Fisheries Technology Committee **ICES CM 2001/B:01**

REPORT OF THE

STUDY GROUP ON MESH MEASUREMENTS METHODOLOGY

Seattle, USA
21–22 April 2001

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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1 TERMS OF REFERENCE

In accordance with ICES C.Res.2000/2BME adopted at the 2000 Annual Science Conference (88th Statutory Meeting) the Study Group on Mesh Measurements Methodology [SGMESH] (Chair: R. Fonteyne, Belgium) met in Seattle (USA) from 21–22 April 2001 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.

SGMESH will report by 21 May 2001 for the attention of the Fisheries Technology Committee.

2 PARTICIPANTS

See Annex 1.

3 AGENDA

See Annex 2.

4 REPORT

4.1 Opening

The Chair opened the meeting on 21 April 2001 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 Terms of Reference

The terms of references were presented. The Study Group will initially reconsider 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 Study Group will complete an inventory of commercially available netting associated with the selectivity process, identifying the fisheries in which they are used. The Study Group will then investigate the need to define groups of netting types for which the same measurement conditions (e.g. tension) can be applied, based on the results of the inter-laboratory mesh measurement exercises. Finally the Study Group will consider 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 Report of Study Group and Related Activities in the Past Year

During the past year the Study Group worked by correspondence to complete the tasks agreed at the 2000 meeting.

The Study Group agreed on a methodology to measure the mesh opening using a variable measuring force. The average mesh opening of a representative range of cod-end netting materials was measured using four different methodologies viz. the ICES 4 kg mesh gauge, the Textile Standard Force (TSF), the hand operated flat wedge gauge and the same wedge gauge with a 5 kg weight or 5 kg dynamometer. An analysis of the results was undertaken.

The inventory of netting materials was augmented.

The chair informed the group on related activities:

- the European Standardisation Committee has drafted a standard (CEN, 1999) for the determination of mesh opening. The standard is based on the use of the flat wedge gauge which is the current methodology required by the European Commission (EU, 1984).
- the EU sponsored Accompanying Measure "Preparing the conditions for the development of an objective mesh gauge" (PREMEGADEV, Contract No. Q5AM-2000–00005). The objectives of the project are to seek instrument makers for the development, construction and commercialisation of a new mesh gauge, to discuss with them possible solutions for exerting a stable measuring force with the new gauge, to investigate the legal aspects of mesh size measurements for inspection purposes and to prepare and write a proposal for a Combined R&D and Demonstration Project for the development proper of a new mesh gauge.

4.5 Definition of Mesh Size

The Study Group confirmed last year's agreement on the definition of mesh opening:

It was decided:

a) to continue using the existing ISO-definition:

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

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

For practical reasons the inside opening should be considered as the longest inside opening of mesh to cope with the ambiguity caused by large knots. This approach has been taken into account by the definition of mesh opening given in the draft European Standard "Fishing Nets - Basic Terms and Definitions"(CEN, 1999).

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 the development of optical methods. If found reliable these alternative methods would enable other definitions of mesh size to be used, e.g., the mesh lumen.

4.6 Completion of the Inventory of Commercially Available Netting

At the request of the Study Group the European Association of Netting Manufacturers (EUROCORD) supplied additional information on cod-end netting commonly used within the ICES area.

The representatives of the USA, as a new member of the Study Group, provided information on materials used by US vessels. The information, however, is not yet complete and further details will be supplied. Denmark also participated for the first time and will also contribute to the inventory. The augmented inventory is given in Annex 3.

The group again 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 again 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 such as plastic coated exit windows
- some knotless netting constructions
- netting turned 90° to the direction of tow
- 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.

4.7 Results of Mesh Measurements on Selected Netting Materials

The purpose of the inter-laboratory mesh measurements proposed at the previous meeting was to investigate the relationship between the mesh opening with the ICES gauge with a preset measuring force of 4 kg, the wedge gauge using hand force or the prescribed 5 kg weight, and the Textile Standard Force (TSF). The underlying idea was to investigate whether groups of netting could be identified for which the same conditions of measurement (e.g., force) apply.

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. At the 2000 meeting 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 Rtex value; e.g. ISO 2307, ISO 3090). The TSF based measuring force is equal to the 4 kg force used with the ICES gauge for single twine meshes of R8000tex. For meshes with twines of around R8000tex the ratio between the mesh opening measured with a 4 kg measuring force and a force based on the TSF will be around 1. This ratio is further abbreviated “ICES/TSF”. For lower Rtex values the ICES gauge overestimates the mesh size while underestimation occurs for Rtex values over 8000. This is graphically represented in Figure 1.

4.7.1 Mesh measurement methodologies used

A method for measuring mesh openings with a wide range of measuring forces was proposed by the Sea Fisheries Department in Oostende and is presented in Annex 4. Most participants used this method. An alternative method, used by the Institute of Fishing Technology and Fish Quality in Hamburg is described in Annex 5.

4.7.2 Selected netting materials

The mesh opening measurements were performed on representative cod-end netting materials selected from the inventory. Samples of netting were measured by scientists from Belgium, Canada, Germany, Norway, The Netherlands, Sweden and the United Kingdom (Scotland). A total of twenty samples were measured (See Table 1). The netting material was polyamide (PA) or polyethylene (PE) and of braided single, double or triple twines or knotless twines. The linear density ranged from R4060tex to 53500, the twine thickness from 3.2 to 10.8 mm and the mesh size from 70 mm to 145 mm.

The value Rtex and the twine thickness were either measured or taken from data supplied by the manufacturer.

