Fisheries Technology Committee **ICES CM 2000/B:02**

REPORT OF THE

STUDY GROUP ON MESH MEASUREMENT METHODOLOGY

IJmuiden, The Netherlands
8–9 April 2000

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

Palægade 2–4 DK–1261 Copenhagen K Denmark

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1 TERMS OF REFERENCE

In accordance with ICES C.Res.1999/2B02 adopted at the 1999Annual Science Conference (87th Statutory Meeting) a Study Group on Mesh Measurements Methodology [SGMESH] (Chair: R. Fonteyne, Belgium) was established and met in IJmuiden (Netherlands) from 8–9 April 2000 to:

a) advise on improvements and further standardisation of current mesh measurement practices in view of the netting types now in use in ICES Member Countries;
b) consider whether the current definition of mesh size is still appropriate for scientific and industrial purposes;
c) compile an inventory of commercially available netting associated with the selectivity process, identifying the fisheries in which they are used;
d) consider the need to define groups of netting types for which the same measurement conditions (e.g., tension) can be applied;
e) propose the specification of a suitable mesh measurement methodology and the conditions under which mesh measurements for all fishing gears in ICES areas are made
f) SGMESH will report to the Fisheries Technology Committee at the 2000 Annual Science Conference.

2 PARTICIPANTS

See Annex I

3 AGENDA

See Annex II

4 REPORT

4.1 Opening

The Chairperson opened the meeting on 8 April 2000 at 09.00.

The agenda was presented and agreed by all participants.

4.2 Appointment of a rapporteur

Mr Derek Galbraith (UK) was appointed rapporteur.

4.3 Background of SGMESH – Terms of Reference

In 1998/1999 the Working Group on Fishing Technology and Fish Behaviour established the need to refine mesh measurement methodologies to take account of the wider range of twines and netting types used in the fishing industry since 1962 when the current ICES and wedge gauge methods were adopted. Modern twines vary significantly in e.g., thickness and stiffness and it is known that these characteristics affect both mesh size measurement and selectivity. At the same time two other international bodies (CEN and EU) and the fishing industry (both fishermen and netmakers) have agreed that there is a need to consider the adoption of a standard mesh measurement method for use by the fishing industry, enforcement agencies, and scientists.

The terms of references were presented. The SG will initially consider whether the current definition of mesh size is still appropriate for scientific and industrial purposes, taking account of the need in stock assessment for the selection factor (L50/MS) to have a consistent meaning. The SG will compile an inventory of commercially available netting associated with the selectivity process, identifying the fisheries in which they are used. The SG will then consider the need to define groups of netting types for which the same measurement conditions (e.g., tension) can be applied. Finally the SG will agree on the specification of a suitable mesh measurement methodology and the conditions under which mesh measurements for all fishing gears in ICES areas are made.

4.4 Is the current definition of mesh size still appropriate for scientific and industrial purposes?

Three definitions exist (Figure1; ISO 1107):

- - length of mesh side
- - length of mesh
- - opening of mesh.

Since these definitions were devised, the fishing industry has adopted much heavier twine for cod-end netting. The material is much stiffer, the knots larger, and multiple twines are used to a much greater extend. This presents difficulties to netmakers, fisheries inspectors and scientists using the present gauges to measure the opening of mesh. Netmakers would prefer to use length of mesh to describe netting as this is a basic parameter of sheet netting which can be easily measured e.g., with a measuring tape. Scientists would prefer a parameter that is more closely related to fish escape such as mesh lumen (opening area).

New definitions for mesh size are being suggested to address these problems, such as the LONGEST inside opening of mesh to cope with the ambiguity caused by large knots (Comité Européen de Normalisation – CEN, 1999). Mesh size is measured either with a flat wedge gauge (inspection and manufacture) or with the ICES gauge (science), both instruments are subject to alignment problems when inserted in a mesh.

