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Manual for the Midwater Ring Net sampling during IBTS Q1

Version 3.0

The International Bottom Trawl Survey Working Group

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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1 Introduction

The Midwater Ring Net is at present the standard gear for sampling fish larvae during the North Sea International Bottom Trawl Survey in the first quarter. Fish larvae sampling during the IBTS Q1 was initiated in 1977. During the period 1977–1991 an Issacs Kidd Midwater Trawl was used as the standard gear. When changing to the present ring net (which use a long two-legged bridle attachment as for the frame trawl described by R. D. Methot) the abbreviation for the new gear – MIK- was erroneously interpreted as an abbreviation of the names Methot, Isaacs and Kidd. This is not the case, and the present gear has only a passing resemblance to the gears described by R. D. Methot or Isaacs and Kidd. Hence the names to be used for the gear are either "MIK" or "Midwater Ring Net".

The construction of the MIK is strong and robust because of the often harsh conditions in the first quarter period in the North Sea. Hence compared to the smaller conical nets traditionally utilized for plankton sampling, the gear is made more robust by using a very strong (and heavy) ring frame, and a net strengthened with nylon or canvas reinforcing straps. The main target of the MIK-sampling is larval herring between 2 and 3 cm length, which at that size are of quite low densities. Therefore, the gear has a relatively large opening of 2 metre in diameter. Furthermore, because of the fast escape behaviour of the large herring larvae, sampling is carried out at night (with a black net) at a towing speed of 3 knots. The speed constraints the mesh size and a relatively coarse mesh of 1.6 mm is standard.

The standard rigging and procedures for undertaking MIK sampling during IBTS Q1 is described in the sections below. Minor differences in MIK design may occur among participants, however, these differences are all believed to be insignificant with respect to catchability of the gear. Nevertheless, the comparability among participants is verified for each survey. This is done by comparing the results of participants that sample the same ICES rectangles.

Since 2016, the MIKeyM sampling constitutes the North Sea Cod and Plaice Egg Survey (ICES 2016a) has been fully incorporated in to the standard sampling protocols for the MIK sampling in the 1st Quarter IBTS. At an identical survey design only a different gear is needed to capture fish eggs effectively.

2 Gear construction and sampling procedures

2.1 The Midwater Ring Net

The MIK net consists of a rigid ring frame to which the net is attached, a conical net made of nylon gauze, a codend bucket, a pair of bridles for towing, a depressor with bridles, a flowmeter for filtered volume determination and a depth gauge for monitoring net depth. In particular, the parts of the gear, as shown in Annexes 1, 2 and 3 are:

a) Ring of 2 metre diameter. This should be reasonably strong, preferably made of two connected steel tubes (picture in Annex 1). When the ring is heavy (~100 kg) there is no need for a depressor, but only a weight to stabilize the ring (see "d" below);

b) Dark coloured (preferably black or dark blue) net of 1.6 mm pore, i.e. measured inside the openings, 13 metre long, strengthened by nylon or canvas straps. The filtering area ratio of the fabric should be >40%. In the last metre of the net a 500 μm net is inserted (Figure b1 in Annex 1);

c) Straps (with nuts, bolts and plates) or a strong line for mounting the net on the ring, ensuring that the gap between ring and net is small as possible;

d) Saddle shaped weight or depressor of approx. 25 kg or more where necessary dependent on weight of the 2 m ring;

e) Pair of 10-metre-long towing bridles. This length in order to keep the bridles away from the path into the net;

f) Pair of suitable (2–3 m) bridles attached to the weight or depressor. This length is needed in order to prevent the bridles chaffing or damaging the net;

g) Codend bucket (Ø 11 cm) for collection of the plankton sample. Use a netting of 500 μm or less for the codend (see examples in Annex 3);

h) Calibrated flowmeter mounted on a string crossing the ring, positioned in the centre of the ring. Keep string slack so that flowmeter is approx. 0.5 m inside the net. Suggested flowmeter types are General Oceanic 2030R or the newer types of Hydrobios 438 110;

i) In order to monitor the real-time depth of the gear (and thereby calculate the distance to bottom) a depth sensor (e.g. trawl headline or depth sensor) should be mounted in the ring.

2.2 The MIKeyM-net attachment

The MIKeyM-net consists of a 20 cm stainless steel ring, which is attached to the outside the 2 m MIK ring, and a cylinder-conical net of black 335 μm mesh. Distance between the large and the small ring should be roughly 10 cm. The ring has fixtures to place a flowmeter in approximately the centre of the net-opening. Either 1 or 2 MIKeyM-nets can be attached to the MIK in various configurations according to Figure 2.1.1 (and see also Annex 4 for pictures of the MIKeyM-net deployment).