4.7.3 Results

Figure 2 depicts the relationship between the ratio ICES/TSF and the twine diameter. As expected, there is a tendency of increasing underestimation of the mesh opening measured with the ICES 4 kg gauge with increasing twine diameter. In many cases the 4 kg force applied by the ICES-gauge does not fully stretch the meshes of modern netting (as compared to the TSF). Due to the scatter it is difficult to define clear sub-groups. The situation is clearer if only the single twine nettings are considered (Figure 3). The mesh openings are slightly overestimated for the 3 and 4 mm twines and more significantly underestimated for the diameters larger than 5 mm. The results for the double twine nettings remain, however, scattered (Figure 4).

A comparison of existing methodologies is given in Figure 5. The following general conclusions can be drawn:

- mesh opening obtained with the ICES 4 kg gauge is lower than wedge gauge (both hand force and 5 kg weight) measurements
- mesh opening obtained with the wedge gauge with a 5 kg weight is lower than hand force measurements
- all differences were statistically significant at the 90 % level, all but two were statistically significant at the 95 % level.

These conclusions confirm the results from other comparative studies (e.g., Ferro and Xu, 1996; Fonteyne *et al.,* 1998).

4.7.4 Problems encountered

The large scatter of the ratio ICES/TSF versus the yarn diameter finds its origin in the variable Rtex values with relation to the twine diameter (Figure 6). Most values used were nominal, as given by the netting manufacturers. Since the TSF is based on the Rtex, the variability of the latter is also reflected in the ICES/TSF versus twine diameter graph.

Relations between Rtex-value and other dimensions as e.g., diameter have been described occasionally for a few chosen netting yarn constructions (Klust, 1982). It is doubtful however whether these can be transferred to other yarn constructions and whether the strict relations detected apply also for these other constructions, particularly if braided twines with/without a core, high tenacity or compacted twines are considered.

The Rtex can be measured by weighing a known length of the netting twine and then calculating the weight of 1000 m of twine. There is however no standard method for this measurement. Lengths of netting should be measured under a tension equal to the TSF±10% (see e.g., ISO 3090, 1974).

An additional problem lies in determinating twine diameter with sufficient accuracy. The operation of hand held callipers developed at FRS Marine Laboratory, Aberdeen for fisheries inspection purposes was demonstrated by D Galbraith. These callipers do not measure twine diameter but ascertain whether twine thickness exceeds a specified limit. An optical method for the measurement of the twine diameter under laboratory conditions was described by Ferro (1989) and adopted by the ICES Study Group on Twine Thickness Measurement. Recently the Marine Laboratory has developed an updated optical machine manufactured by the US company "Lawson-Hemphill" (http://www.lawsonhemphill.com) and the accuracy and measuring capabilities of this device were discussed.

4.7.5 Need for further measurements

In view of the inaccuracies in the nominal thickness and Rtex values used, it was decided to measure these characteristics and to repeat the TSF mesh measurements and data analysis. Samples of twine of about 2 m lengths are to be sent to the Marine Laboratory, where optical twine diameter measurements will be carried out.

It was noted that the current study included only demersal trawl cod-ends, for which problems of mesh measurement are well known. Smaller mesh sizes as used in pelagic trawling, industrial fishing and shrimp fishing were not investigated. Samples of pelagic trawl cod-ends and shrimp trawl cod-ends are to be included to ensure that the new method is also applicable to these materials. A list is given in Table 2.

Additional measurements are to be carried out before 1 September 2001. Mr Gramaxo kindly offered to supply netting samples through EUROCORD for selected nettings that cannot be obtained by any institute participating in these tests.

4.8 Discussion: Need to Define Groups of Netting Types for Which the Same Measurement Conditions (e.g., tension) Applies

In regard to the question whether specific ICES gauge measuring forces for groups of netting types can be specified based on results from our experiment, the consensus of the group was that no changes in the ICES gauge tension can be recommended at this time. This judgement is based on the lack of consistency among the results from testing the various netting materials and sizes measured by the six countries that participated in the study.

The consensus of the group is that changes in measuring force need to be determined. However, the current data are inadequate to determine specific tensions for groups of netting types. Hopefully, additional data, to be provided by September 2001, will be sufficient to draw clearer conclusions.

4.9 Specification of a Suitable Mesh Measurement Methodology – Conditions Under Which Mesh Measurements for all Fishing Gears in ICES Areas Should be Made

A detailed description of mesh measurement procedures for selectivity experiments is already available in the ICES trawl selectivity manual (Wileman *et al.*, 1996). With regard to the number of meshes to be measured the report states: "The number of measurements to be measured in order to give a sufficiently accurate estimate of the average will depend on the variance of the measurements. For any given cod-end this can be determined only by measurement, although experience may enable the minimum number of meshes to be stated in advance. In Europe the legal requirement is for 60 meshes to be measured by enforcement officers. Over a whole cod-end, it is recommended that a minimum of 100 meshes is measured."

For inter-laboratory mesh measurements described in Section 4.7, 60 meshes were measured. This number is based on a series of preliminary measurements and was found to be sufficient to yield a mean mesh size with a precision at the 95% level for the selected samples.

Based on these results and on the fact that modern netting sheets have more uniform meshes it was agreed that 60 meshes should be sufficient to obtain an accuracy of +/-1 mm. The meshes should be measured in the N-direction at the longest position. This procedure also applies to knotless netting where the N-direction corresponds to the longest axis.

Square meshes should be measured along both diagonals and the mean value calculated. The study group discussed the problems with distortion and the use of multiple twines in these meshes but it was concluded that these problems were outside the TORs. However these problems are increasingly important as the use of square mesh windows and cod-ends becomes more widespread and the group recommended this be studied further.

The group recommends continuing the use of the ICES mesh gauge for scientific experiments. It depends, however, on the final advice on the measuring force whether it will be possible to cope with the proposed measuring forces with the ICES gauge in its present form.