The group discussed the underlying objective of mesh size measurements, namely to control fishing mortality through specifying the selectivity characteristics of fishing gears and as such contribute to creating sustainable fisheries. It was acknowledged that the key factor affecting gear selectivity is mesh lumen, which is also influenced by twine characteristics (stiffness, thickness, elasticity) other than opening of mesh. Other design parameters of cod-ends such as cod-end circumference and number of meshes round also affect selectivity. There seems to be no benefit for scientists to use length of mesh instead of opening of mesh in selectivity work, as opening of mesh allows for twine thickness. There is already a large body of data linking selectivity parameters with opening of mesh.

The suggestion was raised to investigate gauge shapes other than the flat wedge. A conical shape may better represent the girth of a fish and assess its possibilities to escape, which is the actual requirement for improved selectivity. Some initial trials have been carried out in Norway (Isaksen *et al.*, 1989) and elsewhere with a conical shape, but no further work has been undertaken since. A disadvantage of this approach is that the girth shapes of target fish differ between species (e.g., flatfish vs. roundfish).

Another approach might be to develop an optical system using image processing techniques, which may be preferred by the net making industry. This could circumvent many problems concerning definitions, but has at present the disadvantage of impracticality for onboard measurement.

It was decided:

a) to continue using the existing ISO-definitions,
b) that opening of mesh was still the most useful parameter relating to selectivity which could be measured with the existing gauges,
c) to recommend investigation of the use of wedge gauge shapes other than the flat gauge and of optical methods. If found reliable these alternative methods would enable other definitions of mesh size to be used, e.g., the mesh lumen.

4.5 Inventory of commercially available netting associated with the selectivity process, identifying the fisheries in which they are used

It was agreed that most problems in measuring the opening of mesh are at present related to cod-end meshes of towed gears. Static gears are generally made of finer twines and require a modified measuring technique. Mesh selection in purse seines is of minor importance and hence mesh measurement is seldom carried out. As a consequence the Group decided to concentrate on the cod-end of towed gears. Attention was drawn to the existence of specific netting materials for which the current mesh measurement techniques may not be appropriate. Examples of such materials include:

- stiff netting used in the Baltic cod trawl exit windows
- some knotless netting constructions

- netting constructions to reduce the effective mesh opening such as K-meshes (meshes with unequal bar lengths), netting with twisted knots and hexagonal meshes. These netting constructions, however, are not thought to be widely used.

A cod-end material inventory format with the following parameters was discussed and agreed:

- country
- gear type
- netting material
- netting construction
- number of twines (single/double/triple)
- length of mesh
- opening of mesh
- yarn type (e.g., monofilament, multifilament; the diameter of monofilament yarns is between 0.1 mm and 1.0 mm, the diameter of multifilament yarns is < 0.05 mm (Klust, 1982))
- twine construction (twisted/braided)
- runnage (m/kg)/R…tex (g/1000 m)
- twine diameter (mm)
- frequency of use.

An overview of typical cod-end materials used in the following countries was presented: Belgium, Canada, Germany, the Netherlands, Norway and the UK (Table 1). Sweden will supply further data on cod-end materials and escape panels, e.g., Baltic cod trawl exit windows. A preliminary inventory of cod-end netting materials is given in Table 1. ICES member countries not represented in the SGMESH are requested to submit similar data for the cod-end materials used in their fisheries. The European Association of Netting Manufacturers will be invited to supply the above information on the netting materials manufactured for cod-end construction.

4.6 Is there a need to define groups of netting types for which the same measurement conditions (e.g., tension) can be applied?

The ICES gauge is calibrated to deliver a constant measuring force of 4 kg. This means a varying stress (force per unit area) on the twine for different diameters. For example: polyethylene, braided, single twine, 4mm diameter and R5504tex compared to the same material with 6mm diameter, double twine and R11627tex for single twine, R23254tex for the mesh bar. Thus the ratio of stress for single 4mm twine to double 6 mm twine is >4. On the other hand thinner twines are measured with a force higher than necessary, overestimating the “real” opening of mesh. This principle was confirmed by an exercise with a limited amount of available data (from Ferro & Xu, 1996).