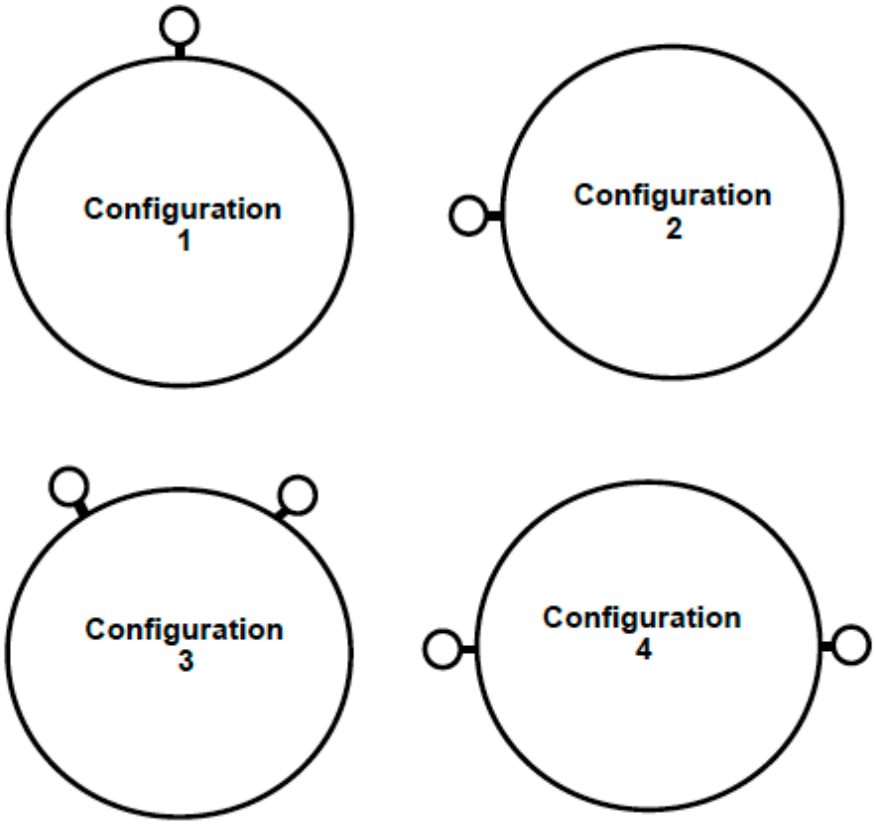


Figure 2.1.1. Placement of the accessory rings (20 cm) on the standard 2 m MIK Ring Trawl. Configuration 1 utilized by Ifremer, France (an additional bridle attached to the top of the ring), configuration 2 utilized by DTU-Aqua, Denmark, Configuration 3 utilized by Wageningen Marine Research, The Netherlands, and Configuration 4 utilized by IMR, Norway.

The nets are cylindro-conical with a porosity of about 50% and >1 m long with a 20 cm diameter inlet. Due to the relatively high towing speeds of the MIK (up to 3 knots) and the often poor weather conditions and severe sea states during the early part of the year, which could induce short burst speeds for the nets in excess of 6 knots there is the addition of a 0.5–1 m tube in front of a 75 cm conical section. This would give an open net area to inlet ratio in excess of 10 which should be sufficient for most extreme sampling conditions.

Nets should be constructed to the following specifications:

20 cm diameter inlet, 335 µm mesh net (50 cm parallel, 75 cm taper) all in black with fitted (security bolt + stainless clamp) screw-fit codend adapter, for either lace-on or clamp band fitting.

2.3 Fishing method

Hauls should only be made at night during the period between 30 minutes past sunset to 30 minutes before. If there is no cloud cover, i.e. the daylight period has been extended, fishing should not begin until 60 minutes after sunset and cease 60 minutes before sunrise. See the IBTS manual (ICES 2015a) for latitudinal and date specific official sunrise and sunset times).

The haul profile is double oblique. Maximum tow depth is 100 metre, measured at the lower part of the ring. At shallower depths the tow should be to 5 metre above the bottom measured from the lower part of the ring. If the haul duration of a single haul

is less than 10 minutes (usually only at very shallow depths <30–40 m) a double haul must be made, i.e. to above the bottom again without the net breaking the surface.

The shooting position is defined as the sampling position.

Haul duration and distance towed must be recorded. Both values are measured between the points of the flowmeter getting in and out of water. In addition, bottom depth and maximum depth of the net must be noted and reported. In case the depth sounder is not working properly or not at all, depth can be roughly calculated from the wire length and wire angle. The wire angle is determined with an inclinometer as the deviation of the towing cable from the vertical. The depth can then be calculated as:

$D_{net} = L_{wire} \cdot \cos \alpha$

with D_{net} = Depth of net in m

L_{wire} = Length of wire in m and

α = wire angle.

This method should only be used in emergency, if all electronic/acoustic devices to measure gear depth failed, in order to prevent the MIK sampling from termination.

The depth of the net should be monitored throughout the haul.

2.4 Haul procedures

Because of the length of the bridles they will have to be hauled partly through the block, and a wide-opening block is necessary (see pictures in Annex 3). The connection between bridle and hauling wire should be flexible.

When the gear is put out the net should float freely, and the weight should be underwater before the ring is lowered underwater.

Fishing speed of the net is 3 knots through the water.

