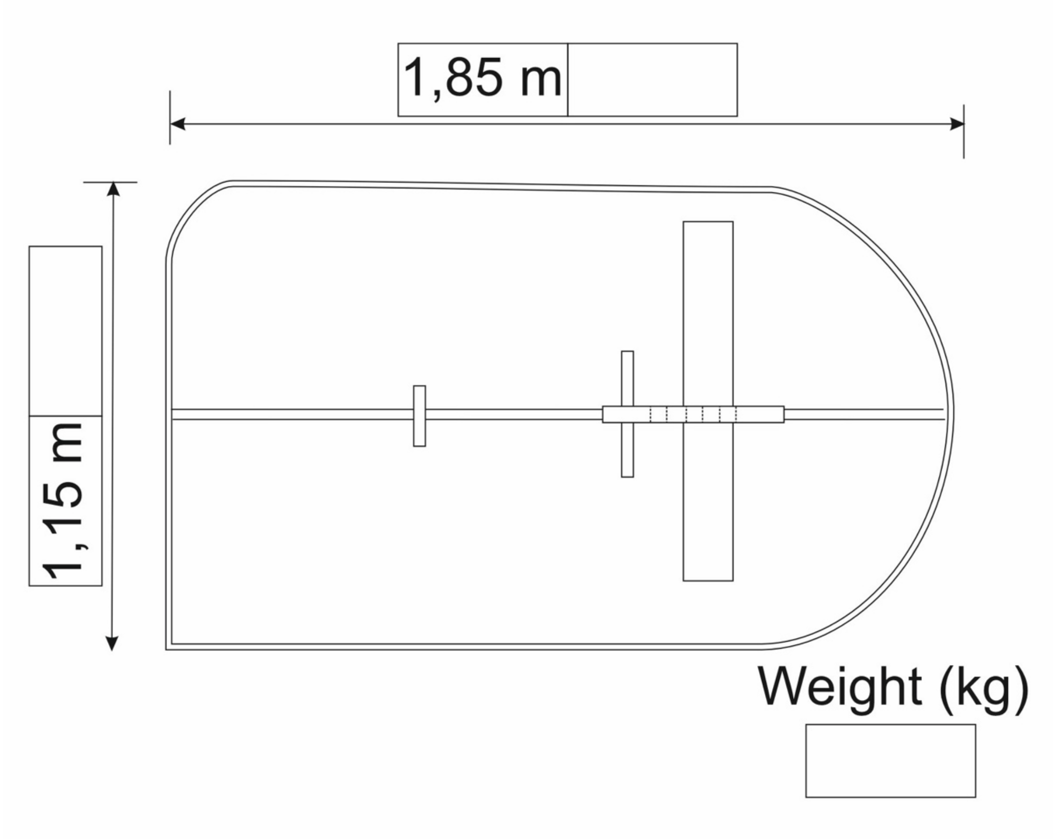

Figure 3. Gear check template for the otter boards

Template for lines (headline, sidelines, fishing line, footrope)