There is a management implication in changing the measuring principle. An increase in measuring force on heavy twine netting will produce larger values of opening of mesh. To maintain comparable selectivity for such cod-end materials the minimum opening of mesh should be increased.

The Study Group agreed that it would be desirable to investigate the difference between measurements with constant force and with constant stress, corresponding to textile standard force (25 % of the R…tex value; e.g., ISO 2307, ISO 3090). It was recommended to perform opening of mesh measurements on representative cod-end netting materials used today in ICES countries. The opening of mesh should be measured with a constant force of 4 kg, as recommended by ICES, and a stretching force corresponding to the textile standard force. In addition the same netting samples will be measured with a wedge gauge as used by fisheries inspectors with hand force and also with a 5 kg weight to obtain comparative data.

To start this investigation four institutes (Marine Laboratory, Aberdeen; DZ-CLO, Oostende; IMR, Bergen and BFAFi, Hamburg) will perform preliminary tests to establish standard procedures for these measurements.

The results of the preliminary tests must be available by October 2000. From the inventory of netting materials a range of samples will be selected for investigation by Study Group members. The results should be reported for further analysis before the end of February 2001. It is anticipated that groups of netting twines for which the same measurement conditions can be applied will be identified.

4.7 Specification of a suitable mesh measurement methodology and the conditions under which mesh measurements for all fishing gears in ICES areas should be made

The SG discussed this topic in anticipation of the proposed mesh measurement exercise. With modern manufacturing techniques there is less variability in mesh size than was the case in the past. Thus it may be possible to achieve a required precision with fewer measurements. An inquiry amongst ICES fisheries institutes showed that at present between 40 and 60 meshes are measured during selectivity experiments (Fonteyne *et al.*, 1998). The number of meshes to be measured will be determined by the SG, based on the results of the preliminary exercise.

The requirements for objective measurements of meshes for both flat wedge and ICES gauges were discussed (Table 2). It was agreed that neither fulfilled all requirements. A suitable instrument should be capable of calibration with respect to force and distance measurement. A direct readout is preferable to estimation, as is the case with the wedge gauge. The method of measuring should have a minimum of human influence, with no bias from material characteristics, neither from gauge or netting. Depending on the results of the afore-mentioned study it is anticipated that the required measuring force will be variable, based on the textile standard force.

The Group advised that diamond meshes should continue to be measured in the N-direction but square meshes should be measured along both diagonals and the mean value calculated. The latter is required because of the tendency of some square mesh netting to change shape with increased use.

It is not envisaged that the proposed developments will yield methods appropriate to measurement of devices such as Baltic escape panels made of coated twines, loosely knotted netting, twisted knotless as used in Norwegian seine net fishing and other netting which experiences knot slippage.

4.8 Advise on improvements and further standardisation of current mesh measurement practices in view of the netting types now in use in ICES Member Countries

If the proposed laboratory tests result in a recommendation for various groups of netting to be measured at different tensions, then such groups will be specified. The test should also determine the minimum number of meshes to be measured.

4.9 Recommendations for future activities

The SG will work by correspondence in 2000–2001. The inventory will be completed. The proposed study will be carried out. The SGMESH should reconvene in 2001 to finish its task.

4.10 Discussion of draft report

The Group members discussed the draft SG report and agreed on the final version.

The meeting was closed on 9 April 2000 at 19.00.

5 REFERENCES

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Klust, G., 1982. Netting materials for Fishing Gears (2nd edition). Fishing News (Books) Ltd. Farnham, U.K. ISBN 0 85238 118 2.

Table 1 - Preliminary inventory of cod-end netting materials used in the ICES area.