The wire is paid out at a speed of 25 metre per minute (= 0.4 ms^{-1}) and retrieved at 15 $m.min^{-1}$ (= 0.25 ms^{-1}). These speeds are chosen to get a reasonable haul duration, and to some extent take ship's speed into consideration. Care should be taken that the fished water column is sampled in an even (not stepped) 'V' shaped dive profile, filtering the same volume of water from each depth band.

All flowmeters are to be read before and after each haul.

On deck the hindmost part, i.e. at least the last 2 m, of the net and the 500 μm netting is washed from outside into the codend bucket

For the MIKeyM-net attachment, the complete netting needs to washed from outside into the codend bag.

2.5 Calibration of the flowmeter

All flowmeters used in the survey should either be calibrated at least twice per survey, or under controlled conditions at land prior to each survey, to give revolutions per metre. The method at the survey is to tow the MIK (without any codends) at a depth of at least 10 metre for a known distance. At least two measurements are needed which need to be collected in opposing directions in order to compensate for residual water currents. The average of the two values represents the calibration value indicative of the unimpeded flow. Towing duration should be between 10 and 15 minutes and

should not exceed 1 Nm. The distance is measured between the points where the flowmeter enters and leaves the water. Calibration on land can be done e.g. in a tank towing the flowmeter over a defined distance at an a priori defined speed.

If a flowmeter is changed then a new calibration is necessary.

3 Sample and Data Treatment

The samples from both, MIK and MIKeyM-nets, should be preserved in either buffered (e.g. Sodium Acetate Trihydrate or Sodium Tetraborate) 4% formaldehyde-freshwater solution or in 70% ethanol. If samples are preserved in formaldehyde or the herring larvae are sorted fresh, it is recommended that the herring larvae are transferred to 70% ethanol as soon as possible.

MIK samples should be processed during or as soon as possible after the survey in order to meet the close deadline for data submission to the MIK coordinator for subsequent index calculation for the Herring Assessment Working Group. MIKeyM-net samples should be kept and stored at the participating institutes. The samples of every third year should be shipped to IMR Bergen for analysis.

All fish larvae should be sorted from the MIK samples and herring, sardine and sprat larvae should be identified. Sorting of fresh material must be carried out while keeping the sample cold on ice and sorting time should be kept as short as possible. Care should be taken for the correct identification of clupeoid larvae, in particular differentiating between herring (*Clupea harengus*), sprat (*Sprattus sprattus*), sardine (*Sardina pilchardus*), and anchovy (*Engraulis encrasicolus*). Descriptions of those larvae are given in Annex 7.

Where large numbers of clupeoid larvae have been removed from a plankton sample, a minimum 50 herring larvae must be identified and measured from the sorted sample. The rest of the clupeoid larvae must then be apportioned across the appropriate species and size classes. If 50 herring larvae are NOT found in 25% of the sample, then the whole sample will have to be sorted.

If a representative length composition cannot be achieved (large numbers (hundreds to thousands) of small larvae and small numbers (up to 200) large larvae) it will be necessary to sort herring larvae into 2 or more size categories. The procedure should then be as follows

1. Collect the large clupeoid larvae and these should all be identified and measured;
2. Subsample the clupeoid larvae with a Motodo box making sure to end up with a subsample containing at least 100 clupeoid larvae;
3. In the subsample collect all larvae, count all larvae but identify and measure only 100 randomly selected clupeoid larvae;
4. If 50 herring larvae cannot be found in that subsample, another subsample must be sorted.

Larval standard lengths (see Annex 5) should be measured to the "millimetre below". Ethanol preserved larvae might appear quite rigid; soaking for approximately 30 minutes in freshwater will soften them, making measurement easier. The condition of larvae at length measurement (i.e. fresh or from formaldehyde or ethanol) should be indicated on the standard form.

Catches and lengths of eel (*Anguilla anguilla*) and of lemon sole (*Microstomus kitt*) should also be indicated in the standard form. If possible, other larval species (fish <6 cm) should be reported, in particular flatfish (Pleuronectiformes), pearlside, *Maurolicus muelleri*, crystal *Crystallogobius linearis* and transparent *Aphia minuta* goby as well as sand *Pomatoschistus minutus* and Norwegian *P. norvegicus* goby should be measured and recorded. A rough description and pictures of those species are given in Annex 6.

Preferably samples are processed and reported by the deadline referred to in the survey programme. The immediate reporting of herring and sprat catches (for the use of

the Herring Assessment Working Group Meeting) should be made using the new data submission format that was agreed upon during the recent workshop on ICES fish egg and larvae database (WKIELD, ICES 2015b) and e-mailed to Matthias Kloppmann (matthias.kloppmann[@]thuenen.de). Subsequently the standard forms (Annex 7) should be retained by the institute for future reference.

The data will be included in the fish egg and larvae database at ICES.

4 Allocation of Rectangles

At least 2 hauls per ship per rectangle should be carried out within each standard rectangle and the distance between hauls within and between rectangles should be at least 10 Nm. Hauls should also be carried out at least 5 Nm distance from the border of a standard rectangle. Only where rectangle areas intersecting with land prohibit 10 Nm distances between 2 hauls within 24 hours the distance to the border can be <5 Nm.

