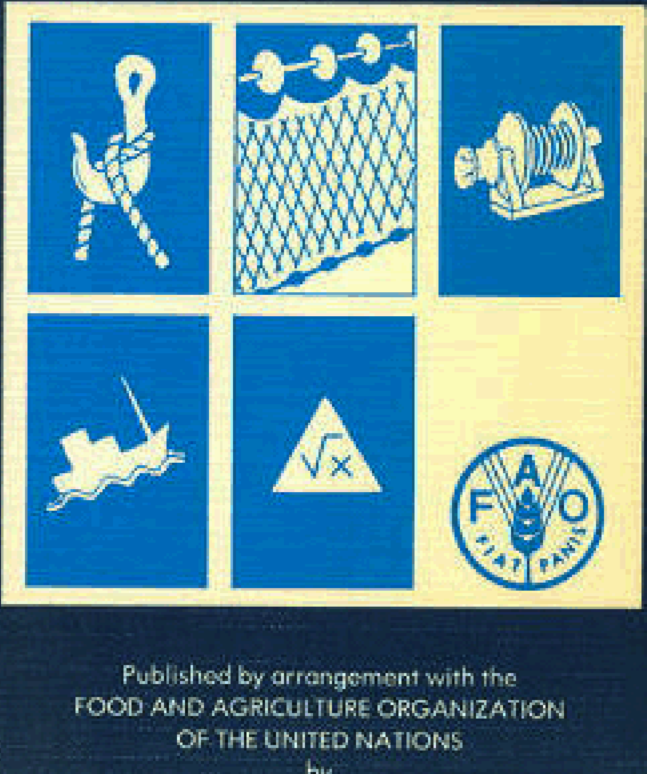
FISHERMAN'S
WORKBOOK



Published by arrangement with the
FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS
by
FISHING NEWS BOOKS

Acknowledgements

The *Fisherman's Workbook* has been prepared in the Fishing Technology Service, Fishery Industries Division, in the Fisheries Department of the FAO.'

A number of consultants and experts in fishing technology worked on the preparation of this book, over a period of several years. Without their contributions it would have been impossible to compile the book, and we wish to thank them. We wish to thank the FAO masterfishermen working in various countries, who offered valuable comments on the draft, and Messrs A. Smith and S. Drew, for translating and editing the English language edition.

Finally, we wish to thank the draftspeople in the FAO Fisheries Department for preparation of the illustrations.

FISHERMAN'S
WORKBOOK

Compiled by J. Prado
Fishery Industries Division, FAO

in collaboration with P.Y. Dremiere
IFREMER, Sete, France

Published by arrangement with the
FOOD AND AGRICULTURE ORGANIZATION
OF THE UNITED NATIONS
by
FISHING NEWS BOOKS
OXFORD 1990

Fishing News Books
A division of Blackwell Scientific Publications Ltd
Editorial Offices:
Osney Mead, Oxford OX2 OEL (Orders: Tel. 0865 240201)
25 John Street, London WC1N 2BL
23 Ainslie Place, Edinburgh EH3 6AJ
3 Cambridge Center, Suite 208, Cambridge MA 02142, USA
107 Barry Street, Carlton, Victoria 3053, Australia

Set by Best-set Typesetter Ltd.
Printed and bound in Great Britain by St Edmundsbury Press Ltd,
Bury St Edmunds, Suffolk

British Library
Cataloging in Publication Data Prado, J.
Fisherman's workbook.
1. Fishing equipment
I . Title
II. Dremiere, P.Y.
III. Food and Agriculture Organization 639.2

ISBN 0-85238-163-8

Notice

To fishermen, net makers, boatbuilders, and other professionals working in commercial fisheries:

The **Fisherman's Workbook** is a tool intended for field use, to carry with you for easy reference on land or sea. It contains essential information about the choice and use of a variety of materials and equipment necessary for commercial fishing.


Materials and accessories

p. 1

The first part of the book, **'Materials and ac-cessories',** contains a review of common materials and components used in commercial fishing, with examples and explanations of their use. This part should help with the choice and use of appropriate materials.


Fishing gear and operations

p. 61

The second part, **'Fishing gear and operations',** will help with the choice of particular types of fishing gear, their characteristics and use.


Equipment for deck and wheelhouse

p. 121

The third section, **Equipment for deck and wheelhouse',** outlines the characteristics of echo-sounders and deck machinery for handling fishing gear and gives examples of such equipment.


Fishing vessel operation

p. 135

A fourth part, **'Fishing vessel operation',** gives information about the most effective use of fishing vessels. Guidelines for calculating the costs and benefits of fishing operations are presented.


Formulae and tables

p. 145–161

The fifth part, **'Formulae and tables',** gives tables for converting units and numbers among different systems of measurement as well as formulae for calculations which a fisherman may need. Finally, the section on **'Ordering equipment'** gives recommendations about the specifications to be listed when ordering fishing gear and equipment.

Notice

Fishing technologies in use are generally not dependent on exact, absolute science. Individua experience, knowledge and skill are of great importance, and these are often specific for particular fishing grounds or regions. Therefore, the **Fisherman's Workbook** is not an absolute set of rules or formulae appropriate for all questions and situa-tions. It does contain sets of guidelines drawn from wide experience in professional fishing. These guidelines may be helpful, when considered in combination with your own experience, knowledge and expertise.

Although the **Fisherman's Workbook** covers a wide range of subjects, it cannot pretend to cover everything, and in the preparation of the book it was necessary to leave out many subjects. It is hoped that the reader will fill these 'gaps' with his personal knowledge, skill and experience in the context of the area in which he works.

Contents

Materials and accessories
- density of materials
- strength of hardware
- synthetic fibres
- twine
- rope
- wire rope
- net webbing
- fish hooks
- line fishing accessories
- floats
- sinkers
- hardware
- lifting

Fishing gear and operations
- purse seines
- beach seines
- bottom seines
- trawls
- entangling nets
- traps and pots
- line fishing
- longlines
- nets, traps, lines — buoys
- dredges

Equipment for deck and wheelhouse
- light
- echo-sounders
- deck equipment

Fishing vessel operations
- propulsion
- fish holds, tanks
- bait
- operations
- bookkeeping
- regulations

Formulae and tables
- units of measurement
- formulae

Ordering equipment
- fishing gear and accessories
- deck equipment

Index

Materials and accessories

Density of materials

SINKING MATERIALS

■ Metals

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
aluminium	2.5	0.60 +	0.59 +
brass	8.6	0.88 +	0.88 +
bronze	7.4	0.86 +	0.86 +
	to 8.9	0.89 +	to 0.88 +
cast iron	7.2	0.86 +	0.86 +
	to 7.8	0.87 +	0.87 +
copper lead	8.9	0.89 +	0.88 +
	11.4	0.91 +	0.91 +
steel	7.8	0.87 +	0.87 +
tin	7.2	0.86 +	0.86 +
zinc	6.9	0.86 +	0.85 +

■ Textiles

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
aramide (kevlar)	1.20	0.17 +	0.15 +
cotton	1.54	0.35 +	0.33 +
hemp	1.48	0.32 +	0.31 +
linen	1.50	0.33 +	0.32 +
manilla	1.48	0.32 +	0.32 +
polyamide (PA)	1.14	0.12 +	0.10 +
polyester (PES) polyviny	1.38	0.28 +	0.26 +
alcohol (PVA) polyvinyl	1.30	0.23 +	0.21 +
chloride (PVC)	1.37	0.27+	0.25 +
polyvinylidene	1.70	0.41 +	0.40 +
ramie	1.51	0.34 +	0.32 +
sisal	1.49	0.33 +	0.31 +

■ Other Materials

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
brick	1.9	0.47 +	0.46 +
chalk	2.4	0.58 +	0.57 +
concrete	1.8	0.44 +	0.43 +
	to 3.1	0.68 +	0.67 +
earthenware	2.2	0.55 +	0.53 +
glass	2.5	0.60 +	0.59 +
rubber	1.0	0.00	0.03 -
	to 1.5	0.33 +	0.32 +
sandstone	2.2	0.55 +	0.53 +
stone	2.5	0.60 +	0.59 +
ebony	1.25	0.20 +	0.18 +

' Multiplication factor used to calculate the weight in water' of different materials, as shown on page 4.

FLOATING MATERIALS

■ Wood

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
bamboo	0.50	1.00-	1.05-
cedar, red	0.38	1.63-	1.70-
cedar, white	0.32	2.13-	2.21-
cork	0.25	3.00-	3.10-
cypress	0.48	1.08-	1.14-
fir	0.51	0.96-	1.01-
oak, dry	0.65	0.54-	0.58-
oak, green	0.95	0.05-	0.08-
pine	0.65	0.54-	0.58 -
pine, Oregon	0.51	0.96-	1.01-
pine, poplar	0.41	1.44-	1.50-
oplar	0.48	1.08-	1.14-
spruce	0.40	1.50-	1.57-
teak	0.82	0.22-	0.25-
walnut	0.61	0.64-	0.68-

■ Fuel

Type	Density (g/cc)	Multiplication factor*	
		freshwater	sea water
petrol (normal or super)	0.72	0.39 -	0.43-
petrol for lamps	0.79	0.27-	0.30-
diesel fuel	0.84	0.19-	0.22-
crude oil, heavy	0.86	0.16-	0.19-
crude oil, light	0.79	0.27-	0.30-
fuel oil, heavy	0.99	0.01-	0.04-
fuel oil, intermediate (merchant vessels)	0.94	0.06-	0.09-

■ Textiles

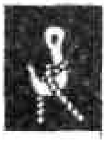
Type	Density (g/cc)	Multiplicatie factor*	
		freshwater	sea water
polyethylene	0.95	0.05-	0.08-
polypropylene	0.90	0.11-	0.14 -
polystyrene, expanded	0.10	9.00-	9.26-

■ Others

ice	1 0.95	0.11-	0.14- I
oil	0.90-0.95		

Examples of loss of buoyancy as a function of duration of immersion:

after	0 days	10 days	15 days
cork	4.5 kgf	4.0	
wood	2.0 kgf	1.0	0



Weight in water, with examples for materials and for a rigged gillnet

P = A x {1 - DW/DM}*

where :

P = weight (kg) in water

A = weight (kg) in air

DW = density (g/cc) of water (freshwater 1.00; sea water 1.026)

DM = density (g/cc) of material

* The term in brackets, the multiplication factor, has been calculated for the materials most commonly used in fisheries, with the results given in the tables on pages 2-3. The factor followed by a + sign indicates a sinking force. The factor followed by a - sign indicates a buoyant or floating force. To obtain the weight in water of a certain quantity of material, simply multiply its weight in air by the factor.

Example a:

1.5 kg of cork in air The table on page 3 gives the multiplication factor for cork:

freshwater : 3.00(-)
sea water : 3.10(-)

so,

1.5 x 3.00(-) = 4.5 kg flotation in freshwater

1.5 x 3.10H = 4.65 kg flotation in sea water

Example b:

24.6 kg of polyamide (nylon) in air The table on page 3 gives the multiplication factor for polyamide:

freshwater : 0.12(+)
sea water : 0.10(+)

so,

24.6 x 0.12(+) = 2.95 kg flotation in freshwater

24.6 x 0.10(+) = 2.46 kg flotation in sea water

■ Example c: Calculating the weight in water of a bottom gillnet

component	weight(kg) in air	weight (kg) in sea water
ropes: 2 x 90 m PP Ø 6 mm	3.060	-0.430 -
netting: 900 x 11 meshes 140 mm stretched mesh PAR 450 tex with bolchlines	1.360	+ 0.136 +
floats: 46 corks x 21 g (in air) (or 50 floats of 60 gf each)	0.970	- 3.000 -
sinkers: 180 lead sinkers, 80g each (in air) (1 or 111 stones, avg. weight 200 g (2)	14.400 22.200	+13.100 +
TOTAL	(1)19.790 (2) 27.590	9.806 +

The weight of a gillnet in water is calculated by adding the weights of the different components, taking into account the sign of the factor. The sign of the total indicates the type of net we have made; thus, this gillnet with a + sign would be a bottom net with a sinking force of 9.806 kg.

Safe working load, breaking load, safety factor

■ Definitions

— **Safe working load (SWL),** is the maximum load that an item is certified to lift in service. Another equivalent term in use is *Working load limit.*

— **Breaking load (BL)** is the maximum load that an item can hold with a static load before it breaks. Another equivalent term in use is *Breaking strength.*

— **Safety factor**

$$= \frac{\text{breaking load}}{\text{safe working load}}$$

Very important : The loads used in these calculations *are* static loads. Dynamic or shock loads increase the stress considerably, and thus increase the possibility of breakage.

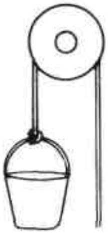
■ Values of the safety factor

(a) For ropes

Diameter (mm)	3-18	20-28	30-38	40-44	48-100
Safety factor	25 (est)	20	15	10	8

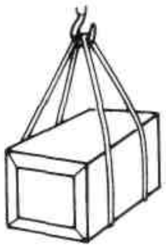
(b) For wire ropes and metal hardware : safety factor about 5—6.

■ Safe working load



Weight held by one line
SWL

Weight held by 2 lines
SWL × 2



Weight held by 4 lines
SWL × 4

Synthetic fibres and commercial names

■ Polyamide (PA)

Amilan (Jap)
Anid (USSR)
Anzalon (Neth)
Caprolan (USA)
Denderon (E. Ger)
Enkalon (Neth, UK)
Forlion (ltd)
Kapron (USSR)
Kenlon (UK)
Knoxlock (UK)
Lilion (ltd)
Nailon (ltd)
Nailonsix (Braz)
Nylon (many coun)
Perlon (Ger)
Platil (Ger)
Relon (Roum)
Roblon (Den)
Silon (Czec)

■ Polyethylene (PE)

Akvaflex (Nor)
Cerfil (Port)
Corfiplaste (Port)
Courlene (UK)
Drylene 3 (UK)
Etylon (Jap)
Flotten (Fran)
Hiralon (Jap)
Hi-Zex (Jap)
Hostalen G (W. Ger)
Laveten (Swed)
Levilene (ltd)
Marlin PE (Ice)
Norfil (UK)
Northylen (Ger)
Nymplex (Neth)
Rigidex (UK)
Sainthene (Fran)
Trofil (Ger)
Velon PS (LP) (USA)
Vestolen A (Ger)

■ Polypropylene (PP)

Akvaflex PP (Nor)
Courlene PY (UK)
Danaflex (Den)
Drylene 6 (UK)
Hostalen PP (Ger)
Meraklon (Ital)
Multiflex (Den)
Nufil (UK)
Prolene (Arg)
Ribofil (UK)
Trofil P (Ger)
Ulstron (UK)
Velon P (USA)
Vestolen P (Ger)

■ Copolymers (PVD)

Clorene (Fran)
Dynel (USA)
Kurehalon (Jap)
Saran (Jap, USA)
Tiviron (Jap)
Velon (USA)
Wynene (Can)

■ Polyester (PES)

Dacron (USA)
Diolen (Ger)
Grisufen (E. Ger)
Tergal (Fran)
Terital (Ital)
Terlenka (Neth, UK)
Tetoron (Jap)
Terylene (UK)
Trevira (W. Ger)

■ Polyvinyl alcohol (PVA)

Cremona (Jap)
Kanebian (Jap)
Kuralon (Jap)
Kuremona (Jap)
Manryo (Jap)
Mewlon (Jap)
Trawlon (Jap)
Vinylon (Jap)

■ Commercial names of combined twines for netting

Kyokurin	Cont. fil PA + Saran
Livlon	Cont. fil PA + Saran
Marlon A	Cont. fil PA + St. PVA
Marlon B	Cont. fil PA + Saran
Marlon C	Cont. fil PA + Cont. fil PVC
Marlon D	Cont. fil PA + Saran
Marlon E	St. PA + St. PVA (or PVC)
Marumoron	Cont. fil. PA + St. PVA
Polex	PE + Saran
Polysara	PE + Saran
Polytex	PE + cont. fil. PVC
Ryolon	Cont. fil. PES + Cont. fil. PVC
Saran-N	Cont. fil. PA + Saran
Tailon (Tylon P)	Cont. fil. PA + St. PA
Temimew	St. PVA + St. PVC

Cont. fil. = continuous fibres
St. = staple fibre

Synthetic fibres: physical properties

■ **Nylon, polyamide (PA)**	Sinks (density = 1.14) Good breaking strength and resistance to Abrasion Very good elongation and elasticity
■ **Polyester (PES)**	Sinks (density = 1.38) Very good breaking strength Good elasticity Poor elongation (does not stretch)
■ **Polyethylene (PE)**	Floats (density = 0.94-0.96) Good resistance to abrasion Good elasticity
■ **Polypropylene (PP)**	Floats (density = 0.91-0.92) Good breaking strength Good resistance to abrasion
■ **Polyvinyl alcohol (PVA)**	Sinks (density = 1.30-1.32) Good resistance to abrasion Good elongation

SYNTHETIC FIBRES

Synthetic fibres: identification

Properties	PA	PES	PE	PP
Floats	No	No	Yes	Yes
- Appearance				
- Continuous fibres	X	X	-	X
- Short (staple) fibres	(X)	(X)	-	(X)
- Monofilament	(X)	(X)	X	(X)
- Sheets			(X)	X
Combustion	Melts following short duration of heating - forms molten droplets	Melts and burns slowly with bright yellow flame	Melts and burns slowly with pale blue flame	Melts and burns slowly with pale blue flame
Smoke	White	Black with soot	White	White
Smell	Celery-like fishy odour	Hot oil faintly sweet	Snuffed out candle	Hot wax/ burning asphalt
Residue	Solid yellowish round droplets	Solid blackish droplets	Solid droplets	Solid brown droplets

X = Commonly available

(X) = Material exists but is less common

\- = Not available

Twine: number, tex, denier, metres/kg, diameter

■ Simple fibres

Titre (denier) : Td = weight (g) of 9000 m of fibre
Metric number : Nm = length (m) of 1 kg of fibre
English number for cotton : Ne_c = length (in multiples of 840 yd) per lb
International system: tex = weight (g) of 1000 m of fibre

■ Finished twine

Runnage, metres/kg : m/kg = length (m) of 1 kg of finished twine
Resultant tex : Rtex = weight (g) of 1000 m of finished twine

■ Equivalents and conversions

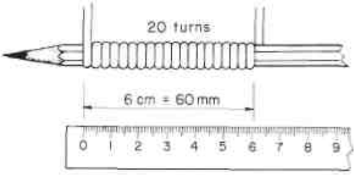
Textile\system	PA	PP	PE	PES	PVA
Titre/denier	210	190	400	250	267
International tex system	23	21	44	28	30

$$\text{tex} = 0.111 \times \text{Td} = 1000/\text{Nm}$$
$$= 590.5/\text{Ne}_c$$
$$\text{Rtex} = \frac{1\,000\,000}{\text{m/kg}}$$
$$= \frac{496\,055}{\text{yd/lb}} = 0.132 \times \text{Td}$$
$$\frac{\text{kg/100 m}}{25} = \text{lb/fathom (approximate)}$$
$$\text{kg/m} = 1.5 \times \text{lb/ft (approximate)}$$
$$\text{kg/m} = 0.5 \times \text{lb/yd (approximate)}$$

■ Estimating the diameter of twine

In addition to precise measurements from instruments such as micrometer, magnifying glass and microscope, there exists a quick method of estimation. Roll 20 turns of the twine to be measured around a pencil and measure the total length of the turns.

***Example**:*



If 20 turns of the twine measure 6 cm, then the diameter of the twine = 60 mm/20 turns = 3 mm

Note : *The strength of twine or rope depends not only on its thickness, but also on the method and degree of twisting or braiding its yarns.*

Twin : calculation of tex

■ Calculation of Resultant tex (Rtex) of twine

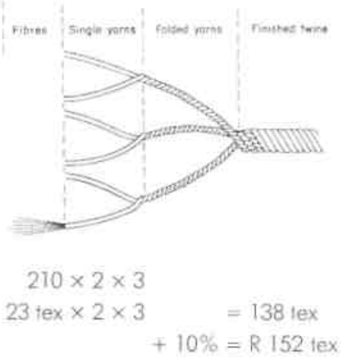
Case 1 : When the structure of the twine is known

***Example**:*
Netting twine made of nylon (polyamide), with 210 denier single yarns, 2 single yarns in each of the 3 folded yarns (strands) which make up the twine.

210 x 2 x 3 = 23 tex x 2 x 3
= 138 tex

To find the Resultant tex (Rtex) we have to apply a correction to the calculated value, taking into account the structure of the finished twine (twisted, braided, hard lay, degree of twist, etc.). A rough estimation of Rtex can be found by adding 10% to the value calculated above:

138 tex + 10% = R 152 tex (estimate)



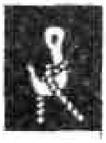
Note : *in view of the complex structure of braided twines, it is the general practice in fisheries for the gear designer to use the Rtex value without going into detail.*

Case 2 : A sample of twine is available for evaluation

Example ;
5 m of twine, placed on a precision scale, weigh 11.25 g. We know that twine of R 1 tex weighs 1 g per 1000 m, and the weight per metre of the sample twine is 11.25/5 = 2.25 g/m. So, 1000 m of the sample would weigh 1000 x 2.25 = 2250 g, or R 2250 tex

Note : *The strength of twine or rope depends not only on its thickness, but also on the method and degree of twisting or braiding its yarns*

Twine: equivalents of numbering systems



Eg.: twisted nylon (polyamide) twine

m/kg	Rtex g/1000m	yds/lb a/
20 000	50	9 921
13 500	75	6 696
10 000	100	4 960
6 450	155	3 199
4 250	235	2 180
3 150	317	1 562
2 500	450	1 240
2 100	476	1 041
1 800	556	893
1 600	625	794
1 420	704	704
1 250	800	620
1 150	870	570
1 060	943	526
980	1 020	486
910	1 099	451
850	1 176	422
790	1 266	392
630	1 587	313
530	1 887	263
400	2 500	198
360	2 778	179
310	3 226	154
260	3 846	129
238	4 202	118
225	4 444	112
200	5 000	99
180	5 556	89
155	6 452	77
130	7 692	64
100	10 000	50

a/ yds/lb = approx. (m/kg)/2

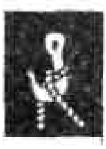
m/kg = approx. (yds/lb) x 2

No of yarns denier	No. of deniers Td	Tex
210x2	420	47
3	630	70
4	840	93
6	1 260	140
9	1 890	210
12	2 520	280
15	3 150	350
18	3 780	420
21	4 410	490
24	5 040	559
27	5 670	629
30	6 300	699
33	6 930	769
36	7 560	839
39	8 190	909
42	8 820	979
45	9 450	1 049
48	10 080	1 119
60	12 600	1 399
72	15 120	1 678
96	20 160	2 238
108	22 680	2 517
120	25 200	2 797
144	30 240	3 357
156	32 760	3 636
168	35 280	3 916
192	40 320	4 476
216	45 360	5 035
240	50 400	5 594
264	55 440	6 154
360	75 600	8 392

Note: 210 denier = 23 Tex

Twines: nylon (polyamide PA), multifilament twisted or braided

A = breaking load, dry without knots (single twine)
B = breaking load, wet, knotted (single twine)



■ Twisted, continuous filament

m/kg	Rtex	Diam. mm	A kgf	B kgf
20 000	50	0.24	3.1	1.8
13 300	75	0.24	4.6	2.7
10 000	100	0.33	6.2	3.6
6 400	155	0.40	9	6
4 350	230	0.50	14	9
3 230	310	0.60	18	11
2 560	390	0.65	22	14
2 130	470	0.73	26	16
1 850	540	0.80	30	18
1 620	620	0.85	34	21
1 430	700	0.92	39	22
1 280	780	1.05	43	24
1 160	860	1.13	47	26
1 050	950	1.16	51	28
970	1 030	1.20	55	29
830	1 200	1.33	64	34
780	1 280	1.37	67	35
700	1 430	1.40	75	40
640	1 570	1.43	82	43
590	1 690	1.5	91	47
500	2 000	1.6	110	56
385	2 600	1.9	138	73
315	3 180	2.0	165	84
294	3 400	2.2	178	90
250	4 000	2.4	210	104
200	5 000	2.75	260	125
175	6 000	2.85	320	150
125	8 000	3.35	420	190
91	11 000	3.8	560	250

■ Braided, continuous filament

m/kg	Rtex	Diam. Approx . mm	A kgf	B kgf
740	1 350	1.50	82	44
645	1 550	1.65	92	49
590	1 700	1.80	95	52
515	1 950	1.95	110	60
410	2 450	2.30	138	74
360	2 800	2.47	154	81
280	3 550	2.87	195	99
250	4 000	3.10	220	112
233	4 300	3.25	235	117
200	5 000	3.60	270	135
167	6 000	4.05	320	155
139	7 200	4.50	360	178
115	8 700	4.95	435	215
108	9 300	6.13	460	225
95	10 500	5.40	520	245
81	12 300	5.74	600	275
71	14 000	5.93	680	315
57	17 500	6.08	840	390

Twine, nylon (polyamide PA), monofilament and multimonofilament, Japanese numbering system

A = breaking load, dry without knots (single twine)
B = breaking load, wet, knotted (single twine)

Diam. mm	m/kg	Tex*	A kgf	B kgf
0.10	90 900	11	0.65	0.4
0.12	62 500	16	0.9	0.55
0.15	43 500	23	1.3	0.75
0.18	33 300	30	1.6	1.0
0.20	22 700	44	2.3	1.4
0.25	17 200	58	3.1	1.8
0.30	11 100	90	4.7	2.7
0.35	8 330	120	6.3	3.6
0.40	6 450	155	7.7	4.4
0.45	5 400	185	9.5	5.5
0.50	4 170	240	12	6.5
0.55	3 570	280	14	7.5
0.60	3 030	330	17	8.8
0.70	2 080	480	24	12.5
0.80	1 670	600	29	15
0.90	1 320	755	36	19
1.00	1 090	920	42	22
1.10	900	1 110	47	25
1.20	760	1 320	55	30
1.30	650	1 540	65	35
1.40	560	1 790	75	40
1.50	490	2 060	86	46
1.60	430	2 330	98	52
1.70	380	2 630	110	58
1.80	340	2 960	120	65
1.90	300	3 290	132	72
2.00	270	3 640	145	75
2.50	180	5 630	220	113

Japanese numbering system for Monofilament

N' Japan	Diam. (mm)	N" Japan	diam. (mm)
	0.20		0.55
2	-	12	-
	0.25		0.60
3		14	
	0.30		0.70
4	-	18	-
	0.35		0.80
5	-	24	
	0.40	30	0.90
6	-		
7	0.45		
8	0.50		
10	-		

■ **Multimonofilament**

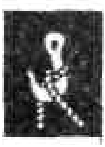
Diameter* x number of (mm) filaments	m/kg	A Kgf
0.20 x 4	6 250	9
0.20 X 6	4 255	14
0.20 x 8	3 125	18
0.20 x 10	2 630	24
0.20 x 12	2 120	26

** for monofilament, tex and Rtex are the same.*

Twine: polyester (PES), polyethylene (PE), polypropylene (PP)

A = breaking load, dry without knots (single twine)

B = breaking load, wet, knotted (single twine)



POLYESTER (PES)

■ **twisted, continuous filaments**

m/kg	Rtex	Diam. mm	A kgf*	B kgf
11 100	90	0.40	5.3	2.8
5 550	80	0.50	10.5	5
3 640	275		16	7.3
2 700	370	0.60	21	9.3
2 180	460	0.70	27	12
1 800	555	0.75	32	14
1 500	670	0.80	37	16
1 330	750	0.85	42	18
1 200	830	0.90	46	20
1 080	925	0.95	50	22
1 020	980	1.00	54	24
900	1 110	1.05	60	26
830	1 200	1.10	63	28
775	1 290	1.15	68	29
725	1 380	1.20	73	30
665	1 500	1.25	78	32
540	1 850	1.35	96	40
270	3 700	1.95	180	78

POLYETHYLENE (PE)

■ **twisted or braided thick filaments**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
5 260	190	0.50	7.5	5.5
2 700	370	0.78	10	7
1 430	700	1.12	27	19
950	1 050	1.42	36	24
710	1 410	1.64	49	35
570	1 760	1.83	60	84
460	2 170	2.04	75	54
360	2 800	2.33	93	67
294	3 400	2.56	116	83
225	4 440	2.92	135	97
190	5 300	3.19	170	125
130	7 680	3.68	218	160
100	10 100	3.96	290	210

POLYPROPYLENE (PP)

■ **twisted, continuous filaments**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
4 760	210	0.60	13	8
3 470	290	0.72	15	9
2 780	360	0.81	19	11
2 330	430	0.90	25	14
1 820	550	1.02	28	15
1 560	640	1.10	38	19
1 090	920	1.34	44	23
840	119011	1.54	58	30
690	10	1.70	71	36
520	1 920	1.95	92	47
440	2 290	2.12	112	59
350	2 820	2.32	132	70
300	3 300	2.52	152	80
210	4 700	2.94	190	100
177	5 640	3.18	254	130

■ **twisted staple fibres**

m/kg	Rtex	Diam. approx. mm	A kgf	B kgf
4 760	210	0.60	9	6
3 330	300	0.73	13	9
2 560	390	0.85	18	12
1 250	800	1.22	32	22
1 010	990	1.36	38	24
720	1 390	1.62	57	36
530	1 900	1.94	73	46
420	2 360	2.18	86	54
325	3 070	2.48	100	59
240	4 100	2.90	150	88
185	5 400	3.38	215	120
150	6 660	3.82	300	170

Vegetable fibre ropes*

Tarred Cotton		
Diameter mm	kg/100 m	R kgf
3.0	1.056	45
3.5	1.188	55
4.0	1.320	66
4.5	1.585	77
5.0	1.915	88
5.5	2.448	100
6.0	2.905	113
6.5	3.300	127

Sisal				
Diameter mm"	Standard		Extra	
	kg / 100 m	R kgf	kg/ 100 m	R kgf
6	2.3	192	3.3	336
8	3.5	290	4.7	505
10	6.4	487	6.4	619
11	8.4	598	9.0	924
13	10.9	800	11.0	1 027
14	12.5	915	14.0	1 285
16	17.0	1 100	17.2	1 550
19	24.5	1630	25.3	2 230
21	28.1	1 760	29.30	2 390
24	38.3	2 720	39.5	3 425
29	54.5	3 370	56.0	4 640
32	68.0	4 0501	70.0	5510
37	90.0	5 220	92.0	7 480
40				
48				

R = Breaking strength, dry Safe working load, see page 5

" In English-speaking countries the size of a rope is sometimes measured by its circumference in inches (in.)

or by its diameter in inches Diameter of rope 0 *(mm) = approx. 8 x c (inch)*

Example: 0 *(mm) of a rope of 2.25 inch circumference*

0 *(mm) = 2.25 x 8=18 mm (approximate)*

Hemp				
Diameter mm"	Standard		Extra	
	kg/ 100 m	R kgf	kg/ 100 m	R kgf
10	6.6	631	7.8	600
11	8.5	745	10.0	708
13	11.3	994	13.3	944
14	14.3	1 228	17.0	1 167
16	17.2	1 449	20.3	1 376
19	25.3	2017	29.8	1 916
21	30.0	2318	35.4	2 202
24	40.2	3 091	47.4	2 936
29	59.0	4 250	70.0	4 037
32	72.8	5 175	86.0	4916
37	94.8	6 456	112.0	6 133
40	112.0	7 536	132.0	7 159
48	161.0	10 632	190.0	10 100

Manilla				
Diameter mm"	Standard		Extra	
	kg/ 100 m	R kgf	kg/ 100 m	R kgf
10	6.2	619	6.2	776
11	9.15	924	9.25	1 159
13	11.2	1 027	12.4	1 470
14	14.2	1 285	15.0	1 795
16	17.5	1 550	18.5	2 125
19	25.5	2 230	26.65	2 970
21	29.7	2 520	30.5	3 330
24	40.5	3 425	41.6	4 780
29	58.4	4 800	59.9	6 380
32	72.0	5 670	74.0	7 450
37	95.3	7 670	98.0	9 770
40	112.5	8 600	115.8	11 120
48				

Synthetic fibre rope*

Diameter mm"	Polyamide kg/100	(PA) R kgf	Polyethyene kg/100m	(PE) Rkgf	Polyester kg/100m	(PES) R kgf	Polypropyene Kg/100m	(PP) Rkgf
4	1.1	320			1.4	295	_	.
6	2.4	750	1.7	400	3	565	1.7	550
8	4.2	1 350	3	685	5.1	1 020	3	960
10	6.5	2 080	4.7	1 010	8.1	1 590	4.5	1 425
12	9.4	3 000	6.7	1 450	11.6	2 270	6.5	2 030
14	12.8	4 100	9.1	1 950	15.7	3 180	9	2 790
16	16.6	5 300	12	2 520	20.5	4 060	11.5	3 500
18	21	6 700	15	3 020	26	5 080	14.8	4 450
20	26	8 300	18.6	3 720	32	6 350	18	5 370
22	31.5	10 000	22.5	4 500	38.4	7 620	22	6 500
24	37.5	12 000	27	5 250	46	9 140	26	7 600
26	44	14 000	31.5	6 130	53.7	10 700	30.5	8 900
28	51	15 800	36.5	7 080	63	12 200	35.5	10 100
30	58.5	17 800	42	8 050	71.9	13 700	40.5	11 500
32	66.5	20 000	47.6	9 150	82	15 700	46	12 800
36	84	24 800	60	11 400	104	19 300	58.5	16 100
40	104	30 000	74.5	14 000	128	23 900	72	19 400

R = breaking strength, dry

Direction of twist of twines, ropes and cables

Left hand laid

Right hand laid

' *Safe working load see page 5*

'' *Conversioninch-mm, seepage 15*

Rope: joining knots and loops

Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

■ Joining two cords

Two cords of the same diameter, multifilament

Reef knot

Fisherman's knot

Two cords of same diameter, monofilament

Two cords of different diameters or different types

Double sheet bend

Sheet bend (sufficient if the two ends are tied)

Sheet bends are also useful for joining two identical cords

■ Loops

Fixed loop

Simple bowline

Chair knot

Running loop

Running bowline

Knots for stoppers and mooring

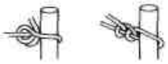
Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

■ **For stopping a rope from running through a narrow space** (i.e. sheave)

Figure of eight

■ **Knots for mooring**

Clove hitch



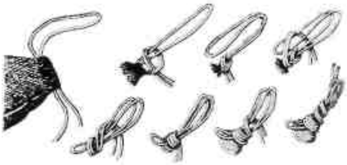
Round turn and two half hitches

Double sheet bend

Anchor bend

■ **To close the codend of a trawl**

(codend knot)



■ **To shorten a rope**

Sheepshank
(not effective with monofilament)

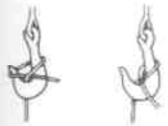
Knots for hitches and stoppers

Some knots are used more than others. In selecting which knot to use the following points should be considered : — the use of the knot — the type of rope — whether the knot will slip — whether the knot is permanent.