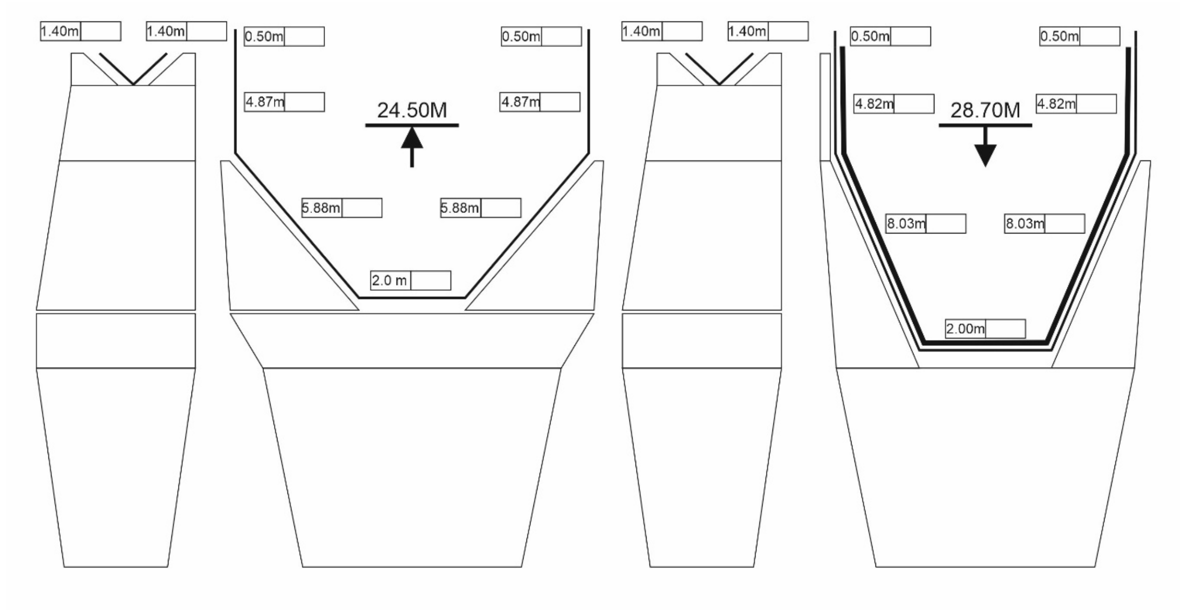

Figure 4. Gear check template for lines

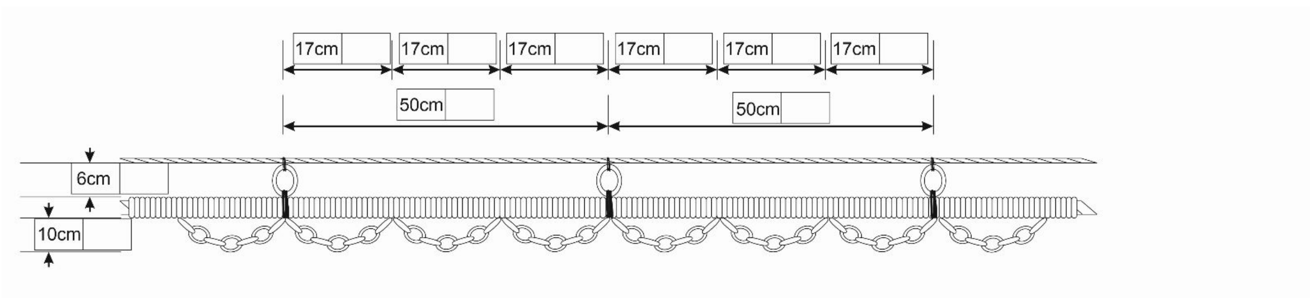

Figure 5. Gear check template for ground gear

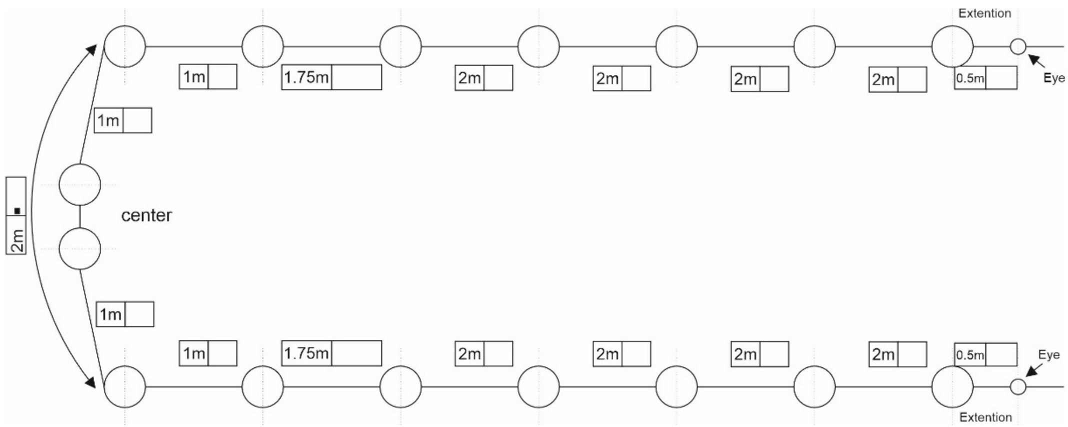

Figure 6. Gear check template for headline and floats

Glossary of terms and references to the acronyms used in the manual

AB direction (AB): Direction parallel to a rectilinear sequence of mesh bars, each from adjacent meshes.

Bar cut (B): A cut parallel to a line of sequential mesh bars, each from adjacent meshes, and severing one or more bars.

Belly: Section of panel between wings and extension piece of the trawl.

Body: The centre that is usually the main part of a net or section of a trawl.

Bottom otter trawl: Trawl towed by a single boat. Its horizontal opening is obtained using otter boards that are relatively heavy and equipped with a steel sole designed to withstand rough contact with the bottom.

Bottom trawl: Trawl designed and rigged to work near the bottom. According to the type used, one may distinguish low-opening trawls (specially designed for the capture of demersal species), such as beam trawls and shrimp, sole or *Nephrops* trawls, and high-opening trawls, which are suitable mainly for the capture of the semi-demersal or pelagic species.