An example of a typical distribution of samples per rectangle within one survey is given for the years 2009 and 2010 in Annex 8.

During the survey the status of MIK-sampling and, if available, the numbers of herring larvae caught should be reported to the survey coordinator. If there is any risk that rectangles will be left unsampled then initiatives should be taken to reallocate sampling between participants.

Prior to each survey, rectangle allocations for MIKeyM-net sampling will be provided by Richard Nash, IMR, Bergen, Norway (Richard.Nash[@]imr.no).

5 Calculation of herring larvae index

The standard areas for which the abundance of herring larvae is calculated, and used in the calculation of the Herring Assessment Working Group indices, are shown in Annex 7.

The procedure for herring larvae index (IBTS0) has been to calculate the total abundance of larvae in the sampled area. Hence basically a calculated mean density of larvae (in no per m²) is multiplied by the total standard area.

In order to consider "skewness" in sampling intensity due to less intense or no sampling in some areas, the averaging of densities is first done for each statistical rectangle and subsequently for defined, larger sections. Finally, abundances are obtained for these sections and are summed for the total area.

In order to exclude the Downs larvae, which are too patchily distributed and too young (might reach extreme abundances), the following exclusion rule applied to the calculation of the MIK index until 2016: All stations south of 54°N with mean larval herring lengths <20 mm were excluded from the index calculation. This lead to biased index values particularly at times when strong drift transported small larvae of Downs origin northwards beyond the 54°N boundary, e.g. in 2014 and 2016 (ICES 2014, 2016b). These biased results were thoroughly discussed at the herring assessment working group (ICES 2014, 2016b) at the working group on improvement of survey data use for assessment and advice (ICES 2015c, 2016c) and at the workshop on herring larvae surveys 2 and a new exclusion rule proposed (ICES 2016d).

That exclusion rule was for the first time applied for the 2017 MIK survey and all MIK survey data back to 1992 (ICES 2017). The new rule now uses the data of all station while only the abundances of all larvae ≤18 mm SL at stations in an area west of 6°E and south of 54°N and in the area east of 6°E and south of 57°N excluded before calculating the standard IBTS0 index.

The remaining calculation procedure is the following:

1. Averages of no-per-m² is calculated for each rectangle
2. Averages of no-per-m² for rectangles are averaged for sections defined by:

if stat1 is the first two digits of "statistical rectangle" and stat4 is the two last then

if stat4<F2 and stat1>39 and stat1<46 then section = 'cw';

if stat4>F1 and stat1>39 and stat1<46 then section = 'ce';

if stat4<F2 and stat1<40 and stat1>34 then section = 'sw';

if stat4>F1 and stat1<40 and stat1>34 then section = 'se';

if stat4<F2 and stat1>45 then section = 'nw';

if stat4>F1 and stat1>45 then section = 'ne';

if stat4>F8 then section = 'ka';

if stat1<35 and stat1>30 then section = 'ch';

The sections cw, ce, nw, ne, sw, se, ka and ch denote the following subsections of the North Sea (see also Figure in Annex 7): Central West (cw), Central East (ce), North West (nw), North East (ne), South West (sw), South East (se), Kattegat (ka) and Channel (ch).

3. Averages of no-per-m² for subareas are multiplied by section-area factors defined by

if section = 'cw' then af = 28;

if section = 'ce' then af = 33;

if section = 'sw' then af = 12;

if section = 'se' then af = 30;

if section = 'nw' then af = 27;

if section = 'ne' then af = 11;

if section = 'ka' then af = 10;

if section = 'ch' then af = 10;

miksec = section average in no-per-m^2 *af * 3086913600;

4. The index is then the sum of all abundances in sections (which amount to an estimate of the total number of larvae);

IBTS0 = sum of miksec.

6 References

ICES 2014: Report of the Herring Assessment Working Group for the Area South of 62°N (HAWG). ICES CM 2014/ACOM:06. 1193 pp.

ICES 2015a: Manual for the International Bottom Trawl Surveys. Series of ICES Survey Protocols SISP 10 - IBTS IX. 86 pp.

ICES 2015b: Report of the Workshop on the ICES Egg and Larval Database (WKIELD). ICES CM 2015/SSGIEOM:33. 12 pp.

ICES 2015c: First Interim Report of the Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA). ICES CM 2015/SSGIEOM:28. 24 pp.

ICES 2016a: Interim Report of the Working Group on North Sea cod and plaice egg surveys in the North Sea 2 (WGEGGS2). ICES CM/2016:26. 11 pp.

ICES 2016b: Report of the Herring Assessment Working Group for the Area South of 62°N (HAWG). ICES CM 2016/ACOM:07. 854 pp.