Single or double blackwall hitch

Mousing a hook

A catspaw



Midshipman's hitch

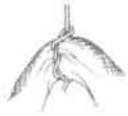
Catspaw

Rolling hitch

Timber hitch

Cow hitch
(sling looped around load)

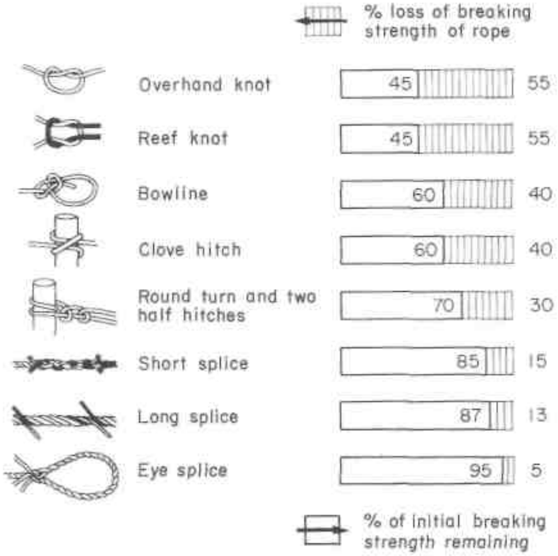
Becket hitch
(often used to lift codend)



Timber hitch

Stopper hitch

Loss of breaking strength due to knots and splices



Combination wire (1)*

■ Steel - Sisal 3 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
10	0.094	1 010	0.103	910
12	0.135	1 420	0.147	1 285
14	0.183	1 900	0.200	1 750
16	0.235	2 400	0.255	2 200
18	0.300	3 100	0.325	2 800
20	0.370	3 800	0.405	3 500
22	0.445	4 600	0.485	4 200
25	0.565	5 700	0.615	5 300
28	0.700	7 500	0.760	6 700
30	0.820	8 400	0.885	7 600

■ Steel - Sisal 4 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
12	0.135	1 420	0.147	1 285
14	0.183	1 900	0.200	1 750
16	0.235	2 400	0.255	2 200
18	0.300	3 100	0.325	2 800
20	0.370	3 800	0.405	3 500
22	0.445	4 600	0.485	4 200
25	0.565	5 700	0.615	5 300
28	0.700	7 200	0.760	6 400
30	0.775	8 400	0.840	7 600

R = Breaking strength dry

**Safe working loads, see page 5*

22 Combination wire (2)*

■ Steel -Manilla B, 4 strands

Diameter (mm)	Untreated		Tarred	
	kg/m	Rkgf	kg/m	Rkgf
12	0.138	1 500	0.150	1 370
14	0.185	2 000	0.205	1 850
16	0.240	2 500	0.260	2 350
18	0.305	3 300	0.335	3 000
20	0.380	4 000	0.410	3 800
22	0.455	5 000	0.495	4 600
25	0.575	6 200	0.630	5 700
28	0.710	7 600	0.775	6 900
30	0.790	8 900	0.860	8 200
32	0.890	9 500	0.970	8 750
34	1.010	11 200	1.100	10 200
36	1.140	12 000	1.235	11 000
40	1.380	15 000	1.495	14000
45	1.706	18 500	1.860	17 500
50	2.045	22 500	2.220	20 000

■ Steel - Polypropylene

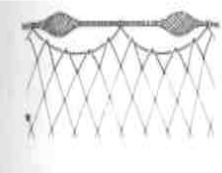
Diameter (mm)	Number of strands	kg/m	Rkgf
10	3	0.105	1 230
12	3	0.120	1 345
14	3	0.140	1 540
16	3	0.165	2 070
18	3	0.240	3 000
14	6	0.250	4 000
16	6	0.275	4 400
18	6	0.350	5 300
20	6	0.430	6 400
22	6	0.480	7 200
24	6	0.520	7 800
26	6	0.640	9 700

R = **Breaking strength dry**

** Safe working loads, see page 5*

Floatlines and leadlines

■ **Floatline (with floats inside)**



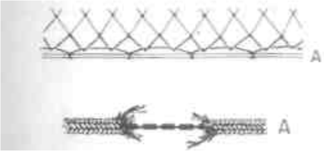
Principal advantages (1) and disadvantages (2)

1) Ease of rigging; less entanglement in the meshes.
2) Need to calculate the rigging as a function of the distance between the floats; fragility of some types of float when passing through certain gillnet haulers.

Floatline (with floats inside)

Interval between floats (cm)	Flotation gf/100m
52	480
47	500
35	570
20	840
35	2850
20	3 000

■ **Leadline (with leads inside)**



Principal advantages (i) and disadvantages (2)

1) Ease of rigging; uniform weight of leadline; better hanging; no entanglement in meshes.
2) In the case of breaking, loss of leads; difficult to repair; high cost.

Braided with a centre core of lead

Diameter (mm)	kg/100 m	Rkgf
2	2.3 - 3.5	73
2.5	4.6	
3	6.5-7.1	100
3.5	9.1	
4	11.1 -12.3	200
4.5	14.5	
5	15.2-18.1	300

Diameter (mm)	kg/100m	Rkgf
7.2	7.5	360
8	12.5	360
8	18.8	360
9.5	21.3	360
9.5	23.8	360
9.5	27.5	360
11.1	30.0	360
12.7	37.5	675

Rope with a lead core in three strands

Diameter	kg/100m	Rkgf
6	8.7	495
7	11.2	675
8	13.3	865
10	21.6	1 280
12	26.6	1 825
14	33.0	2510

R = breaking strength

there are also leadlines
of 0.75; 0.90; 1.2; 1.5; 1.8 kg/100m

Steel wire rope: structure, diameter and use

Examples of common marine wire rope

Type	Structure and diameter	Example of Use	S
	7x7(6/1) central heart: steel ∅ 12 to 28 mm	Standing rigging	+
	6x7 (6/1) Central heart: textile ∅ 8 to 16 mm	Standing rigging Warps for small trawlers Small coastal vessels	+
	6x12(12/fibre) Central heart, strand cores, fibre ∅ 8 to 16 mm	Bridles and warps for small trawlers moorings and running rigging	++
	6x19 (9/9/1) Central heart of steel or textile ∅ 16to30mm	Trawler warps	+
	6x19(12/6/1) Central heart of textile ∅ 8 to 30 mm	Trawler's sweeps and warps running rigging	+
	6x24(15/9/fibre) Central heart and strand cores of textile ∅ 8 to 40 mm	Purse wire bridles and otter board strops, running rigging moorings and towing	++
	6x37(18/12/6/1) Central heart of textile ∅ 20 to 72 mm	Purse wire moorings and running rigging mooring	++

S = flexibility
+ = poor or average
++ = good

As a general rule, the greater the number of strands, and the greater the number of filaments per strand, the greater the flexibility of the cable.

Galvanised steel wire rope: runnage. breaking strength*

(for structure, see page 24) examples

6x7 (6/1)

diam. mm	kg/ 100 m	R kgf
8	22.2	3 080
9	28.1	3 900
10	34.7	4 820
11	42.0	5 830
12	50.0	6 940
13	58.6	8 140
14	68.0	9 440
15	78.1	10 800
16	88.8	12 300

6x12 (12/fibre)

diam. mm	kg/ 100 m	R kgf
6	9.9	1 100
8	15.6	1 940
9	19.7	2 450
10	24.3	3 020
12	35.0	4 350
14	47.7	5 930
16	62.3	7 740

6x19(9/9/1)

diam. mm	kg/ 100 m	R kgf
16	92.6	12 300
17	105	13 900
18	117	15 500
19	131	17 300
20	145	19 200
21	160	21 200
22	175	23 200
23	191	25 400
24	208	27 600
25	226	30 000
26	245	32 400

6x19(12/6/1)

diam. mm	kg/ 100 m	R kgf
8	21.5	2 850
10	33.6	4 460
12	48.4	6 420
14	65.8	8 730
16	86.0	11 400
18	109	14 400
20	134	17 800
22	163	21 600
24	193	25 700

6 x24(15/9/fibre)

Diam mm	kg/ 100 m	R kgf
8	19.8	2 600
10	30.9	4 060
12	44.5	5 850
14	60.6	7 960
16	79.1	10 400
18	100	13 200
20	124	16 200
21	136	17 900
22	150	19 700
24	178	23 400
26	209	27 500

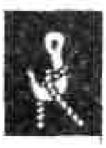
6x 37 (18/12/6/1)

diam mm	kg/ 100 m	R kgf
20	134	17 100
22	163	20 700
24	193	24 600
26	227	28 900

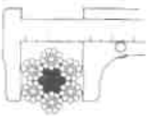
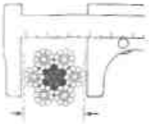
R = Breaking strength

(steel 145 kgf/mm^2)

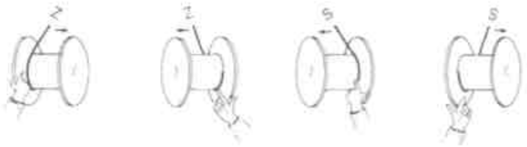
** Safe Working Loads, see page 5*



26 Handling wire rope

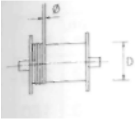
NO	YES
	
	
	
	
	

■ Winding onto a drum depending on the direction of lay in a wire



Matching wire ropes with drums and sheaves

■ **Drums:**

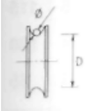


the diameter of a drum (D) relative to the diameter of the wire rope (0) to be held on the drum —

D/ ∅ depends on the structure of the wire rope, and depending on the particular situation, D should range from 20 ∅ to 48 ∅. In practical use on board fishing vessels, depending on the space available, the following values are common :

D = 14 ∅ or more

■ **Sheaves :**

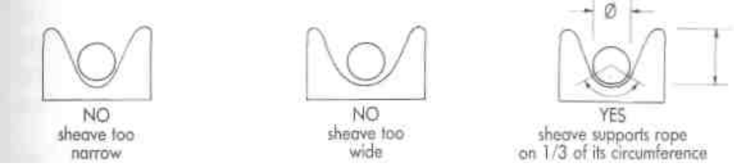


The diameter of a sheave (D) relative to the diameter of the wire rope (0) to be used with the sheave —

D/ ∅ depends on the structure of the wire rope, and depending on the particular situation, D should range from 20 ∅ to 48 ∅. In practical use on board fishing vessels, depending on the space available, the following values are common:

D = 9 ∅ or more

Width of sheave relative to the diameter of the wire rope



■ **Location of sheave relative to drum**

Maximum fleet angle of a steel wire between a fixed sheave and a drum with manual or automatic spooling gear:

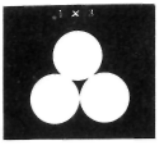
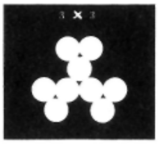
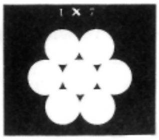
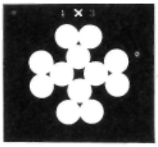
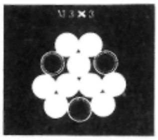
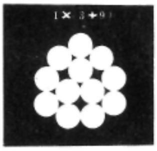
L - C x 5 (or more); C x 11 is recommended

(In order to let a sheave shift with changing wire angles, it is often better to use a flexibly attached block rather than a fixed sheave.)

■ **Cable clamps should be fastened with nuts on the standing part of the wire**

Steel wire rope, small diameter

■ Stainless steel, heat treated and painted (examples)

Construction	diam. mm	R kgf	Construction	diam. mm	R kgf
	1.00 0.91 0.82 0.75 0.69 0.64 0.58	75 60 50 45 40 34 28		2.2 2.0 1.8 1.6 1.5 1.4 1.3	220 180 155 130 115 100 85
	1.5 1.4 1.3 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.6	210 170 155 140 120 100 90 75 65 50 40 30		2.4 2.2 2.0 1.8 1.6 1.5 1.4	290 245 200 175 155 130 110
	2.2 2.0 1.8 1.6 1.5	290 245 200 175 155		1.9 1.8 1.6 1.5 1.3 1.2 1.1	290 245 200 175 155 135 110

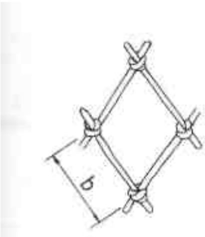
■ Galvanised steel, not lubricated

Diameter mm	Number of		Diameter of wires mm	kg/m	Rkat (steel 80 - 90 kgf/mm)
	Strands	Wires			
2	5	1 plus 6	0.25	0.016	125
3	6	1 plus 6	0.30	0.028	215
4	6	1 plus 6	0.40	0.049	380
5	6	7	0.50	0.081	600
6	6	9	0.50	0.110	775

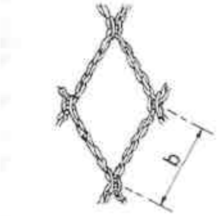
R = breaking stength

Meshes: Definition

■ Types of mesh nets



Knotted netting

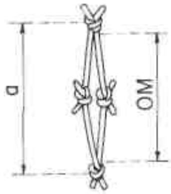


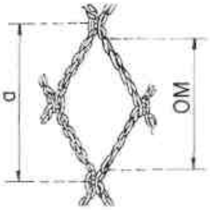
Knotted netting (Raschel type)

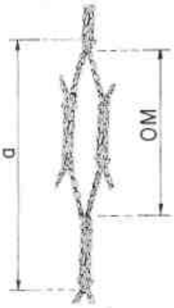
Hexagonal mesh

b = bar length

■ Dimension of mesh, stretched mesh (a), and mesh opening (OM)







Meshes of metallic or plastic netting
see page 107

Systems of measuring net meshes in different countries

	SYSTEM	PLACES USED	TYPE OF MEASURE
a	stretched mesh	international	distance (N direction) between the centres of the 2 opposite knots of a stretched mesh *
OM	mesh opening	international	maximum inside measure (N direction) between the 2 opposite knots of a stretched mesh *
b	bar length	some European countries	length of one bar of mesh
P	pasada	Spain, Portugal	number of meshes per 200 mm
On	omfar	Norway, Iceland	half the number of meshes per Alen (1 Alen = 628 mm)
Os	omfar	Sweden	half the number of meshes per Alen (1 Alen = 594 mm)
R	rows	Netherlands, UK	number of rows of knots per yard (1 yard = 910 mm)
N	knots	Spain, Portugal	number of knots per metre
F	Fushi or Setsu	Japan	number of knots per 6 inches (6 inches = 152 mm)
	Conversions		
	$a\ (\text{mm}) = \frac{200}{P} = \frac{1260}{O_n} = \frac{1190}{O_s} = \frac{1830}{R} = \frac{2000}{(N-1)} = \frac{300}{(F-1)}$		

* Note that stretched meshsize is not the same as mesh opening, which is considered in many fisheries regulations.

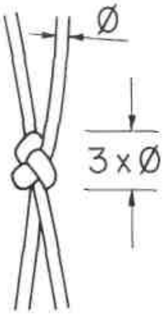
A simple method of measuring stretched meshsize is as follows: extend a panel of twine fully in the N direction (see page 32 for N direction), and measure the distance between the centres of 2 knots (or connexions) separated by 10 meshes. Then divide this measure by 10.

Knots and edges or selvedges

■ Knots

Sheet bend

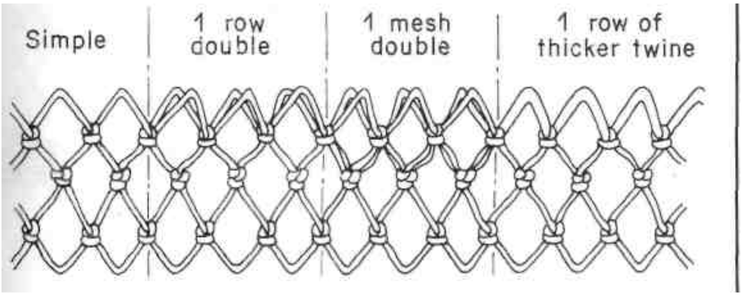
Double sheet bend



The height of the single knot is approximately equal to three times the diameter of the twine.

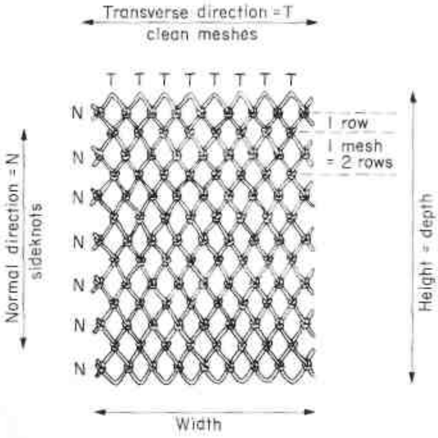
Reef knot

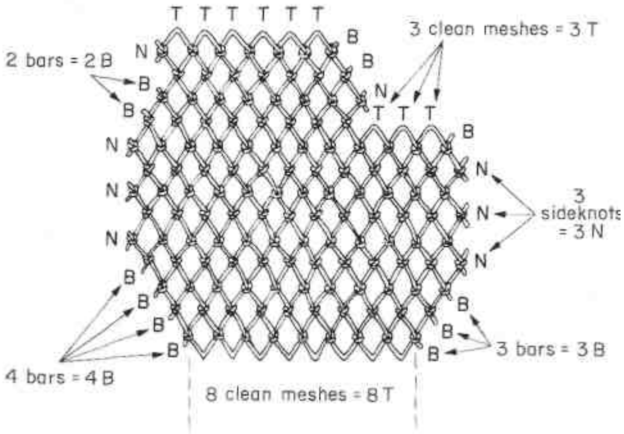
■ Edges and selvedges



NET WEBBING

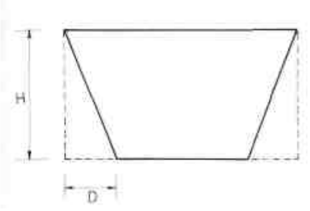
Definition of cuts





Cutting rates

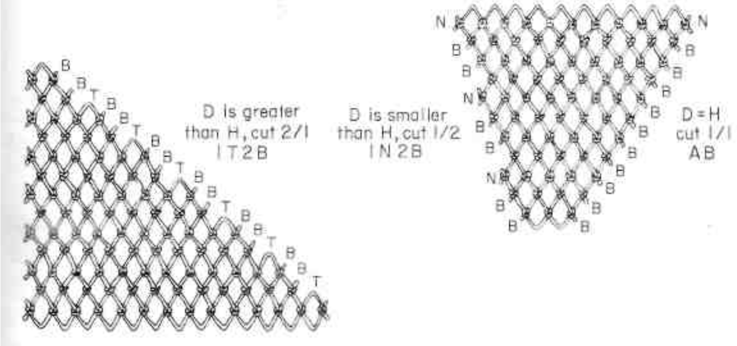
■ Cutting rate



D = number of meshes to decrease
H = number of meshes in height

■ Values of the parts of a cut

	Bars B	Sideknots N	Meshes T	1T2B	4N3B
Decrease in meshes D	0.5	0	1	1 +2x0.5	4x0 + 3x0.5
Height in meshes H	0.5	1	0	0 + 2x0.5	4x1 + 3x0.5
Value $\frac{D}{H}$	$\frac{0.5}{0.5}$	$\frac{0}{1}$	$\frac{1}{0}$	$\frac{2}{1}$	1.5/ 5.5=3/11



Common cutting rates and tapers

Number of meshes decreasing (or increasing) in width

Number of meshes in height (or depth)

	1	2	3	4	5	6	7	8	9	10
1	AB	1T2B	1T1B	3T2B	2T1B	5T2B	3T1B	7T2B	4T1B	9T2B
2	1N2B	AB	1T4B	1T2B	3T4B	1T1B	5T4B	3T2B	7T4B	2T1B
3	1N1B	1N4B	AB	1T6B	1 T3B	1T2B	2T3B	5T6B	1T1B	7T6B
4	3N2B	1N2B	1N6B	AB	1T8B	1T4B	3T8B	1T2B	5T8B	3T4B
5	2N1B	3N4B	1N3B	1N8B	AB	1T10B	1T5B	3T10B	2T5B	1T2B
6	5N2B	1N1B	1N2B	1N4B	1N10B	AB	1T12B	1T6B	1T4B	1T3B
7	3N1B	5N4B	2N3B	3N8B	1N5B	1N12B	AB	1T14B	1T7B	3T14B
8	7N2B	3N2B	5N6B	1N2B	3N10B	1N6B	1N14B	AB	1T16B	1T8B
9	4N1B	7N4B	1N1B	5N8B	2N5B	1N4B	1N7B	1N16B	AB	1T18B
10	9N2B	2N1B	7N6B	3N4B	1N2B	1N3B	3N14B	1N8B	1N18B	AB
11	5N1B	9N4B	4N3B	7N8B	3N5B	5N12B	2N7B	3N16B	1N9B	1N20B
12	11N2B	5N2B	3N2B	1MB	7N10B	1N2B	5N14B	1N4B	1N6B	1N10B
13	6N1B	11N4B	5N3B	9N8B	4N5B	7N12B	3N7B	5N16B	2N9B	3N20B
14	13N2B	3N1B	11N6B	5N4B	9N10B	2N3B	1N2B	3N8B	5N18B	1N5B
15	7MB	13N4B	2N1B	11N8B	1MB	3N4B	4N7B	7N16B	1N3B	1N4B
16	15N2B	7N2B	13N6B	3M2B	11N10B	5N6B	9N14B	1N2B	7N18B	3N10B
17	8N1B	15N4B	7N3B	13N8B	6N5B	11N12B	5N7B	9N16B	4N9B	7N20B
18	17N2B	4N1B	5N2B	7N4B	13N10B	1MB	11N14B	5N8B	1N2B	2N5B
19	9N1B	17N4B	8N3B	15N8B	7N5B	13M12B	6N7B	11N16B	5N9B	9N20B

N = Sideknots
T = Meshes
B = Bars

Estimation of weight of netting

■ **Knotless netting**

W = H x L x Rtex/1000 = H x L x (1000/m/kg)

■ **Knotted netting**

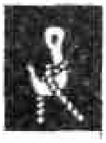
W = H x L x Rtex/1000 x K = H x L x (1000/m/ka)

Where

W = H x L x Rtex/1000 x K = H x L x (1000/m/ka)
W = estimated weight (g) of netting
H = number of rows of knots in the height of the netting 2 x number of meshes
L = Stretched length (m) of netting
Rtex and m/kg = the size of twine in the netting
K = knot correction factor to take into account the weight of the knots (single knot); see table below

K = (knot correction factor) for different netting panels

Stretched meshsize (mm)	Twine diameter (d) in mm							
	0.25	0.50	0.75	1.00	1.50	2.00	3.00	4.00
20	1.20	1.40	1.60	1.80	1.80	-	-	-
30	1.13	1.27	1.40	1.53	1.60	2.07	-	-
40	1.10	1.20	1.30	1.40		1.80	-	-
50	1.08	1.16	1.24	1.32	1.48	1.64	1.96	2.07
60	1.07	1.13	1.20	1.27	1.40	1.53	1.80	1.80
80	1.05	1.10	1.15	1.20	1.30	1.40	1.60	
100	1.04	1.08	1.12	1.16	1.24	1.32	1.48	1.64
120	1.03	1.07	1.10	1.13	1.20	1.27	1.40	1.53
140	1.03	1.06	1.09	1.11	1.17	1.23	1.34	1.46
160	1.02	1.05	1.07	1.10	1.15	1.20	1.30	1.40
200	1.02	1.04	1.06	1.08	1.12	1.16	1.24	1.32
400		1.02	1.03	1.04	1.06	1.08	1.12	1.16
800	-	-	-	1.02	1.03	1.04	1.06	1.08
1 600	-	-	-	-	-	1.02	1.03	1.04

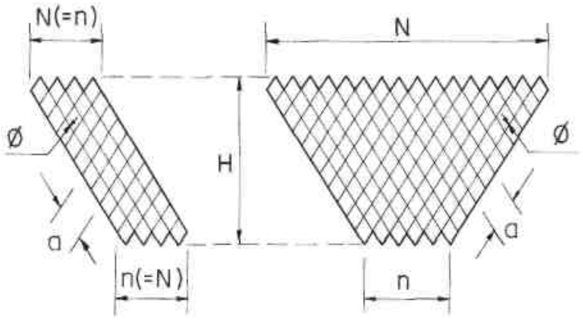


***Example** :* Knotted netting of twisted nylon twine, R1690 tex (590 m/kg), 100 mm bar length (200 mm stretched mesh length), height 50 meshes, length 100 meshes
50 meshes = 100 rows of knots in height
Stretched length = 100 meshes x 0.200 m = 20 m
Diameter of twisted polyamide twine 1690 Rtex = 1.5 mm (see page 12)
K in the table above =1.12 (stretched mesh 200 mm; diameter 1.5 mm)
W= 100 x 20 x (1690/1000) x 1.12 = 3785 g = about 3.8 kg

Calculating twine surface area

The drag of a net is proportional to the number and type of meshes in the netting, and to the orientation of the net panel(s) in the water.

$$S = \frac{\left(\frac{N+n}{2} \times H\right) \times 2(a \times \varnothing)}{1000000}$$

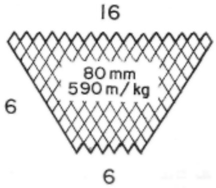


where

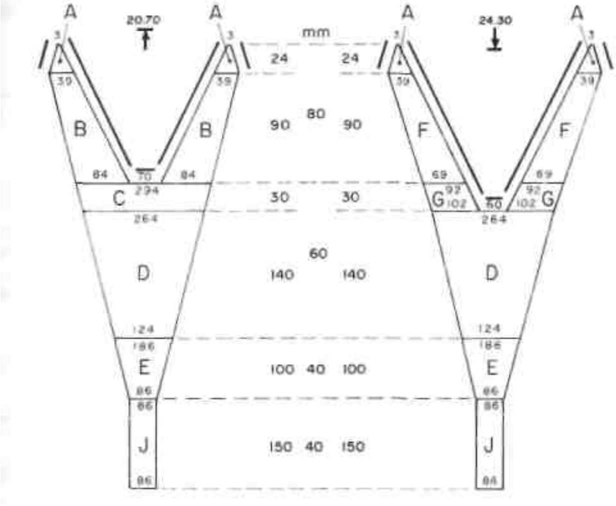
S = twine surface area (square metres)
N = number of meshes at the top of the panel
n = number of meshes at the bottom of the panel
H = number of meshes in the height of the panel
a = stretched mesh (mm)
∅ = diameter of twine (mm)

Example : In the piece of netting shown above on the right, if N = 16; n = 6; H = 6; a = 80 mm; 0 = 1.5 mm

$$\text{then} \quad S = \frac{\left(\frac{16+6}{2} \times 6\right) \times 2(80 \times 1.5)}{1\,000\,000} = 0.016 \text{ m}^2$$



Calculating twine surface area of a trawl



■ **NET WEBBING: CALCULATING TWINE SURFACE AREA OF A TRAWL**

PANEL Surface	No of Panels	$\frac{N+n}{2}$	H	$\frac{N+n}{2} xH$	A (mm)	∅ (mm)	2(a x ∅)	Twine Area
A	4	21	24	504	80	1.13	181	0.36
B	2	61	90	5490	80	1.13	181	1.99
C	1	279	30	8370	60	0.83	100	0.84
D	2	194	140	27160	60	0.83	100	5.43
E	2	136	100	13600	40	0.83	66	1.80
F	2	54	90	4860	80	1.13	181	1.76
G	2	97	30	2910	60	0.83	100	0.58
J	2	86	150	12900	40	1.13	90	2.32

Twine surface area without knots TOTAL S = 15.08 m^2

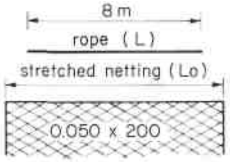
In order to compare the twine surface areas of two trawls, the trawls should be as nearly the same shape as possible. In the case of such comparisons the surfaces of the lengthening pieces and the codend (parts without oblique orientation), will cause no significant drag, and can be disregarded.

Hanging ratios, definition and calculation

■ **Hanging ratio (E) is commonly defined as** :

F = L / Lo = Length of rope on which a net panel is mounted (L) / Length of stretched netting hung on the rope (Lo)

Example: 200 meshes of 50 mm stretched mesh size hung on a rope of 8 m



$$E = \frac{8\text{ m}}{0.050\text{ m} \times 200} = \frac{8}{10} = 0.80 = 80\%$$

■ **Other expressions used for hanging ratio :**

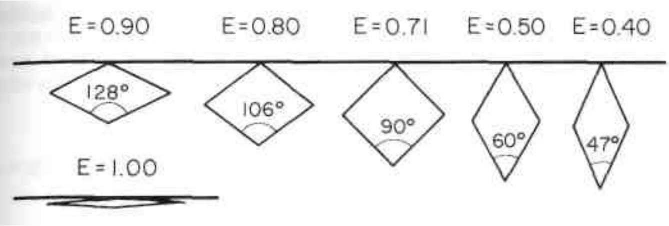
$E = \frac{L}{Lo}$ (hanging ratio)		$\frac{Lo}{L}$ (1)	$\frac{(Lo-L)}{Lo}x100$ (2)	$\frac{(Lo-L)}{R}x100$ (3)	Estimate of the height as mounted % of stretched height
0.10	10%	10	90%	900%	99%
0.20	20%	5	80%	400%	98%
0.30	30%	3.33	70%	233%	95%
0.40	40%	2.5	60%	150%	92%
0.45	45%	2.22	55%	122%	89%
0.50	50%	2.00	50%	100%	87%
0.55	55%	1.82	45%	82%	84%
0.60	60%	1.66	40%	67%	80%
0.65	65%	1.54	35%	54%	76%
0.71	71%	1.41	29%	41%	71%
0.75	75%	1.33	25%	33%	66%
0.80	80%	1.25	20%	25%	60%
0.85	85%	1.18	15%	18%	53%
0.90	90%	1.11	10%	11%	44%
0.95	95%	1.05	5%	5%	31%
0.98	98%	1.02	2%	2%	20%

1) Also called external hanging co-efficient
2) Also called percentage of hanging in — Setting in x 100 — Looseness percentage of hanging — Hang in (Asia, Japan)
3) Also called Hang in ratio (Scandinavia)

Note : It *is recommended that only the hanging ratio E be used*

Surface covered at different hanging ratios

■ **Examples of common horizontal hanging ratios**



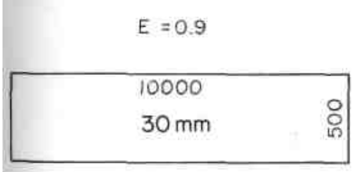
■ **Calculation of the surface covered by a piece of netting**

$$S = E \times \sqrt{1 - E^2} \times L \times H \times a^2$$

where

S = surface covered by netting (in square metres)
E = hanging ratio (horizontal)
L = number of meshes in length
H = number of meshes in height
a^2 = (stretched mesh size in metres) squared

Example:



$$S = 0.9 \times \sqrt{1 - (0.9)^2} \times 10000 \times 500 \times (0.030)^2 = 1765\ m^2$$

Note : *The surface covered is at a maximum when E = 0.71, that is when each mesh forms a square*

Mounted height of a net

■ Calculation of mounted height

The actual height of a mounted (rigged or hung) net depends on the stretched height and the hanging ratio. The general formula permitting estimation in all cases is :

$$\text{mounted height (m)} = \text{stretched height (m)} \times \sqrt{1 - E^2}$$

Where E^2 = horizontal hanging ratio multiplied by itself

***Example**:* Given the piece of netting described on the preceding page with hanging ratio of 0.90 :

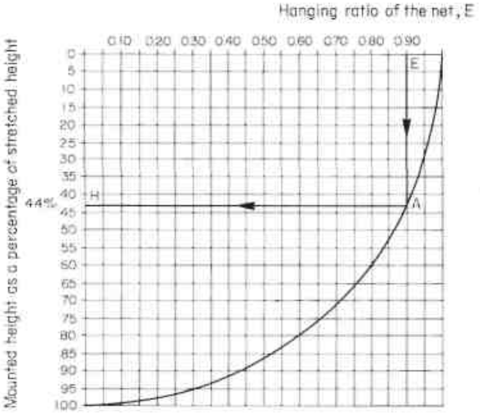
Stretched height of netting
500 meshes of 30 mm, 500 x 30 = 15000 mm = 15 m

$$\text{Mounted height} = \text{stretched height x } \sqrt{1 - E^2}$$

$$= 15 \times \sqrt{1 - (0.9)^2}$$

$$= 15 \times 0.44 = 6.6 \text{ m}$$

■ Table for estimating mounted height



Example:

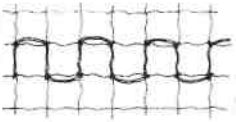
Given the piece of netting described on the preceding page, mounted with the horizontal hanging ratio 0.90, we can deduce from the table above (E to A to H) that its mounted height is 44% of the stretched height.

Stretched height = 500 meshes of 30 mm = 500 x 30 mm = 15 m
Mounted height = 44% of 15 m = 6.6 m

Joining panels of netting

■ **Netting with straight edges (i.e. AB, AT, and AN)**

Netting having the same number of meshes, and meshes of the same size, or approximately the same size.



Netting having a different number of meshes or meshes of a different size

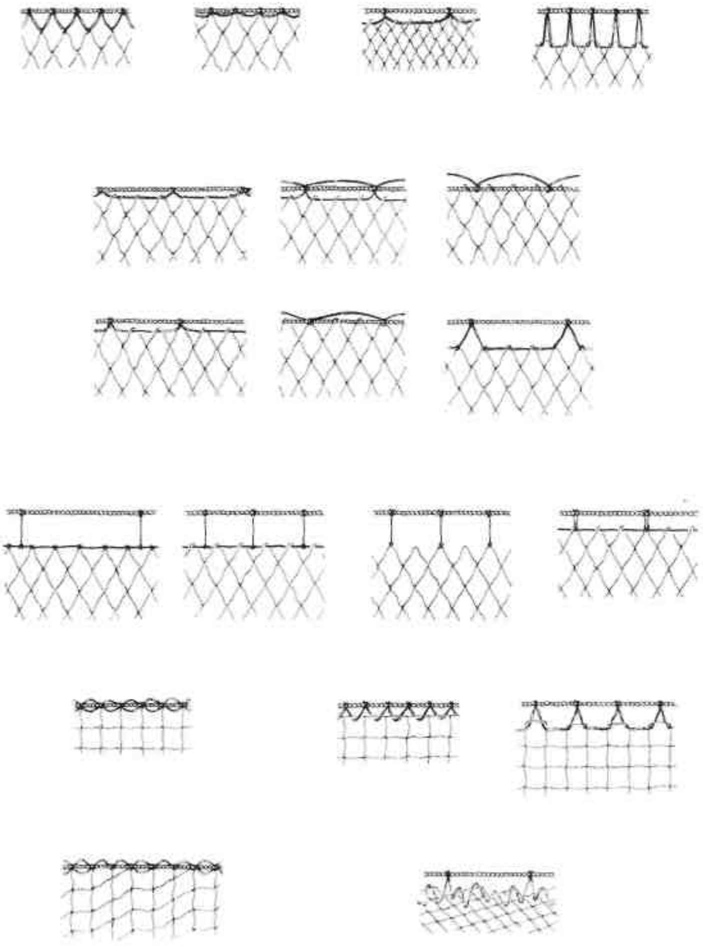
Example of joining 2/3

2 meshes of 45 mm
on 3 meshes of 30 mm
(2 x 45 = 3 x 30)

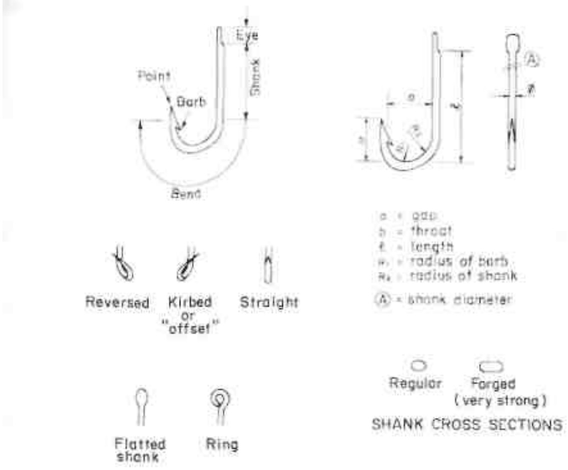
■ ***Netting cut obliquely with a combination of cuts B and N orT Pieces having a different number of meshes and different cuts***

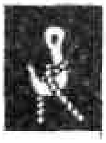
Mounting (hanging or rigging) panels of netting

Examples



Terms for describing fish hooks





■ - Examples of fish hook characteristics

Regular hooks

Number	gap (mm)	Shank diam. (mm)
12 11 10	9.5 10 11	1 1 1
9 8 7	12.5 14 15	1.5 1.5 2
6 5 4	16 18 20	2 2.5 3
3 2 1	23 26.5 31	3 3.5 4
1/0	35	4.5

Forged hooks

Number	gap (mm)	Shank diam. (mm)
2 1 1/0	10 11 12	1 1 1
2/0 3/0 4/0	13 14.5 16.5	1.5 1.5 2
5/0 6/0 8/0	10 27 29	2.5 3 3.5
10/0 12/0 14/0	31 39 50	4 5 6

Principal types of fish hooks

■ Straight hooks

'J' shape, ring eye

Circle hook

Shank bent down

Flatted shank

With swivel

■ Kirbed (offset) hooks

Kirbed, ring eye

■ Reversed hooks

Reversed, flatted shank

Large gap

■ Double and treble hooks

Double, reversed

Double, closed

Treble, straight

Treble, reversed

■ Specialised hooks for particular species or fishing methods

Trolling

Double hook,
tuna Trolling

Longlines

Flatted shank, hole in flat,
for tuna or shark

Pole and line

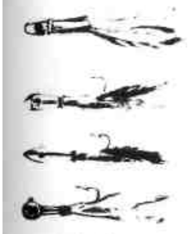
Tuna jig hook, barbless

Barbless, for tuna poles and line

Lures, knots for fish hooks

■ Lures

Flies



Feathers

Spoons

Jigs

■ Knots for ring-eyed hooks

For all twines

For multifilament; (with monofilament increase the number of turns)

Convenient for all types of twine

■ Knots for flatted shank hooks

For multifilament

Swivels, snaps, knots for longlines

■ Swivels


Barrel swivel

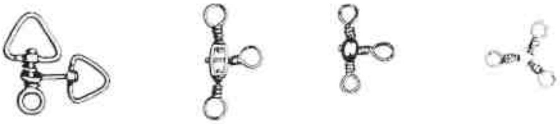

Barrel Swivel


Box swivel


Triangle swivel

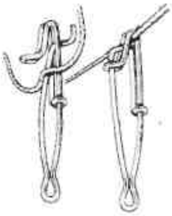

Extra strong torpedo swivel

■ Three-way swivels

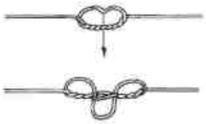


■ Snaps


Snap swivel


Snap for attaching branchline to mainline

■ Knots for joining branchline or snood to mainline

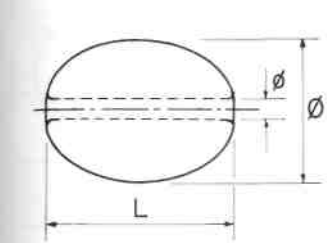

Dropper loop

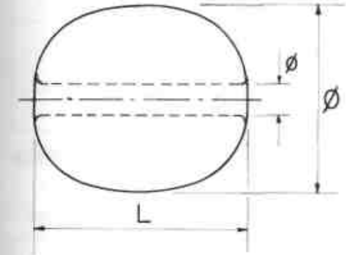

Gangion knot (multifilament, loop for hook)


Snood to mainline (multifilament)

■ Knots for joining branchline to snood

Floats for seines: examples





There are a great variety of seine floats, with L ranging from 100 to 400 mm; 0 from 75 to 300 mm; and buoyancy from 300 to 22 000 gf.