With the wedge gauge used for inspection purposes the measuring force is applied perpendicular to the plane of the netting. The force on the mesh twines is much larger and varies according to the force exerted by the inspector, the friction between the gauge and the netting, the finishing of the gauge, the angle of insertion and even the movement of the vessel. However, in order to compare with mesh opening values required for legislative purposes it is recommended that measurements with the wedge gauge in selectivity experiments are still necessary.

Further specifications can only be given when the final results of the Study Group work are available.

4.10 Advice on Improvements and Further Standardisation of Current Mesh Measurement Practices in View of the Netting Types Now in Use in ICES Member Countries

Advice on improvements and further standardisation of mesh measurement practices can only be given after finalising the Study Group’s work with relation to the measuring force.

The chairman presented an ongoing EU-project aiming at producing an improved instrument for mesh measurement, to be approved for use by fisheries inspectors, scientists and industry.

4.11 Recommendations for Future Activities

It was recommended:

- to extend the activities of the Study Group by one year
- to work by correspondence in 2001–2002
- to perform further inter-laboratory tests
- to perform a more detailed analysis of the results of these tests, taking into account parameters such as netting material and netting construction
- to continue to communicate with other relevant groups (CEN, development of a new mesh gauge project)
- to have a three day Study Group meeting prior to the 2002 WGFTFB meeting to make final recommendations.

4.12 Discussion of the Draft Report

The Study Group discussed the contents of the draft report compiled from contributions on specific agenda items by Study Group members.

4.13 Any Other Business

No other items were presented for discussion.

4.14 Closing of the Meeting

The meeting was closed on 21 April 2001 at 18.30.

5 REFERENCES

CEN, 1999. Draft European Standard pr EN 248298–1. Fishing nets – Method of test for the determination of mesh size. Part 1 – Mesh size opening. European Committee for Standardization, Brussels.

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Ferro, R. S. T., 1989. Objective measurement of the thickness of netting twine used in the fishing industry. Fisheries Research, 8: 103–112.

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ISO 1107, 1974. International Standard ISO 1107. Fishing nets - Netting - Basic terms and definitions. International Organisation for Standardisation, Ref. No. ISO 1107–1974 (E).

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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.

Wileman, D, Ferro, R. S. T., Fonteyne, R., and Millar, R. B., 1996. Manual of methods of measuring the selectivity of towed fishing gears. ICES Cooperative Research Reports No. 215.

Table 1. Selected nettings for the inter-laboratory tests.

Institute/ Country	Material	Twine diameter(mm)	Braided/ Twisted/UC	SIN/DBL/ TRI	R.tex
BFAFi-D	PA 6.6	4	BR	DBL	23000
BFAFi-D	PA 6.6	6	BR	DBL	14000
BFAFi-D	PA 6.6	8	BR	SIN	23000
DFO-CA	PE	4	BR	DBL	5850
DFO-CA	PE	5	BR	DBL	8740
DFO-CA	PE	5,5	BR	DBL	11650
DFO-CA	PE	6	BR	DBL	10460
DVZ-BE	PE	4	BR	DBL	6250
DVZ-BE	PE	5	BR	SIN	8000
IMR-N	PE	5	BR	DBL	13900
IMR-N	PA	8	BR	DBL	15400
IMR-N	PE	7,1	KNLS	SIN	21200
IMR-N	PE	10,8	KNLS	SIN	53500
IMR-N	PE	3,2	BR	TRI	5300
IMR-S	PE	4	BR	SIN	5400
MARLAB-UK	PE	6	BR	DBL	14225
MARLAB-UK	PE	3	BR	SIN	4060
MARLAB-UK	PE	5	BR	SIN	13632
RIVO-NL	PE	4	BR	DBL	5208
RIVO-NL	PE	6	BR	DBL	12500

PA : polyamide
PE: polyethylene
BR: braided
KNLS: knotless
SIN: single twine
DBL: double twine
TRI: triple twine

Table 2. Additional cod-end netting samples to be measured in inter-laboratory tests.

Country	# Samples	Mesh sizes	Gears
Belgium	1	20 mm	Shrimp trawl
Canada	1	40 mm	Shrimp trawl
Denmark	3	35 mm, 70 mm, 100 mm	Shrimp trawl, Nephrops trawl Whitefish trawl.
Germany	1	40 mm	Herring trawl.
Netherlands	2	40 mm, 20 mm	Pelagic trawl Shrimp trawl
Norway	1		Blue whiting trawl
Sweden	2	35 mm 70 mm	Shrimp trawl Nephrops trawl
USA	4	45 mm 45 mm ? 150 mm 165 mm	New England shrimp trawl, Gulf of Mexico shrimp trawl Groundfish trawl Groundfish trawl

Figure 1. ICES/TSF in relation to twine diameter – hypothesis.