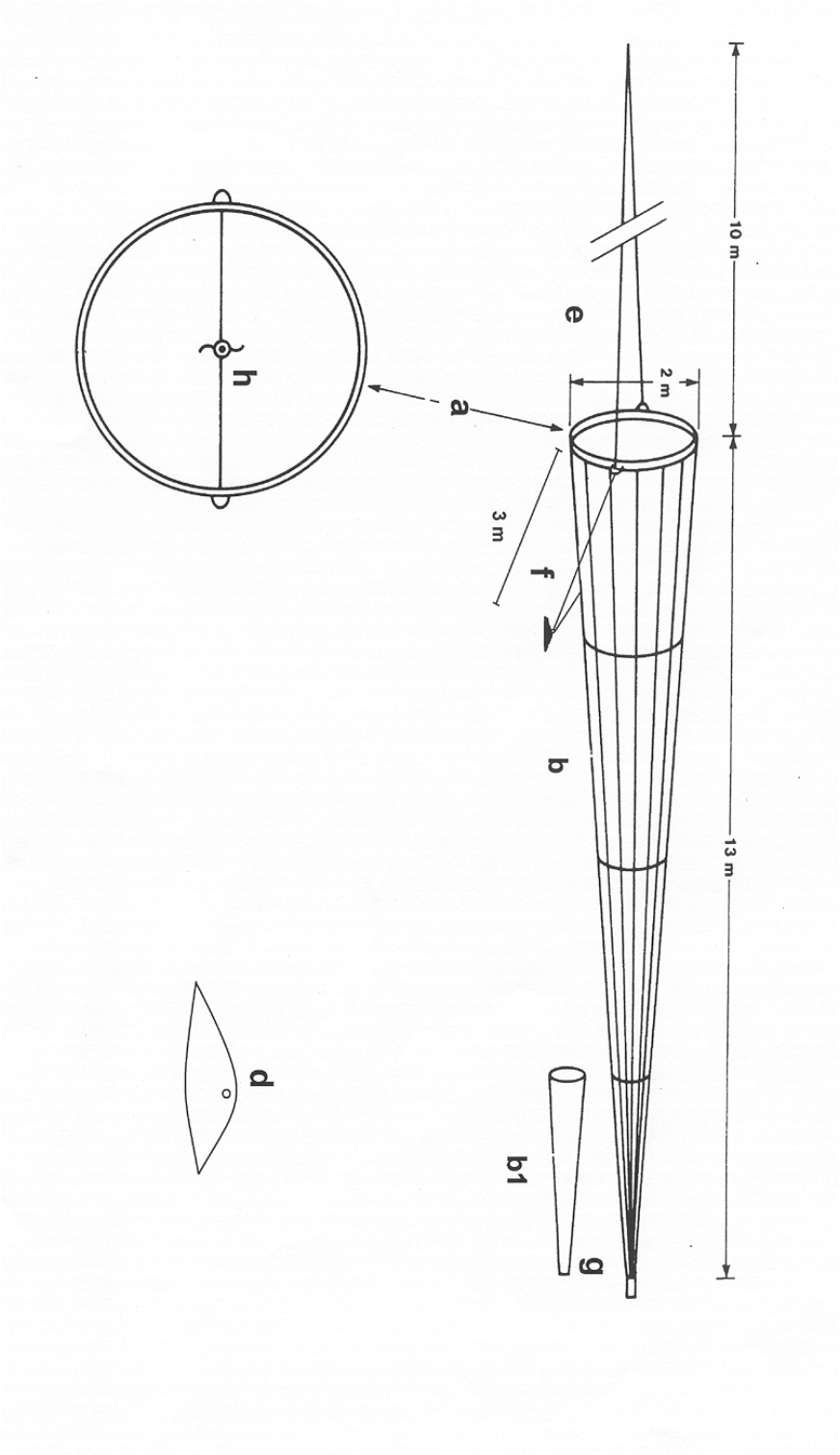
ICES 2016c: Interim Report of the Working Group on Improving use of Survey Data for Assessment and Advice (WGISDAA). ICES CM 2016/SSGIEOM:28

ICES 2016d: Report of the Workshop on North Sea herring larvae surveys, data needs and execution (WKHERLARS2). ICES CM 2016/SSGIEOM:33

ICES 2017: Herring Assessment Working Group for the Area South of 62 deg N (HAWG). ICES HAWG Report. ICES CM 2017/ACOM:07. 857 pp.