Durability is a most important characteristic of a seine float.

Examples *:* in expanded PVC, two types of manufacture

L	Ø	Ø	Wt. (g) in air	buoyancy kgf
195	150	28	350	2.2
203	152	28	412	2.2
203	175	28	515	3.0

L	Ø	Ø	Wt. (g) in air	buoyancy kgf
192	146	26	326	2.4
198	151	28	322	2.5
198	174	33	490	3.5

For the dimensions given, the buoyancy varies depending on the material.

Rough estimation of the buoyancy may be found by measuring the float.

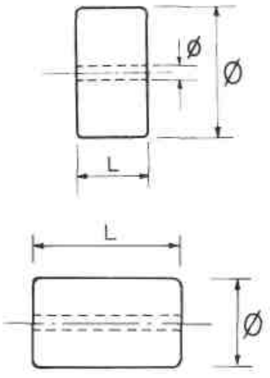
$$\text{buoyancy (gf)} = 0.5 \text{ to } 0.6 \times L \text{ (cm)} \times \varnothing \text{ (cm)}^2$$

Estimation of the number of floats necessary for a seine :

$$N = \frac{1.5 \times \text{weight of ballasted net in water}}{\text{buoyancy of a float}}$$

Floats for gillnets and seines (1)

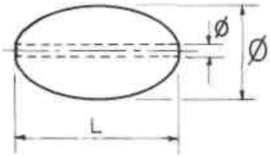
Examples



Cylindrical, expanded PVC

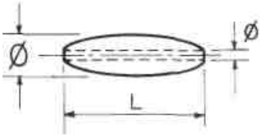
Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
30 x 50	6	30
50 x 30	8	50
50 x 40	8	67
65 x 20	8	55
65 x 40	8	110
70 x 20	12	63
70 x 30	12	95
80 X 20	12	88
80 x 30	12	131
80 x 40	12	175
80 x 75	12	330
85 x 140	12	720
100 x 40	14	275
100 x 50	14	355
100 x 75	14	530
100 x 90	14	614
100 x 100	14	690
125 x 100	19	1 060
150 x 100	25	1 523

Estimating the buoyancy from the size of the Float:
buoyancy (in gf) = 0.67 x L (cm) x Ø ^{2} (cm)^2



Ovals, expanded PVC

Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
76 x 44	8	70
88 x 51	8	100
101 x 57	10	160
140 x 89	16	560



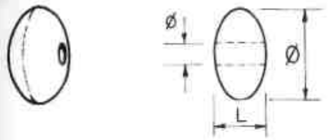
'Cigars', expanded PVC

Dimensions (mm)		Buoyancy (gf)
Ø x L	Ø	
76 x 45	8	70
89 x 51	8	100
102 x 57	10	160
140 x 89	16	560
158 x 46	8	180

Estimation of the buoyancy from the size of a float
buoyancy (in gf) = 0.5 x L (cm) x Ø ^{2} (cm)^2
Ø^2 = external diameter multiplied by itself

Floats for gillnets and seines (2)

Examples

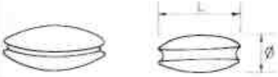


PVC

L (mm)	Ø (mm)	Ø (mm)	Buoyancy (gf)
25	32	6	20
32	58	10	60
42	75	12	110
58	66	12	175
60	70	12	200
65	75	12	220

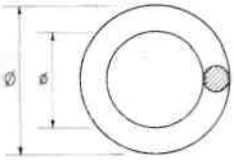
PVC

65	80	12	250



Hard plastic

58	23		8
60	25		10
72	35		25
80	40		35
100	50		100



PVC rings

Ø (mm)	Ø (mm)	Buoyancy (gf)
146	100	110
146	88	200
146	82	240
184	120	310
184	106	450
200	116	590
200	112	550

Spherical floats and trawl floats

Examples from suppliers' catalogues

		Diameter (mm)	Volume (litres)	Buoyancy kgf	Maximum depth (m)
	plastic, center hole	200 200 280	4 4 11	2.9 3.5 8.5	1 500 350 600
	plastic, side hole	75 100 125 160 200	0.2 0.5 1 2 4	0.1 0.3 0.8 1.4 3.6	400 500 400-500 400-500 400-500
	plastic, with "ears" or lugs	203	4.4	2.8	1 800
	plastic with screw lug	200 280	4 11-11.5	3.5 9	400 500-600
	Aluminium	152 191 203 254	1.8 3.6 4.4 8.6	1.3 2.7 2.8 6.4	1 190. 820 1 000 1 000

The table below shows that, for floats of equal diameter (200 mm in this case), the volume and buoyancy may vary a great deal, depending on the material and placement of holes or lugs.

Ø 200 mm	Plastic, center hole		Plastic, side hole	Plastic, with screw lug	Aluminium, with lugs
Volume	4	4	4	4	4.4
Buoyancy (kgf)	2.9	3.5	3.6	3.5	2.8

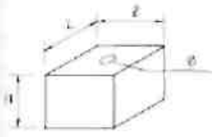
*** Note**: *The maximum effective depth of a float depends on the manufacture, and should be specified by the supplier. It cannot be deduced from the appearance, shape or colour*

Floats (buoys) for marking nets, lines and traps

Examples:

1/ Solid floats (PVC)

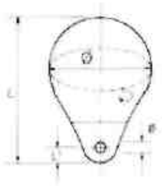
Ø (mm)	L (mm)	Ø (mm)	B (mm)	C (mm)	Buoyancy kgf
125	300	25	200	90	2.9
150	530	25	380	100	7.8
150	600	25	450	100	9.2
150	680	25	530	100	10.4
150	760	25	580	100	11.5
200	430	45	290	110	10.5



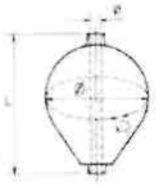
Polystyrene

L (mm)	L (mm)	H (mm)	Ø (mm)	Buoyancy kgf
300	300	200	35	12 – 15
180	180	180	25	4

2/ Inflatable floats



Ø (mm)	Ø (mm)	Ø (mm)	L (mm)	L (mm)	Buoyancy kgf
510	160	11	185	18	2
760	240	30	350	43	8
1 015	320	30	440	43	17
1 270	405	30	585	43	34
1 525	480	30	670	43	60
1 905	610	30	785	48	110
2 540	810	30	1 000	48	310

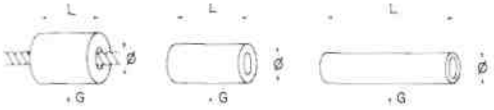


Ø (mm)	Ø (mm)	Ø (mm)	L (mm)	Buoyancy kgf
760	240	38	340	7.5
1 015	320	38	400	17
1 270	405	51	520	33.5
1 525	480	51	570	59

Groundrope leads and rings

Examples

- **Leads for ropes**



∅, diameter of the hole = diameter of rope + 3 mm approx.

L(mm)	25	38	38	32	32	32	25	45	45	45
Ø (mm)	16	16	13	10	8	6	6	5	5	6
G (g)	113	90	64	56	50	41	28	28	28	16

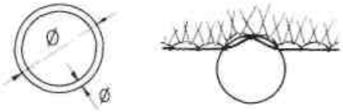
- **Leads for lines, examples of shapes**

Range of weights = 7–230 g

Cigar shaped
Range of weights = 57–900 g

- **Example of mould for leads**

- **Example of groundrope rings for a gillnet**

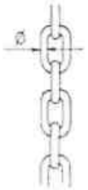


Ex:

Ø mm	Ø mm	Pg
210	5	105
220	6	128

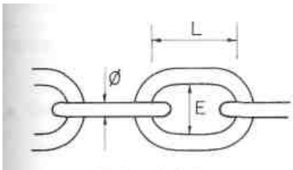
Chains and thimbles*

■ Chains



Groundrope chain

Ø mm	Approximate Weight kg/m	Ø mm	Approximate weight kg/m
5	0.5	11	2.70
6	0.75	13	3.80
7	1.00	14	4.40
8	1.35	16	5.80
9	1.90	18	7.30
10	2.25	20	9.00

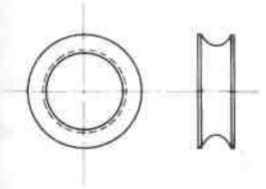


High tensile chain

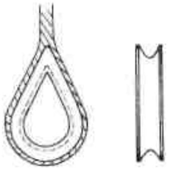
High tensile steel

Ø mm	LxE (mm)	S.W.L. Ton.f	Breaking strength Ton.F	Weight kg/m
7	21 X 10.5	1.232	6.158	1.090
10	40x15	2.514	12.570	2.207
13	52x19.5	4.250	21.240	3.720
16	64x24	6.435	32.175	5.640
19	76 X 28.5	9.000	45.370	7.140

■ Thimbles

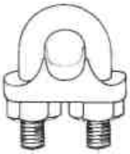


Round thimble



Oval thimble

■ Clips for wire rope

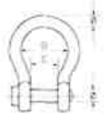


Cable clamps or 'bulldog grips'

Safe Working Load see page 5

Steel accessories for joining : shackles, links and clips*

■ Shackles


Bow shackle

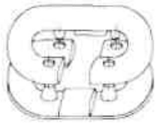

Straight shackle

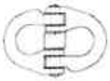

Bow shackle with countersunk screw


Straight shackle with countersunk screw

Ø (mm)	C (mm)	O (mm)	S.W.L Ton.f	B.S. Ton.f
6	12	18	0.220	1.350
8	16	24	0.375	2.250
10	20	30	0.565	3.400
12	24	36	0.750	4.500
14	28	42	1.200	7.250
16	32	48	1.830	11.000
18	36	54	2.200	13.200
20	40	65	2.600	16.000
24	40	75	3.600	22.000
30	45	100	5.830	35.000

■ Links and Clips

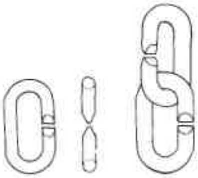

Riveted link


Lock-type connector


Screw link


Spring clip


Straight

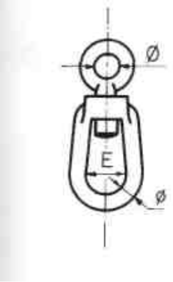

Tapered


Half-cut link

** Safe Working Load see page 5*

Swivels

- Swivel, forged steel

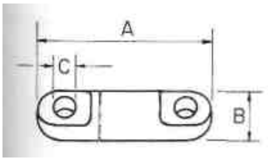


Ø (mm)	E (mm)	Ø (mm)	S.W.L.* Ton.f	B.S.** Ton.f
8	17	14	0.320	1.920
10	25	15	0.500	3.000
12	28	18	0.800	4.800
14	35	20	1.100	6.600
16	35	20	1.600	9.600
18	38	25	2.000	12.000
20	43	26	2.500	15.000
25	50	33	4.000	24.000
30	60	40	6.000	36.000

- Swivel, tempered steel and hot galvanized

Ø mm	S.W.L.* Ton.f	Weight Kg
8	0.570	0.17
16	2.360	1.12
22	4.540	2.61
32	8.170	7.14

- Swivel, high tensile stainless steel



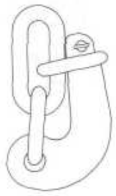
A (mm)	B (mm)	C (mm)	S.W.L.* Ton.f	B.S.** Ton.f	Weight Kg
146	48	20	3	15	1.3
174	55	27	5	25	2.1
200	62	34	6	30	2.8

* Safe working load see page 5
** Breaking strength, see page 5

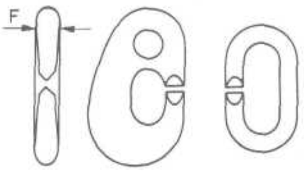
Hooks and 'G' links*

Slip hook

Swivel hook
with spring clip



Stenhouse clip
(quick release)



'G' link with
tapered cut

'G' link with
straight cut

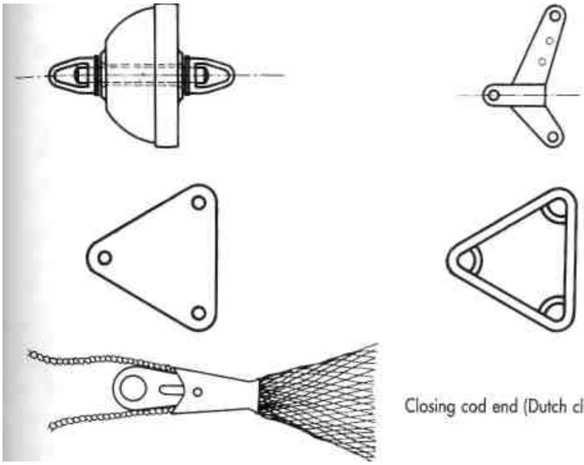
"G" link High tensile steel

F mm	S.W.L.* Ton.f	B.S.* Ton.f
25	1.1	8
30	3.6	15
34	5.0	25
38	7.0	35

** Safe working load and breaking strength see page 5*

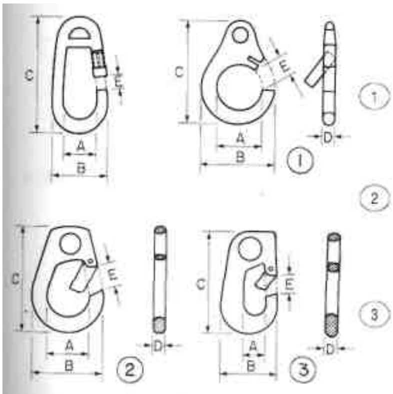
Spreaders, codend release and purse rings

■ **For trawl**



Closing cod end (Dutch clip)

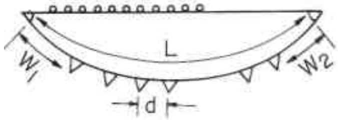
■ **For seine :** Opening purse clips or rings



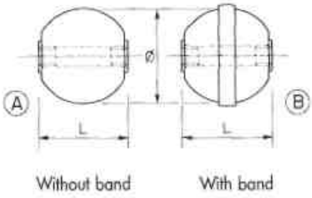
Interior Diam, mm A	Exterior Width mm B	Exterior Length mm C	Thickness Mm D	Opening Mm E	Breaking strength Ton.t	Weight kg
86	128	180	22	34	0.400	1.3
107	172	244	32	47	3.800	4.0
107	187	262	32	52	5.400	5.0
110	187	262	37	53	6.500	6.0
75	128	200	19	40	1.800	2.0
94	150	231	25	47	2.200	3.0
103	169	253	28	50	3.000	4.0
103	169	262	35	53	3.500	5.0
106	175	264	38	53	3.600	6.0
25	65	111	17	17	5.000	0.5
38	80	140	15	25	6.000	0.65
36	90	153	19	29	12.000	1.1

Number of rings required

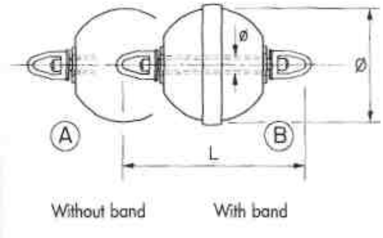
$$N = \frac{L - W_1 - W_2 + d}{d}$$



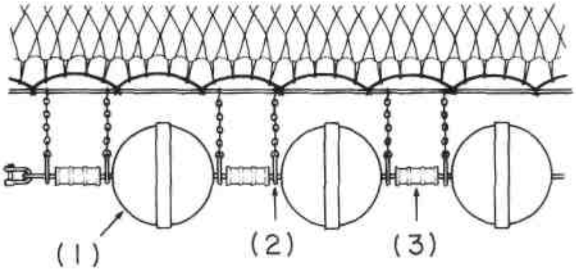
Elements of trawl groundropes: steel bobbins



Ø mm	L mm	A Weight in air Kg	B Weight in air kg
200	165	7.5	9.5
250	215	10	12.5
300	260	18	22
350	310	29	34
400	360	35	40



Ø mm	L mm	Ø mm	A Weight in air kg	B Weight in air kg
200	380	30	12	14
250	570	32	15	17.5
300	610	35	25	29
350	660	60	42	46
400	715	60	51	56



Example of rigging a groundrope with bobbins (1), chains (2} and spacers (3)

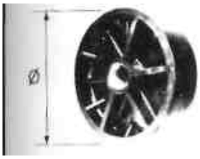
Elements of trawl groundropes: steel bobbins

Examples

- **Bunts**

Ø (mm)	229	305	356	406
Wt. in air (kg) per piece	4.40	9.10	11.80	19.50
Wt. in water (kg) per piece	0.98	2.10	2.85	4.4

- **Bobbins**



Ø (mm)	305	356	406
Wt. in air (kg) per piece	5.10	8.00	11.50
Wt. in water (kg) per piece	1.65	2.20	3.50

- **Spacers**

L(mm)	178	178
Ø (mm)	121	165
Ø (mm)	44	66
Wt. in air (kg) per piece	1.63	2.30
Wt. in water (kg) per piece	0.36	0.57

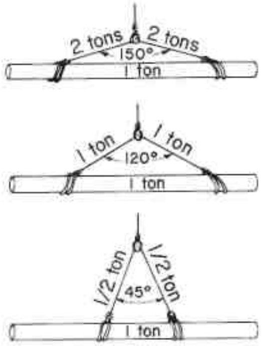
- **Rings or "cookies" (made from old tyres)**

diameter ext. Ø (mm)	60	80	110
diameter int. Ø (mm)	25	30	30
Weight* (kg/m)	2.3	3.0	7.5

diameter ext. Ø (mm)	200	240	280
diameter int. Ø (mm)	45	45	45
Weight* per piece (kg)	5.0	7.0	10.5

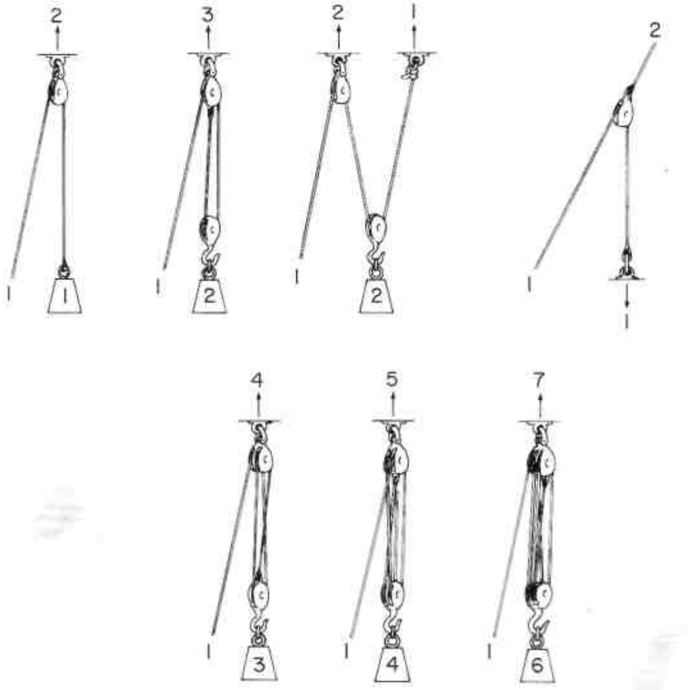
* Weight in air

Slings and tackles

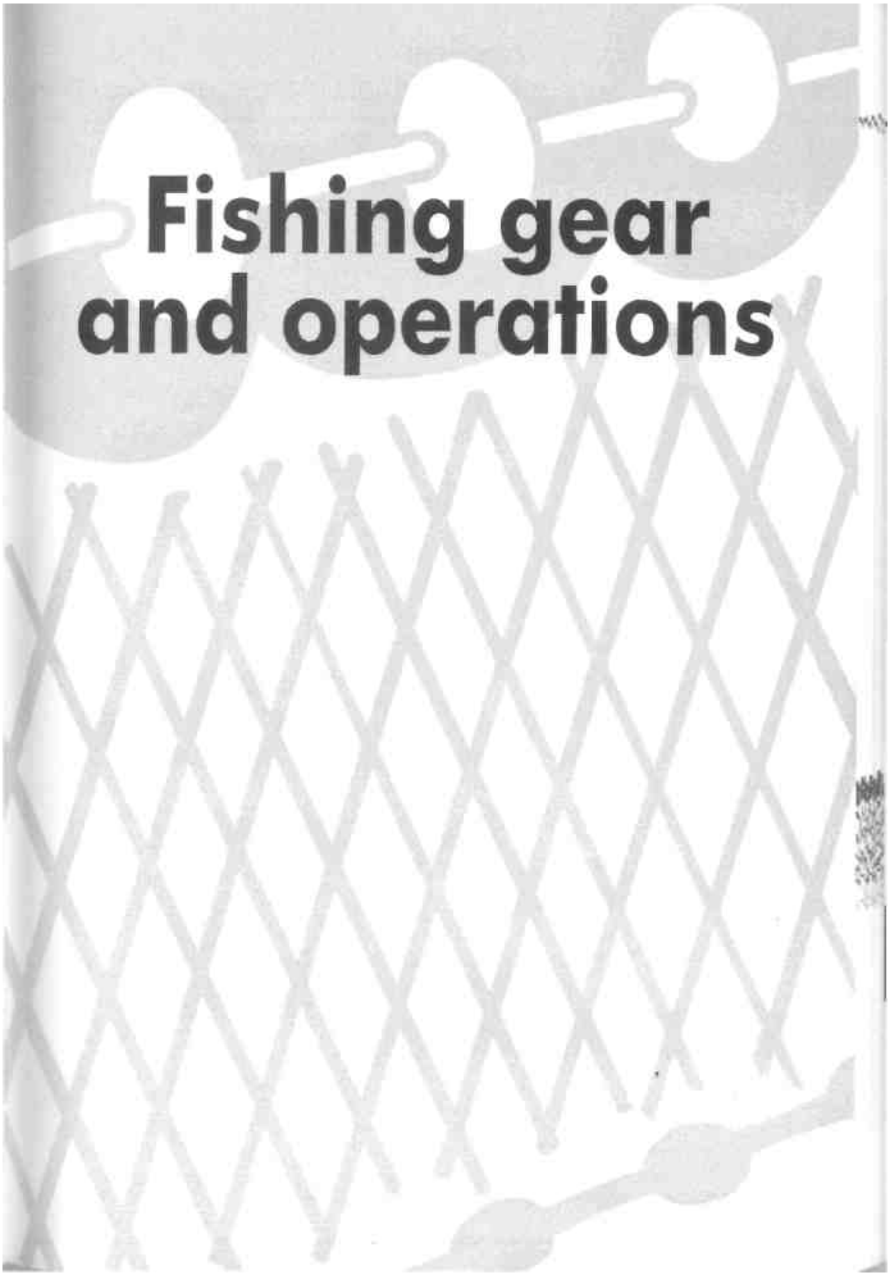



NO

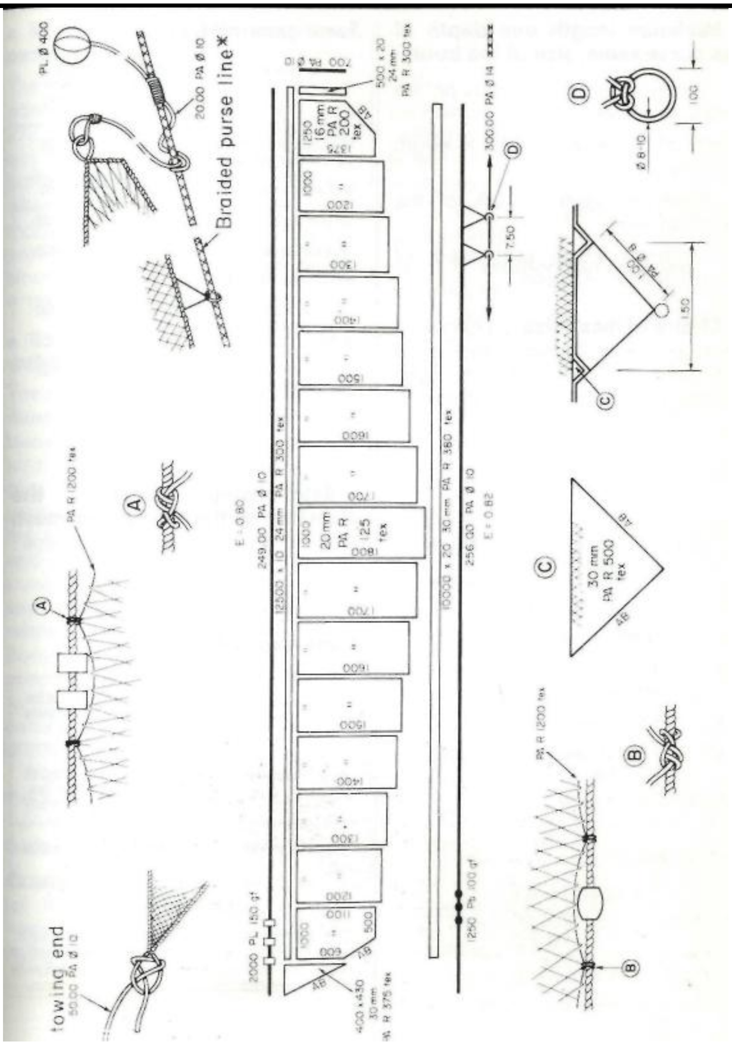

YES



Fishing gear and operations



Purse seine: example of plan and rigging



Purse seine for sardine and other small pelagic species for a boat of 10 m LOA (PAJOT FAO) * Note : *With small purse seines where the purse line is not coiled on a drum, the purse line may* ***be*** *lashed to the buoy line.*

Purse seines: minimum dimensions, mesh sizes, twine sizes

■ **Minimum length and depth of the purse seine, size of the bunt***

— Minimum length depends on the length of seiner : length of purse seine $\geq$ 15 x length of seiner

— Minimum depth : 10% of the length of seine

— Minimum length and depth of bunt = length of vessel

■ **Choice of mesh size** is a function of the target species. It is necessary to avoid enmeshing or gilling the fish (with respect for regulations on minimum mesh size].

$$OM = \frac{2}{3} \times \frac{L\,(\text{fish})}{K}$$

(Fridman formula)

where:

OM = mesh opening (mm] in the bunt

L = length (mm) of target species

K = coefficient, a function of the target species

K = 5 for fish that are long and narrow

K = 3.5 for average shaped fish

K = 2.5 for flat, deep-bodied, or **wide fish**

Some examples

Species	Stretched meshsize (mm)	Size of twine (Rtex)
small anchovy, n'dagala, kapenta (East Africa)	12	75-100
anchovies, small sardine	16	75-150
sardine, sardinella	18-20	100-150
large sardinella, bonga, flying fish, small mackerel and Spanish mackerel	25-30	150-300
mackerel, mullet, tilapia, Spanish mackerel, small bonito	50-70	300-390
Bonito, tuna, wahoo, Scorn beromorus sp.	50-70 (min)	450-550

■ **Relationship between the diameter of the twine and mesh size** in different parts of the purse seine :

$$\frac{\text{diameter of twine (mm)}}{\text{stretched mesh size (mm)}}$$

Some examples

	Body of the purse seine	Bunt of the purse seine
Small Pelagic Fish	0.01 to 0.04	0.01 to 0.05 North Sea 0.04 to 0.07
Large Pelagic Fish	0.005 to 0.03	0.01 to 0.06

---

* *In purse seines, as in many types of fishing gear, the 'bunt' refers to the section of net which is hauied last or the section in which the catch may be concentrated*

Weight of ballast*, buoyancy of floats, weight of netting

■ Ratio of ballast to weight of netting (in air)

The weight (in air) of the ballast normally ranges between 1/3 and 2/3 the weight of the netting (in air).** The weight (in air) of the ballast per metre of seine footrope is often between 1 and 3 kg (although more is used for small mesh purse seines used to catch deep-swimming small pelagic fish and up to 8 kg/m is used in large tuna seines).

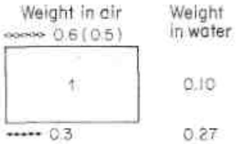
■ Ratio of buoyancy to total weight of the seine

The rigging of floats on a purse seine must take into account not only the buoyancy needed to balance the total weight of the gear in water, but also additional buoyancy.*** This additional buoyancy should be of the order of 30% for calm waters, and up to 50-60% in areas of strong currents, to compensate for rough sea conditions and other factors related to handling of the gear. Buoyancy should be greater in the area of the bunt (which has heavier twine) and mid-way along the seine (where pulling forces are greater during pursing).

In practical terms, the buoyancy of the floats should be equal to about 1.5 to 2 times the weight of the ballast along the bottom of the seine, the buoyancy needed is a bit more than half the weight (in air) of the netting.

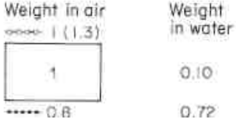
Examples

(a) If a **large purse seine** has relatively heavy netting (as is common), ballast may be relatively light, and



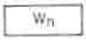
Buoyancy = 1.3 to 1.6 x (weight of
netting in water + weight of ballast in
water)
= (1.3 to 1.6) x (0.10 + 0.27)
= 0.5 to 0.6 kg per kg of netting
(weight in air)

(b) If a **smaller purse seine** has relatively light netting (as is common), the ballast should be relatively heavy, and the buoyancy may be equal to or slightly greater than the weight of the netting (in air).

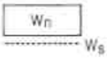


Buoyancy = 1.3 to 1.6 (weight of
netting in water + weight of ballast
in water)
= (1.3 to 1.6) x (0.10 + 0.72)
= 1 to 1.3 kg per kg of netting (in air)

In summary, the procedure of choosing weight of ballast and buoyancy*** required is to calculate :



(1) the weight (in air) of netting Wn**



(2) the weight (in air) of leads Ws
Ws= (0.3 to 0.8) x Wn

(3) Buoyancy = (1.3 to 1.6)
x (0.1 Wn + 0.9 Ws)
= (1.3 to 2) x Ws

** Ballast in this case Is considered to include the sinkers on the leadline, purse rings, chain and any other lead or Iron rigging along the bottom of the seine*
*** Weight of netting, see page 35*
**** Buoyancy of purse seine floats, see pages*

Hanging, leadline, tow line, purse line, depth, volume on board, performance

The leadline of a purse seine is usually longer than the floatline by up to 10%; however in some types, the two lines are equal in length.

The hanging ratio (E), is usually greater on the leadline than on the floatline. Hanging ratios generally range from 0.50 to 0.90, depending on the type of net. The hanging ratio may also vary along the floatline or leadline, usually being lower in the bunt. For more on hanging ratios and methods of hanging, see pages 38, 39, and 42.

The tow line is normally about 25% of the length of the purse seine.

The purse line is generally 1.1 to 1.75 times the length of the leadline, usually about 1.5 times the length of the purse seine. The purse line must have good resistance to abrasion and good breaking strength. As a general guideline, the breaking strength (R) of the purse line should be as follows :

R > 3 x (combined weight of netting, leadline, leads and purserings)

$R \text{ (tons)} \simeq \sqrt{\text{tonnage of vessel}}$

Volume (on board) occupied by the seine when rigged

$V(m^3) = 5 \times$ weight (tons) of the seine (in air)

Depth in water of the seine (see also pages 39 and 40). As an approximation, the actual depth or height (AD) can be considered equal to roughly 50% of the stretched depth (SD, or stretched meshsize x number of meshes) of the seine at its extremities, and 60% near the centre of the net.

AD = SD x 0.5 = SD/2 extremities

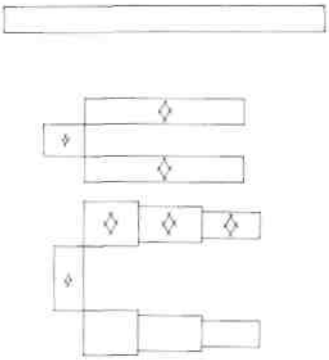
AD = SD x 0.6 centre of net

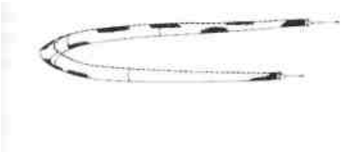
Sinking speed of a purse seine — for different seines, sinking speed has been measured in a range from 2.4 to 16.0 m/min, with an average of 9.0 m/min.

Types of beach seine, bridles, ropes

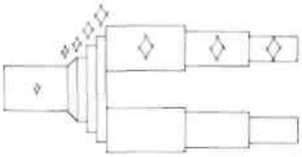
■ Beach seine without bag

A single panel of netting — no particular rules concerning height and length or Special meshsize and/or twinesize in the central part



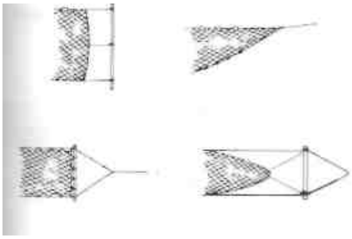


■ Beach seine with bag



■ Hauling points

For a rather high small seine with bridle, handled by one man alone



■ Ropes for hauling beach seines

Natural fibre rope or nylon, polyethylene, polypropylene

Seine length (m)	diameter synthetic fibre bridle (mm)
50- 100	6
200 – 500	14- 16
800- 1500	18

Beach seines: materials and hanging

■ Mesh size and twine thickness

In the wings, the mesh size and twine thickness may be the same as, or different from, those of the central section or bunt.

Examples of specifications for bunts of beach seines

target species	stretched mesh (mm)	twine thickness (R tex)
sardine	5-12	150-250
sardinella	30	800-1200
tilapia	25	100
tropical shrimp/prawn	18	450
diverse large species	40-50	150-300

The headrope and footrope (float line and lead line) are usually of the same material (PA or PE) and diameter.

Hanging ratios (E) are usually the same on headrope and footrope. For central sections, E = 0.5 or slightly greater (0.5-0.7). In the wings the hanging ratio is usually the same as in the bunt, but it is sometimes slightly greater (E = 0.7-0.9).

■ Floats on the headrope

The number of floats required increases with the height of the seine. The following are examples of buoyancy observed in the central part of seines :

height (m) of seine	Buoyancy (g/m of hung net)
3-4	50
7	150
10	350-400
15	500-600
20	1000

The floats are either evenly spaced along the headrope, or placed closer together in the bunt, and spaced increasingly farther apart toward the ends of the seine.