Country	Gear	Netting					Yarn				Origin/ Application
		Material	Construction	No of Yarns	Length of mesh	Opening of mesh	Twine type	Construction	Runnage	Diameter	
B	TBB-*Crangon*	PA	knotted	single	22		multifil	twisted			100%
B	TBB-flatfish	PE	knotted	double		80	monofil	braided		4	Van Belen
B	TBB-flatfish	PE	knotted	double		80	monofil	braided		4	Senaflex
B	TBB-flatfish	PES	knotted	double		80	multifil	braided		3	Bay of Biscay only
B	TBB-flatfish	PES	knotted	double		80	multifil	braided		4	Bay of Biscay only
B	TBB-flatfish	PE	knotted	double		80	monofil	braided		4	EUROLINE 5–10%
B	TBB-flatfish	PES	knotted	single		82	multifil	braided		4.5	5–10%
B	TBB-flatfish	PE	knotted	double		82	monofil	braided		3.5	EUROLINE
B	TBB-flatfish	PE	knotted	double		82	monofil	braided		3.5	PREMIUM
B	TBB-flatfish	PE	knotted	single		82	monofil	braided		6	Type 2001
B	TBB-flatfish	PE	knotted	double		82	monofil	braided		4	Type 2002
B	TBB-flatfish	PE	knotted	double		82	monofil	braided		4	BREZLINE
B	TBB-flatfish	PE	knotted	double		84	monofil	braided		4	BREZLINE 90%
B	OTB-NEP	PE	knotted	double		82	monofil	braided		4	BREZLINE 90%
B	OTB	PE	knotted	single		105	monofil	braided		4	
B	OTB	PE	knotted	double		110	monofil	braided		5	BREZLINE 90%
CA	OTB-Cod	PE	knotted	double		155		braided		5.5	cod, haddock, saithe
CA	OTB-Cod	PE	knotted	double		155		braided		6	cod, haddock, saithe

Table 1 - Preliminary inventory of cod-end netting materials used in the ICES area.

Country	Gear	Netting					Yarn				Origin/ Application
		Material	Construction	No of Yarns	Length of mesh	Opening of mesh	Twine type	Construction	Runnage	Diameter	
CA	OTB-shrimp	PE	knotted	double	50	45		braided		1.8	shrimp
CA	OTB-shrimp	PE	knotted	double	50	43		twisted	210/72	2.5	shrimp
CA	OTB-redfish	PE	knotted	double		105		braided		4	redfish
CA	OTB-redfish	PE	knotted	double		105		braided		5.5	redfish
CA	OTB-redfish	PE	knotted	double		105		braided		6	redfish
CA	OTB-skate	PE	knotted	double		300		braided		6	skate
CA	OTB-Cod	PE	knotted	double	92	76		braided		5	cod, sole, rockfish
CA	TBB	PE	knotted	single	38	30		twisted	380/48	No. 30	
D	OTM	PE	knotted	double		100	monofil	braided	86	6	Reykjanes
D	OTB	PE	knotted	double		105	monofil	braided	185	4	Baltic Sea
D	OTB	PE	knotted	single		105	monofil	braided	185	4	Baltic Sea
D	OTB	PE	knotted	double		117	monofil	braided	86	6	NW Atlantic
D	OTB	PE	knotted	single		110	monofil	braided	36	8	N Pacific, EUROLINE Premium
D	OTB	PE	knotted	double		120		braided	60	6	EUROLINE, Baltic Sea
D	OTB	PE	knotted	double		142	splitfibre	braided	75	6	Cotesi
D	OTB	PE	knotted	single		35	splitfibre	braided		2	Cotesi
D	OTB	PE	knotted	double			monofil	braided	165	4	
NL	TBB	PE	knotted	double		82	monofil	braided		3	CIV Den Oever
NL	TBB	PE	knotted	double		82	monofil	braided		5	CIV Den Oever
NL	TBB	PE	knotted	double		82	monofil	braided		5	EUROLINE
NL	TBB	PE	knotted	double		82	monofil	braided		5	EUROLINE
NL	OTM	PA	knotted	double		40	monofil	braided			
NL	TBB-*Crangon*	PA	knotted	single	22–24		multifil	twisted			CIV Den Oever

Table 1 - Preliminary inventory of cod-end netting materials used in the ICES area.