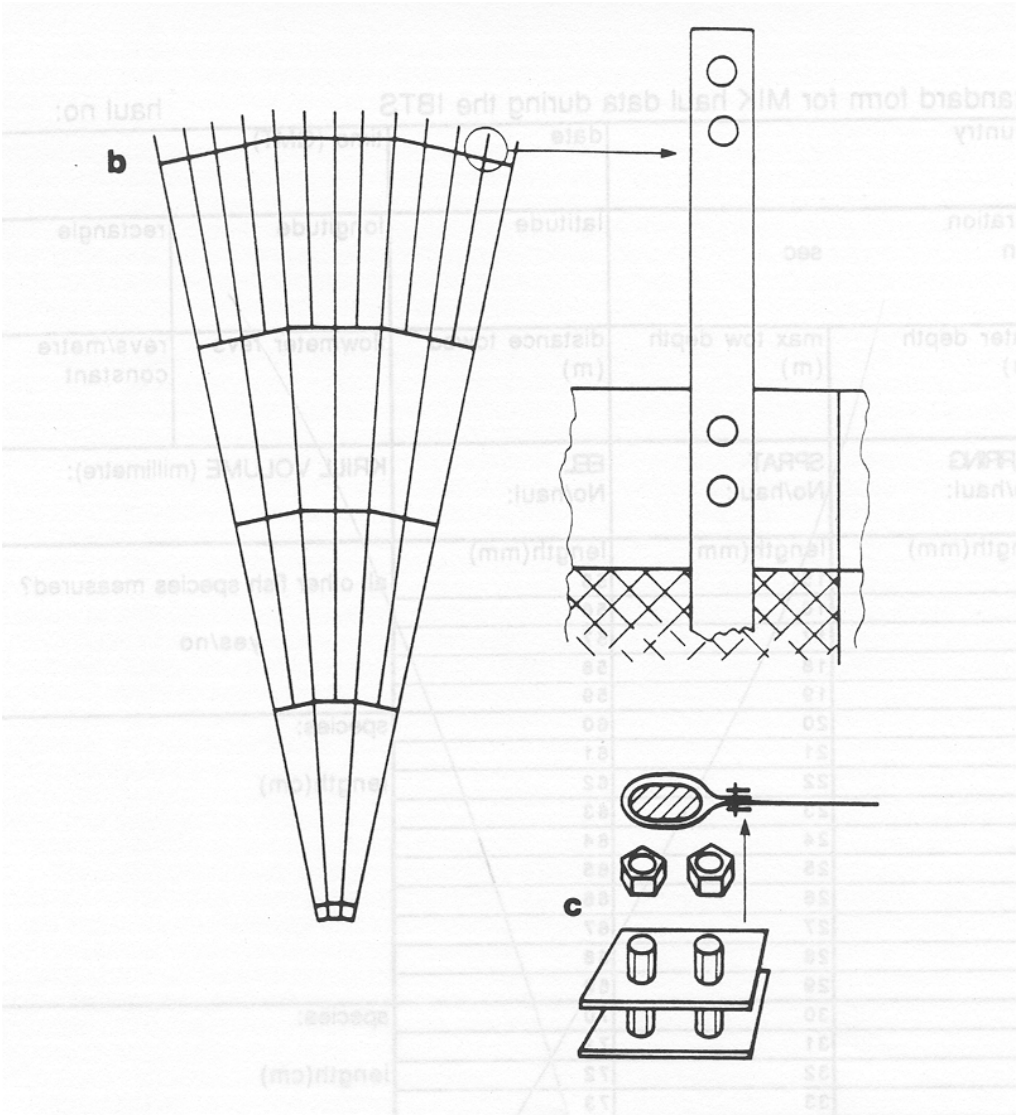
Annex 1: Rigging

Construction and rigging of the Midwater Ring Net. Letters refer to description in the text of section 2.1

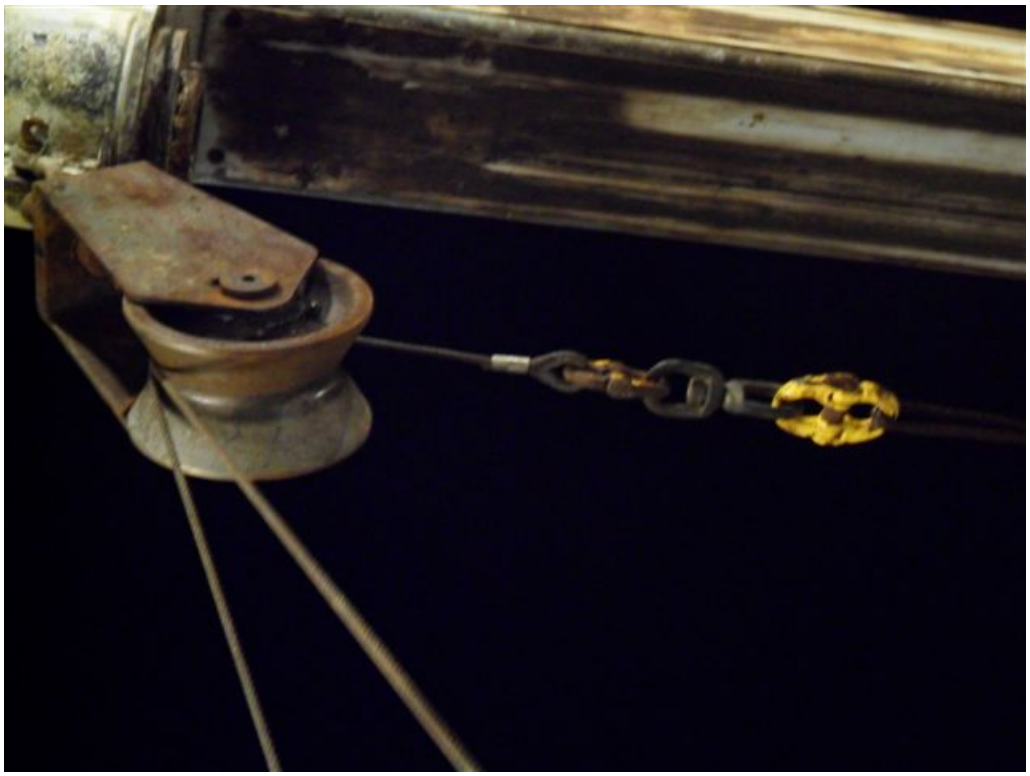


Annex 2: Net construction

Unfolded net of the MIK midwater trawl and illustration of possible net attachment.