■ Sinkers on the footrope

The quantity and type of sinkers varies according to the intended use (to 'dig' more, or 'dig' less). Sinkers may be spaced evenly along the footrope, or concentrated more near the bunt.

■ Ratio of buoyancy/weight

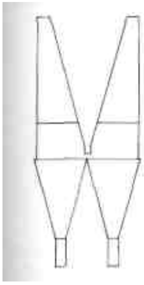
In the bunt, the ratio of buoyancy/ weight of sinkers is around 1.5-2.0, but sometimes, to make the net 'dig' more, a net is rigged with more weight than buoyancy. In the wings, the ratio of buoyancy/weight of sinkers is equal to, or slightly less than, 1.

Bottom seines: types of bottom seines and method of setting

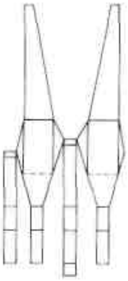
■ **Construction, rigging** :

very similar to bottom trawls

Bottom seine



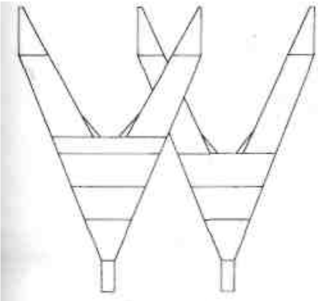
Original European type



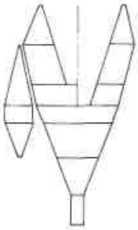
Asian type

Rigging of spreader without bridles

Bottom seine with high headline



(2 panel)



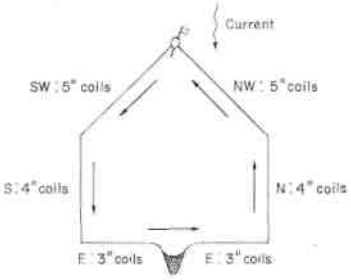
(4 panel)

Rigging of spreader with bridles

Bridles	Headline
20-25 m	35 m
45-55 m	45 m

■ **Track of the boat for shooting the anchor seine or Danish seine**

Example *:* Shooting 12 'coils' or 2640 m (1 coil = 220 m)



Bottom seines: dimensions and properties of net

■ Size of nets

	Boat		Net	
	Length (m)	Power (hp)*	Mouth" opening (m)	Headline (m)
Bottom seine (Japan)	10-15		30	50
Bottom seine (Europe)	15-20	100-200	20-30	55-65
Bottom seine (high op.)	10-20	100 200	35-45	25-35
	20		45-65	35-45
	20-25	300 - 400	~100	45-55 I
	25 +	500		55 - 65

■ Vertical opening (estimation)

$$\simeq \frac{\text{length of headline}}{20}$$

vertical opening of high-opening bottom seine with bridles

$$\simeq \frac{\text{length of headline}}{10}$$

■ Mesh size, twine size

stretched mesh (mm)	Rtex
110-150	1100-1400
90-110	1000-1100
70-90	700-1000
40-70	600-800

** Power in (hp) = 1.36 x Power in (kW)*

" The mouth opening is measured along the forward edge of the bellies, and is equal to*
(bar length x number of meshes) + (bar length x number of meshes)
jupper panel) {lower panel)
However, there are local differences in how this term is used, (in some places it refers to stretched meshsize x number of meshes), so caution in interpretation is necessary.

Bottom seines: ropes

Durability, resistance to abrasion, and weight are essential qualities of seine ropes.

Materials

3-strands, PP with lead cores (combination rope)

Anchor seining (Danish seining) :	combination rope Ø18-20
Fly dragging (Scottish seining) :	PE or PP, Ø 20-32 (3 strands with lead core in each strand)
Fly dragging (Japan, Korea) :	small boats : manila mid-sized boats : PVA

Diameter

Rope	
Ø	Weight (kg/100 m)
PP 20	35
24	43
26	55
28	61
30	69

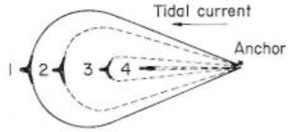
Often the diameter changes along a single rope, from 24-36 mm (for mid-sized boats). Weights are often attached along the rope.

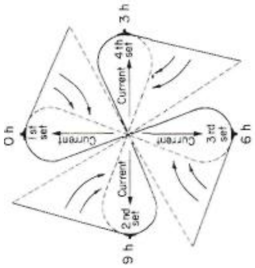
Length is expressed in coils of 200-220 m, total length usually 1000-3000 m.

Method	Fishing grounds	Rope length
Scottish technique	shallow waters (50-70 m) or small areas of soft bottom surrounded by rocky areas medium depths (80-260 m) or large smooth bottom areas	less than 2000 m 3000 m or longer
Japanese technique	for depths as great as 300-500 m or soft, regular bottom	8 to 15 times depth of water

Bottom seines: operations

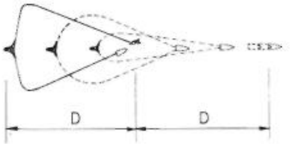
■ **Operating with an anchor (Denmark)**



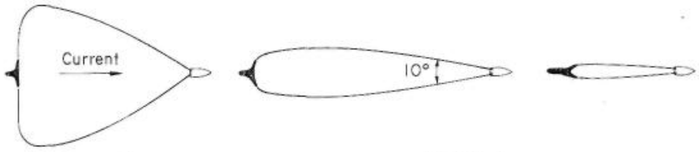


Where the direction of the current changes with the height of the fide

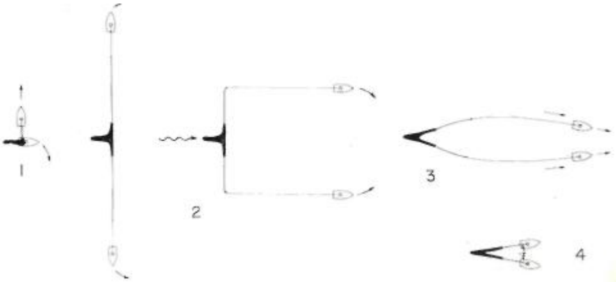
■ **Fly-dragging (Scotland)**



■ **Fly-dragging (bull trawling) (Japan, Korea)**

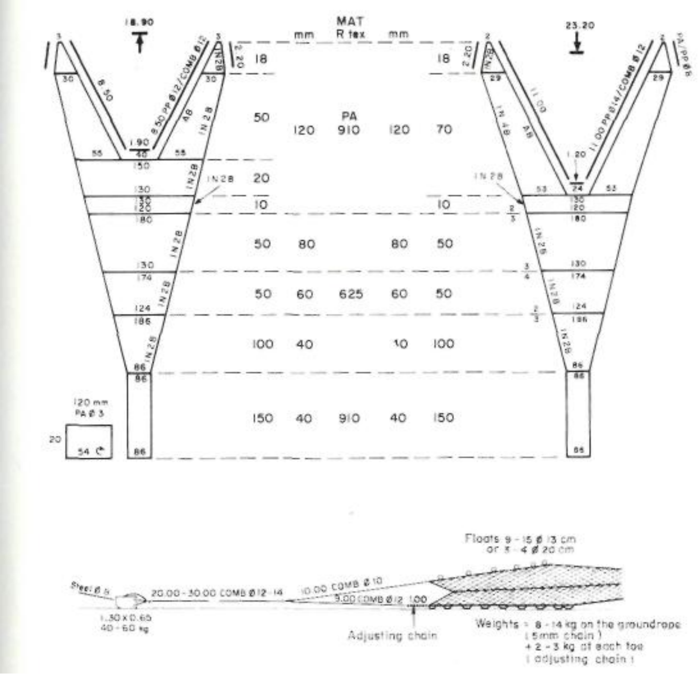


■ **Operations of 2 boats (pair seining, Canada)**



Plan of a 2-panel bottom trawl

This example, from FAO, is for a 50-70 hp vessel. See table below for terms.



Terms used in net plan

MAT = twine material (see pages 6-8]

Rtex = Resultant tex (twine size, see page 10)

a (mm) = stretched meshsize (see pages 29-30)

n = depth of panel in number of meshes (N direction)

The numbers appearing along the front and aft edges of panels represent number of meshes.

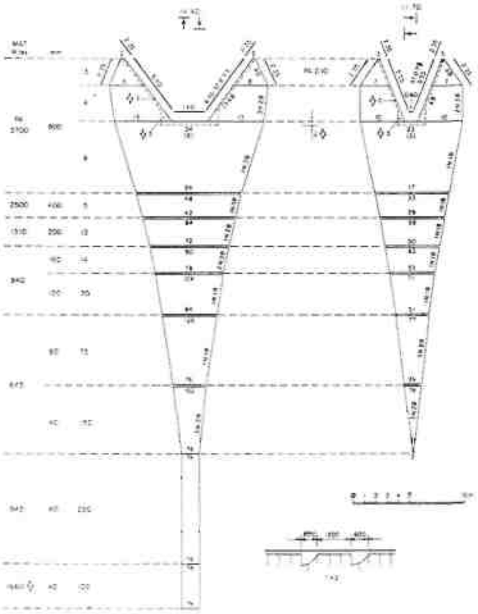
Numbers and letters along inside edges of net represent cutting rates; for example, 1N2B means 1 sideknot, 2 bars (see pages 32-33).

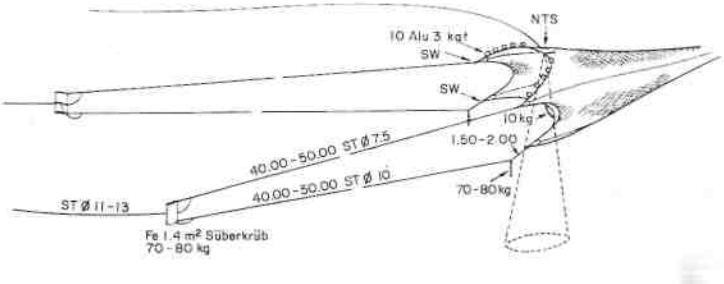
Ratios presented along inside edges represent numbers of meshes taken up when joining the corresponding panels (see page 41).

Lengths of lines are presented in metres (11.00, etc).

Plan and rigging of a 4-panel midwater trawl

This example is a midwater pair trawl used by French vessels of 120-150 hp, for herring and mackerel





Trawls: relationship between mesh size and twine size for bottom trawls

■ **Bottom Trawls**

Power 30 to 100hp*	
Stretched mesh (mm)	Size of twine(Rtex)
100	950-1 170
80	650- 950
60	650
40	650

Power 100 to 300 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
200	1 660-2 500
160	1 300
120	1 300-2 000
80	950-1 550
60	850-1 190
40	850-1 190

Power 300 to 600 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
200	2 500-3 570
160	1 230-2 000
120	1 230-2 000
80	1 660
60	950-1 190
40	950-1 190

■ **Shrimp trawls, American type, semi-balloon**

try-net (see pg. 84)	
Stretched mesh (mm)	Size of twine(Rtex)
39.6	645

Power 150 to 300 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
44 39.6	940-1190 1 190

Power 300 to 600 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
47.6	1 190
39.6	1 540

$$m/kg = \frac{1000000}{Rtex}$$

** brake horsepower (BHP) or Apparent Nominal Power (ANP), see pg. 95 Power in* HP *= 1.36 x (power in kW)*

■ **High-opening bottom trawls**

Power 75 to 150 hp*	
Stretched mesh (mmW)	Size of twine (Rtex)
120	950
80	650-950
60	650-950
40	650-950

Power 150 to 300 hp*	
Stretched mesh (mm)	Size of twine (Rtex)
200	1 660-2 500
160	1 300-1 550
120	1 300-2 000
80	950-1 550
60	850-1 190
40	850-1 020

Power 300 to 800 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
800	5 550
400	3 570
200	2 500-3 030
160	1 660-2 500
120	1 550-2 500
80	1 300-2 500
60	1 190-1 540
40	940-1 200

Relationship between mesh size and twine size for midwater trawls

■ Midwater trawls
(for single vessel)

Power 150 to 200 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
400	2 500
200	1 190-1 310
160	950-1 190
120	650-950
80	650-950
40	450
40	950-1 310

Power 400 to 500 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
800	3 700
400	2 500
200	1 310-1 660
160	1 190-1 310
120	950
80	650-950
40	650-950
40	1 660

Power 700 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
800	7 140-9 090
400	3 700-5 550
200	2 500-3 700
160	2 500
120	1 660
80	1 660
40	1 660
40	2 500

■ Midwater pair trawls

Power 2 x 100-300 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
800	3 030-4 000
400	1 190-2 280
200	1 190-1 540
120	950
80	650-950
40	450-950

Power 2 x 300-500 hp*	
Stretched mesh (mm)	Size of twine(Rtex)
800	5 550
400	2 280
200	1 540
120	950-1 190
80	950-1 190
40	950-1 190

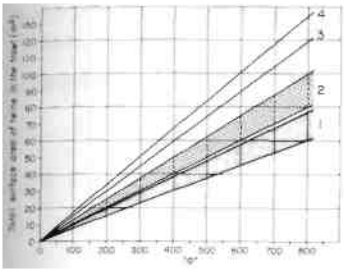
$$m/kg = \frac{1000000}{RTex}$$

** Brake horsepower (BHPj or Apparent Nominal Power(APNj, see page 95. Power in Hp = 1.36 X (power in kWj*

Choosing the right size trawl for the power of the vessel

■ Selection according to the calculated twine surface area of the net (see page 37 for twine surface area)

Given the vessel horsepower, and the type of trawling intended, the best results will be obtained by choosing a net of which the twine surface area falls within a particular range.



1 Two-panel bottom trawls
2 Four-panel bottom trawls
3 Single-boat mid-wotertrawls (stretched mesh in wings up to 200mm)
4 Single-boat mid-water trawls
(wing meshes larger than 200 mm)

Given the vessel horsepower and trawl type, the twine surface area may vary according to several factors, for example : real delivered horsepower, rate of utilisation of the motor, type of rigging, meshsize, type of bottom, strength of currents, etc.

For pair trawling, the twine surface areas (m^2) indicated above should be multiplied by the factors shown in the table:

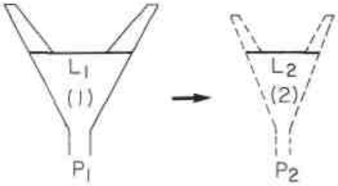
trawl type	factor
two-panel bottom trawls:	2.4
four-panel bottom trawls :	2.2
single-boat mid-water trawls (stretched mesh in wings up to 200 mm) :	2
single-boat mid-water trawls (wing meshes largerthan 200 mm) :	2

■ Choice by comparison with a trawl of the same type used by a vessel in the same horsepower range

Let us say you know the dimensions of a particular trawl (TI) used by a particular trawler which has horsepower P|. In order to calculate the right net size for another vessel of horsepower P_2, the length and width of each panel of P] are multiplied by

the square root of $\frac{P_2}{P_1}$.

$$L_2 = L_1 \times \sqrt{\frac{P_2}{P_1}}$$

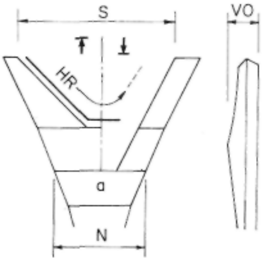


** Brake Horsepower (BHP) or Apparent Nominal Power (ANP), see page 95*
Power in (HP) = 1.36 x Power in (kW)

Opening of bottom trawls

VO (m) | S(m)

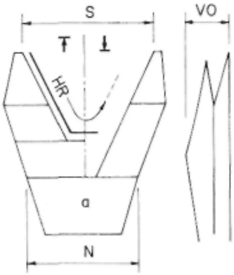
■ Bottom trawl with low vertical opening (VO)



VO = 2 x N x a x 0.05 to 0.06

S ≃ HR x 0.50

■ High-opening bottom trawl

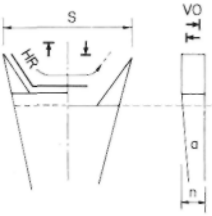


VO = 2 x N x a x 0.06 to 0.07

S ≃ HR x 0.50

■ Shrimp trawl (flat or semi-balloon)

S ≃ HR x 0.67
S ≃ VO x 10



VO ≃ n x a x 0.40

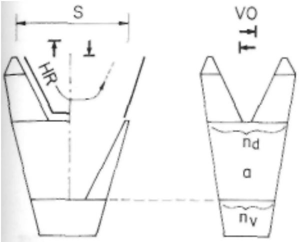
or VO = height of panel x 1.2

S ≃ HR x 0.7
S ≃ VO x 12

N or n = width in number of meshes of front edge of belly (seams not included)
a = meshsize, length in metres of one stretched mesh at the part of net considered
VO = approximate vertical opening of net mouth (metres)
S = approximate horizontal spread between ends of wings (metres)
HR = length in metres of headrope

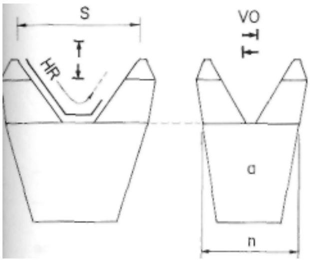
Opening of bottom trawls and mid-water trawls

■ High-opening, 4-panel bottom trawl



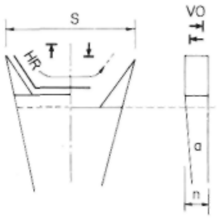
VO (m)	S(m)
(1) Fork rigging: $VO \simeq \left(\frac{n_d + n_v}{2}\right) \times a \times 0.50–0.60$	S ≃ HR x0.60
(2) Bridle rigging: $VO \simeq \left(\frac{n_d + n_v}{2}\right) \times a \times 0.40$	S ≃ HR x0.50

■ Single-boat mid-water trawl



VO (m)	S(m)
VO = n x a x 0.25 to 0.30	S ≃ HR x 0.50 to 0.60

■ Mid-water pair trawl



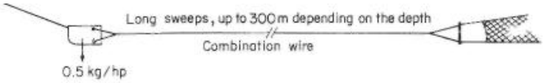
VO (m)	S(m)
VO = n x a x 0.25 to 0.30	S ≃ HR x0.60

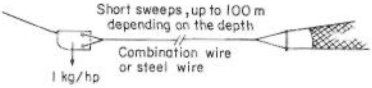
n = width in number of meshes of front edge of belly (seams not included)
n_v = width in number of meshes of aft edge of belly (seams not included)
HR = length of headrope in metres (not including free ends)
a = meshsize (length in metres of one stretched mesh at the part of the net being considered)
VO = approximate vertical opening of net mouth (metres)
S = approximate horizontal spread between ends of wings (metres)

Rigging of bottom trawl for one boat

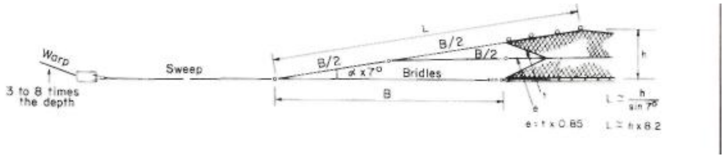
Principal types, adjustments, relative length

■ Bottom trawls with low headline height

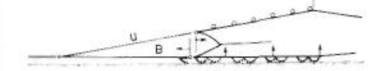




■ Bottom trawls with high headline heights (OV) : sweeps and bridles



■ Adjustments



To increase the vertical height: lengthen the upper bridle (U) or shorten the lower bridle (B)

To increase the ground contact: lengthen thelower bridle (B) or shorten the upper Dridle (U)

N.B. the adjustments made are extremely small, measured in single chain links

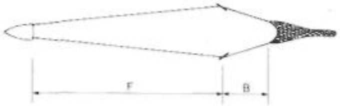
■ Relative lengths of different parts of the trawl gear

F about 2.2 times the depth for deep water
about 10 times the depth for shallow water

As a general rule

$$B = \frac{F}{3} \text{ to } \frac{F}{8}$$

F = trawl warps (m)
B = length of sweeps or sweeps + bridles or 'forks'**

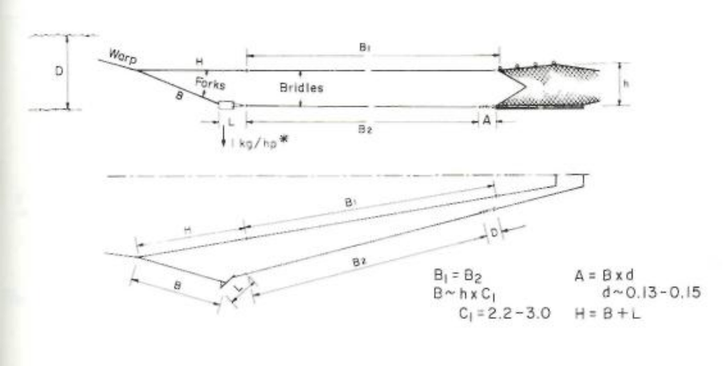


** Brake horsepower (BHPj or Apparent Nominal Power (ANP), see page 95 Power in (HP) = 1.36 x Power in (kW) ** Fork rig, see page 8 1*

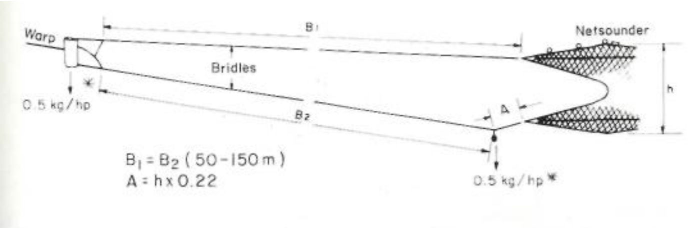
Rigging of bottom and midwater trawls for single-boat operation

■ High-opening bottom trawls : fork rigging

The length of warps equals 3 to 4.5 times the depth of water



■ Single-boat midwater trawl

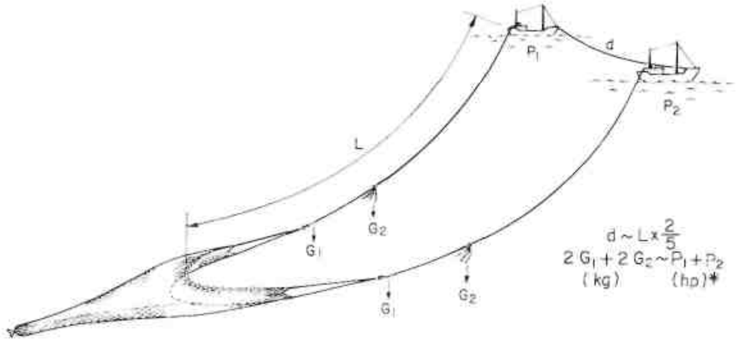


---

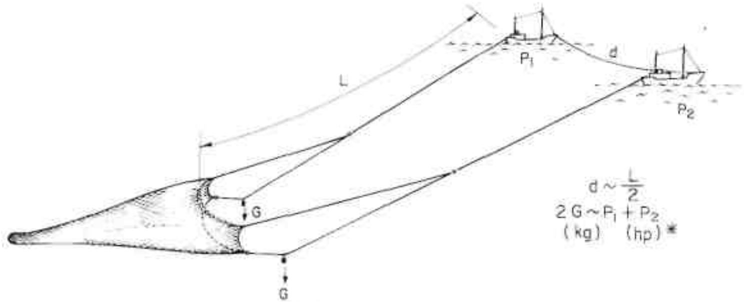
* For power to use in calculation, see page 95
Power in (HP) = 1.36 × Power in (kW)

Rigging for pair trawling

■ Bottom trawls



■ Midwater trawls



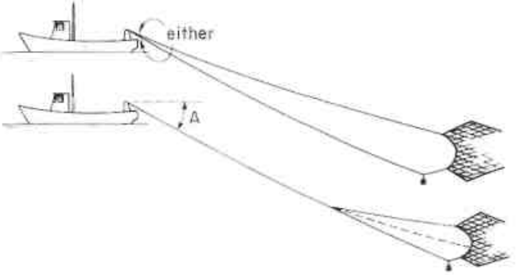
P = power of the trawler
L = distance trawl — trawler
G = weights in front of the trawl
d = distance between the trawlers

** Broke horsepower (BHP) or Apparent Nominal Power (ANP), see paqe 95 Power in (HP) = 1.36 x Power in (kW)*

Estimating the depth of a midwater pair trawl

It is necessary to estimate the vertical angle of the warps. (In other words, the inclination, or angle between the warps and the horizontal plane.)

Note : *These methods give only very rough approximations. They should be used only when you have | no nelsounder to give more accurate information. Be careful to keep the net away from the bottom.*



The warp angle may be measured with a protractor or other device

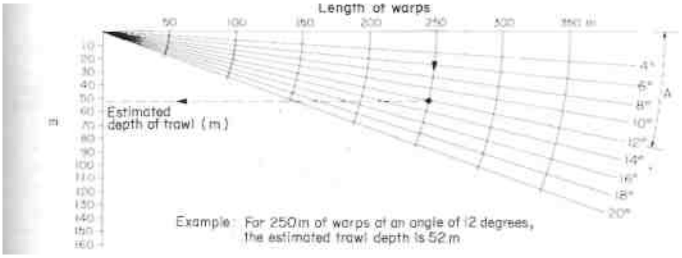
Depth of the trawl is estimated as follows :

(1) Measure the warp angle A

(2) On the horizontal scale of the graph below, find the warp length

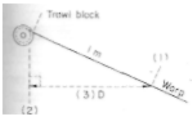
(3) Follow the warp length down to the angle A

(4) Read the estimated trawl depth from the vertical scale at the left



Example: For 250m of warps at an angle of 12 degrees, the estimated trawl depth is 52 m

Another method without using a protractor is shown below



(1) Mark the warp I m aft ot block

(2) Drop a vertical line from the block

(3) Measure the distance D

4) Find the trawl depth in the table on the right

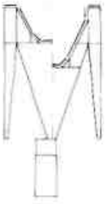
Distance measured D cm	WARP LENGTH (M)				
	100	200	300	400	500
99	14	27	42	56	70
98	21	42	62	83	103
97	25	49	72	94	116
96	28	57	82	106	130
95	31	62	92	123	153
94	34	68	103	138	174

Shrimp (prawn) trawls and their rigging

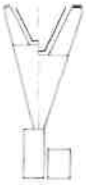
■ **Gulf of Mexico type**

Example **;**

Flat



Semi-balloon



Balloon

Examples of mesh sizes

Stretched mesh (in mm) French Guyana : 45 West Africa : 40-50 Persian Gulf : 30-40/ 43-45 Madagascar ; 33-40 India : 50-100 Australia : 44

In tropical zones the catch rate is proportional to the horizonta spread of the trawl. In order to obtain the greatest horizontal opening, special types of trawl are used, and also special rigging.

(1) Special types of trawl

Trawl with 3 toes
Headline in two parts

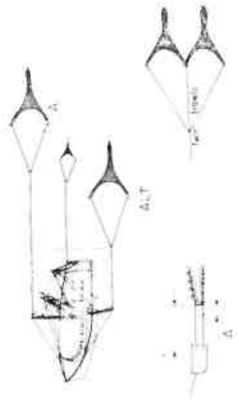
Tongue trawl
Headline and groundrope in two parts

(2) Special rigging

Twin trawls

■ **Rigging of booms**

This rigging allows an increase in shrimp catch rate of 15-30% over that of a single trawl. Towing speed is 2.5 to 3 knots.



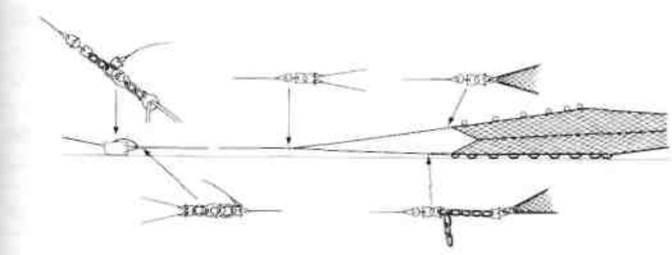
Power of enqine* TO	Lengths (m)		
	Headline	Bridles	Booms
150 to 200	12-14	33	9
200 to 150	15-17	35	9
250 to 300	17-20	40	9
300 to 400	20	45	10
500	24	50	12

Depth (m)	Warp length (m)
-20	110
20 to 30	145
30 to 35	180
35 to 40	220

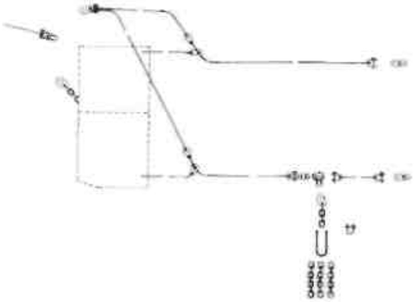
** Brake horsepower {BMP) or Apparent Nominal Power (ANP), see page 95 Power in (HP) = 1.36 x Power in (kW)*

Rigging between different parts of trawls

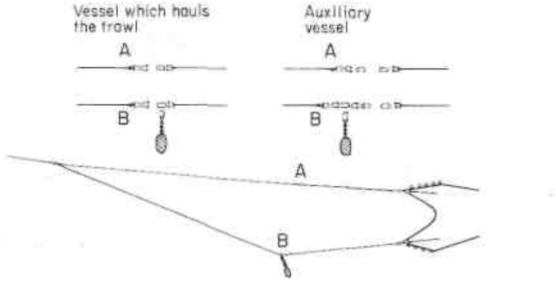
■ Bottom trawls



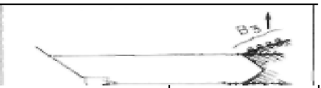
■ Midwater trawls for 1 boat



■ Midwater pair trawls



Headline buoyancy and groundrope weight recommended for trawls

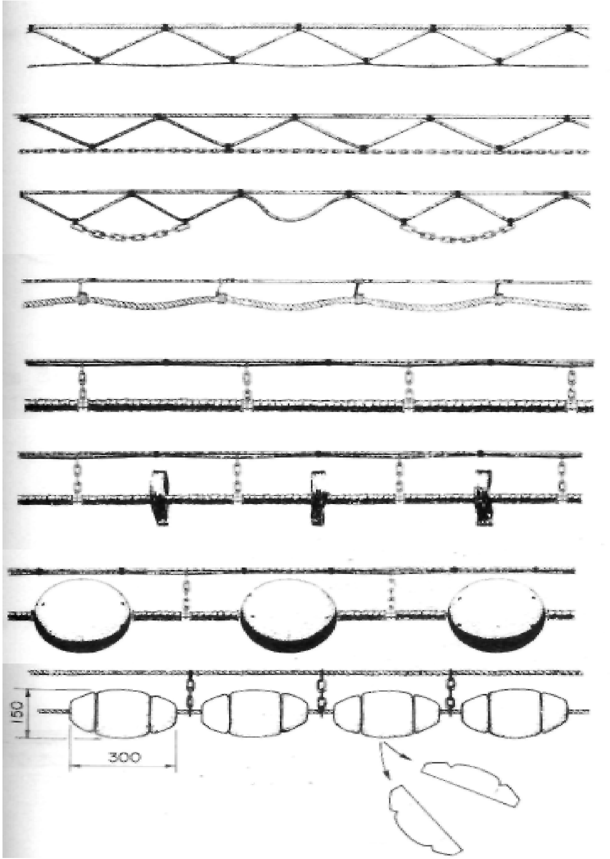
Real horsepower* hp						
	B1 (kgf) P (hp)*	W1 (kg air) P (hp)*	B2 (kgf) P (hp)*	W2 (kg air) P (hp)*	B3 (kgf) P (hp)*	W3 (kg air) P (hp)*
50	B1=Px...	W1=Px ...	B2=P x...	W2=P x ...	B3=P x ...	W3=P x ...
100	0.20	0.28	0.27	0.29	0.28	0.33
200	0.20	0.25	0.24	0.27	0.25	0.31
400	0.20	0.22	0.22	0.24	0.22	0.28
600	0.20	0.22	0.21	0.23	0.21	0.27
800	0.18	0.20	0.19	0.22	0.19	0.26

— For buoyancy, the indicated values correspond to nets made of poly-amide (nylon), a synthetic fibre with negative buoyancy (it sinks). For nets made of floating materials, the floats may be decreased by 10-15%.

— The weights presented are estimated, with a 5-10% margin of error. They may vary according to the trawling speed, type of bottom, buoyancy of the net and floats, target species, etc. These weights have been calculated assuming that steel chain will be used for ballast. If another material is used, its density must be taken into account. For example, in order to get the same sinking force in water, a length of chain weighing 1 kg in air must be replaced by a quantity of rubber rollers which weighs 3-3.5 kg in air.