Bridle: The extended part of the headrope (upper bridle) and the footrope (lower bridle) is called the bridle.

Codend: Netting bag made up of one or more panels (pieces of netting) of the same mesh size attached to one another along their sides in the axis of the trawl by a seam where a side rope may also be attached.

Door length: The horizontal overall distance between the forward and aft edges of the otter board. On a cambered otter board, the length is measured along a direction parallel to the shoe.

Door weight: The weight, as usually indicated by manufacturers, is the weight in air. It should be noted that, when considering otter board performance, the effective weight of the otter board is the weight in water.

Extension: The untapered section, made of one or more panels, between the trawl body and the codend.

Fishing circle: The length, in metres, of the circumference obtained considering a vertical section of the net at the footrope bosom.

Float: A buoyant unit used to give lift or to mark the position of a net, or both.

Footrope length: The length of the lower combination rope, usually expressed in metres.

Headline (headrope): The principal upper frame rope of a net to which the netting is attached.

Headline length: The length of the upper combination rope, usually expressed in metres.

Horizontal cut (T): A cut parallel to the general course of the netting yarn just beyond the knots.

Horizontal door spread: The distance between the otter boards measured perpendicular to the trawling direction.

Length of the net: The overall distance, along the longitudinal axis between, between the wings and the extension. When not specified, the codend is not included.

Lower panel: All the net sections of the lower part of the trawl net.

Lower wing: Net section extending forward from one side of the belly and usually joined to the adjacent top wing (two-panel trawls) or adjacent side wing (four-panel trawls).

Mouth horizontal opening: The horizontal distance between the ends of the headline.

Mouth vertical opening: The vertical distance (height) of the headline bosom from the ground.

Otter board: Shearing device, two of which hold open the wings and mouth of a trawl horizontally.

Piece of netting: A section of netting consisting of a uniform size mesh.

Rig: The process of fitting the necessary ropes and accessories so as to make a net ready for fishing.

Side wing: Lower or upper wing of side panel of a four-panel trawl

Strengthening bag: A cylindrical piece of netting completely surrounding the codend of the trawl.

Sweep: The rope, usually of wire or combination rope, between the otter boards and net.

Top panel: All the net sections of the upper part of the trawl.

Top wing (upper wing): Net section extending forward from one side of the square and usually joined to the adjacent lower wing (two-panel trawls) or adjacent side wing (four-panel trawls).

Vertical cut (N): A cut at right angles to the general course of the netting yarn just beyond the knots.

Warp: Long, flexible steel rope connecting the vessel to the trawl gear.

Wing: Tapered net section extending forward from one side of the main body of the net.

Appendix 14

Catch sub-sampling and raising

Accurate sub-sampling of the catch is extremely important for efficient data collection. In other words, the samples must truly represent the original catch data and not simply be a smaller random selection in which obvious characteristics of the catch are ignored.

Taking the example sample of a single species catch below, we can see several fish lengths are very common within the catch (Plate 1). In contrast, there appears to be only one very large fish and only very few small fish. Increasing measurements of the same fish lengths is not efficient and does not add equivalent extra precision (Gerritsen *et al*., 2007). However, since the size of the fish is known to be not distributed evenly, the largest and smallest fish, in particular, can be low in number. Intuitively, then, an efficient and accurate sub-sample will reduce the number of common lengths to be measured, while ensuring the tails of the distribution (big and small fish) are not sub-sampled as much or at all.

Plate 1. Single species catch example (haddock) ©IMR/Dave Stoke

If half this catch is sampled completely at random, then one large fish will either be left behind unmeasured or else end up in the sample. It will be then multiplied by the raising factor (RF) of two implying there were either two large fish, or no large fish in the catch. Both scenarios are clearly wrong, and, the bigger the RF, the more that error will be multiplied.

As with separating out rare species in initial catch processing, if the rare lengths are separated out into length categories, it can be efficiently decided with each category what sub-sampling may be appropriate. To convert the sampled numbers at length back to the numbers at length in the original catch, an RF is used, which is simply the ratio of the category catch weight to the category sample weight.

In another example below, the small fish (Cat 1) and large fish (Cat 3) have been separated out from the common lengths (Cat 2) (Figure 1). The less common lengths are all being measured so that both Cat 1 and Cat 3 have an RF = 1 (i.e., not sub-sampled). The common lengths (Cat 2 here) are then well mixed by the sampler and a random sample of half is being taken out for measurement. Therefore, Cat 2 will need to be multiplied by two afterward to indicate what was in the total catch for those lengths (i.e. RF = 2). Obviously, Cat 1 x 1, Cat 2 x 2 and Cat 3 x 1 will all need to be added together again to recreate the complete length frequency in the original catch (Figure 1).