Annex 3: Misc. pictures of rigging and net construction



Block and bridle attachment

Flowmeter and SCANMAR attachment

Examples of codend buckets

Annex 4: Misc. pictures of MIKeyM-net deployment

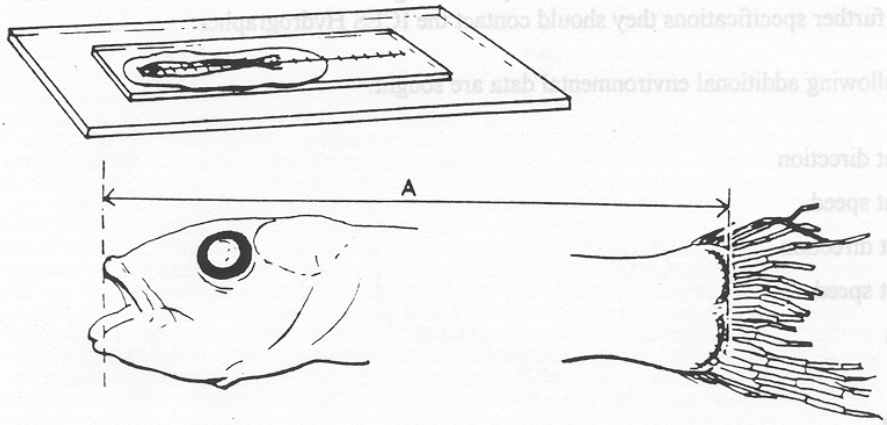
Example of MIKeyM-net deployment according to configuration 4

Flowmeter attachment inside MIKeyM ring

MIKeyM-net according to configuration 3

Example of MIKeyM-net attachment to MIK ring

Annex 5: Measuring standard length of herring larvae



Annex 6: Description of clupeoid and other larval fish species commonly found during the MIK survey

A compilation of the distinctive features of clupeoid larvae was done during the recent ICES workshop WKIDFL. The results are given in the following paragraphs and are copied from the respective workshop report (ICES 2011)

Clupeoids

General characteristics:

- Tubular, slender shape of body;
- Long gut with anus near the tail end;
- Number of myotomes in the trunk;
- The body proportion changes during development thus the anus moves forward and the myotome count decreases with age;
- The difference between clupeiods and sandeel is the position of the anus. In sandeel the anus is halfway the body, in clupeoids the guts is much longer and the anus is positioned close to the tail. Argentinids which also have a long gut tend to have a deeper body and different pigmentation than clupeids.

Primary characteristics of clupeoids (from Russell 1976)

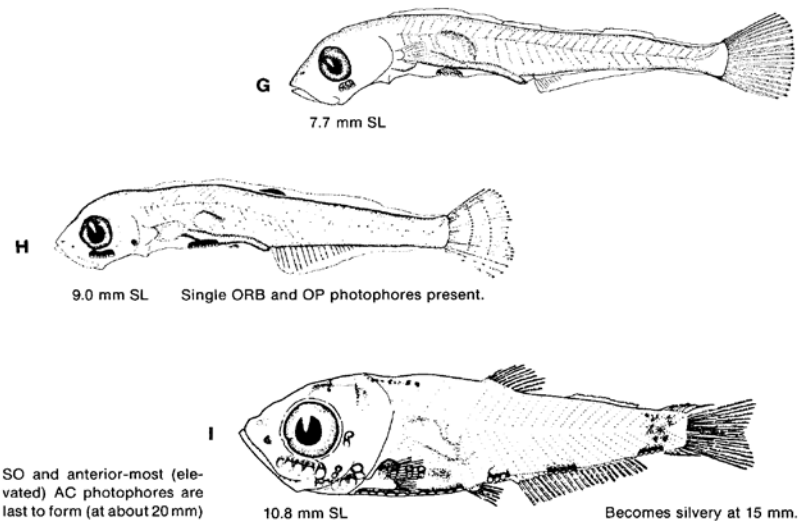
Developement stage	Herring	Sprat	Pilchard/Sardine	Anchovy
Yolk sac	Yolk not segmented	Yolk segmented	Yolk segmented	Yolk segmented, oblong shape
10 mm				
No. myotomes in trunk	47	37	41–42	
10–20 mm				
No. myotomes in trunk	46–47	35–37	41–42	
Position pelvic fin	Not appeared yet	Appears at 17.5–20 mm, 4–5 myotomes behind the pylorus	Appear at 18–20 mm, level with the pylorus	
Dorsal fin				Rear edge of dorsal fin overlaps with the anal fin
20-40 mm				
No. myotomes in trunk	41–46	31–35	36–41	
Position pelvic fin	7–8 myotomes behind the pylorus	4–5 myotomes behind the pylorus	Level with the pylorus	
Length of tail from anus to base of caudal fin	Greater than 6 times in total length	Less than 6 times in total length		

Secondary characteristics:

Herring is always bigger at any developmental stage compared to the other species. Herring have pigmented eyes at hatching while other species do not gain pigment until later (5 mm). Herring attain flexion stage later (17 mm) than other species so a larvae at 11–13 mm with flexion will not be herring (Munk and Nielsen, 2005). The head of anchovy is bigger compared to the other species (not very useful).