Country	Gear	Netting					Yarn				Origin/ Application
		Material	Construction	No of Yarns	Length of mesh	Opening of mesh	Twine type	Construction	Runnage	Diameter	
NO	OTB	PE	knotted	double	155	138		braided		6	cod, haddock, saithe
NO	OTB	PA	knotted	double	150	138		braided		5	cod, haddock, saithe
NO	OTB	PA	knotted	double	155	138		braided		6	cod, haddock, saithe
NO	OTB	PE	knotless	single	143	138		braided		9.4	cod, haddock, saithe
NO	OTB	PA	knotted	single	45	38		twisted		No. 24	shrimp
NO	OTB	PA	knotted	double	49	38		twisted		No. 20	shrimp
NO	seine net	PE	knotted	triple	145	136		braided		3.2	cod, haddock, saithe
NO	seine net	PA	knotted	double	135	126		braided		3.5	cod, haddock, saithe
NO	seine net	PE	knotted	double	146	136		braided		6	cod, haddock, saithe
NO	seine net	PE	knotless	single	135	127		braided		7.5	cod, haddock, saithe
S	OTB	PE	knotted	double		120		braided		6	Baltic Sea
S	OTB	PE	knotted	single		105	mono	braided		4	Baltic Sea, Danish window
S	OTB	PE	knotted	single		106	mono	braided and latex coated		6	Baltic Sea, Swedish window
UK	OTB	PE	knotted	double	120	102		braided		5	
UK	OTB	PE	knotted	double	115	102		braided		4	
UK	OTB	PE	knotted	double	128	112		braided		4	
UK	PTB	PE	knotted	double	120	102		braided		5	
UK	MTB*	PE	knotted	double	120	103		braided		6	
UK	MTB*	PE	knotted	single	80	72		braided		4	*Nephrops*
UK	MTB*	PE	knotted	single	80	74		braided		3	*Nephrops*
UK	OTB	PE	knotted	single	80	72		braided		4	*Nephrops*
UK	STM*	PES	knotless	single	50	40		braided		3	
UK	OTB	PA	knotted	single	40	36		twisted	210/15		Shrimps
UK	OTB	PA	knotted	single	40	36		twisted	210/20		Shrimps
UK	OTB	PE	knotted	double	120	100		braided		6	
UK	OTB	PE	knotted	double	130	110		braided		6	
UK	OTB	PE	knotted	double	120	100		braided		5	
UK	SSC	PE	knotted	double	120	100		braided		5	
UK	SSC	PE	knotted	double	120	100		braided		4	
UK	Pair gears	PE	knotted	double	120	100		braided		6	
UK	Pair gears	PE	knotted	double	120	100		braided		5	
UK	MTB*	PE	knotted	double	120	100		braided		6	

Table 1 - Preliminary inventory of cod-end netting materials used in the ICES area.

Country	Gear	Netting					Yarn				Origin/ Application
		Material	Construction	No of Yarns	Length of mesh	Opening of mesh	Twine type	Construction	Runnage	Diameter	
UK	MTB*	PE	knotted	double	120	100		braided		5	
UK	MTB*	PE	knotted	double	120	100		braided		5	
UK	MTB*	PE	knotted	single		70		braided		6	*Nephrops*
UK	MTB*	PE	knotted	single		70		braided		5	*Nephrops*
UK	OTB/ twinOTB	PE	knotted	single		70		braided		5	*Nephrops*
UK	OTB/ twinOTB	PE	knotted	single		70		braided		4	*Nephrops*
UK	OTB/ twinOTB	PE	knotted	single	77	70		braided		3	*Nephrops*
UK	STM*/ PTM	PA	knotted	double	50	40		twisted	210/96		Mackerel, herring
UK	STM*/ PTM	PA	knotted	treble	40	30		twisted	210/72		blue whiting
UK	STM*/ PTM	PA	knotted	single	22	15		twisted	210/72		Sprat
UK	TBB	PE	knotted	double	130	115		braided		6	
UK	SSC	PE	knotted	double	125	100		braided		6	
UK	OTB	PE	knotted	double		105		braided	80.66	5	COMPACT twine
UK	OTB	PE	knotted	double		105		braided	54.49	6	COMPACT twine
UK	OTB	PE	knotted	double		105		braided	122	5	
UK	SSC	PE	knotted	double		105		braided	183.45	4	
UK	Pair gears	PE	knotted	double		105		braided	59.49	6	COMPACT twine
UK	twinOTB	PE	knotted	double		105		braided	80.66	5	COMPACT twine
UK	twinOTB	PE	knotted	single		73		braided	183.45	4	*Nephrops*
UK	twinOTB	PE	knotted	single		73		braided	132.55	4	COMPACT twine, *Nephrops*
UK	OTB	PE	knotted	single		73		braided	183.45	4	*Nephrops*