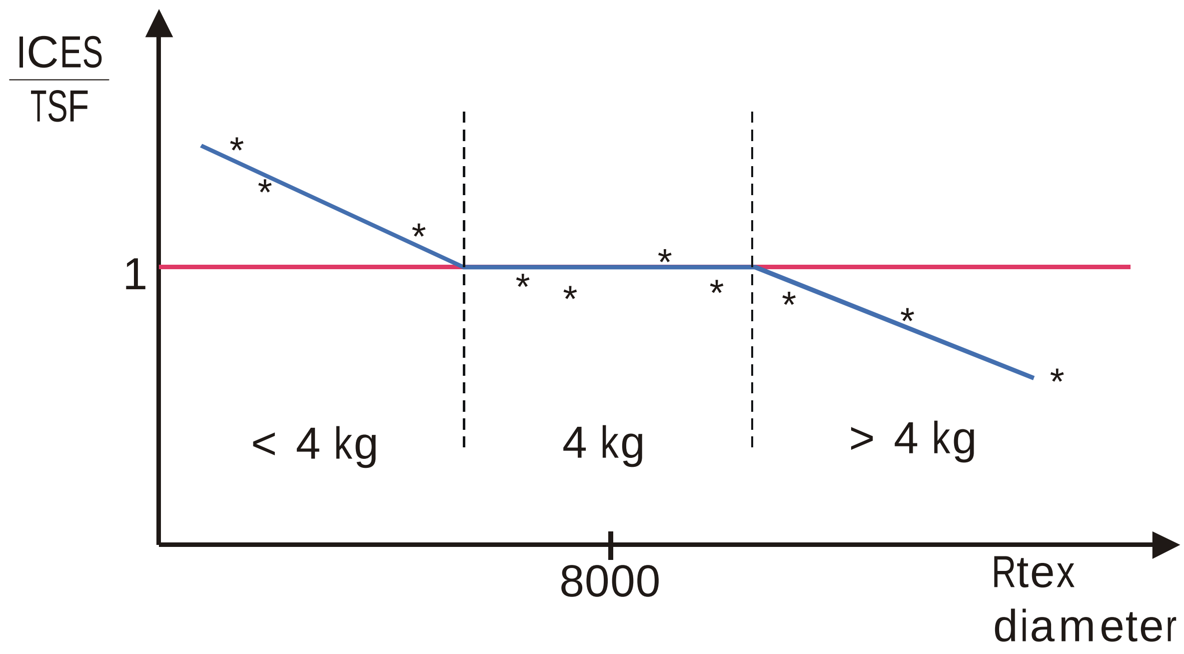


Figure 2. Ratio ICES/TSF in relation to twine diameter for all mesh constructions.

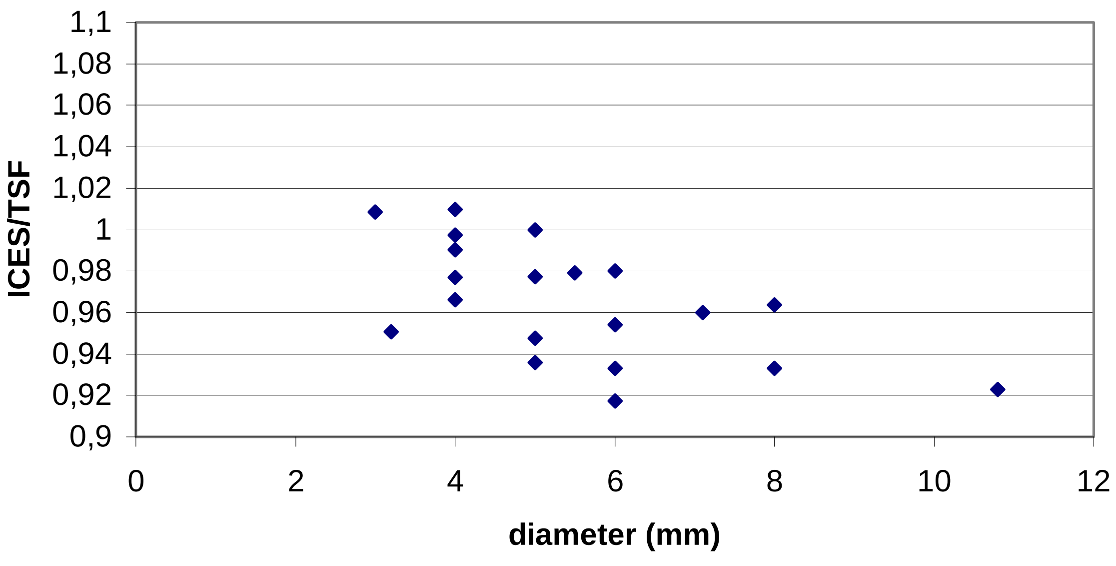


Figure 3. Ratio ICES/TSF in relation to twine diameter for single twine meshes.

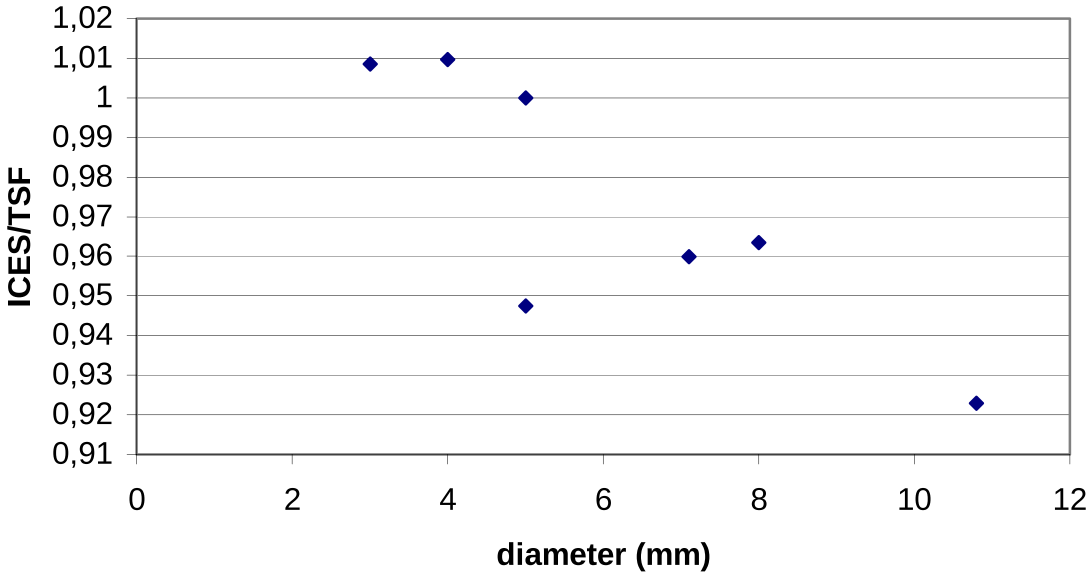


Figure 4. Ratio ICES/TSF in relation to twine diameter for double twine meshes.