** Brake horsepower (BHP) or Apparent Nominal Power (ANPj, see page 95 Power in (HP) = 1.36 x Power in (kW)*

Examples of groundropes



■ **Midwater trawls** (maximum vertical opening) joining lines of braided PP. Groundrope of leaded rope

■ **High-opening bottom trawls** : Joining lines of braided PP. Groundrope of chain

■ **Shrimp trawls, smooth bottom** Grassrope with lead rings (chain ground-rope is also common)

■ **High-opening bottom trawl** with 2 bridles : groundrope of rubber rings

For use on rougher bottom : groundrope of rubber bobbins or rollers with rubber disc spacers and chain joining lines

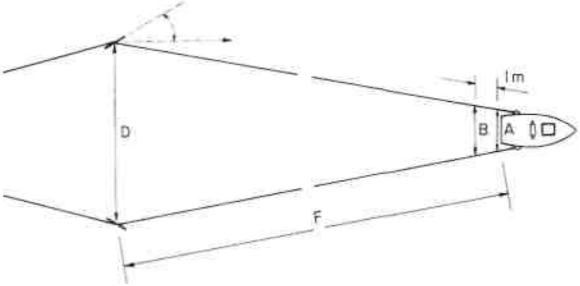
■ **Fish or shrimp trawls, hard bottom :** groundrope of rubber rings and hard plastic spheres

■ **Fish or shrimp trawls for soft or** muddy bottom : split wooden rollers which can be added or removed without running groundrope through centre

Spread of otter boards and trawl

■ Estimating the spread of otter boards (doors)

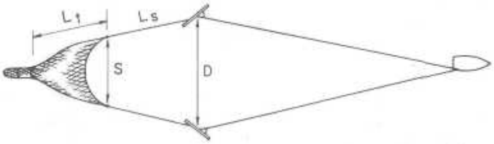
$$\underset{(m)}{D} \sim [(\underset{(m)}{B} - \underset{(m)}{A}) \times \underset{(m)}{F}] + \underset{(m)}{A}$$



***Example**:* On the vessel above, if :
A = 4.00
B = 4.18
F = 200
then
D = [(4.18 - 4.00) x 200] + 4 = 40 m spread at otter boards

■ Estimating the spread of the trawl
To estimate the horizontal spread between the wing ends :

$$S = \frac{\text{spread of otter boards } (D) \times \text{length of trawl without bag } (L_t)}{\text{length of trawl without bag } (L_t) + \text{length of sweep } (L_s)}$$

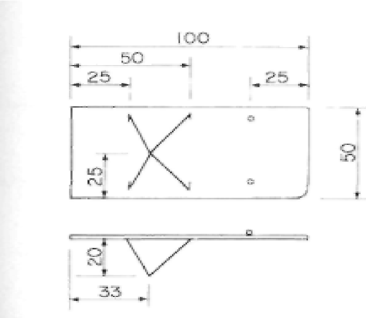


***Example**:* given a trawl of 25 m in length (without bag) rigged with sweeps of 50 m and otter board spread of 40 m, then spread of trawl wing ends :

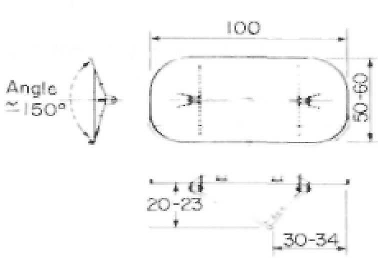
$$S = \frac{40 \times 25}{25 + 50} = 13.33 \text{ m}$$

Otter boards: proportions, angles of attack

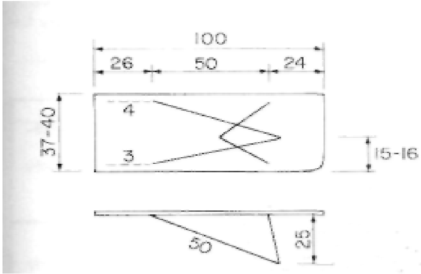
■ Flat rectangular otter boards



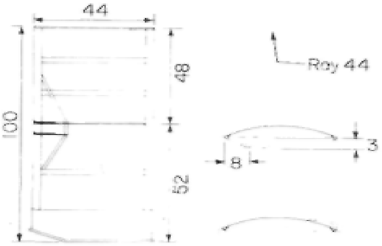
■ Rectangular V section otter boards



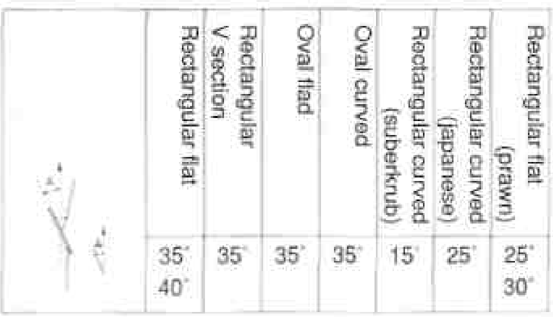
■ Shrimp otter boards



■ Suberkrub pelagic otter boards



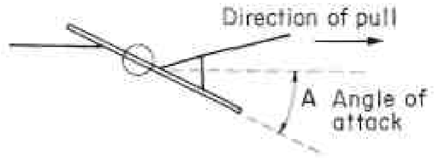
■ Angles of attack

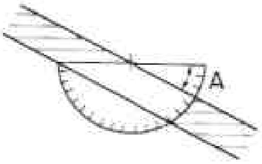


Rectangular flat	35° 40°
Rectangular V section	35°
Oval flad	35°
Oval curved	35°
Rectangular curved (suberkrub)	15°
Rectangular curved (japanese)	25°
Rectangular flat (prawn)	25° 30°

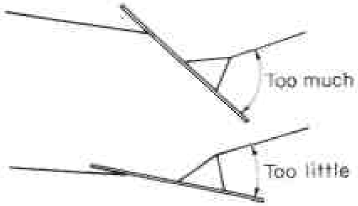
Otter boards: angle of attack, adjustments

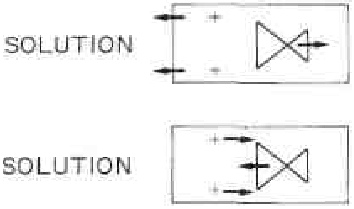
■ Angle of attack



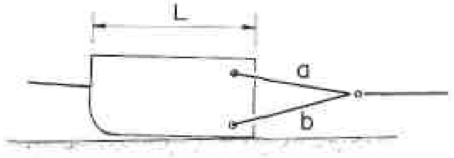


■ Adjustment of angle of attack



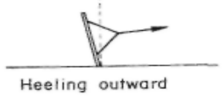
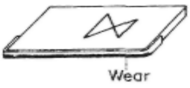
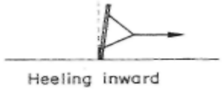
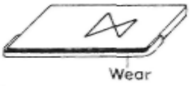
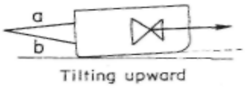
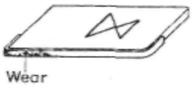
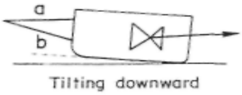
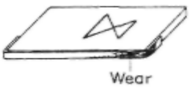


■ Adjustment of orientation



a ~ L x 1-2
Generally a = b
or b = a + (2-5% of L)
However on soft muddy bottom or small corals, some upward tilting (b) longer than (a) may be good

Problem

		**Recommended adjustment** Raise the towing brackets a little if possible
		Lower the towing brockets a little if possible or add weight to the keel
		Lengthen the upper back-strop (a) or shorten the lower backstrop (b), keeping in mind that a little upward till is good for certain bottom conditions
		Lengthen the lower back-strop lb) or shorten the upper backstrop (a)

Otter boards: properties of the principal types, choice depending on the trawler's power

■ Rectangular and oval curved

The weights indicated below (for single board) are the maximum values used. For a given horsepower, the surface area listed below is often used, but with a lighter material which may make a board as much as 50% lighter.

Power* (hp)	Rectangular flat otter boards			Oval Curved Otter boards			Weight (Kg)
	Dimensions		Surface	Dimensions		Surface	
	L(m)	h(m)	m2	L(m)	h(m)	m2	
50-75	1.30	0.65	0.85				45
100	1.50	0.75	1.12	1.40	0.85	0.93	100-120
200	2.00	1.00	2.00	1.75	1.05	1.45	190-220
300	2.20	1.10	2.42	1.90	1.10	1.65	300-320
400	2.40	1.20	2.88	2.20	1.25	2.15	400-420
500	2.50	1.25	3.12	2.40	1.40	2.65	500-520
600	2.60	1.30	3.38	2.60	1.50	3.05	600-620
700-800	2.80	1.40	3.92	2.90	1.60	3.65	800-900

■ V otter boards

Power* (hp)	Surface m^2	Weight kg
100	1.40	240
200	2.10	400
300	2.50	580
400	2.90	720
500	3.30	890
600	3.60	1 000
700	3.90	1 100
800	4.20	1 200

■ Shrimp otter boards (double rig)

Power (hp)*	Dimensions m	Weight kg
100-150 150-200 200-250	1.8 x 0.8-2.4 x0.9 2 x 0.9 - 2.45 x 1 2.4 x 1 - 2.45 x 1	60-90 90-100 120
250-300 300-450 450-600	2.5 x 1 -2.7 x 1.1 3 x 1.1 -3 x 1.2 3.3 x 1.1 -3.3 x 1.3	160 220 300

■ Midwater, Suberkrub

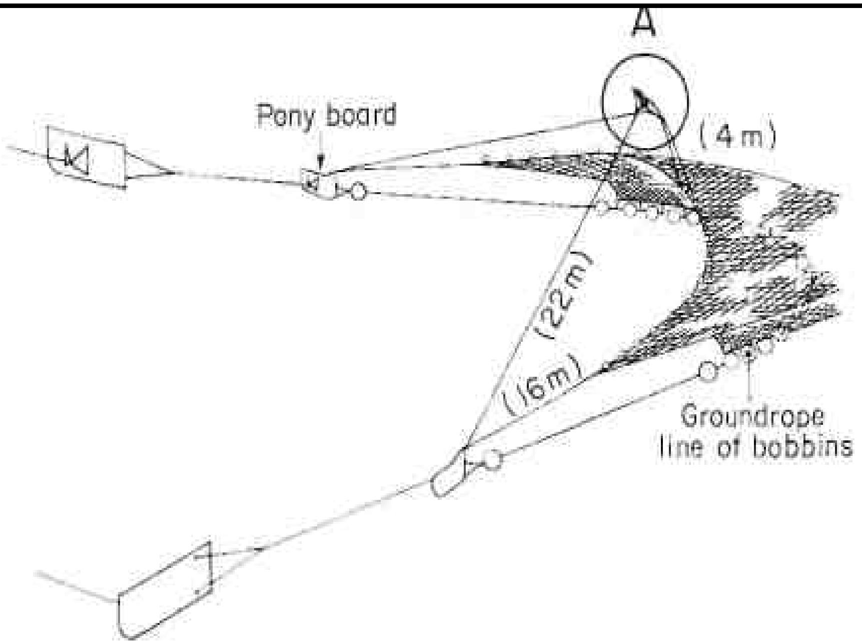
Power* (hp)	Dimensions		Surface (m^2)	Weight (kg)
	H(m)	L(m)		
150 200 250	1.88 2.05 2.12	0.80 0.87 0.94	1.50 1.80 2.00	90-100 110-120 150-160
300 350 400	2.28 2.32 2.42	0.97 1.03 1.07	2.20 2.40 2.60	170-180 220-240 240-260
450	2.51	1.12	2.80	260-280
500	2.68	1.14	3.00	280-300
600	2.86	1.22	3.50	320-350
700-800	3.00	1.33	4.00	400-430

Example of the relationship between the twine surface *area* (see page 37) of a pelagic trawl (S_f in m^2) and the surface area of a Suberkrub otter board used by the boat (S_p in m^2)

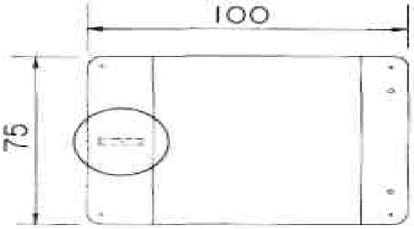
$$Sp = (0.0152 \times S_f) + 1.23$$

** Brake horsepower (BHP) or Apparent Nominal Power (ANP), see page 95*
Power in HP = 1.36 X Power in (kW)

Kites

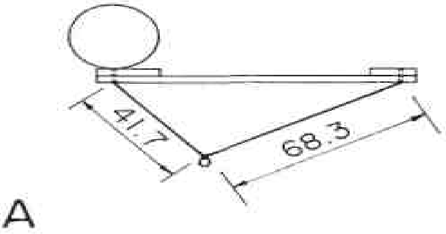


May be mounted directly on the headline



Power (hp)*	Lxl
150-250	0.55 x 0.45 m
250-350	0.60 x 0.45 m
350-500	0.65 x 0.50 m
500-800	0.80 x 0.60 m

Many types of kites exist and are being tested, the simplest being a piece of sail cloth mounted on the headline and patched to the inside netting.



** Brake horsepower (BHP) or Apparent Nominal*

Warps: diameter and length

■ Characteristics of steel trawl warps, according to power of trawler

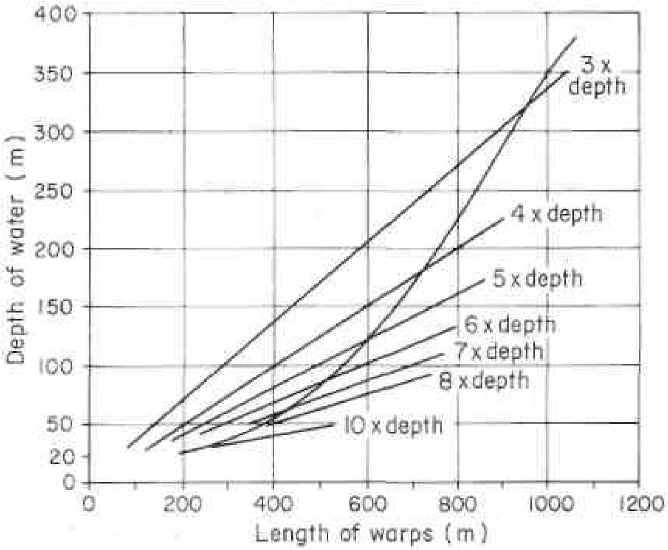
hp*	0 (mm)	kg/m	R kgf
100	10.5	0.410	5 400
200	12.0	0.530	7 000
300	13.5	0.670	8 800
400	15.0	0.830	11 000
500	16,5	1.000	13 200
700	18.0	1.200	15 800
900	19.5	1.400	18 400
1 200	22.5	1.870	24 500

R= breaking strength

■ Length of warps according to depth of water (for bottom trawling)

(for shallow water less than 20 m, the length should not be less than 120 m)

This curve gives only estimates; the captain should decide warp length according to the type of bottom, sea conditions, current, etc.



** Brake horsepower (BHP) or Apparent Nominal Power (ANP), see page 95 Power in (HP) = 1.36 x Power in (kW*

Trawling speed

Main species groups	Average trawling speed (knots)
shrimp, small bottom species, flat fish	
very small trawlers	1.5-2
mid-sized and large trawlers	2.5-3.5
mid-sized bottom species, small pelagic fish	
small trawlers	3-4
mid-sized to large trawlers	4-5
cephalopods (squid, cuttlefish)	3.5-4.5
mid-sized pelagic fish	>5

Power of trawlers

■ **The choice of fishing gear depends on the power of the trawler**

For trawlers with a fixed propeller, reduction gear between 2 : 1 and 4 : 1, and no nozzle, the tables in this book are intended for use with the Brake Horsepower (BHP). This is the figure given most often by manufacturers as the horsepower or rated power of an engine. It is expressed in horsepower (HP) or in kilowatts (kW).

1 HP = 0.74 kW 1 kW=
1.36 HP

If a trawler has a variable pitch propeller and/or a nozzle, Apparent Nominal Power (ANP), should be used in the tables of this book.
It may be calculated as follows :

ANP = bollard pull (kg) x 0.09

Example *:* A trawler, with a variable pitch propeller and a nozzle, has an engine rated at 400 BHP, and the bollard pull is 6000 kg

ANP = 6000 x 0.09 = 540 HP

Thus, the fishing gear should be chosen from the tables according to an Apparent Nominal Power of 540 HP, and not 400 HP.

Power available for trawling (p), is usually 15 to 20% of the BHP or ANP. This power is used to pull the gear, and may be calculated as follows :

In calm waters, p = 0.75 x k x (BHP or ANP)

type of propeller and engine		k
fixed propeller	high RPM engine	0.20
	slow turning engine	0.25 - 0.28
variable pitch propeller		0.28 - 0.30

In rough weather, p is reduced by 1/3.

Pulling power of trawlers

■ Bollard pull BP_0 of a trawler at fixed point (speed = 0)

BP_0(kg) = 10 to 12 kg per BHP* (with fixed propeller)

13 to 16 kg per HP of Apparent Nominal Power* (with a variable pitch propeller or nozzle)

■ Bollard pull BP (when fishing)

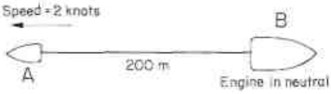
If you have calculated the engine power (p) available for towing (page 95),

$$BP\ (kg) = \frac{150 \times p\ (HP)}{\text{trawling speed (knots)}}$$

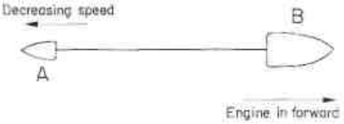
If you have measured the bollard pull BP0 at speed 0 knots,

$$BP(kq) = BP_0(kg) \times \left(1 - \frac{\text{trawling speed (knots)}}{\text{maximum free running speed (knots)}}\right)$$

Choosing the appropriate engine speeds (RPM) for 2 boats of different characteristics for pair trawling



Vessel A pulls vessel B, engine in neutral, at the chosen speed, for example 2 knots. Then vessel B engine is engaged and the revs progressively increased until vessel B holds vessel A stationary.



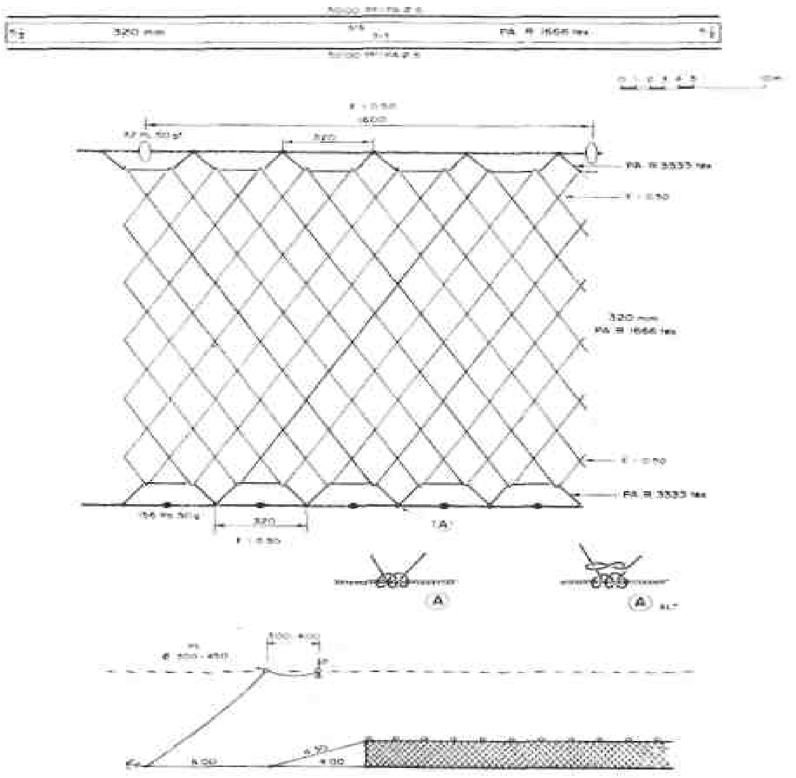
The engine RPM of both vessels A and B are noted, for the chosen speed of 2 knots. The same operations are repeated for other speeds until the range of normal trawling speeds is covered.

Revs	Vessel A	Vessel B
Speed		
2 knots	—	—
2.5	—	—
3	—	—
3.5	—	—

Plan and rigging of a gillnet : example

Gillnet
bottom set for spider crabs
Brittany, France

Vessel
length 5-15 m
HP 15-20



This drawing shows the following information about the net: for more details

Stretched meshsize : 320 mm *pages 29-30*
Length : 313 meshes
Height : 5 1/2 meshes
Hanging ratio (Ej : 0.50 *pages 38-39*
Floats" : 32 plastic floats, each with buoyancy of 50 gf *pages 47-49*
Sinkers +. 156 leads, each weighing 50 g
Twine : material — polyamide; size — R 1666 tex *pages 7-10*
Floatline : polypropylene/polyamide, diameter 6 mm, length 50 m *pages 7-8*
Leadline : polypropylene/polyamide, diameter 6 mm, length 50 m *pages 7-8*

Choosing the meshsize of gillnets*

■ Choice of meshsize according to fish species

There is a ratio between the body girth or length of a fish one wants to catch, and the gillnet meshsize which will be effective for that fish (Fridman formula).

$$OM = L(fish)/K$$

where

OM = mesh opening (mm)

L(fish) = average length (mm) of fish one wants to catch

K = coefficient, according to species

and

K = 5 for long, thin fish

K = 3.5 for average-shaped fish (neither very thick nor thin)

K = 2.5 for very thick, wide or high (shaped) fish

A few examples of stretched meshsizes (mm) adapted for particular species

Demersal tropical species	
threadfin (Polynemidae)	50
small catfish	75
grunt (Pomadasidae)	50
mullet	110-120
maigre (Sciaenidae)	120-140
croaker (Sciaenidae)	160-200
seabream (Sparidae)	140-160
barracuda	120

Temperate demersal species	
cod	150-170
pollack	150-190
Pacific pollack	90
sole	110-115
hake	130-135
red mullet (Mugilidae)	25
halibut (Greenland)	250
turbot, monk, anglerfish	240

Crustaceans	
shrimp (India)	36
shrimp (El Salvador)	63-82
green spiny lobster	160
red spiny lobster	200-220
spider crab	320
king crab	450

Small pelagic species	
sprat	22-25
herring	50-60
anchovy	28
sardine	30-43
sardinella	45-60
shad (Ethmalosa)	60-80
small mackerel	50
large mackerel	75
Spanish mackerel	100-110

Large pelagic species	
mackerel, bonito, skipjack	80-100
marlin, flying fish	120-160
bonito, jacks	125
Atlantic bluefin tuna	240
sharks	170-250
swordfish	300-330
salmon	120-200

** For clarification of terms stretched meshsize and mesh opening see page 29*

Choosing twine type for gillnets

The twine should be **relatively thin,** but not so fine that it damages, entangled fish. **Good breaking strength** is important, especially for bottom set gillnets, taking into account the size of the fish and the meshsize. The twine should have **low visibility,** either clear (mono or multi-monofilament) or of a colour which blends in with the environment. It should also be **flexible.**

Note : *A length of twine may stretch 20-40% before breaking*

■ Choosing twine diameter for gillnets

Twine diameter should be proporional to meshsize. The ratio

$$\frac{\text{twine diameter}}{\text{stretched meshsize}}$$ (same units of measurement)

should be between 0.0025, for calm waters and low catches, and 0.01, for rough waters or bottom set. An average ratio is 0.005.

■ Examples of twine sizes used with certain types of gillnets and meshsizes

stretched meshsize	inland waters, lakes, rivers		coastal waters			pen ocean		
mm	multifil. m/kg	monofil. Ømm	multifil. m/kg	monofil. Ømm	multimono. nxØmm	multifil. m/kg	monofil. Ømm	multimono. nxØmm
30			20 000	0.2		10 000	0.4	
						6 660		
50	20 000		13 400	0.2		6 660		
60	13 400	0.2	10 000			4 440		
80	10 000		6 660		4x0.15	4 440	0.28-0.30	6a8x0.15
100	6 660		4 440	0.3		3 330	0.5	6x0.15
120	6 660		4 440	0.35-0.40		3 330	0.6	
140	4 440		3 330	0.33-0.35	6x0.15	2 220		8x0.15
160	3 330		3 330	0.35	8a10x0.15	2 220	0.6-0.7	
200	2 220		2 220			1 550	0.9	10x0.15
240	1 550		1 550			1 100	0.9	
500						1 615-2 220		
600			3 330			1 615-2 220		
700			2 660					

Rigging or hanging gillnets

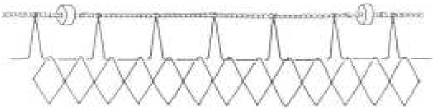
■ Effect of the hanging ratio on the catching efficiency of the net

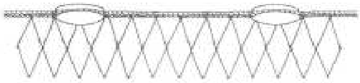
Generally the horizontal hanging ratio is about 0.5 for gillnets (see page 38).

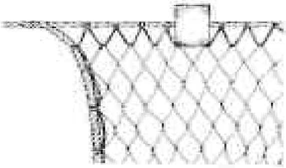
- If E is smaller than 0.5 the net will tend to tangle fish, and will capture a variety of different species. This is the case with most set nets.
- If E is greater than 0.5 the net will tend to gill the fish and be more selective than in the preceding case. This is the case with most driftnets.

■ Examples of rigging

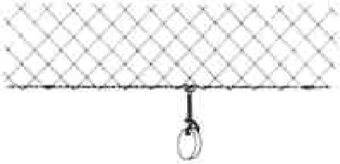
On the headrope with floats attached





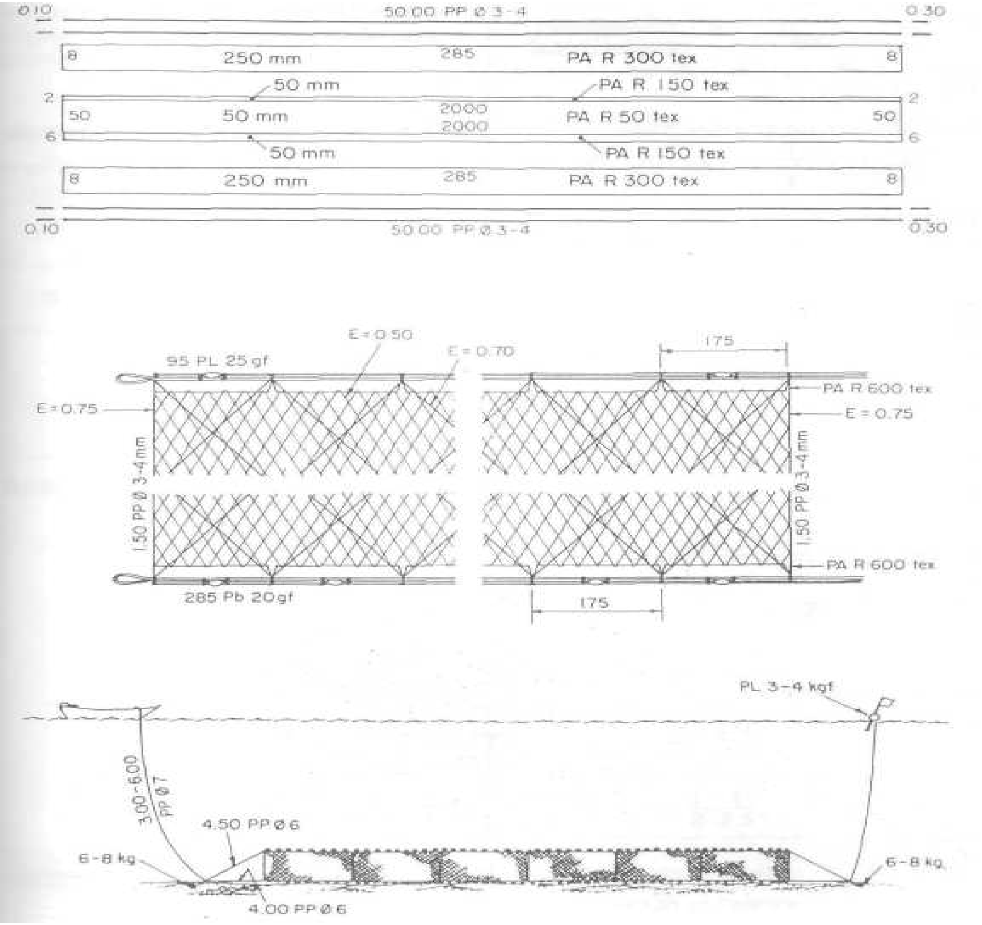


On the footrope with sinkers attached



plan and rigging of trammel net

Trammel net*
Bottom set or drifting, for shrimp
Sri Lanka



* *For clarification of symbols used in drawing of entangling net* see *page 97*

Trammel nets: mesh sizes and rigging

■ Choosing the mesh sizes according to the size of target species*

— **Central panel : The meshsize** should be small enough to catch the smallest fish wanted, by bagging. A rough estimate of the required meshsize is given by the Fridman formula for net bags:

OM should be smaller than :

$$\frac{L}{K} \times 0.66$$

where

OM (mm) = mesh opening of the central net

L (mm) = length of the smallest fish wanted

K = coefficient dependent on the target species

K = 5 for long and narrow fish

K = 3.5 for average fish

K = 2.5 for flat, thick or large fish

— **External panels :** the mesh size should be 4 to 7 times larger than that of the central netting.

The stretched height of the central net panel should be 1.5 to 2 times the stretched height of the external netting.

The actual height in the water of the trammel net depends on the height of the external netting. The central net panel should be very slack.

■ Hanging ratios of the net panels

The horizontal hanging ratios are often close to the following values:

E central netting = 0.4 to 0.5

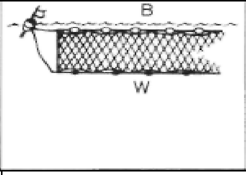
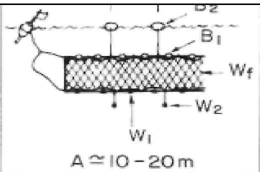
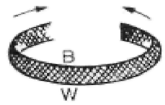
E external netting = 0.6 to 0.75

---

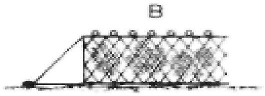
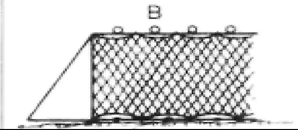
* *For clarification of terms stretched meshsize and mesh opening see page 29*

Average bouyancy (B) and ballast (W) of gillnets and trammel nets

■ Floating gillnets and trammel nets

			
B(gf/m)	100-160	B2 = 50-120 B1 = 50 - 80	600 - 1 500
W (g/m)	50-80	W1 = 30-80 W2 = 25-60	300 - 1 000
B/W	2	$\frac{B_2}{W_2} \sim 2\text{-}2.5$	1.5-2
	$\frac{\text{Length of leadline}}{\text{Length of floatline}} \le 1$ (smaller or equal)	B1 - Wf + W_1 Wf = weight of netting in water	

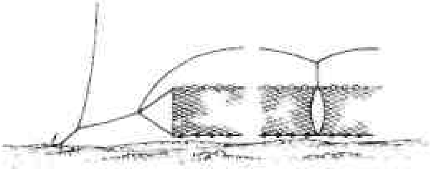
Bottom set gillnets and trammel nets

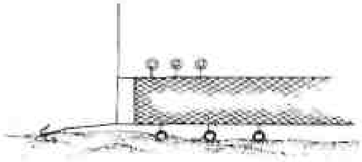
		
B (gf/m)	40-80	100-200
W (g/m)	120-250	250-400
B/W	$\frac{1}{3}-\frac{1}{5}$	$\frac{1}{2}-\frac{1}{2.5}$
		$\frac{\text{length of leadline}}{\text{length of floatline}} \geq 1$ (greater or equal)

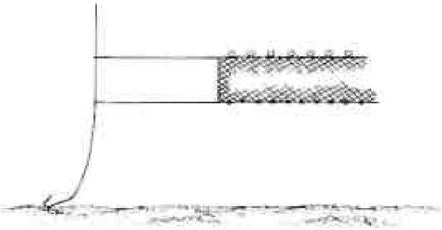
Note : *These weights do not include anchors, etc.*

Rigging of entangling nets: some examples

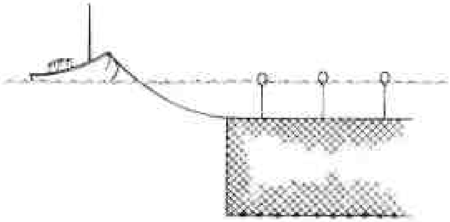
■ Set gillnets and trammel nets

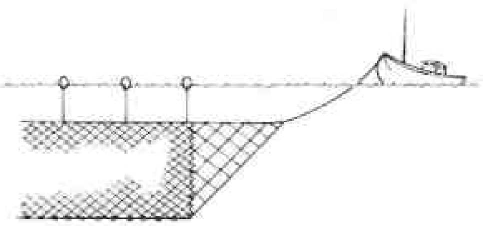


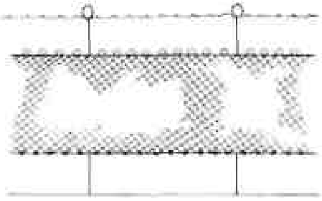


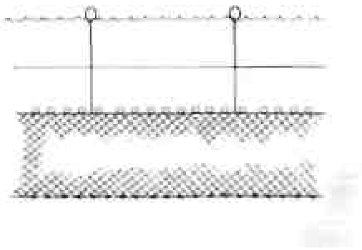


■ Drifting gillnets



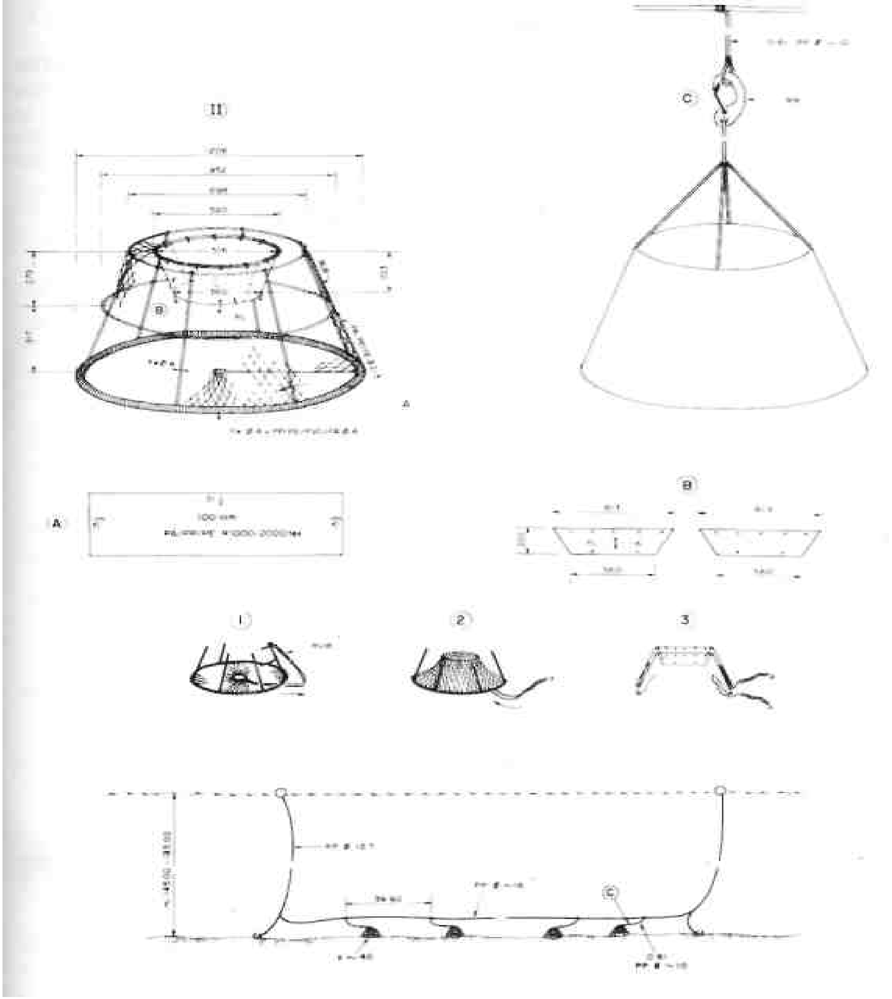






Plan and rigging of pots: an example

Crab trap	**Vessel**
Hokkaido, Japan	Length 12-15 m
Nova Scotia, Canada	hp 40-100



Dimensions of pots and traps

These gears, which can be used for catching fish, crustaceans, molluscs, and cephalopods (squid, octopus, etc.), are made in a wide variety of shapes and sizes, using many different materials. They may be used on the bottom or in mid-water, with or without bait.

■ Choosing the size of a pot or trap

If a pot gets too crowded with captured fish inside, it will stop catching. The interior volume of a pot must be large enough to avoid this situation. On the other hand, in some cases an interior volume which is too large may lead to cannibalism (some captives eating others). Some types of pots appear to be effective because their shape and size make them attractive shelters for certain species.

A few examples:

Species	Country	Volume (cubic decimeters - see p. 157)
octopus		6
small shrimp		40-70
small crabs	Japan	70-90
crabs	Canada	450
King crab, snow crab	USA	2500-4500
spiny lobster	Europe	60-130
lobster	USA	200
spiny lobster	Caribbean	300-800
spiny lobster	Australia	2500
sea bream	Morocco	150-200
mixed reef fish	Caribbean	500-700 (up to 2000)
torsk, wolf fish	Norway	1300
grouper	India	1400
black cod	USA, Alaska	1800

Making fish traps and pots

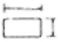
Choice of materials must consider such factors as durability, resistance to immersion, corrosion, and fouling by marine growth.

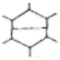
Spacing of bars or laths; or size of meshes has a direct relation to the size of the target species.

A few examples (measurements in mm] :

Species	bar of mesh (diamond shape)
small shrimp (Europe)	8-10
small crabs (Japan)	12
rock crab (Europe)	30
crab (Canada, USA)	50
King crab (Alaska)	127
spiny lobster (France, Morocco)	30-40
lobster	25-35
torsk, wolffish (Norway)	18
sea bream	(see Alternatives)
grouper (India)	40
reef fish (Caribbean)	15-20
black cod (USA)	(see Alternatives)
threadfin (Australia)	(see Alternatives)

Alternatives

— For lobster pots : Triangular meshes  60-80 mm side Rectangular meshes  25 x 50 mm
Parallel wooden strips or laths, spaced 25-38 mm apart

— For fish pots : For sea bream, triangular meshes  35-40 mm on a side For black cod, USA west coast, square meshes  51 x 51 mm For threadfin, Australia, hexagonal meshes  25-40 mm across

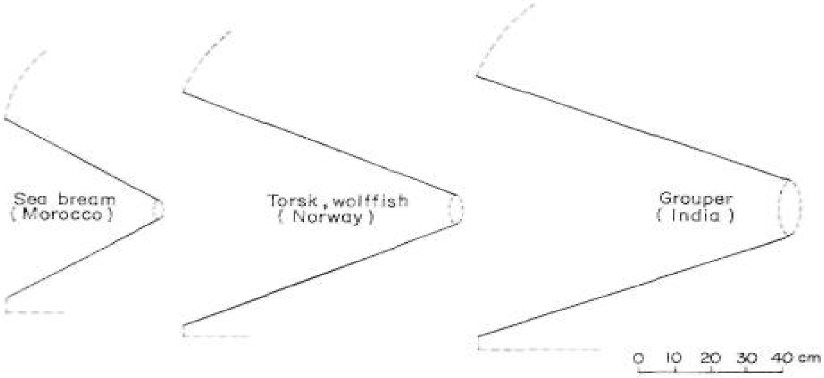
Ballast in traps is very variable, from 10 to 70 kg per trap, according to the type and size of trap, the type of bottom, and strength of currents.