Table 2 – Requirements for objective mesh measurement (Fonteyne *et al.*, 1998).

Requirement	wedge gauge	ICES gauge
mesh opening	✔	✔
all types of netting	0	0
range 10–300 mm	✔	0
precision: 1 mm	✔	✔
calibration of measuring force and distance measured	(1)	✔
direct reading of measuring force applied	(2)	0
direct reading of mesh opening	0	✔

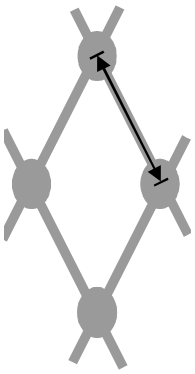
1) (1) If the wedge gauge is used with hand force calibration of the force is impossible. It is, however, possible to calibrate a dynamometer.
2) (2) When using a dynamometer the force perpendicular to the netting is measured, not the force in the plane of the netting.

Figure 1 – Definitions

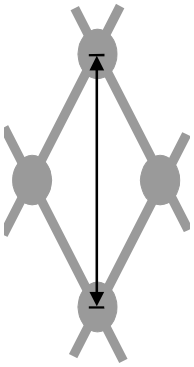
Three different measures are used to indicate the mesh size:

- length of mesh side (bar length)
- length of mesh
- opening of mesh.

The definitions of these sizes are given in the International Standard ISO 1107 (1974):



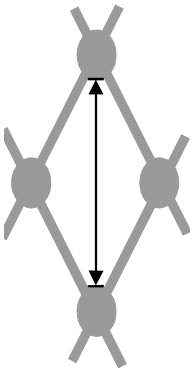
length of mesh side: the distance between two sequential knots or joints, measured from centre to centre when the yarn between those points is fully extended



length of mesh:

for knotted netting, the distance between the centres of two opposite knots in the same mesh when fully extended in the N-direction[1]

for knotless netting, the distance between the centres of two opposite joints in the same mesh when fully extended along its longest possible axis



opening of mesh:

for knotted netting, the inside distance between two opposite knots in the same mesh when fully extended in the N-direction[1]

for knotless netting, the inside distance between two opposite joints in the same mesh when fully extended along its longest possible axis

[1] **N-direction**: in knotted netting the direction at right angles (Normal) to the general course of the netting yarn; in knotless netting the direction of the longest possible mesh-axis (ISO 1107, 1974)

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ANNEX II – AGENDA

1) Opening.
2) Appointment of a rapporteur
3) Background of Study Group MESH – Terms of Reference
4) Discussion: Is the current definition of mesh size still appropriate for scientific and industrial purposes?
5) Inventory of commercially available netting associated with the selectivity process, identifying the fisheries in which they are used.
6) Discussion: Is there a need to define groups of netting types for which the same measurement conditions (e.g., tension) can be applied?
7) Specification of a suitable mesh measurement methodology and the conditions under which mesh measurements for all fishing gears in ICES areas should be made.
8) Advise on improvements and further standardisation of current mesh measurement practices in view of the netting types now in use in ICES Member Countries.
9) Recommendations for future activities.

Discussion of draft report.