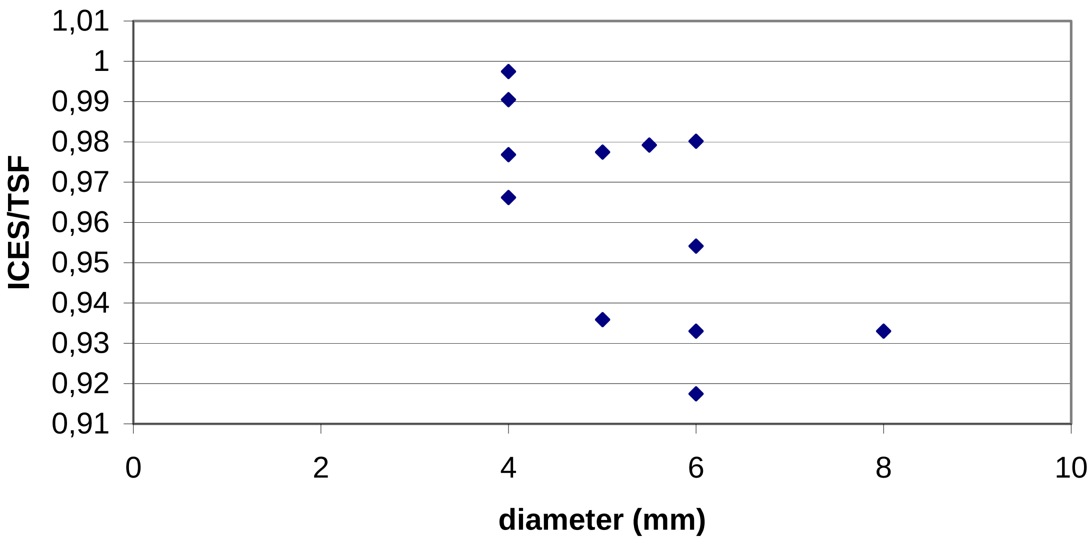


Figure 5. Comparison of existing methodologies.

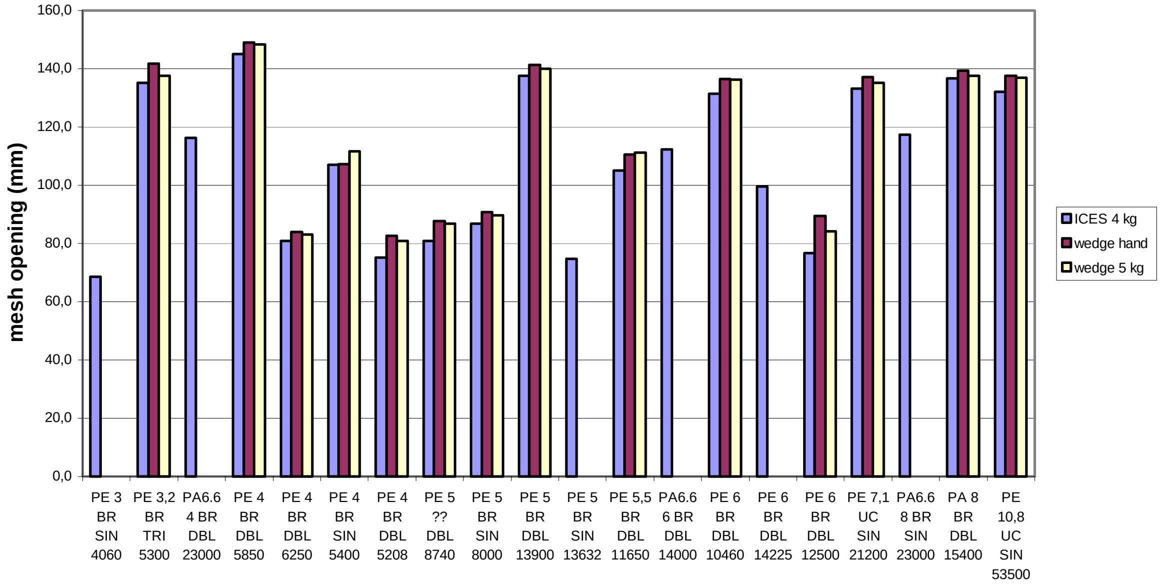
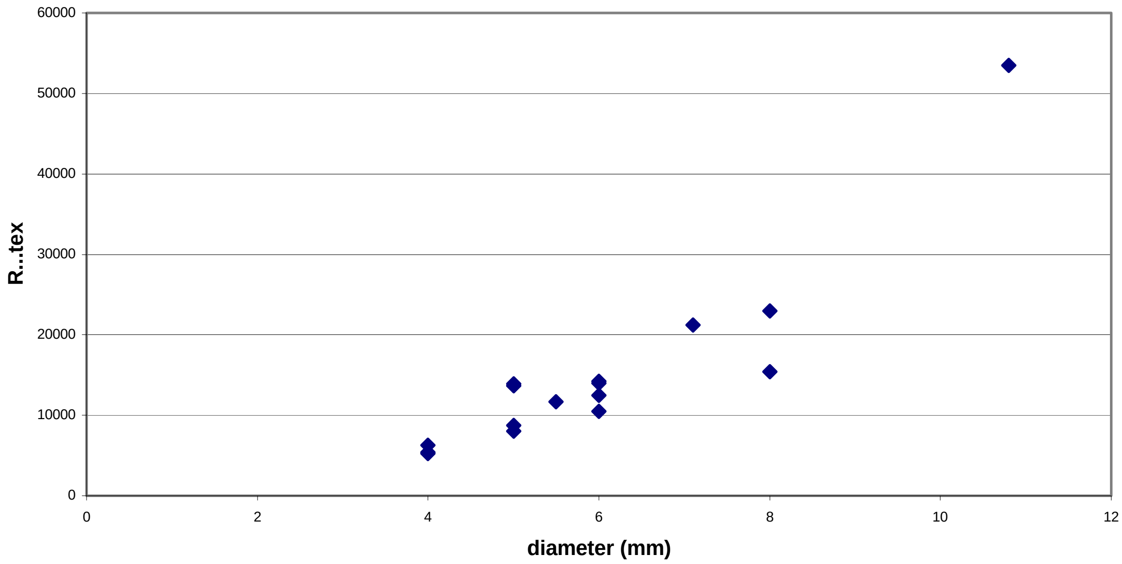