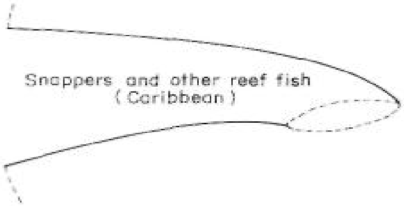
Entrances: shape and position

The shape is usually that of a cone or truncated pyramid, straight or curved.

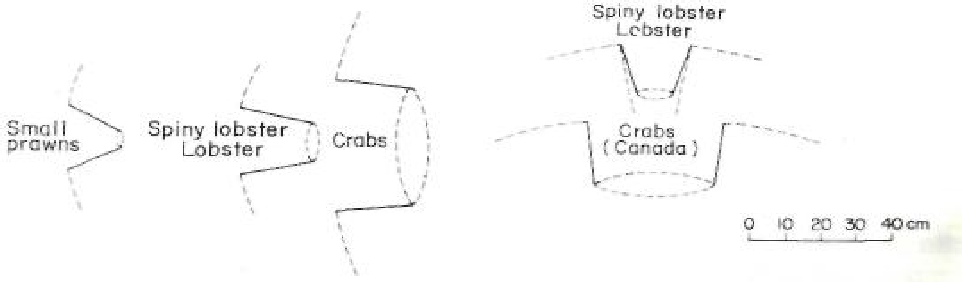
■ **The position : examples**

Traps for fish and cephalopods : entrance(s) at the side(s)





Traps for crustaceans : entrance(s) on the side(s) or on the top



Entrances: dimensions

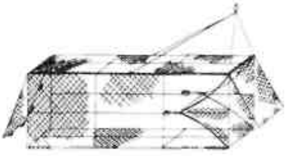
The diameter of a pot entrance is directly related to the size and characteristics of the target species.

A few examples:

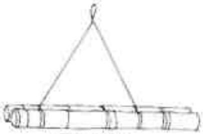
Species	Country	Entrance diameter (mm)
small shrimp		40-60
small and medium crabs	Japan, USA	140-170
snow crab	Canada	360
King crab	USA Alaska	350-480
spiny lobster, crayfish	Europe	100-200
spiny lobster	Australia, Caribbean	230
lobster	Europe	100-150
sea bream	Morocco	70-100
torsk, wolffish	Norway	100
grouper	India	210
black cod	USA, W. coast	250
threadfin	Australia	250-310
snapper	Caribbean	230

Examples of pots or traps

■ For fish or cephalopods



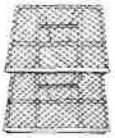
Cod (Norway)

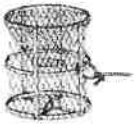


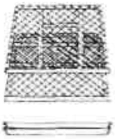
Eel tube
(Japan)

Octopus pot
(Japan, Tunisia)

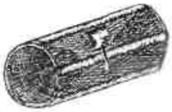
■ For crustaceans







Crayfish, lobster, crab

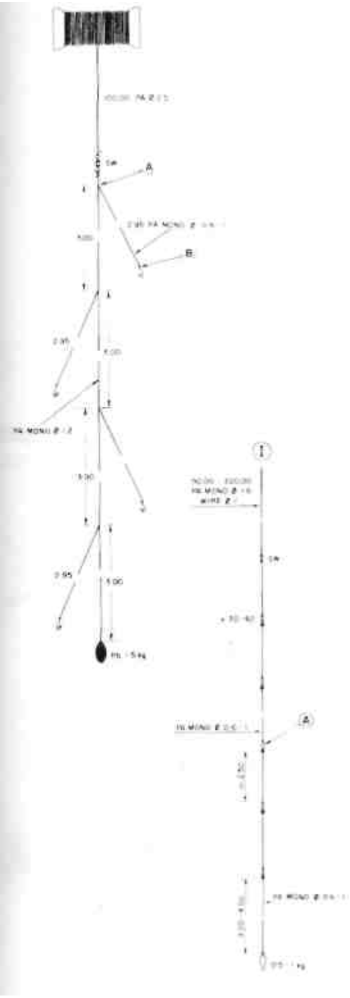


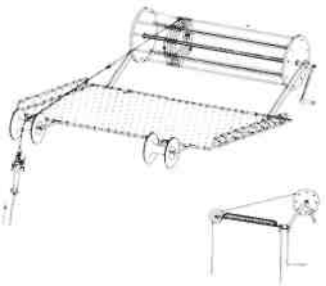
Shrimp

Vertical line fishing: examples, breaking strength

A: Mainline

B : Branchline (also called snood leader, gangion, drop line)

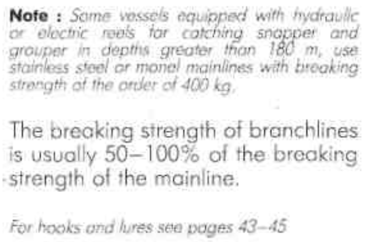




The breaking strength of the mainline should be greater than or equal to the maximum weight of an individual fish to be caught (even if there are several branchlines).

Examples of mainline breaking strength in common use for certain species

Species	Breaking strength (kg, wet, knotted)
sea bream,snapper	7-15
meagre, conger, dogfish	15-30
weakfish, grouper, cod, moray	30-40
snapper, grouper	100
yeliowfin tuna	150-200



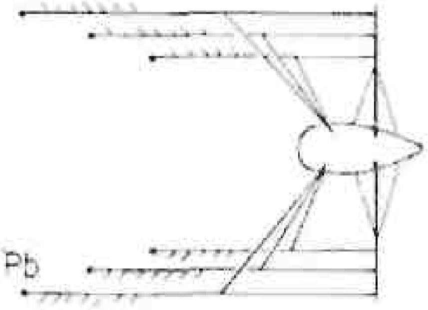
Note : *Some vessels equipped with hydraulic or electric reels for catching snapper and grouper in depths greater than 180 m, use stainless steel or monel mainlines with breaking strength of the order of 400 kg.*

The breaking strength of branchlines is usually 50–100% of the breaking strength of the mainline.

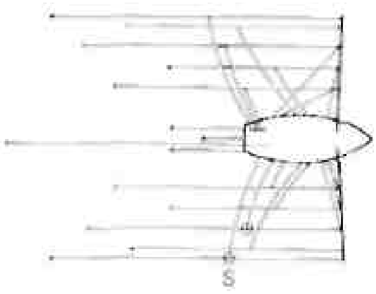
For hooks and lures see pages 43–45

Trolling methods

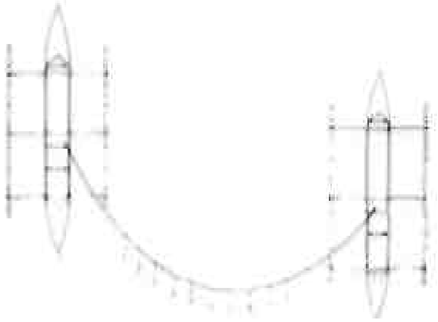
Trolling speeds vary from 2 to 7 knots, depending on target species



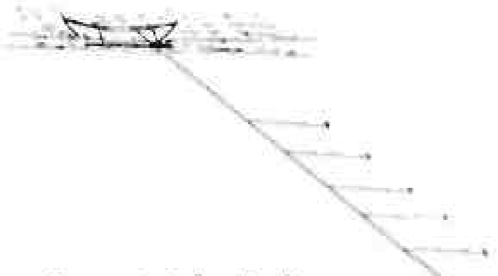
salmon trolling, near-surface
to deep water, northeast Pacific



albacore trolling, surface, France



Tuna trolling, surface, Philippines



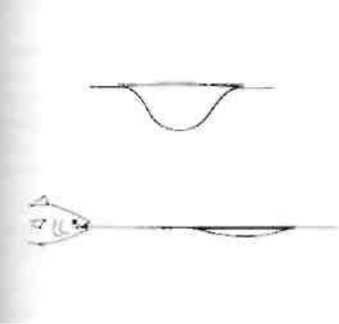
Deep water trolling, Pacific

S ; shock absorber or snubber
DP: depressor or diving board
Pb : 'cannonball' weight

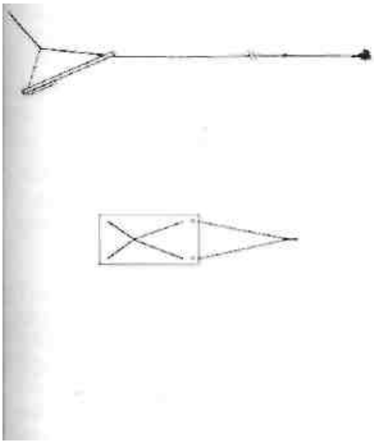
Trolling lines: rigging equipment

■ Shock absorber or snubber

Absorbs the shock load on the line when the fish strikes

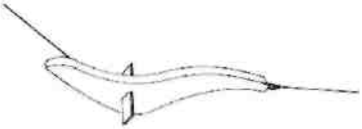


Depressor or diving board to troll deeper



■ Shearing depressor or diving board

May be adjusted to dive and also shear horizontally to spread lines



Left divergent depressor

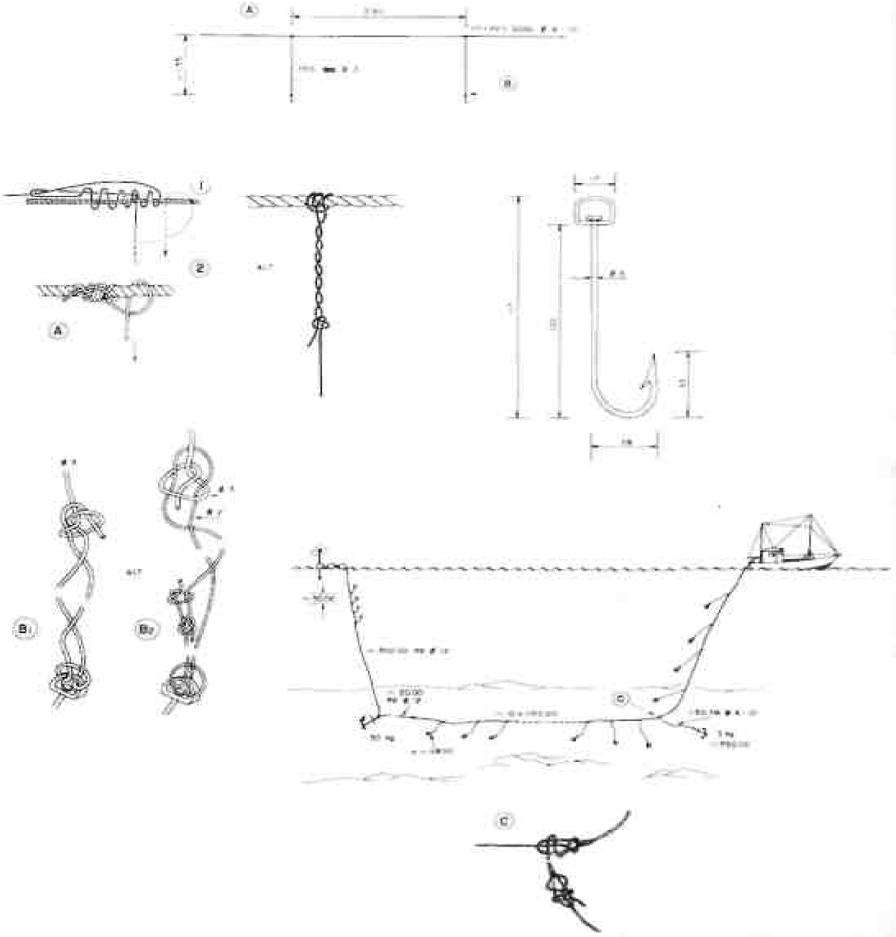
Depressor

Plan and rigging of bottom longlines: an example

Longline for dogfish, rays, conger,
ling
Channel, France

Boat

Length 14-15 m
TJB 20-30
Hp 150



Longline components

A longline consists of a main line, to which a number of branchlines (also called snoods or gangions) are attached. A hook is attached to the end of pnch branchline.

The material and diameter of the mainline will depend on the target species, the type of longline (bottom or mid-water), and gear-handling methods (manual or mechanical hauling). The diameter and breaking strength must take into account not only the weight of the fish, but also the displacement (and therefore, inertia) of the vessel.

As a general rule, one can choose a mainline whose breaking strength (dry, unknotted, in kg) is ;

— both greater than 10 times the tonnage of the vessel, and greater than the square of the vessel's length (in metres).

— at least 10 times the weight of the largest fish one expects to catch.

For example:

What would be the minimum breaking strength for the main line of a longline used by a 9 m, 4 t vessel, catching sea bream and gurnards?

Breaking strength must be greater

than 4 x 10 = 40 kg

or 9x9 = 81 kg

But, if one expects to catch individual fish weighing 10 kg, it is necessary to calculate

10 kg x 10 = 100 kg

Therefore, the line could be twisted or braided nylon (PA), 2 mm diameter (breaking strength 130-160 kg); or nylon monofilament 170/100 (breaking strength 110 kg); or polyethylene (PE) 3 mm diameter (breaking strength 135 kg).

Branchlines (snoods or gangions) should be as close as possible to invisible in water, but sometimes of steel (for example, in some tuna and shark fisheries).

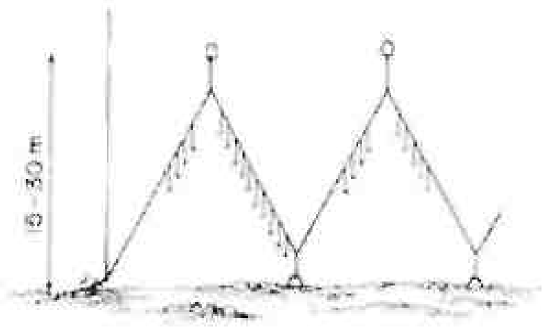
Breaking strength of branchlines (wet, with knots) should be at least equal to twice the weight of the fish one expects to catch. (The breaking strength of the main line should equal 3 to 10 times that of the branchlines.)

The length of a branchline is usually less than half the distance between branchlines, in order to avoid tangling.

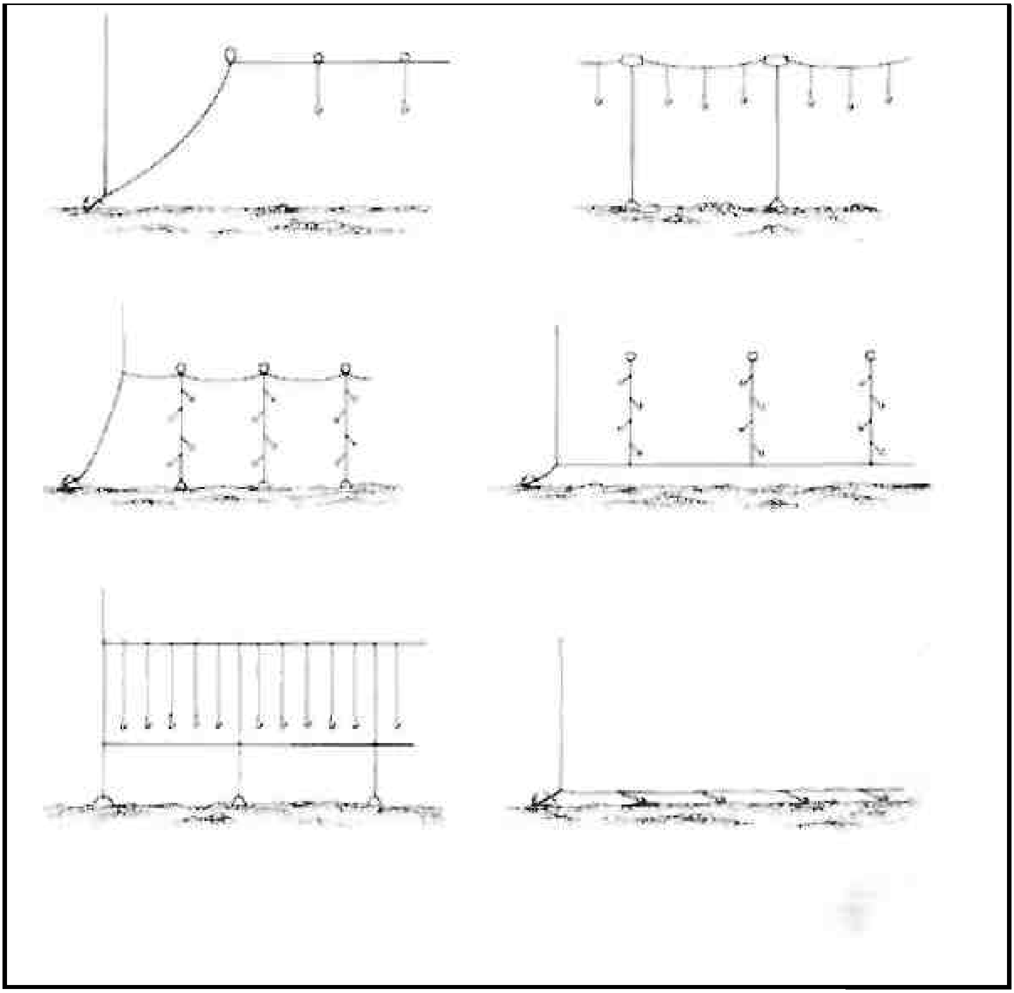
Hooks are usually chosen by experience, according to the size and behaviour of the target species; hooked fish should stay alive (for species which can live when hooked), but should not come unhooked.

Set longlines: various rigs in use

■ **Semi-pelagic longlines**

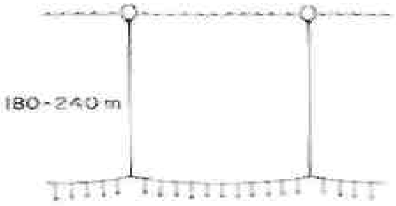


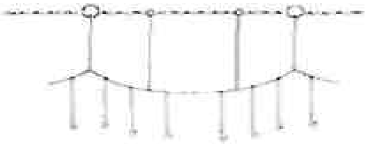
■ **Bottom longlines**

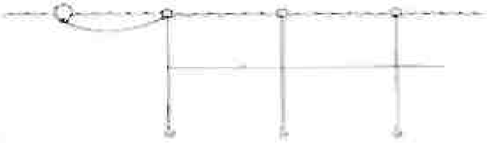


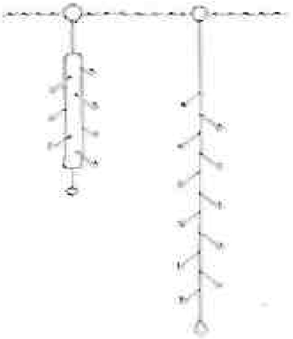
Drifting longlines: various rigs in use

Some examples:

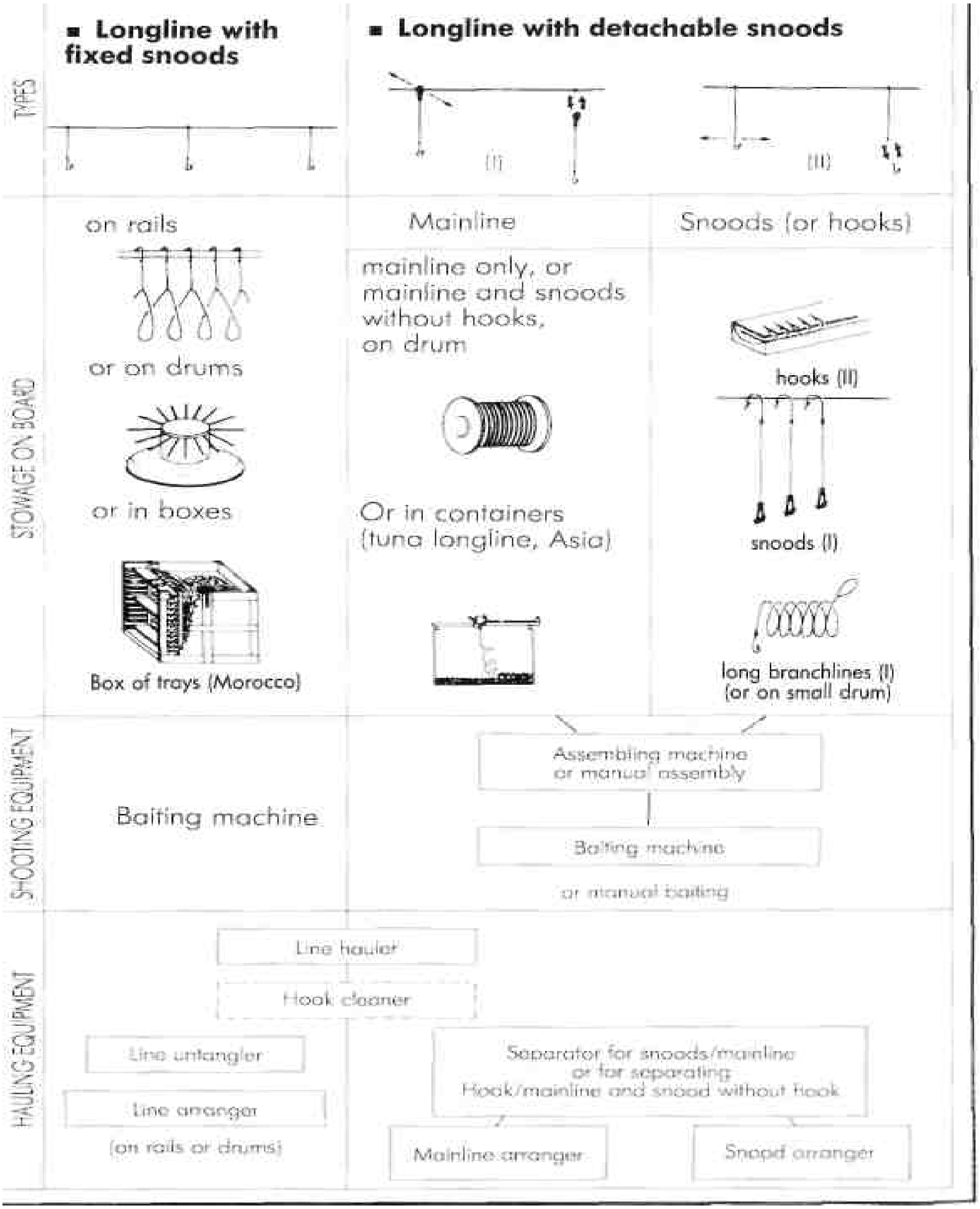








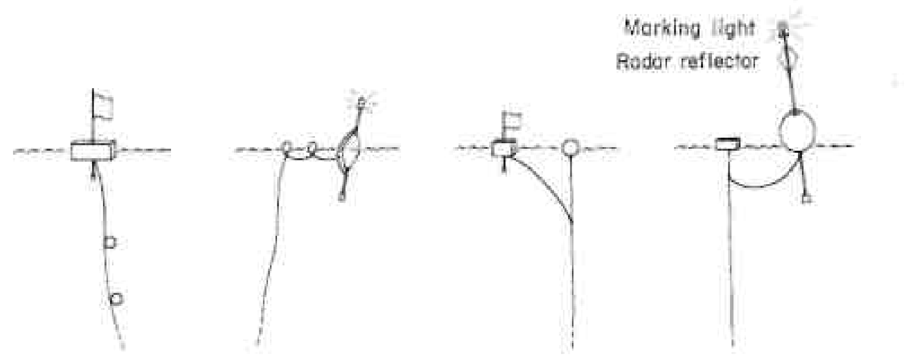
Longlines: automation of operations



	Longline with fixed snoods	Longline with detachable snoods	
TYPES		(I)	(II)
		Mainline	Snoods (or hooks)
STOWAGE ON BOARD	on rails or on drums or in boxes Box of trays (Morocco)	mainline only, or mainline and snoods without hooks, on drum Or in containers (tuna longline, Asia)	hooks (II) snoods (I) long branchlines (I) (or on small drum)
SHOOTING EQUIPMENT	Baiting machine	Assembling machine or manual assembly Baiting machine or manual baiting	
HAULING EQUIPMENT	Line hauler Hook cleaner Line untangler Line arranger (on rails or drums)	Separator for snoods/mainline or for separating Hook/mainline and snood without hook Mainline arranger	Snood arranger

Marking bouys and anchors; for nets, traps and lines

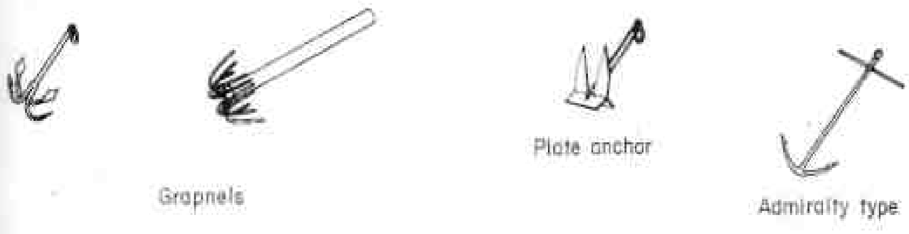
■ On the surface



■ On the bottom

Special rigging of anchor to assist recovery

■ Some types of anchors



Dredges

■ Characteristics

Rigid fishing gear for pulling over the bottom (types for soft bottom, types for very hard bottom)

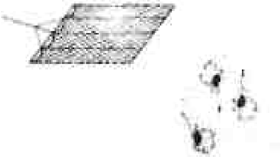
Sizes (usually the width is less than 2 m, exceptionally up to 5 m) Height is always less than 0.5 m

Heavy (to scrape the bottom)

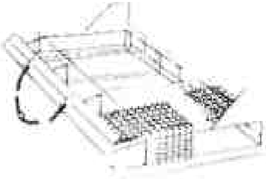
■ Examples of different types

Dredge for small fish
Weight: 30 kg

Rigid dredge with
teeth for venus clam
Weight: 200-300 kg

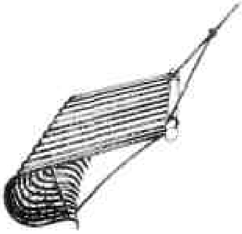


Dredge without bag for whelks.
The shells entangle in the netting
Weight: 20-25 kg



Industrial shellfish dredge
Weight 500-1000 kg

Dredge with teeth, on the lower edge of the frame and with depressor flap on the upper edge Weight 70-100 kg



Shellfish rake

■ Power required

1 hp per 2 kg of dredge

■ Towing cable

(one)

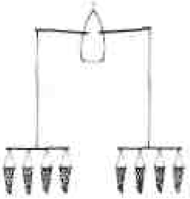
■ Amount of warp depends on the depth of water and the speed

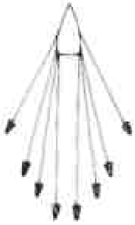
(The warp paid out will need to be increased with the speed). In general, 3 to 3.5 x depth (at 2-2.5 knots)

■ Speed of dredging :

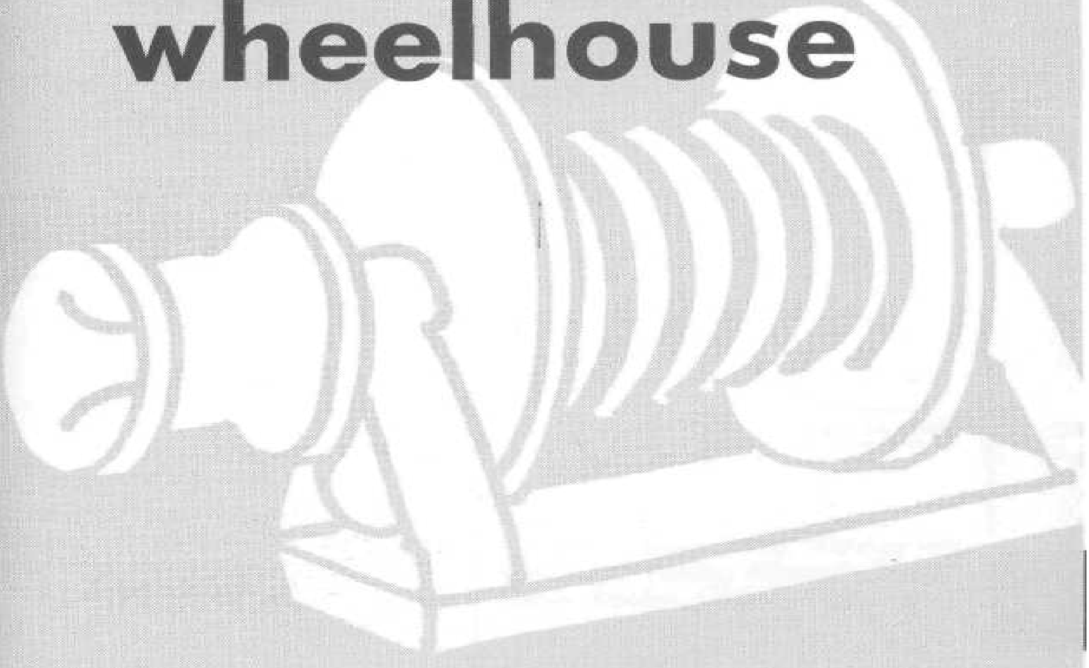
2 to 2.5 knots

■ Rigging, some examples





Equipment for deck and wheelhouse



Fishing with light

■ Conditions which favour fishing with light

	Not favourable	Average	Favourable
Colour of the Sea	Brown-yellow	Yellow-Green	Green-Blue
Transparency (visibility m)	0 to 5	5 to 10	10 to 30
Moon phase	Full	-	New
Current	Strong to Medium	Medium to Weak	None

■ Type of Lamp and utilization

	Petrol (gasoline) or liquified gas	Electric
Advantages	inexpensive easy to maintain and use	effective above the surface or in the water
Disadvantages	fragile used only above the water	expensive heavy bulky batteries or generators

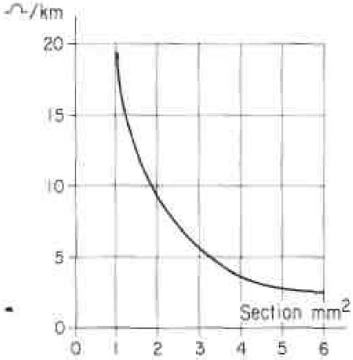
It is better to use several lights of moderate intensity, sufficiently spaced apart, rather than a single light of strong intensity.

When a lamp.is mounted above the surface, only half its light effectively penetrates the water, due to reflection from the surface.

■ Resistance of electric cables

Running lamps with low voltages (for example, 12-24 V) may involve significant power losses through conducting wires. Therefore, wires used with low voltages should be thicker than those needed for higher voltages.

Resistance to a continuous current (in ohms/km) in a copper conductor is a function of the cross section area of the cable (mm^2).



From Ben-Yami, 1976. *Fishing with light.* FAO Fishing Manuals, Fishing News (Books), Oxford.

Characteristics of echo-sounders

Depth Range
Frequency Common frequencies are 30-400 KHz

	High Frequency Echo-sounders (100 to 400 kHz)	Low Frequency Echo-sounders (50 kHz or less)
Common use	shallow water	deep water
Width of Beam	narrow	wide
Precision	very good	less precise
Size of transducer	small	large
Usual Use	fish detection	navigation

Electric supply required on the vessel (voltage, power)
If the echosounder's power supply is a bit weak, its performance will be poor.

The type of display may be lamp display (flasher), paper (chart recorder), or colour screen.

	Paper display (dry, black and white)	Television type display (colour)
Advantages	paper record may be kept	different colours may indicate very small differences in strengths of echoes
Disadvantages	differentiation of different echo strengths is limited (shades of black and grey) cost of Recording Paper	no memory or limited memory, but note that recording equipment is now available

■ Other predetermined characteristics

Wavelength (m) = 1500/frequency (Hz)
The smaller the wavelength the greater the precision of detection.

Pulse length :
Short 0.1 to 1 millisecond
Long more than 2 milliseconds
The shorter the pulse length, the greater the precision but, in fact, this is predetermined according to the frequency and the depth of sounding.

Beam-width :
Wide : 20 to 30 degrees
Narrow : 4 to 10 degrees

Output power ranges from 100 to 5000 watts.
The greater the power, the better will be the strength and precision of detection.

Choice of an echo-sounder according to the application

	Navigation echosounder	Fish-finding echosounder
Depth of Water Limited to 100 m	Frequency 20-100 kHz Beamwidth 10-20 degrees Output Power less than 1 kW	Frequency 100-400 kHz Beamwidth 4-15 degrees Output Power around 1 kW
	Pulse length less than 1 millisecond Flasher display may be sufficient	Pulse length less than 1 millisecond Usually with TVG and whiteline
Deeper Water	Frequency 10-20 kHz Beamwidth 4-10 degrees Output Power 5 -10 Kw depending on depth Pulse length greater than 2 milliseconds	Frequency 30-50 kHz Beamwidth 4-10 degrees Output Power 5-10 kW depending on depth Pulse length 1-2 milliseconds, with TVG and whiteline

Winches and net drums

■ Power required

$$P = \frac{(F \times v)}{75}$$

where

P = actual power of winch or hauler (HP)

F = pulling force needed (kgf)

v = speed of hauling needed (m/s)

When estimating the engine power required to produce the actual power at the winch, it is necessary to add 25% for power loss through mechanical transmission, or 100% for hydraulic transmission. For example, if actual winch power (P) of 10 HP is required and transmission is mechanical, then 12.5 HP engine power will be needed to produce this.

■ Turning speed required

$$R \sim \frac{1000 \times v}{3 \times \varnothing}$$

where

R = turning speed of winch or hauler **(RPM)**

v = speed of hauling required (m/min)

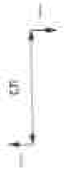
Ø = diameter of full drum (mm)

■ At a constant hauling speed, pulling force available decreases as a drum fills

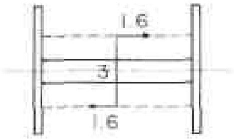
Pulling force

$$= \frac{\text{torque}}{\text{effective diameter of drum}}$$

The torque of the drum is constant (at 5, in the example in next column).



Pull at full drum



Pull at mid-drum
(half full)

Pull at bare drum

■ At a constant drum diameter, the pulling force available decreases as speed increases

Work done by drum = pull x speed = constant

***Example**:*

pull at mid-drum at 1 m/s : 1.6 t
pull at mid-drum at 1.6 m/s : 1.0 t
(1.6 t x 1 m/s = 1.0 t x 1.6 m/s)

■ Tension on the material being hauled

$$T = \frac{75 \times P}{v}$$

where

T = tension on the material (kgf)

P = power of the winch or hauler (HP)

v — speed of hauling (m/s)

Note : *Main characteristics of a winch or drum are the dimensions, the capacity and the pulling force (in tonnes force or in daN; see pages 150.*

152)

purse seine winches and drums

The pulling force of the purse line winch required for a seine of given weight can be estimated by the following formula :

$$F = 4/3 (Wn/2 + Wr + Ws)$$

where :

F = pulling force of the winch (tf, tons force)

Wn = weight in air of the netting (t, tons)

Wr = weight in air of the footrope and purse rings (†)

Ws = weight in air of the ballast on the footrope (†)

Characteristics of some purse line winches in use (after Brissonneau and Lotz)

		Drum Capacity				
Vessel Length (m)	No. Drums	Cable Ø (mm)	Length (m)	Pull (†) (bare drum)	Speed (m/s) (bare drum)	P(HP)*
20	2	15.4	1300	8	0.5	44
20-25	2	15.4	1800	11	0.42	70
25-30	2	17.6	1800	17	0.37	100
30-40	3	17.6	1800	21	0.30	
		17.6	800	21	0.30	100
		17.6	600	21	0.30	
45-60	3	20	2220	27	0.35	
		20	975	27	0.35	150
		20	975	24.5	0.35	
60-75	3	22	2420	27	0.35	
		22	1120	27	0.35	300
		22	1120	24.8	0.35	

■ **Seine drums**

some examples

width of drum inside flanges (m)	3.00	3.90
flange diameter (m)	2.45	2.44
drum diameter (m)	0.6	0.45
Seine dimensions: hung length x stretched height (m)	360 x 30	450 x 64
stretched meshsize (mm) (centre section)	32	
twine size (centre section, Rtex)	376	

** Power (HP) = 1.36 x Power (kW)*

Trawl winches

Power* of trawler(HP)	Power of winch(HP)	Capacity of drums		hauling speed (m/sec)	Pull at mid-drum (kg) drums combined
		Length(m)	Ø of wire(mm)		
50-75	200	6.3	500-750		
100	25	700	10.5	1.00	900
200	40	1000	12.0	1.20	1600
300	60	1250	13.5	1.35	2500
400	80	1350	15.0	1.40	3500
500	120	2100	16.5	1.50	4500
700-800	165	2000	19.5	1.50	6500

* *Brake horsepower (BHP) or Apparent Nominal Power (ANP), see page 95 Power in (HP] = 1.36 x Power in (kW)*

At constant drum RPM, pull x diameter = constant; thus,

$$\text{pull at bare drum} = \frac{\text{pull at mid-drum} \times \varnothing \text{ at mid-drum}}{\varnothing \text{ at bare drum}}$$

$$\text{pull at full drum} = \frac{\text{pull at mid-drum} \times \varnothing \text{ at mid-drum}}{\varnothing \text{ at full drum}}$$

■ Performance

— Power :

$$\text{Power of winch (HP)} = \frac{\text{Power of engine (HP)}}{4 \text{ or } 5}$$

— Maximum Pull : At the most, equal to 1/3 the breaking strength of the warp.
In order to haul the trawl the winch has to develop more power than tha' which is exerted in towing the trawl.