Maurolicus muelleri

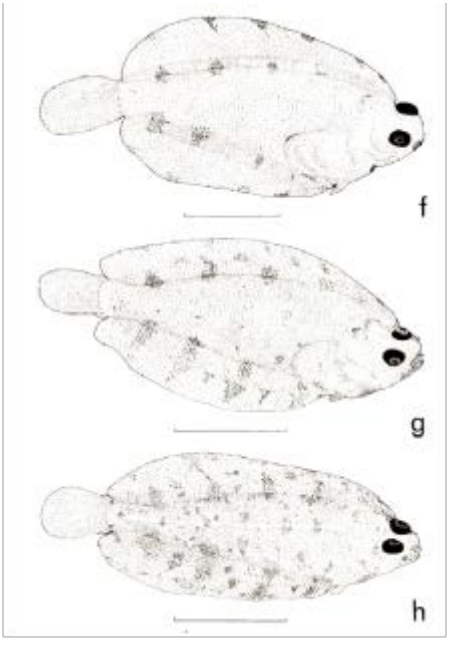
Larvae and juveniles of pearlside (*M. muelleri*) that typically occur in MIK samples from the northern part of the North Sea during the 1Q IBTS are characterized by the presence of photophores below the eyes and on the belly. The gut stretches to about half the body length. Typical sizes of pearlside larvae and juveniles are between 15 and >25 mm SL.



Figures copied from Fahay, 1983

Microstomus kitt

Larvae of the lemon sole (*M. kitt*) that occur in MIK samples from the 1Q IBTS typically have reached a developmental stage where the left eye has at least started to migrate to the right body side. The larvae are deep bodied. The pigmentation shows a characteristic regular banded pattern along the dorsal and ventral margins of the body. Typical sizes of lemon sole larvae and juveniles are between 10 and >30 mm TL.



Figures copied from Nichols, 1971

Aphia minuta and *Crystallogobius linearis*

Both, transparent (*A. minuta*) and crystal (*C. linearis*) goby, are translucent when alive or freshly dead. When preserved in formalin the appear all white. Both are characterized by a prominent swimbladder. While transparent goby has scales, crystal goby has none. The first dorsal fin of transparent goby has 5 rays while in crystal goby there are 2 rays only in male while in female specimens there are no rays in the first dorsal.

Pomatoschistus minutus and *P. norvegicus*

Sand (*P. minutus*) and Norwegian (*P. norvegicus*) gobies are probably the most abundant goby species in the North Sea. Both are characterized by a distinctive black spot on the hind margin of the first dorsal. The species can only be separated by counts of the pectoral fin rays. While the Norwegian goby has 16–18 pectoral rays, sand goby has 18–20 rays in its pectoral fin.

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Russell FS (1976) The eggs and planktonic stages of British marine fishes, Vol. Academic Press, London

Annex 7: Example of a Sampling form

Standard form for MIK haul data during the IBTS

country		date	time (GMT)	
duration min sec		latitude	longitude	rectangle
water depth (m)	max tow depth (m)	distance towed (m)	flowmeter revs	revs/metre constant
HERRING No/haul:	SPRAT No/haul:	EEL No/haul:	**Larval length measured from** Fresh material □ Formaldehyde preserved □ Ethanol preserved □	
length (mm)	length (mm)	length (mm)		
15	25	55		
16	26	56		
17	27	57		
18	28	58		
19	29	59		
20	30	60	species:	
21	31	61		
22	32	62	length (cm)	
23	33	63		
24	34	64		
25	35	65		
26	36	66		
27	37	67		
28	38	68		
29	39	69		
30	40	70	species:	
31	41	71		
32	42	72	length (cm)	
33	43	73		
34	44	74		
35	45	75		
36	46	76		
37	47	77		
38	48	78		
39	49	79		
40	50	80	species:	
41	51	81		
42	52	82	length (cm)	
43	53	83		
44	54	84		
45	55	85		
46	56	86		
47	57	87		
48	58	88		
49	59	89		
50	60	90	species:	
51	61	91		
52	62	92	length (cm)	
53	63	93		
54	64	94		
55	65	95		
56	66	96		
57	67	97		
58	68	98		
59	69	99		
60	70	100		

all measurements to the mm or cm below
see IBTS Manual for guidelines

sample analysed by:

Annex 8: Distribution of MIK hauls

Chart showing usual number of MIK hauls in each statistical rectangle (illustrated by maximal number of hauls in rectangles during 2009 and 2010). The areas used for calculation of the herring larvae abundance indices are indicated.