Figure 6. Rtex values in relation to the twine diameter.



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ANNEX 2 – AGENDA

1 Opening

2 Appointment of a rapporteur

3 Terms of Reference – Adoption of Agenda

4 Report of Study Group and related activities in the past year

5 Definition of mesh size

6 Completion of netting types inventory

7 Results of mesh measurements on selected netting materials

   a) Mesh measurement methodology used

   b) Selected netting materials

   c) Problems encountered

   d) Results

   e) Need for further measurements

8 Discussion: Need to define groups of netting types for which the same measurement conditions (e.g., tension) applies

9 Specification of a suitable mesh measurement methodology – Conditions under which mesh measurements for all fishing gears in ICES areas should be made

10 Advice on improvements and further standardisation of current mesh measurement practices in view of the netting types now in use in ICES member countries

11 Recommendations for future activities

12 Discussion of draft report

13 Any other business

14 Closing of the meeting

ANNEX 3 – INVENTORY OF COD-END NETTING MATERIALS IN USE IN THE ICES AREA

Country	Gear	Netting					Yarn				Origin/
		material	construction	no of yarns	length of mesh	opening of mesh	twine type	construction	runnage	diameter (mm)	Application
B	TBB-Crangon	PA	knotted	single	22		multi	twisted			100%
B	TBB-flatfish	PE	knotted	double		80	mono	braided		4	Van Belen
B	TBB-flatfish	PE	knotted	double		80	mono	braided		4	Senaflex
B	TBB-flatfish	PES	knotted	double		80	multi	braided		3	Bay of Biscay only
B	TBB-flatfish	PES	knotted	double		80	multi	braided		4	Bay of Biscay only
B	TBB-flatfish	PE	knotted	double		80	mono	braided		4	EUROLINE 5–10%
B	TBB-flatfish	PES	knotted	single		82	multi	braided		4.5	5–10%
B	TBB-flatfish	PE	knotted	double		82	mono	braided		3.5	EUROLINE
B	TBB-flatfish	PE	knotted	double		82	mono	braided		3.5	PREMIUM
B	TBB-flatfish	PE	knotted	single		82	mono	braided		6	Type 2001
B	TBB-flatfish	PE	knotted	double		82	mono	braided		4	Type 2002
B	TBB-flatfish	PE	knotted	double		82	mono	braided		4	BREZLINE
B	TBB-flatfish	PE	knotted	double		84	mono	braided		4	BREZLINE 90%
B	OTB-Nephrops	PE	knotted	double		82	mono	braided		4	BREZLINE 90%
B	OTB	PE	knotted	single		105	mono	braided		4	
B	OTB	PE	knotted	double		110	mono	braided		5	BREZLINE 90%
CA	OTB-Cod	PE	knotted	double		155		braided		5.5	cod, haddock, saith
CA	OTB-Cod	PE	knotted	double		155		braided		6.0	cod, haddock, saith
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	mono	braided	86	6	Reykjanes
D	OTB	PE	knotted	double		105	mono	braided	185	4	Baltic Sea
D	OTB	PE	knotted	single		105	mono	braided	185	4	Baltic Sea

Country	Gear	Netting					Yarn				Origin/
		material	construction	no of yarns	length of mesh	opening of mesh	twine type	construction	runnage	diameter (mm)	Application
D	OTB	PE	knotted	double		117	mono	braided	86	6	NW Atlantic
D	OTB	PE	knotted	single		110	mono	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	split fibre	braided	75	6	Cotesi
D	OTB	PE	knotted	single		35	split fibre	braided		2	Cotesi
D	OTB	PE	knotted	double			mono	braided	165	4	
NL	TBB	PE	knotted	double		82	mono	braided		3	CIV Den Oever
NL	TBB	PE	knotted	double		82	mono	braided		5	CIV Den Oever
NL	TBB	PE	knotted	double		82	mono	braided		5	EUROLINE
NL	TBB	PE	knotted	double		82	mono	braided		5	EUROLINE
NL	OTM	PA	knotted	double		40	mono	braided			
NL	TBB-Crangon	PA	knotted	single	22–24		multi	twisted			CIV Den Oever
NO	OTB	PE	knotted	double	155	138		braided		6	cod,haddocksaith
NO	OTB	PA	knotted	double	150	138		braided		5	cod, haddock, saith
NO	OTB	PA	knotted	double	155	138		braided		6	cod, haddock, saith
NO	OTB	PE	knotless	single	143	138		braided		9,4	cod, haddock, saith
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, saith
NO	Seine net	PA	knotted	double	135	126		braided		3.5	cod, haddock, saith
NO	Seine net	PE	knotted	double	146	136		braided		6,0	cod, haddock, saith
NO	Seine net	PE	knotless	single	135	127		braided		7.5	cod, haddock, saith
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 coated with latex		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	