The pull of the winch at mid-drum should be at least 80% of the maximum bollard pull of the vessel. It is best to use the formula :

Pull of the winch (at mid-drum)
= 1.3 x pull of the trawler

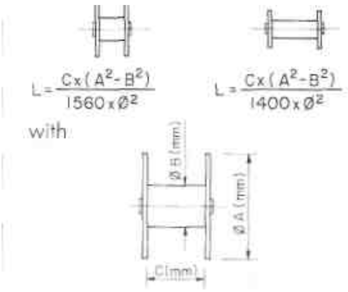
■ Dimensions

— Diameter of the bare drum : about 14 to 20 times the diameter of the warp.

— Depth of drum$\frac{(A - B)}{2}$: at least equal to the diameter of the bare drum

■ Capacity of a winch drum

— With automatic spooling (level-wind) and drum dimensions given above, If L = length (m) of warp, and 0 = diameter (mm) of warp :



$$L = \frac{C x (A^2 - B^2)}{1560 x Ø^2} \qquad L = \frac{C x (A^2 - B^2)}{1400 x Ø^2}$$

— Manual spooling reduces this capacity by about 10%.

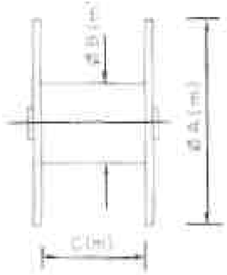
Note : *Tolerances must be taken into account when accessories (i.e. chains, shackles) swivels] are hauled on with the warps.*

Trawl net drums

- **Capacity of a drum**

Usable volume of drum

$(m^3) = \underline{3} \times C \times (A^2 - B^2]$

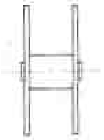


Note : *The volume of a trawl (V) con be estimated from its weight W: midwater trawl V (cubic m) = 3.5 X W (tonnes) bottom trawl V (cubic m) = 4.0 x W (tonnes)*

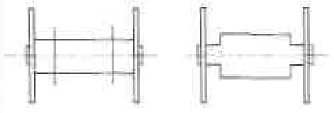
Note : *when sweeps and/or the bridles of combination rope are to be reeled onto the drum with the net, their volume must be taken into account. The same is true for the floats, ballast, sinker chain and bobbins.*

- **Main dimensions**

For a given application (requiring a [certain pull, speed and capacity) there may be several alternatives to choose from.



to hold a net without floats or ballast



Drums with space reserved for the sweeps and bridles

The bare drum diameter B generally does not vary much for a given pull.

Pull (tonnes)	B average (mm)
<3	240
5-8	300
8-13	450
20-30	600

Thus, A and C will be chosen depending on the type of net, use of the drum (storage and/or hauling) the volume of the net, and deck space available.

- **Pulling force**

In order to maintain the speed of hauling, the pull of the net drum at bare drum should be at least equal to the pull of the winch at full drum.

- **Hauling speed** is generally greater than or equal to 30 m/min.

A few guidelines:

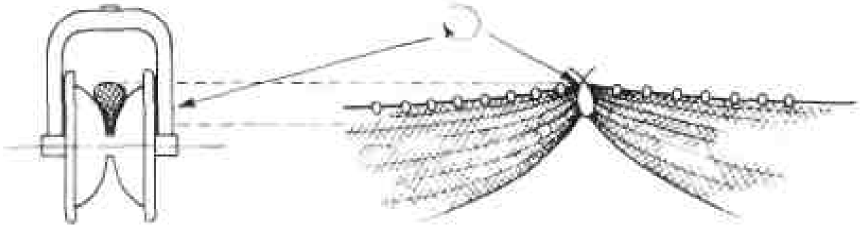
Note that for a given capacity, the pulling force and speed may vary a great deal, according to the strain on the winch.

Vessel horsepower	Capacity (cubic m)	Weight of net (kg)	Pull (t) (bare drum)	Speed (m/min)	Weight of Drum (t)
100	0.5	120			
200	1	250			
300	1.5	400			1-1.2
400	2	550	2-4	10	1.5
500	2.5	700			
600	3	800	6-10	13.5	1.7-1.8
700	3.5	1000			
800	4	1100	7-12	17	2-2.5

** Brake horsepower (BHP) or Apparent Nominal Power (ANP), see page 95*
Power in (HP) = 1.36 x Power in (kW)

Power block

■ Choice of model



The netting should fill only the groove (throat) of the power block. The model is chosen according to the circumference of the seine gathered together, estimated by two different methods :

(1) Direct measurement — take the leadline with the floatline to form a large bundle with the netting and measure the circumference of the bundle with a piece of twine, passing it between the leads and the floats.

(2) Calculation
Circumference (mm) = $450 (0.00006 \times Rtex + 0.02) \sqrt{N}$

where Rtex = size of twine in the body of the net

N = number of meshes deep in the purse seine

■ Pull available

The power block should be capable of pulling 20% to 50% of the total weight of the net (in air), at speeds of between 30 m/min for a small seiner to 80 m/min for a larger seiner.

Values of pulling force available at mid-diameter for power blocks of different capacities in common use.

Capacity (circumference of net, mm)	Pull tonnes
500-800	0.5-1.5
800-1100	1.0-2.0
1100-1800	3.0-5.0
1800-2500	6.0-8.0

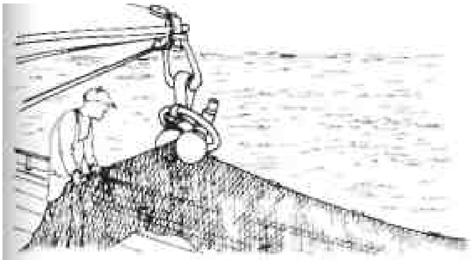
■ Performance of power blocks in common use according to the size of the vessel

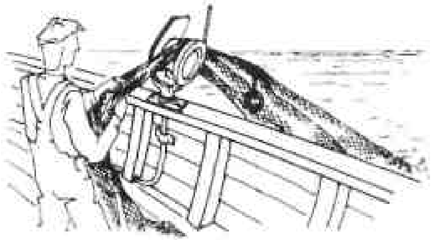
Seiner length (m)	Pull (tonnes) ..	Speed (m/min)	Power (HP*)
9-12	0.5-1.0	30-40	8-16
12-24	1.0-1.5	30-40	13-20
18-30	2	40-50	30-45
24-39	4	40-50	60-85
24-34	5	40-70	80-150
30-75	6-7	40-90	90-220

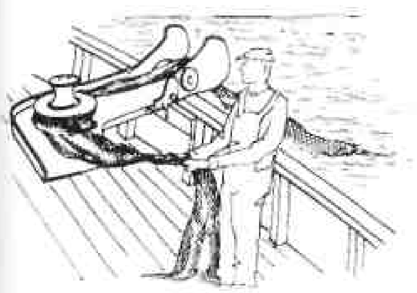
** Power in (HP) = 1.36 x power in (kW)*

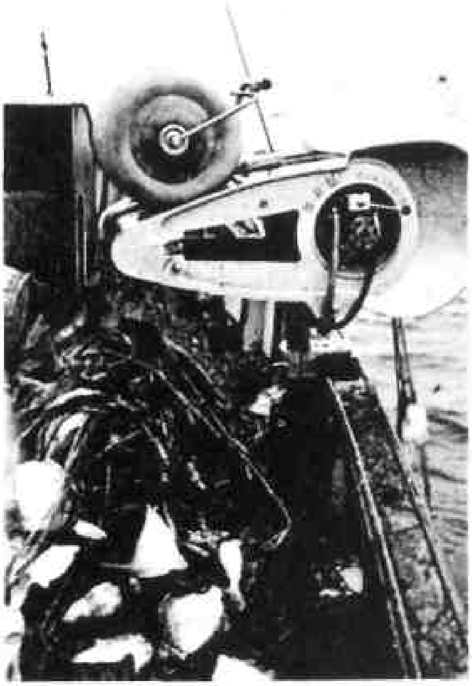
Net haulers: some examples

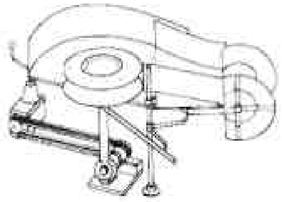
Other than power blocks (page 130)

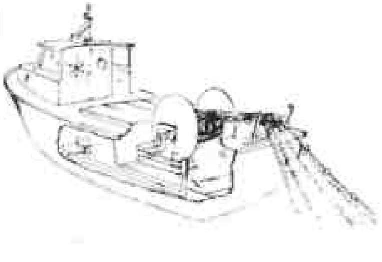




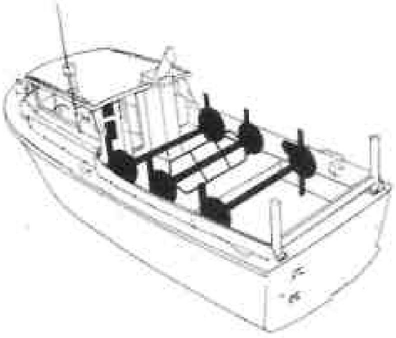








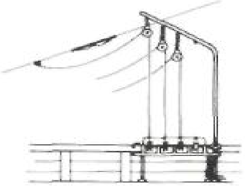
Hauling with a net drum

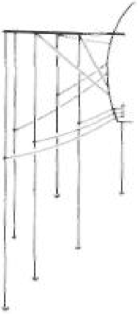


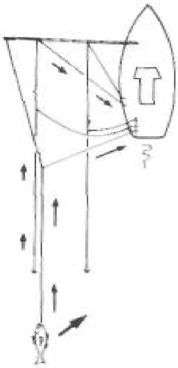
Hauling with a net drum crossing two 'shakers'

Line haulers

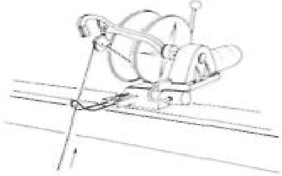
■ Hauler (gurdy) for trolling lines

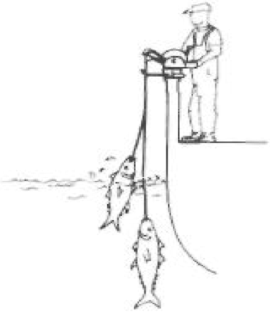


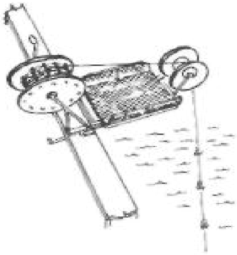




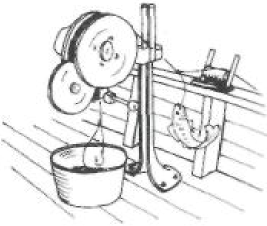
■ Haulers for vertical lines, jigging machine

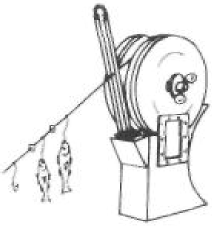


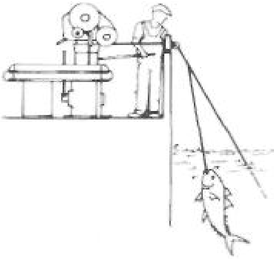




■ Haulers for long-lines

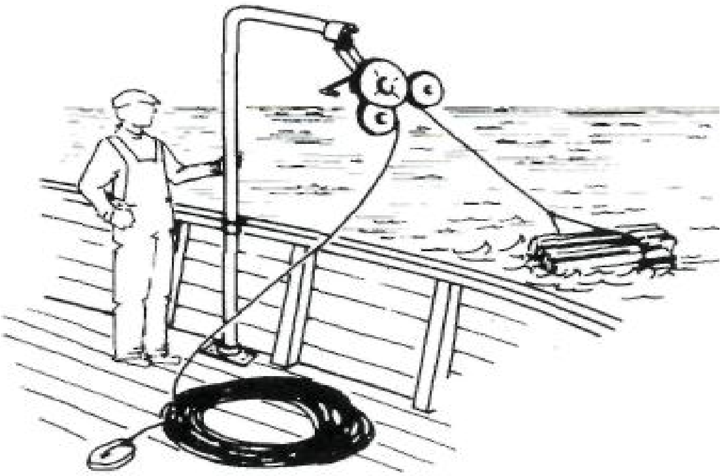


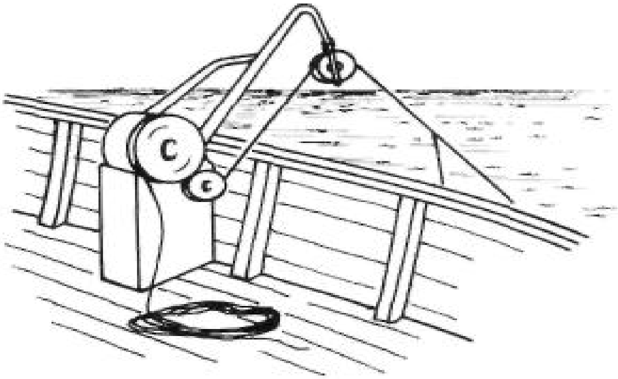




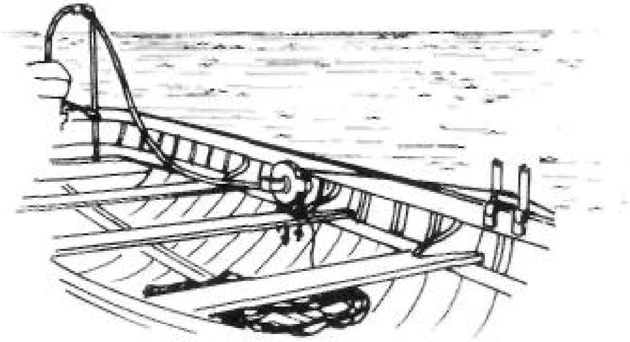
pot/trap haulers

■ Hydraulic pot hauler





■ Pot hauler powered by outboard motor



Haulers for nets, lines and traps: performance of common types

Note : *within the power limits of the engine (constant torque) :*

At the hauler:	*as speed V increases,*	↗	*pulling force F decreases (the inverse is also true*	↘	*F x V = constant = power of hauler*
	as drum diameter decreases,	↘	*Pulling force F increases (the inverse is also true)*	↗	*F x Ø = constant*

Longline haulers

For longlines up to about 30 km long, with relatively short branchlines (5 m or less), the following pertain to a few types in common use.

Vessel Length (m)	Ø Line (mm)	Pull (kg)	Speed of Hauling (m/min)
<10	<6	200-300	20-40
10-15	6-12	300-400	60
15-20	8-16	500-700	70

For drifting midwater longlines (i.e. Japanese-type longlines for tuna), length is of the order of 100 km, with snoods spaced 50 m or more apart.

Vessel Tonnage	Speed of hauling (m/min)
10	70-80
20	70-90
40	150-210
100 ≥	180-260

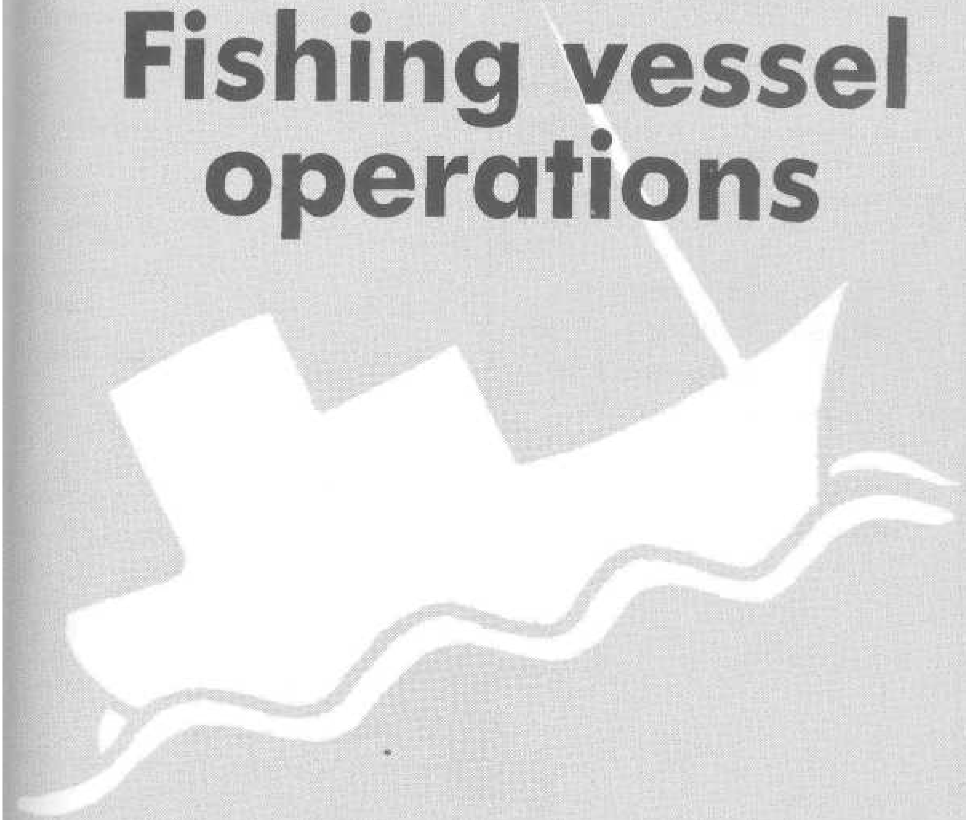
■ **Net haulers** : the following pertain to a few types in common use.

Vessel Length (m)	Depth of Water (m)	Pull (kg)	Speed of Hauling (m/min)
5-10	< 100	150-300	20-35
10-15	<200	200-500	25-45
15-20	300 ≥	500-900	50-70

■ **Pot/trap haulers**

Performance is very variable depending on the model, and comparable to that of line haulers and net haulers, except for the existence of models with pulling force greater than 1000 kg (1000, 1350, 1500 kg) and higher hauling speeds.

Fishing vessel operations



Fuel consumption of engine, speed of vessel

■ Fuel consumption of the engine

Specific consumption of fuel depending on the type of engine

Engine	Density of fuel	Consumption in g/hp/hour
2-stroke petrol	0.72	400-500
2-stroke petrol (improved)	0.72	300-400
4-stroke petrol	0.72	220-270
Diesel	0.84	170-200
Diesel (turbo-charged)	0.84	155-180

— *Consumption of fuel by an engine during a given period of time :*

C = 0.75 x P(max) x (S/d) x † x 0.001

where

0.75 is an average coefficient; free running it is between 0.7 and 0.8 and when fishing 0.5 to 0.8

C = consumption (in litres)

P(max) = maximum power of engine in HP

S = specific consumption of fuel in grams/HP/hour

d = density of fuel

† = time of use of engine in hours

Note : *time can be replaced with*

<u>distance covered in miles</u>

speed in knots

Approximation :

Annual consumption of a trawler = 1000 litres/HP/year

— Consumption of lubricating oil = 1 to 3% (in litres) of fuel consumption

■ Maximum Economic Speed (Critical Speed)

This is related to the length of the vessel at the waterline.

— for a displacement vessel, this speed, V, can be estimated as follows :

$$V\ (\text{knots}) = 2.4 \times \sqrt{(L_w)}$$

where L_w = length at the waterline (m)

— for a planing hull :

$$V\ (\text{knots}) = 5.4 \times \sqrt{(L_w)}$$

* *petrol = gasoline*

Ice, capacity of holds and tanks, fresh water

■ Quantity of ice required

(1 m^3 of ice weighs a round 900 kg)

— In temperate waters : 1 ton of ice for 2 tons of fish (kept for more than a week)

0.7 ton of ice for 2 tons of fish (kept for less than a week)

— In tropical waters :1 ton of ice for 1 ton of fish

These quantities may be reduced by 30 to 50% if the hold is refrigerated.

■ Capacity of the hold in kg of fish or crustacea per m^3

Taking into account the shape of the hold and arrangement for stowage, the real capacity of a hold will reflect a stowing rate 10-20% less than the figures shown here.

Material	Method of stowing	stowing rate kg/m^3
Ice	Crushed	550
Ice	Flake	420-480
Small fish(eg sardine)	Without Ice	800-900
Small fish(eg sardine)	In bulk with ice	650
Small fish (eg sardine)	In chilled sea water	700
Average to large fish	In bulk with ice	500
Average to large fish	In boxes with ice	350
Average to large fish	Frozen whole	500
Average to large fish	Fresh or frozen fillets	900-950
Tailed shrimp	Frozen in blocks	700-800
Tuna	Frozen in bulk	600

■ Capacity of a live tank or well

Crustacea in well or tank on board : 120-200 kg of Crustacea per m^3 of tank **(Note** : *adequate water circulation is essential)*

Crustacea in cage or 'car' set in sea : 400 kg of Crustacea per m^3 of cage Live bait well : 30/50 kg of bait per m^3 (water renewed 6 to 8 times per hour)

■ Consumption of fresh water, minimum allowance to plan :

vessel length 10 m : 10 to 15 litres of water per person per day
20 m : 20 to 25 litres of water per person per day
30 m : 30 litres of water per person per day

Bait: quantity required

■ Longiine

The quantity of bait required obviously depends on the bait type, target species and type of longiine. The figures here are rough estimates taken from examples in use.

Bait type	Quantity (in kg) per 100 hooks
Sandeel, Sardine	2.5-3
Mackerel, Horse mackerel	5-6
Needlefish (for drifting longiine)	10

If mackerel is used as bait, the following estimates may be given.

Target species	Weight of bait (g) per hook
Whiting	20-25
Small sharks, cod, rays	40-60
Large sharks	200 - 300
Swordfish	100 to 450

■ Live bait for tuna

In planning to catch in the order of 10 to 30 † of tuna, reckon on 1 † of bait (the proportion will increase a little with the tonnage of the vessel).

Speed of operation

■ **Longlining** (manual operation aided only by a line hauler)

— **Bottom longline**

number of hooks per man per day : 500-1000
speed of baiting : 2-4 hooks/min/man

speed of shooting (coastal) : 50-150 m/min

speed of shooting (deep-water) : 200-300 m/min

speed of hauling (coastal) : 15-40 m/min

speed of hauling (deep-water) : 60 m/min

— **Midwater drifting longline (tuna type)**

speed of shooting : 400-600 m/min or 500 hooks/h

speed of hauling : 200 hooks/h at 3-5 knots

■ **Gillnetting**

Length of net per man per day : 500-1000 m

speed of shooting : 6000-9000 m/h

speed of hauling : 700-1500 m/h

■ **Purse seining**

Shooting the seine usually takes 2-5 min

Speed of pursing :

Length of purse seine (m)	Duration (mins)
300	7-10
800	10-15
1200-1400	15-25

Speed of hauling with power block :

Length of purse seine (m)	Duration (mins)
300	20-25
800	40-60
1200-1400	60-100

Loading or broiling may take several hours depending on the catch.

■ **Trawling**

The amount of time needed to shoot and haul the warps depends on the depth. Shooting the rest of the gear (doors, sweeps, bridles, net) may take 5-15 min. Hauling may take 15-25 min (excluding warps).

Bookkeeping

■ **Rules**

— Keep a record of all expenses and receipts

— Take a lot of care in organising and classifying records

— Check accounts very regularly

■ **Keeping and presenting accounts**

— The methods of settling and presentation of the accounts depend on the habits and traditions of local fishermen, which will determine the following :

— Particular costs are defined as **joint expenses** (fuel, ice, food etc.) or **boat expenses** (vessel maintenance, renting of equipment, etc.).

— Income from the catch is divided to pay certain expenses, as well as the **labour share** (crew share) and the **boat share;** these proportions vary among different fisheries.

— Division of the labour share among the crew may depend on individual responsibilities, amount of experience, etc.

NEVER mix the payment of the skipper with the boat's accounts, which are the accounts of the company or owner (even if the skipper is the owner).

Keep these two accounts well separated, preferably in two separate books.

(1) A book for the accounts of the crew, skipper included

Date	Transaction #	Grass Receipts from sale and fish	Joint Expenses
			(several columns for different expenses)

This will help with calculation of crew payments.

(2) A book for the boat's accounts (accounts of the company)

Date	Transaction #	Expenses charged to the Owners
		(several columns for different expenses)

This will help with calculation of the boat's net income.

— **Gross receipts - joint expenses = net receipts**

— **Net receipts** are divided into **labour share** and **boat share**

— The labour share is divided among the crew according to the contract (calculated every week or after each trip)

The **boat share - boat expenses = gross profit** (calculated on an annua! basis)

Bookkeeping (continued)

There is a **net profit** only if the gross profit is greater than the sum of interest on loans plus amortisation of equipment.

Table of **loan repayment**

Amortisation is the cost associated with the loss of value, (through use, wearing out) of the **investment**

(vessel, motor, etc.). Depreciation is a related term which is used more commonly. When money for replacement of equipment (which is wearing out) is set aside and considered a cost, this may be called amortisation, and the amount set aside should be equal to the depreciation (anticipated loss of value) of the equipment. During normal periods while the amortisation is calculated, it is not represented by actual payments of money; the money associated with amortisation costs is actually available, but should be set aside for replacement of vessel and equipment, as this eventually becomes necessary.

— Examples of amortisation periods :

new hull	10-15 years
motor	1 -4 years
navigation equipment	5 years
outfitting and fishing gear	3 years

— 2 types :

(1) linear depreciation :
value of the purchase
duration of amortisation

(2) accelerated depreciation : residual value X depreciation rate

— The sum of the amortisation allotments should equal the actual purchase price of the equipment. All equipment should be amortised during the period in which it is actually used.

■ **Keeping accounting records**

- gross receipts = sum of (joint expenses + crew shares + boat expenses)
- money available at year-end = [money available on January 1 (cash + savings) + gross profits (before taxes) + amortisation]

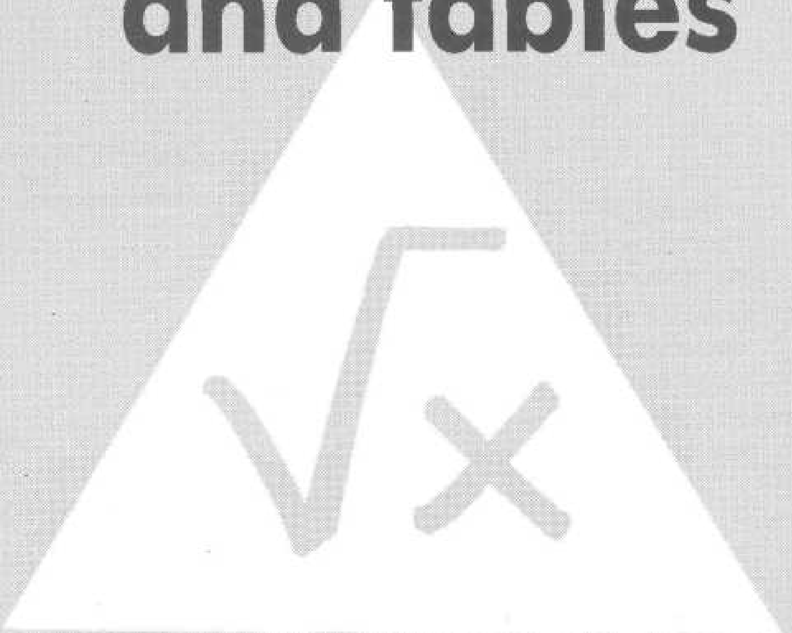
Example of accounts in a situation where the boat and crew split 50/50:

			joint expenses									boat expenses			
date of trip	record #	receipts (sales)	tax on sales	fuel	oil	ice	fishing gear	food	crew share		boat share	taxes	rent for equip.	maint & repairs	gross profit
Jan 9		1000	50	150	50	20	30	60	320		320	32			288
Jan 12		300	15	180		15		50	20		20	2	30	85	97
Jan 15		600	30	140		20	45	65	150		150	15			135
Jan 23		1200	60	200	20	30		50	420		420	42		150	228
		receipts from sales-joint expenses =net receipts									boat share	boat expenses			gross profit

Local fisheries regulations and data

Use this blank page for records of local fisheries regulations and other useful local information.

Formulae and tables



Units of length

1 metre (m) = 10 decimetres (dm) = 100 centimetres (cm) = 1000 millimetres (mm)
1 kilometre (km) = 1000 metres (m)
1 nautical mile = 1852 (m)
1 cable = 185 m
1 fathom = 1.83 m

Conversions between metric and Anglo-American units ►

- 1 mm = 0.04 inch (in) or (")
  1 cm = 0.4 inch (in) or (")
  1 cm = 0.03 foot (ft) or ('}
  1 m = 3.3 feet (ft) or (')
  1 m = 1.09 yards (yd)
  1 m = 0.55 fathom (fm)
  1 km = 0.54 nautical mile (nm)
  1 km = 0.62 statute mile

- 1 in = 25.4 mm
  1 in = 2.54 cm
  1 ft = 30.5 cm
  1ft = 0.3 m
  1 yd = 0.9 m
  1 fm = 1.83 m
  1 nautical mile = 1.85 km
  1 statute mile = 1609 m

Quick approximations ►

10 cm ~ 4 in
30 cm ~ 1 ft
1 m ~ 40 in

Units of area

1 square metre (m^2) = 100 square decimetres (dm^2)
= 10000 square centimetres (cm^2)
= 1 000000 square millimetres (mm^2)
1 square kilometre (km^2) = 1 000 000 m^2
1 are (a) = 100 m^2
1 hectare (ha) = 10000 m^2

Conversions between metric and Anglo-American units

- 1 mm^2 = 0.0015 in^2
  1 cm^2 = 0.15 in^2
  1m^2 = 10.7 ft^2
  1 ha = 2.47 acres

- 1 in^2 = 645 mm^2
  1 in^2 = 6.45 cm^2
  1ft^2 = 0.09 m^2
  1 acre = 0.4 ha

Quick approximations

10 cm b^2	~	1.5 in^2
1 dm^2	~	15 in^2
1m^2	~	11 ft^2
10 m^2	~	12 yd^2

Units of volume, capacity

1 cubic metre (m^3) = 1000 cubic decimetres (dm^3) = 1 000000 cubic centimetres (cm^3)

1 litre (1) = 1000 cubic centimetres (cm^3) = 1 cubic decimetre (dm^3)

1 cubic metre (m^3) = 1000 litres (1)

Conversions between metric and Anglo-American units ►

• 1 cm^3		0.06 in^3
1 dm^3	=	0.03 ft^3
1 m^3	=	35.3 ft^3
1 m^3	=	1.3 yd^3
1 l	=	0.22 gallon (gal)
1 l	=	0.26 US gallon
1 l	=	1.75 pints
1 l	=	2.1 US pints
• 1 in^3		16.4 cm^3
1 ft^3	=	28.3 dm^3
1 ft^3	=	0.03 m^3
1 yd^3	=	0.76 m^3
1 gal	=	4.5 l
1 US gal	=	3.8 l
1 pint	=	0.57 l
1 US pint	=	0.47 l

Quick approximations ►

9l	~	2 gal
1m^3	~	35 ft^3

Units of mass, weight and force

■ Mass and weight

1 kilogram (kg) = 1000 grams

1 tonne or metric ton (†) = 1000 kilograms

◂ Conversions between metric and Anglo-American units

•	1g	=	0.03 ounce (oz)
	1 kg	=	2.2 pounds (lb)
	1 kg	=	0.02 hundred weight (cwt)
	1 t	=	0.98 (long) ton
•	1 oz	=	28.3 g
	1 lb	=	0.45 kg
	1 cwt	=	50.8 kg
	1 (lon g)t	=	1.01 t

◂ Quick approximations

10 kg	~	22 lb
50 kg	~	1 cwt

■ Force

1 kilogram-force (kgf) = 1000 gram-force (gf) 1 kilogram-force (kgf) = 9.81 newtons (N) 1 decanewton (daN) = 10 newtons (N)

◂ Quick approximations

1 kgf ~ 1 daN

Units of pressure, power, light and sound

■ Pressure

$$\text{Pressure} = \frac{\text{force}}{\text{surface}}$$

1 atmosphere (Atm) = 1 kgf/cm^2 = 101 kN/m^2
~ 1 bar ~ 100000 Pascals (Pa)
~ 1013 millibars (mb)
1 millibar (mb) = 100 N/m^2 = 100 Pa
1 kgf/m^2 = 9.81 N/m^2
1 pound per square inch (PSI) = 689 mb

•	1 kg / mm ^{2}	=	1 422 PSI	◄ **Conversions between metric and Anglo-American units**
	1 PSI	=	0.0007 kg / mm ^{2}	

■ Power

Power = force x speed
1 horsepower (HP) = 75 kg x m/s
1 kilowatt (kW) = 1.34 Hp
1 HP = 0.74 Kw

■ Light

The international unit which describes **light intensity** is the candela (cd).

Illumination (E) is described in terms of units called lux (Lx).

Illumination varies inversely with the square of the distance from the light source; that is, illumination decreases quickly as the light source draws farther away.

$$\text{Illumination (Lx)} = \frac{\text{Light Intensity (cd)}}{R^2\ \text{(m)}}$$

where r = distance from light source in metres

■ Sound

The speed of sound in water is approximately 1500 m/s.