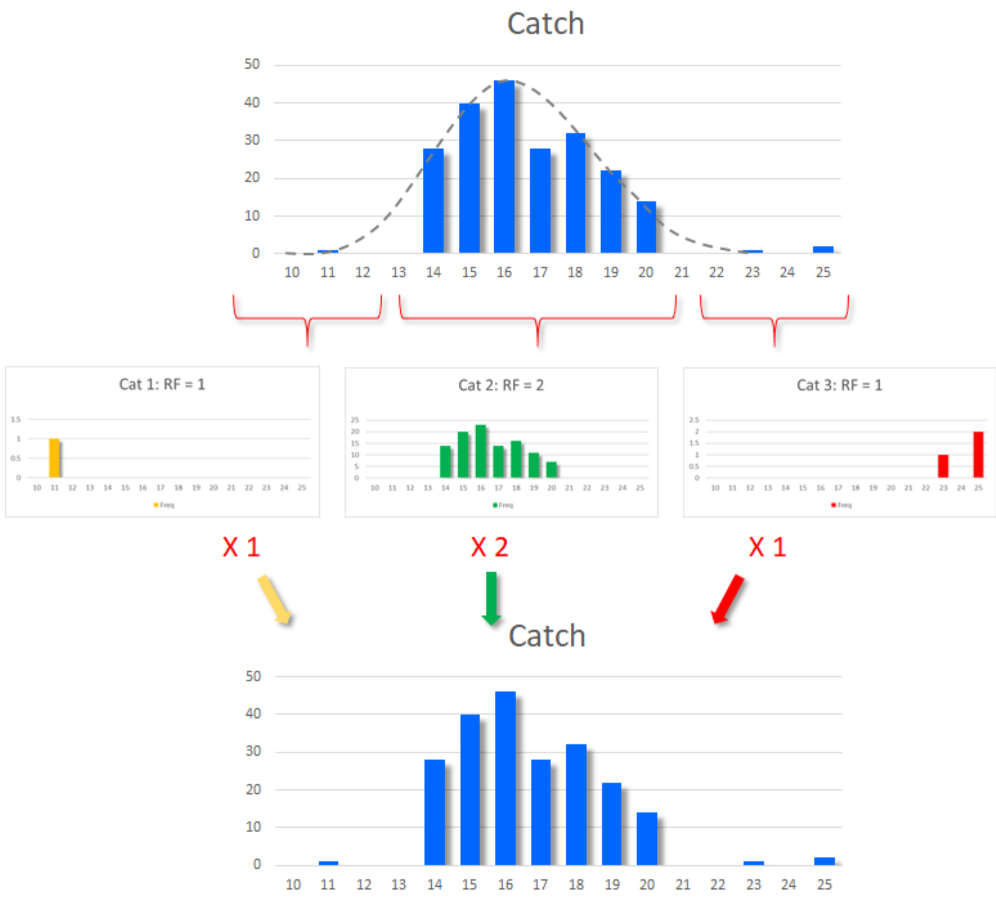

Figure 1. Diagram of catch sub-sampling and raising factors for larger and smaller individuals

It is important to remember the category label here is only for convenience of ensuring that the correct RF is maintained with each sample. It is common for samplers to allocate Cat 1 to the smallest lengths to avoid confusion during busy catch processing, but it is not necessary. In practice, Cat 1 and Cat 3 above would usually be combined, as the RF is the same for both, to avoid the extra data entry for a third sample and the small and large fish can simply be measured together as one sample.

There were 214 fish in the catch above, but in total for all three categories, only 108 fish needed to be measured to accurately recreate the full length frequency of the catch. This was possible because the less common lengths were not sub-sampled and therefore did not disappear or become over-raised simply by chance. In practice, if the sampler needs to think about whether a fish is part of the common length distribution, it probably accounts for <10 percent and is worth keeping aside as a separate category. If the sampler intends to measure all the fish for this species, then categories don't arise, and they simply measure all of them.

Finally, the importance of length ranges, as well as frequency, when sampling for length data is noted. To account for this, the work of Gerritsen *et al.* (2007) suggests a minimum sample size of 10 times the number of length classes in the sample when sampling in the field. This guidance provides good precision while being easy for samplers to apply across the species studied. Therefore, a box has been added to the iBotS length data form (TC) (Appendix 9) for the counting of length classes in the sample, so that a simple quick check can be kept on sampling efficiency. In other words, if the number of fish measured is more than 10 times the count of length classes, the survey is likely to have oversampled for that catch component.