Country	Gear	Netting					Yarn				Origin/
		material	construction	no of yarns	length of mesh	opening of mesh	twine type	construction	runnage	diameter (mm)	Application
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	
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			MAC, HER
UK	STM*/PTM	PA	knotted	treble	40	30		twisted 210/72			Blue WHG
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	Twin OTB	PE	knotted	double		105		braided	80,66	5	COMPACT twine
UK	Twin OTB	PE	knotted	single		73		braided	183,45	4	Nephrops

Country	Gear	Netting					Yarn				Origin/
		material	construction	no of yarns	length of mesh	opening of mesh	twine type	construction	runnage	diameter (mm)	Application
UK	Twin OTB	PE	knotted	single		73		braided	132,55	4	COMPACT twine, Nephrops
UK	OTB	PE	knotted	single		73		braided	183,45	4	Nephrops
2001 entries (EUROCORD)											
NO	OTB	HDPE	knotted	double	169	140	mono	braided	75	6	
NO	OTB	PA	knotted	double	169	140	multi	braided	75(65**)	6	
IS	OTB	HDPE	knotted	single	165	135	mono	braided	40	8	redfish
UK	OTB	HDPE	knotted	double	125	100	mono	braided	75	6	
CA	trawls	euroline	knotted	double	x	x	mono	braided	x	x	
CA	trawls	premium	knotted	double	x	x	mono	braided	x	x	
USA	trawls	premium	knotted	double	x	x	mono	braided	x	x	
USA	trawls	euroline	knotted	double	x	x	mono	braided	x	x	
RU	trawls	premium	knotted	double	x	x	mono	braided	x	x	
PT	trawls	euroline	knotted	double	x	x	mono	braided	x	x	
IS	trawls	PE	knotted	double	x	x	mono	braided	x	x	
ES	trawls	euroline	knotted	double	x	x	mono	braided	x	x	
UK	trawls	PE	knotted	double	x	x	mono	braided	x	x	
ES	trawls	euroline	knotted	double	x	x	mono	braided	x	x	
2001 entries (USA)											
USA	trawl	Euroline	knotted	double	7.25"	6.5"	mono	braided		5	Cod
USA	trawl	Euroline	knotted	single	60	1 7/8"	mono	braided		3	Squid
USA	Trawl	poly?	knotted	single	2.25"	1 7/8"	mono	twisted		2	Squid

x: differs from area to area

** after treatment

ANNEX 4 – METHODOLOGY TO BE USED FOR THE INTER-LABORATORY TESTS

According to the minutes of the Study Group meeting held in 2000 in IJmuiden the following measurements have to be made:

1) with the ICES gauge at 4 kg
2) with a stretching force corresponding to the textile standard force, i.e., 25% of Rtex value
3) with the flat wedge gauge with hand force
4) with the flat wedge gauge with a 5 kg weight

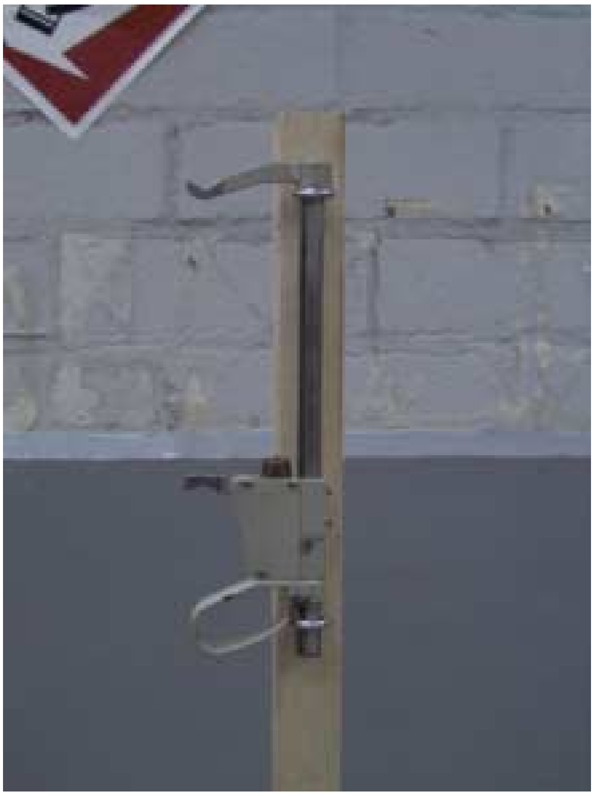
Methods 1, 3 and 4 are well known. Measurements on netting with large knots may cause problems since the jaw of the ICES gauge or the flat wedge gauge can be placed under or at the side of the knot. The jaw/gauge should be positioned to the side of the knot. This will give the largest mesh opening.

Method 2 requires a different methodology. The following method was tested successfully by the Sea Fisheries Department in Oostende and the Marine Laboratory in Aberdeen.

The method is based on the use of an ICES mesh gauge for which the blocking mechanism has been disabled. The figures explain the method.

The ICES gauge is mounted to a wooden stand by means of two eye screws (Figure 1).

Figure 1 – Set-up of the ICES gauge.



The movable jaw can freely move between the upper fixed jaw and the lower eye screw. The mesh to be measured is mounted over the fixed and the movable jaw and a weight corresponding to the measuring force minus the weight of the movable jaw is attached to the handle of the movable jaw Figure 2). The mesh size is read on the scale of the ICES gauge.

Figure 2 – Attachment of the measuring weight.

During the measurement the load on the mesh should as much as possible be determined by the measuring weight only. Excessive weight of the netting acting on the two jaws should be avoided. For this reason the netting sheet is cut into strips containing the 20 successive meshes to be measured. During the measurements the netting under the movable jaw rests on a table and the netting above the fixed jaw is slightly held upright by a counter weight applied by means of a pulley (Figure 3; pulley not visible).

Figure 3 – Complete set-up.

Number of measurements

Some preliminary tests on a number of nettings have shown that measuring 60 meshes will yield a mean mesh size with a precision of 1 mm at the 95% level (and mostly even at the 99% level). Moreover, for legislation purposes also a number of 60 meshes is used. It seems logic to select, as for inspection, 3 rows of 20 meshes.

The measurements are made on dry netting for the following reasons:

- the effect of the measuring force is investigated, not the changes in mesh size due to the state of the netting (dry or wet)
- to avoid bias due to samples being more or less wet, it is easier to maintain the same measuring conditions in the wet state.

Example

This method was applied on 80 mm PE double netting made of 4 mm yarn.

First, three series of 20 meshes were measured with the ICES gauge at 4 kg (Table 1). The average mesh size was 81.0 mm. The measurement was repeated with a measuring load corresponding to 25 % of the Rtex. Since the mesh in the present example counts 4 yarns, the measuring force to apply is equal to the Rtex, i.e., 7177 grams. This time the average mesh opening was 82.5 mm, this means an increase of 1.5 mm. This difference is highly significant.

To test the experimental method, the measurements were repeated with a weight of 4 kg (Table 1). Most measurements gave the same result as the ICES gauge at 4 kg, the others were 1 mm higher or lower, only one measurement showed a difference of 2 mm (mesh 45). The averages were both 81.0 mm. The t-test shows that the two means do not differ significantly.

Summary

The measurements to be made on each of the selected netting samples can be summarised as follows:

1) Select 3 series of 20 meshes.
2) Measure each mesh with an ICES mesh gauge at 4 kg pretension.
3) Calculate the textile standard force.
   Textile standard force = Rtex * number of yarns / 4
   (number of yarns is 2 in a single yarn mesh, 4 in a double yarn mesh)
4) Weight to be applied = textile standard force – weight of movable jaw.
5) Measure each mesh with the textile standard force according to the method described above.
6) Calculate the average mesh sizes and perform a paired two-sample student's t-test.
7) It is advisable to make the measurement also with a 4 kg weight attached to the ICES gauge for control.
8) Measure each mesh with a flat wedge gauge operated by hand force.
9) Measure each mesh with a flat wedge gauge and a 5 kg weight.

Table 1 – Comparison of methods.

PE; diameter 4 mm; double braided; nominal mesh opening: 80 mm; R7174tex

mesh	ICES 4 kg	weight 7.177 kg	weight 4 kg
1	79	81	80
2	75	76	76
3	78	81	78
4	83	86	83
5	77	77	77
6	80	80	79
7	86	87	86
8	86	87	86
9	79	80	79
10	78	79	79
11	85	87	86
12	83	84	83
13	82	84	82
14	80	82	80
15	82	84	83
16	82	83	82
17	80	82	80
18	83	84	83
19	83	84	83
20	85	86	84
21	74	75	74
22	76	77	76
23	84	85	84
24	79	80	79
25	77	78	77
26	80	81	79
27	79	82	80
28	83	84	83
29	82	83	82
30	79	82	79
31	85	88	86
32	81	82	81
33	83	85	84
34	79	80	79
35	80	82	80
36	80	82	80
37	80	81	80
38	85	86	85
39	82	83	82
40	87	87	86
41	75	76	75
42	79	81	80
43	80	80	79
44	82	84	82
45	78	79	76
46	77	79	78
47	82	84	82
48	81	83	80

t-Test: Paired Two Sample for Means

	ICES 4kg	weight 7.177 kg
Mean	80,95	82,45
Variance	9,0652542	9,878813559
Observations	60	60
Pearson Correlation	0,960625	
Hypothesized Mean Difference	0	
df	59	
t Stat	-13,304135	
P(T<=t) one-tail	1,03E-19	
t Critical one-tail	1,6710919	
P(T<=t) two-tail	2,061E-19	
t Critical two-tail	2,0009975	

t-Test: Paired Two Sample for Means

	ICES 4kg	weight 4 kg
Mean	80,95	80,98333333
Variance	9,0652542	8,864124294
Observations	60	60
Pearson Correlation	0,9755459	
Hypothesized Mean Difference	0	
df	59	
t Stat	-0,3894495	
P(T<=t) one-tail	0,3491729	
t Critical one-tail	1,6710919	
P(T<=t) two-tail	0,6983458	
t Critical two-tail	2,0009975	

mesh	ICES 4 kg	weight 7.177 kg	weight 4 kg
49	83	86	83
50	80	81	80
51	85	86	84
52	82	83	82
53	80	81	80
54	81	84	82
55	78	79	78
56	85	88	86
57	79	81	79
58	79	83	80
59	85	86	84
60	85	86	84

ANNEX 5 – MESH MEASUREMENTS USING A TENSILE TESTING MACHINE

This method has the advantage that the material to be tested needs not be cut into strips before testing but that the netting can be examined in the complete cod-end. The netting is hanging on the upper clamp attached to the load cell (Figure 1). Hence, before applying the measuring force a new zero setting must be performed. The measuring force was applied by means of two jaws similarly shaped as those of the ICES mesh gauge. These jaws were screwed to T-shaped pieces of steel firmly fixed onto the regular clamps used for knot breaking tests. This arrangement remained unchanged so that a firm relationship between the distances of both the holding clamps and the touching surfaces of the measuring jaws existed. The extension rate was 120 mm/min. After applying the measuring force the distance between the two fixed points of the holding clamps was measured using a steel measuring tape and the distance proper was calculated taking into account the fixed relationship between jaw and clamp distance.

Figure 1 – Mesh measurement.