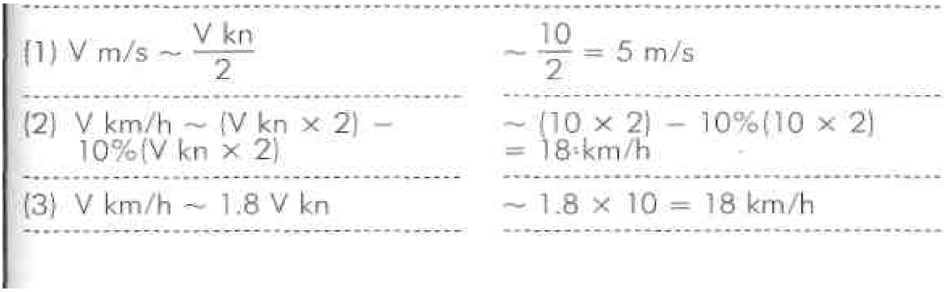
Units of speed

1 metre per second (m/s)

1 knot (kn) = 1 nautical mile per hour* = 1852 m/h = 0.51 m/s

■ **Speed of a vessel**

kn	~ m/s	~ km/h		kn	~ m/s	~ km/h
0.5	0.3	0.9		8	4.1	14.8
1	0.5	1.8		8.5	4.4	15.7
1,5	0.8	2.8		9	4.6	16.7
2	1.0	3.7		9.5	4.9	17.6
2.5	1.3	4.6		10	5.1	18.5
3	1.5	5.6		10.5	5.4	19.4
3.5	1.8	6.5		11	5.7	20.4
4	2.1	7.4		11.5	5.9	21.3
4.5	2.3	8.3		12	6.2	22.2
5	2.6	9.3		12.5	6.4	23.1
5.5	2.8	10.2		13	6.7	24.1
6	3.1	11.1		13.5	6.9	25
6.5	3.3	12		14	7.2	25.9
7	3.6	13		14.5	7.5	26.9
7.5	3.9	13.9		15	7.7	27.8



Quick approximations	**Examples : 10 knots is ab/ou equivalent to :**
(1) $V\ m/s \sim \frac{V\ kn}{2}$	$\sim \frac{10}{2} = 5\ m/s$
(2) $V\ km/h \sim (V\ kn \times 2) - 10\%(V\ kn \times 2)$	$\sim (10 \times 2) - 10\%(10 \times 2) = 18\ km/h$
(3) $V\ km/h \sim 1.8\ V\ kn$	$\sim 1.8 \times 10 = 18\ km/h$

*** Note** : *in some countries, the distances may be measured in 'statute miles', sometimes referred to simply as 'miles'.*

I statute mile = 1609 m = 0.87 nautical mile

Units of temperature

°F	°C
-20	-29.8
-10	-23.3
0	- 17.8
10	- 12.2
20	-6.7
30	- 1.1
40	4.4
50	10.0
60	15.6
70	24.1
80	26.7
90	32.2
100	37.8
110	43.3
120	48.9
130	54.4
140	60.0
150	65.6
160	71.1
170	76.7
180	27.9
190	87.8
200	93.3
210	98.9

°C	°F
-30	-22
-20	-4
- 10	14
0	32
10	50
20	68
30	86
40	104
50	122
60	140
70	158
80	176
90	194
100	212

$$°C=\frac{°F-32}{1.8}$$

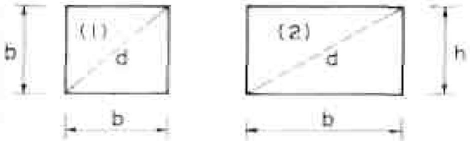
$$°F=(°C x 1.8)+32$$

Conversion of kW to HP, and HP to kW

kW	HP
0.2	0.3
0.4	0.5
0.6	0.8
0.8	1.1
1	1.4
2	2.7
4	5.4
6	8.2
8	10.9
10	14
20	27
30	41
40	54
50	68
60	82
70	95
80	109
90	122
100	136
200	272
300	408
400	544
500	680
600	816
700	952
800	1 088
900	1 224
1 000	1 360
1 100	1 496
1 200	1 632
1 300	1 768
1 400	1 904
1 500	2 040

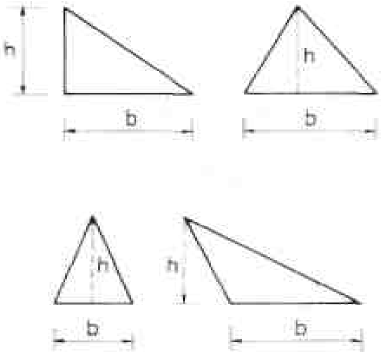
HP	kW
0.5	0.4
1	0.7
2	1.5
3	22
4	2.9
5	3.7
6	4.4
8	5.9
10	7.4
20	15
30	22
40	29
60	44
80	59
100	74
200	147
300	221
400	294
500	368
600	442
700	515
800	589
900	662
1000	736
1200	883
1400	1030
1600	1178
1800	1325
2000	1472

Area

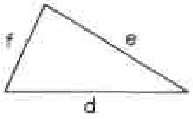


(a) Area : $b \times b = b^2$
$(d = b\ \sqrt{2})$

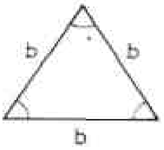
(2) Area : $b \times h$
$(d = \sqrt{b^2 + h^2})$



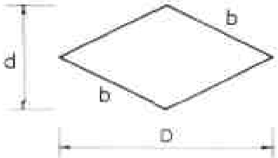
Area : $\dfrac{b \times h}{2}$



Area : $\sqrt{s(s-d)(s-e)(s-f)}$
with s : $\dfrac{d+e+f}{2}$

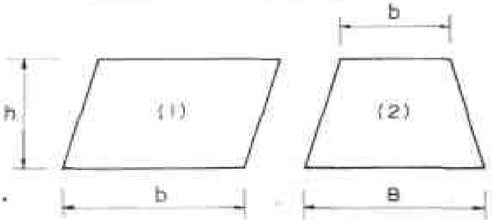


Area : $\dfrac{b^2\sqrt{3}}{4}$



Area : $\dfrac{D \times d}{2}$

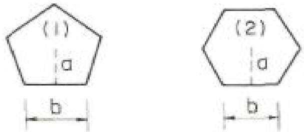
$D^2 + d^2 = 4b^2$



(1) Area : $b \times h$

(2) Area : $\dfrac{b + B}{2} \times h$

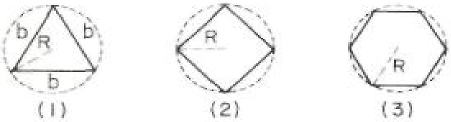
Area, circumference



(1), (2) Area : $C \times \frac{a}{2}$

$C(1) = 5 \times b$

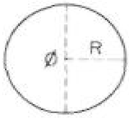
$C(2) = 6 \times b$



(1) Area : $\frac{3R^2\sqrt{3}}{4}$, $(c = 3 \times b)$

(2) Area : $2R^2$

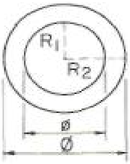
(3) Area : $\frac{3R^2\sqrt{3}}{2}$



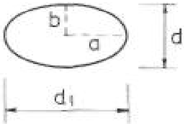
Circumference : $2\pi R = \pi Ø$

Area : $\pi R^2 = \frac{\pi Ø^2}{4}$

$\pi = 3{,}14$

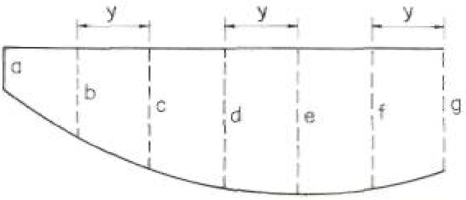


Area : $\pi(R_2 - R_1) = \frac{\pi}{2}(Ø - ø)$



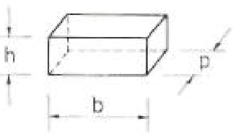
Circumference :
$\pi[1{,}5(a + b) - \sqrt{ab}]$

Area : $\frac{\pi}{4} d_1 \times d_2 = \pi a \times b$

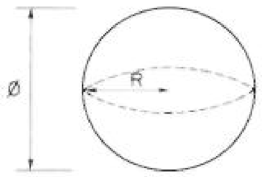


Area :

$y\left(\frac{a}{2} + b + c + d + e + f + \frac{g}{2}\right)$

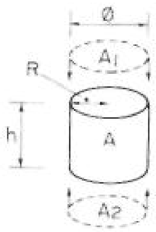


Volume : b × p × h



Area : $4\pi R^2 = \pi\varnothing^2$

Volume : $\frac{4}{3}\pi R^3 = \frac{1}{6}\pi\varnothing^3$

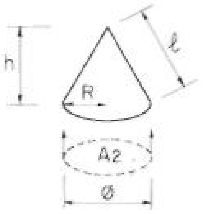


Area around cylinder (A) : $2\pi R \times h = \pi\varnothing \times h$

Total Area (A tot) : $2\pi R \times (R + h) = (A) + (A^1) + (A^2)$

$= \pi\varnothing \times \frac{\varnothing}{2} + h$

Volume : $\pi R^2 \times h = \frac{\pi\varnothing^2}{4} \times h$

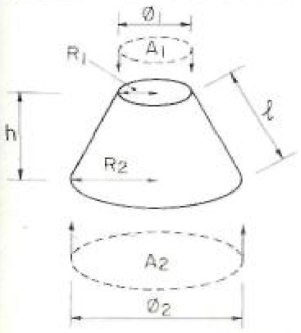


Area around (A) : $\pi R \times l = \pi\frac{\varnothing}{2} \times l$

Total area, (A tot) : $\pi R \times (R + l) = (A) + (A_2)$

$$= \pi\frac{\varnothing}{2} \times \left(\frac{\varnothing}{2} + l\right)$$

Volume : $\frac{1}{3}\pi R^2 \times h = \frac{\pi\varnothing^2 \times h}{12}$



Area around (A) : $\pi(R_1 + R_2) \times l$

Total area (A tot) : $\pi_{R1}(R_1 + l) + \pi R_2(R_2 + l)$
$= (A) + (A_1) + (A_2)$

Volume : $\frac{1}{3}\pi h(R^2{}_1 + R_1R_2 + R^2{}_2) = \frac{\pi h}{12}(\o^2 + \o\varnothing + \varnothing^2)$

Pressure underwater

Depth (m)	Hydrostatic pressure kgf/cm or atmospheres
0	1
10	2 or 1 + 1
20	3 or 2 + 1
40	5 or 4 + 1
50	6 or 5 + 1
60	7 or 6 + 1
100	11 or 10 + 1
200	21 or 20 + 1
300	31 or 30 + 1
400	41 or 40 + 1
500	51 or 50+ 1
1 000	101 or 100 + 1

Pressure (kgf/cm^2) = 0.1 x depth (m) + 1

(specific gravity of water 0.001 kgf/cm^3)

Gravity and buoyancy

G_a (kgf) = weight of a body in air

G_a (kgf) = volume of the body (m^3) x d (specific gravity of the body ii kgf/m^3)

F (kgf) = buoyant force

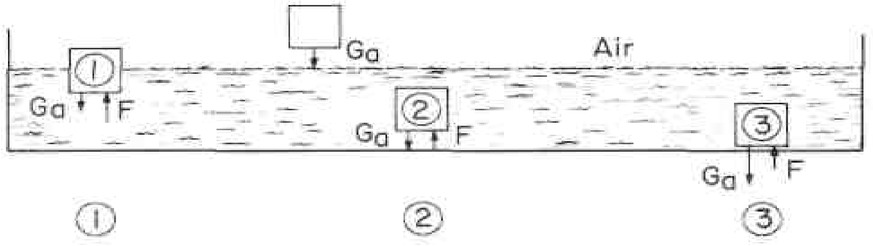
F (kgf) = volume of the body (m^3) x dw (specific gravity of water i kgf/m^3)

G_w (kgf) = weight of the body in water

G_w (kgf) = weight of the body in air (kgf) — buoyant force (kgf)

G_w (kgf) = G_a - F

G_w (kgf) = G_a (1 - 1/d) [for salt water G_w (kgf) = G_a (1 - 1.02/d)]



Buoyantforce is greater than the weight of the body in air.

The difference [weight of the body in air -buoyant force] is negative.

The body (1) **floats.**

Buoyant force is equal to the weight of the body in air.

The difference [weight of the body in air -buoyant force] is zero.

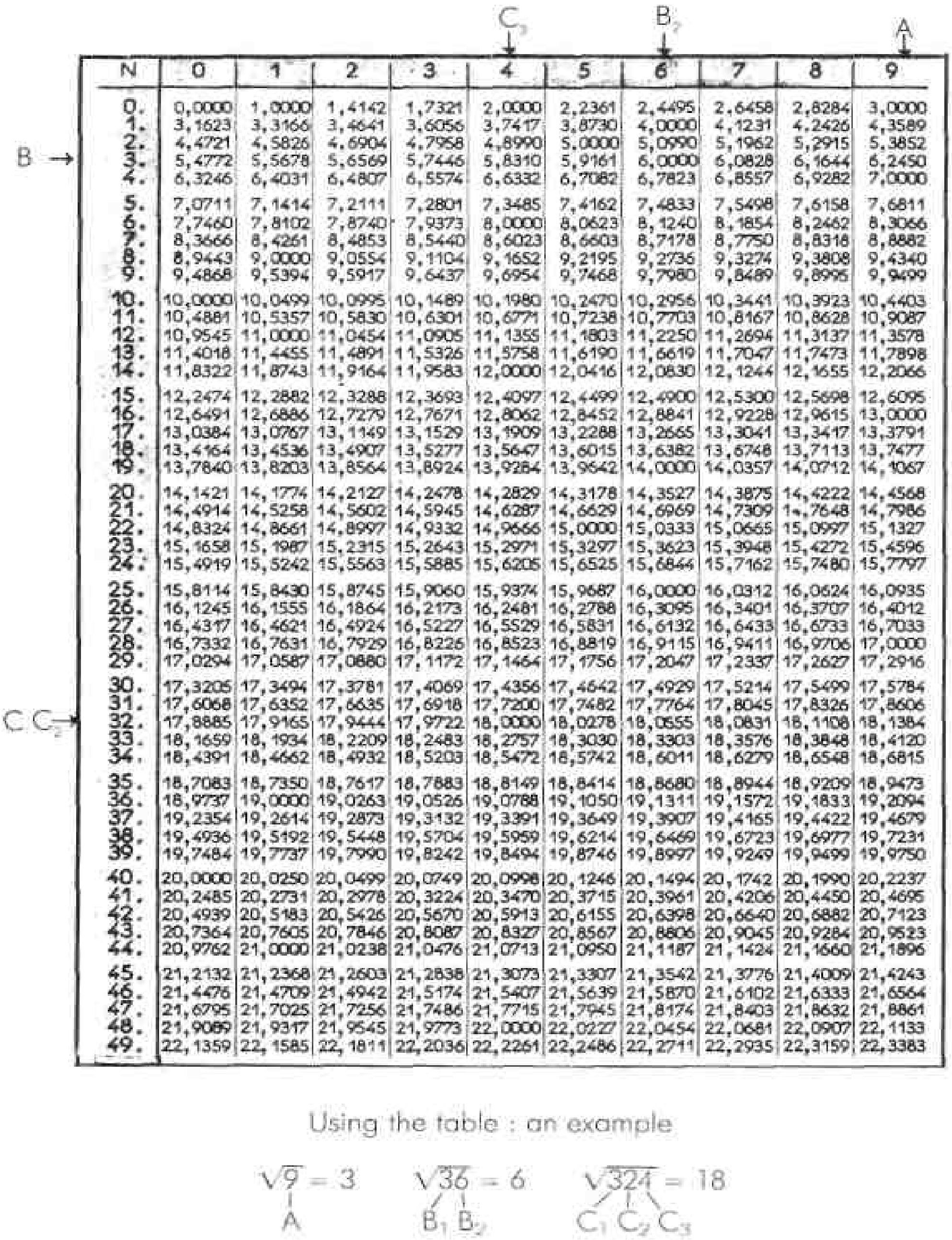
The body (2) has neu-tral buoyancy.

Buoyant force is less than the weight of the body in air.

The difference [weight of the body in air -buoyant force] is positive.

The body (3) **sinks.**

Square roots of numbers from 0 to 499



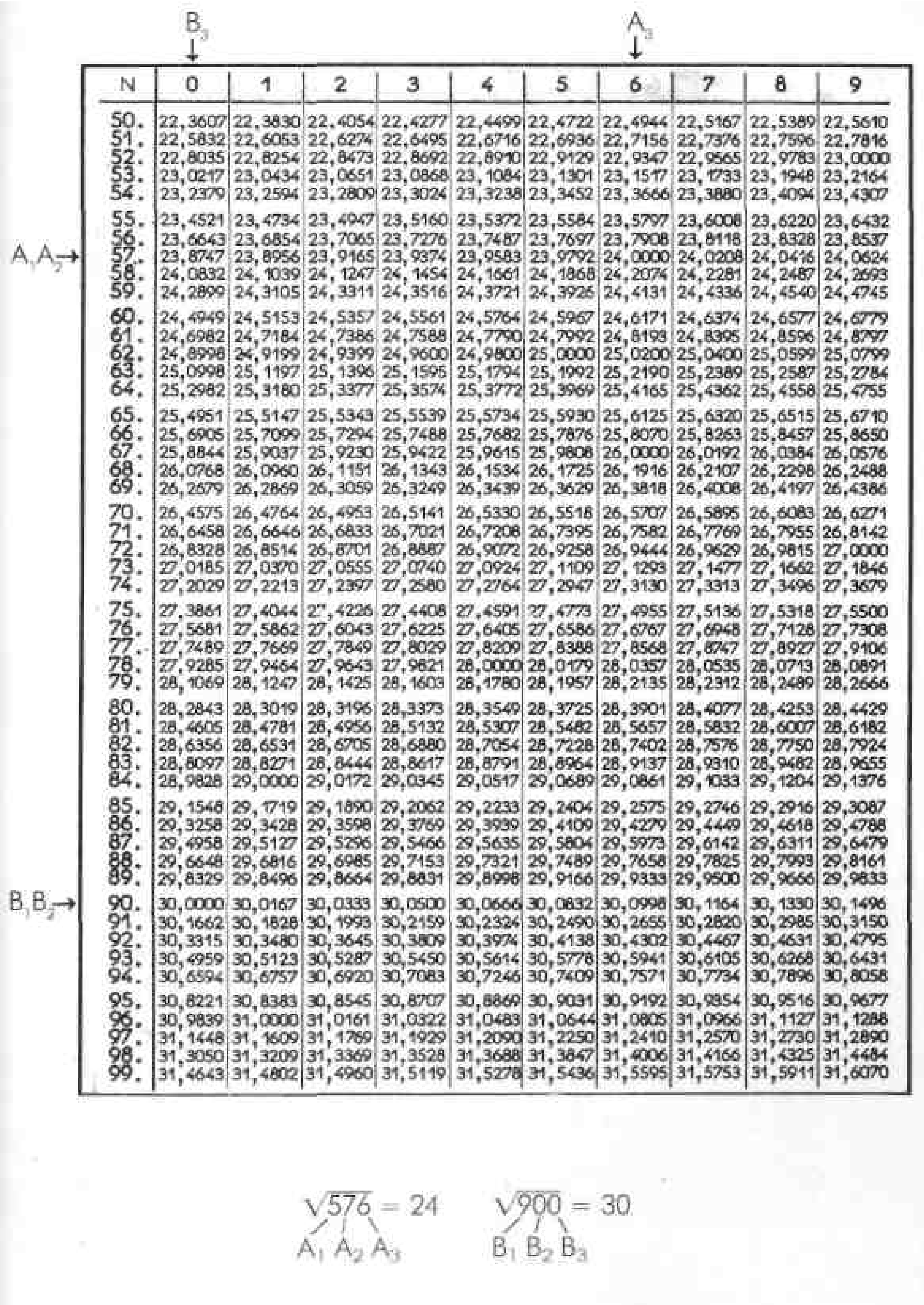
N	0	1	2	3	4	5	6	7	8	9
0.	0,0000	1,0000	1,4142	1,7321	2,0000	2,2361	2,4495	2,6458	2,8284	3,0000
1.	3,1623	3,3166	3,4641	3,6056	3,7417	3,8730	4,0000	4,1231	4,2426	4,3589
2.	4,4721	4,5826	4,6904	4,7958	4,8990	5,0000	5,0990	5,1962	5,2915	5,3852
3.	5,4772	5,5678	5,6569	5,7446	5,8310	5,9161	6,0000	6,0828	6,1644	6,2450
4.	6,3246	6,4031	6,4807	6,5574	6,6332	6,7082	6,7823	6,8557	6,9282	7,0000
5.	7,0711	7,1414	7,2111	7,2801	7,3485	7,4162	7,4833	7,5498	7,6158	7,6811
6.	7,7460	7,8102	7,8740	7,9373	8,0000	8,0623	8,1240	8,1854	8,2462	8,3066
7.	8,3666	8,4261	8,4853	8,5440	8,6023	8,6603	8,7178	8,7750	8,8318	8,8882
8.	8,9443	9,0000	9,0554	9,1104	9,1652	9,2195	9,2736	9,3274	9,3808	9,4340
9.	9,4868	9,5394	9,5917	9,6437	9,6954	9,7468	9,7980	9,8489	9,8995	9,9499
10.	10,0000	10,0499	10,0995	10,1489	10,1980	10,2470	10,2956	10,3441	10,3923	10,4403
11.	10,4881	10,5357	10,5830	10,6301	10,6771	10,7238	10,7703	10,8167	10,8628	10,9087
12.	10,9545	11,0000	11,0454	11,0905	11,1355	11,1803	11,2250	11,2694	11,3137	11,3578
13.	11,4018	11,4455	11,4891	11,5326	11,5758	11,6190	11,6619	11,7047	11,7473	11,7898
14.	11,8322	11,8743	11,9164	11,9583	12,0000	12,0416	12,0830	12,1244	12,1655	12,2066
15.	12,2474	12,2882	12,3288	12,3693	12,4097	12,4499	12,4900	12,5300	12,5698	12,6095
16.	12,6491	12,6886	12,7279	12,7671	12,8062	12,8452	12,8841	12,9228	12,9615	13,0000
17.	13,0384	13,0767	13,1149	13,1529	13,1909	13,2288	13,2665	13,3041	13,3417	13,3791
18.	13,4164	13,4536	13,4907	13,5277	13,5647	13,6015	13,6382	13,6748	13,7113	13,7477
19.	13,7840	13,8203	13,8564	13,8924	13,9284	13,9642	14,0000	14,0357	14,0712	14,1067
20.	14,1421	14,1774	14,2127	14,2478	14,2829	14,3178	14,3527	14,3875	14,4222	14,4568
21.	14,4914	14,5258	14,5602	14,5945	14,6287	14,6629	14,6969	14,7309	14,7648	14,7986
22.	14,8324	14,8661	14,8997	14,9332	14,9666	15,0000	15,0333	15,0665	15,0997	15,1327
23.	15,1658	15,1987	15,2315	15,2643	15,2971	15,3297	15,3623	15,3948	15,4272	15,4596
24.	15,4919	15,5242	15,5563	15,5885	15,6205	15,6525	15,6844	15,7162	15,7480	15,7797
25.	15,8114	15,8430	15,8745	15,9060	15,9374	15,9687	16,0000	16,0312	16,0624	16,0935
26.	16,1245	16,1555	16,1864	16,2173	16,2481	16,2788	16,3095	16,3401	16,3707	16,4012
27.	16,4317	16,4621	16,4924	16,5227	16,5529	16,5831	16,6132	16,6433	16,6733	16,7033
28.	16,7332	16,7631	16,7929	16,8226	16,8523	16,8819	16,9115	16,9411	16,9706	17,0000
29.	17,0294	17,0587	17,0880	17,1172	17,1464	17,1756	17,2047	17,2337	17,2627	17,2916
30.	17,3205	17,3494	17,3781	17,4069	17,4356	17,4642	17,4929	17,5214	17,5499	17,5784
31.	17,6068	17,6352	17,6635	17,6918	17,7200	17,7482	17,7764	17,8045	17,8326	17,8606
32.	17,8885	17,9165	17,9444	17,9722	18,0000	18,0278	18,0555	18,0831	18,1108	18,1384
33.	18,1659	18,1934	18,2209	18,2483	18,2757	18,3030	18,3303	18,3576	18,3848	18,4120
34.	18,4391	18,4662	18,4932	18,5203	18,5472	18,5742	18,6011	18,6279	18,6548	18,6815
35.	18,7083	18,7350	18,7617	18,7883	18,8149	18,8414	18,8680	18,8944	18,9209	18,9473
36.	18,9737	19,0000	19,0263	19,0526	19,0788	19,1050	19,1311	19,1572	19,1833	19,2094
37.	19,2354	19,2614	19,2873	19,3132	19,3391	19,3649	19,3907	19,4165	19,4422	19,4679
38.	19,4936	19,5192	19,5448	19,5704	19,5959	19,6214	19,6469	19,6723	19,6977	19,7231
39.	19,7484	19,7737	19,7990	19,8242	19,8494	19,8746	19,8997	19,9249	19,9499	19,9750
40.	20,0000	20,0250	20,0499	20,0749	20,0998	20,1246	20,1494	20,1742	20,1990	20,2237
41.	20,2485	20,2731	20,2978	20,3224	20,3470	20,3715	20,3961	20,4206	20,4450	20,4695
42.	20,4939	20,5183	20,5426	20,5670	20,5913	20,6155	20,6398	20,6640	20,6882	20,7123
43.	20,7364	20,7605	20,7846	20,8087	20,8327	20,8567	20,8806	20,9045	20,9284	20,9523
44.	20,9762	21,0000	21,0238	21,0476	21,0713	21,0950	21,1187	21,1424	21,1660	21,1896
45.	21,2132	21,2368	21,2603	21,2838	21,3073	21,3307	21,3542	21,3776	21,4009	21,4243
46.	21,4476	21,4709	21,4942	21,5174	21,5407	21,5639	21,5870	21,6102	21,6333	21,6564
47.	21,6795	21,7025	21,7256	21,7486	21,7715	21,7945	21,8174	21,8403	21,8632	21,8861
48.	21,9089	21,9317	21,9545	21,9773	22,0000	22,0227	22,0454	22,0681	22,0907	22,1133
49.	22,1359	22,1585	22,1811	22,2036	22,2261	22,2486	22,2711	22,2935	22,3159	22,3383

Using the table : an example

$\sqrt{\underset{A}{9}} = 3$ $\sqrt{\underset{B_1}{3}\underset{B_2}{6}} = 6$ $\sqrt{\underset{C_1}{3}\underset{C_2}{2}\underset{C_3}{4}} = 18$

Extracted from *Statisfique et probabilité* from the collection Aide-Mémoire TECHNOR, doc. 15 and 16, Delagrave 1985. With permission of the editor.

Square roots of numbers from 500 to 999



N	0	1	2	3	4	5	6	7	8	9
50.	22,3607	22,3830	22,4054	22,4277	22,4499	22,4722	22,4944	22,5167	22,5389	22,5610
51.	22,5832	22,6053	22,6274	22,6495	22,6716	22,6936	22,7156	22,7376	22,7596	22,7816
52.	22,8035	22,8254	22,8473	22,8692	22,8910	22,9129	22,9347	22,9565	22,9783	23,0000
53.	23,0217	23,0434	23,0651	23,0868	23,1084	23,1301	23,1517	23,1733	23,1948	23,2164
54.	23,2379	23,2594	23,2809	23,3024	23,3238	23,3452	23,3666	23,3880	23,4094	23,4307
55.	23,4521	23,4734	23,4947	23,5160	23,5372	23,5584	23,5797	23,6008	23,6220	23,6432
56.	23,6643	23,6854	23,7065	23,7276	23,7487	23,7697	23,7908	23,8118	23,8328	23,8537
57.	23,8747	23,8956	23,9165	23,9374	23,9583	23,9792	24,0000	24,0208	24,0416	24,0624
58.	24,0832	24,1039	24,1247	24,1454	24,1661	24,1868	24,2074	24,2281	24,2487	24,2693
59.	24,2899	24,3105	24,3311	24,3516	24,3721	24,3926	24,4131	24,4336	24,4540	24,4745
60.	24,4949	24,5153	24,5357	24,5561	24,5764	24,5967	24,6171	24,6374	24,6577	24,6779
61.	24,6982	24,7184	24,7386	24,7588	24,7790	24,7992	24,8193	24,8395	24,8596	24,8797
62.	24,8998	24,9199	24,9399	24,9600	24,9800	25,0000	25,0200	25,0400	25,0599	25,0799
63.	25,0998	25,1197	25,1396	25,1595	25,1794	25,1992	25,2190	25,2389	25,2587	25,2784
64.	25,2982	25,3180	25,3377	25,3574	25,3772	25,3969	25,4165	25,4362	25,4558	25,4755
65.	25,4951	25,5147	25,5343	25,5539	25,5734	25,5930	25,6125	25,6320	25,6515	25,6710
66.	25,6905	25,7099	25,7294	25,7488	25,7682	25,7876	25,8070	25,8263	25,8457	25,8650
67.	25,8844	25,9037	25,9230	25,9422	25,9615	25,9808	26,0000	26,0192	26,0384	26,0576
68.	26,0768	26,0960	26,1151	26,1343	26,1534	26,1725	26,1916	26,2107	26,2298	26,2488
69.	26,2679	26,2869	26,3059	26,3249	26,3439	26,3629	26,3818	26,4008	26,4197	26,4386
70.	26,4575	26,4764	26,4953	26,5141	26,5330	26,5518	26,5707	26,5895	26,6083	26,6271
71.	26,6458	26,6646	26,6833	26,7021	26,7208	26,7395	26,7582	26,7769	26,7955	26,8142
72.	26,8328	26,8514	26,8701	26,8887	26,9072	26,9258	26,9444	26,9629	26,9815	27,0000
73.	27,0185	27,0370	27,0555	27,0740	27,0924	27,1109	27,1293	27,1477	27,1662	27,1846
74.	27,2029	27,2213	27,2397	27,2580	27,2764	27,2947	27,3130	27,3313	27,3496	27,3679
75.	27,3861	27,4044	27,4226	27,4408	27,4591	27,4773	27,4955	27,5136	27,5318	27,5500
76.	27,5681	27,5862	27,6043	27,6225	27,6405	27,6586	27,6767	27,6948	27,7128	27,7308
77.	27,7489	27,7669	27,7849	27,8029	27,8209	27,8388	27,8568	27,8747	27,8927	27,9106
78.	27,9285	27,9464	27,9643	27,9821	28,0000	28,0179	28,0357	28,0535	28,0713	28,0891
79.	28,1069	28,1247	28,1425	28,1603	28,1780	28,1957	28,2135	28,2312	28,2489	28,2666
80.	28,2843	28,3019	28,3196	28,3373	28,3549	28,3725	28,3901	28,4077	28,4253	28,4429
81.	28,4605	28,4781	28,4956	28,5132	28,5307	28,5482	28,5657	28,5832	28,6007	28,6182
82.	28,6356	28,6531	28,6705	28,6880	28,7054	28,7228	28,7402	28,7576	28,7750	28,7924
83.	28,8097	28,8271	28,8444	28,8617	28,8791	28,8964	28,9137	28,9310	28,9482	28,9655
84.	28,9828	29,0000	29,0172	29,0345	29,0517	29,0689	29,0861	29,1033	29,1204	29,1376
85.	29,1548	29,1719	29,1890	29,2062	29,2233	29,2404	29,2575	29,2746	29,2916	29,3087
86.	29,3258	29,3428	29,3598	29,3769	29,3939	29,4109	29,4279	29,4449	29,4618	29,4788
87.	29,4958	29,5127	29,5296	29,5466	29,5635	29,5804	29,5973	29,6142	29,6311	29,6479
88.	29,6648	29,6816	29,6985	29,7153	29,7321	29,7489	29,7658	29,7825	29,7993	29,8161
89.	29,8329	29,8496	29,8664	29,8831	29,8998	29,9166	29,9333	29,9500	29,9666	29,9833
90.	30,0000	30,0167	30,0333	30,0500	30,0666	30,0832	30,0998	30,1164	30,1330	30,1496
91.	30,1662	30,1828	30,1993	30,2159	30,2324	30,2490	30,2655	30,2820	30,2985	30,3150
92.	30,3315	30,3480	30,3645	30,3809	30,3974	30,4138	30,4302	30,4467	30,4631	30,4795
93.	30,4959	30,5123	30,5287	30,5450	30,5614	30,5778	30,5941	30,6105	30,6268	30,6431
94.	30,6594	30,6757	30,6920	30,7083	30,7246	30,7409	30,7571	30,7734	30,7896	30,8058
95.	30,8221	30,8383	30,8545	30,8707	30,8869	30,9031	30,9192	30,9354	30,9516	30,9677
96.	30,9839	31,0000	31,0161	31,0322	31,0483	31,0644	31,0805	31,0966	31,1127	31,1288
97.	31,1448	31,1609	31,1769	31,1929	31,2090	31,2250	31,2410	31,2570	31,2730	31,2890
98.	31,3050	31,3209	31,3369	31,3528	31,3688	31,3847	31,4006	31,4166	31,4325	31,4484
99.	31,4643	31,4802	31,4960	31,5119	31,5278	31,5436	31,5595	31,5753	31,5911	31,6070

$$\sqrt{\underset{A_1}{5}\underset{A_2}{7}\underset{A_3}{6}} = 24 \qquad \sqrt{\underset{B_1}{9}\underset{B_2}{0}\underset{B_3}{0}} = 30$$

Ordering equipment

Check list of specifications to order fishing equipment

■ Essential data for suppliers

N.B. If you are uncertain of the precise details for the specification, give the manufacturer full details of the vessel, method and intended use and let him suggest the particular size. Much money and time is wasted foolishly specifying much too large a unit, e.g. '10 ton' winch or '100 mesh deep' gillnet.

■ Fishing gear and accessories

Accessories, Small : (swivel, clasp)	Intended use and in particular nature and resis- tance of elements placed each side or from the catalogue (give the name of the supplier) : trade name of model, size number, resistance a quantity required bearing in mind the handling and selling procedure used by the supplier (box of pieces)
Buoy :	Intended use ; marker buoy, mooring buoy, anchor buoy, protecting buoy, seine buoy, etc. — any mechanical constraints (e.g. crushing, passage for example through a power block) ☐ form : as precise a description as possible, with drawing showing clearly the mooring points, reinforced connectors, central axis (diameter of marking mast to be set) ☐ desired buoyancy or volume (in litres) ☐ number of buoys, bearing in mind the packaging and selling procedure used by the supplier (number per box)
Float :	Intended use : float for trawl, gillnet, seine, etc. — any mechanical constraints (crushing during manoeuvres on a drum or a hauler, etc.) — maximum depth of use ☐ material, shape, central hole or attachment point(s), etc. ☐ unit buoyancy or exact size ☐ quantity required bearing in mind the handling and selling procedure used by the supplier (number per box)
Fish hook :	According to the supplier's catalogue (give the name of the supplier) : name, number(s) of the model and size number chosen,

Fishing gear and accessories (continued)

or

accurate drawing of hook, full-sized

or

use : trolling or rod fishing or handline fishing or bngline fishing

— expected species sought and average size

☐ single, double or triple

☐ normal or forged

☐ normal finish, tinned, galvanised or stainless steel

☐ kirbed or reversed bend

☐ extremity of hook shank : flatted or eye type

☐ with or without lure : description

☐ with or without barb

☐ possibly with swivel incorporated

☐ opening of hook, gap (distance point — shank)

☐ long or short shank

☐ throat (or depth of the hook)

☐ quantity desired, bearing in mind the packaging and selling procedure used by the supplier (box of *x* hooks)

Gillnet, mounted :

The list of data to be supplied will depend on the

supplier's skill and experience in mounting gillnets.

Give a detailed drawing

or

intended used on the bottom : hard or soft bottom; or in midwater; drifting; waters often rough or fairly calm.

— species to be fished

— handling : type of hauler

— method of ranging on board

— volume of expected catch

☐ mesh size (size of the bar or stretched mesh to be specified) or, for trommel nets, mesh size of inside net and outside panels.

☐ nature of twine : twisted multifilament or mono filament or multimonofilament

Fishing gear and accessories (continued)

☐ twine material and twine size

☐ possibly height of net when hung or stretched net; or number of meshes deep

☐ number and type of floats and sinkers

☐ possibly colour

☐ hanging ratio

☐ length of mounted net

Net webbing : (trade) name of textile

☐ twisted (direction of twist: right or left); braided, monofilament or multimonofilament

☐ size of the twine (in R tex or m/kg or denier or diameter)

☐ colour

☐ mesh size, in specified size of mesh bar, or stretched mesh or mesh opening

☐ knotted or knotless netting (intended use)
☐ for knotted netting : simple or double knot

☐ dimensions of netting :

— length of stretched net or number of meshes

— depth of stretched net or number of meshes

☐ simple selvedge or double row or double mesh

☐ placing of selvedges : at top and bottom of netting or along the sides

☐ if necessary, treatment (impregnation) of netting

Purse seine. mounted : The list of data to be supplied will depend on the supplier's skill and experience in mounting seines.

Give a detailed drawing

or

minimum specifications

Intended use :

— length or tonnage of seine boat and winch power

— species to be fished, depth of fish and/or water depth

☐ mesh size (body and bunt with specifications of mesh bar or stretched mesh)

Fishing gear and accessories (continued)

	☐ length when hung (with indication of the hanging ratio along the floatline for each part of the seine) ☐ depth with stretched net (seine fully hung, including border strips or selvedges) ☐ position and dimensions (width, depth) of bunt ☐ form of wings ☐ type of purse rings ☐ number and buoyancy of the floats ☐ weight of the ballast on the leadline (type of ballast : lead or chain)
Rope, combination rope :	(trade) name of textile or composition (fibre synthetic and/or natural and/or steel, with or without core) ☐ braided or twisted (if possible, direction of twist — Z or S) ☐ if possible, breaking strength required ☐ size of the rope : diameter (or circumference) ☐ colour ☐ natural or treated ☐ length intended use of rope — exposure to sunlight; wear
Trawl board :	Type of board (which implies : use on the bottom or in midwater, material, shape, main characteristics) ☐ power of trawler a length, height and weight of board ☐ quantity : the pair or the port board or the starboard board. ☐ special requirements for backstrop fastening or brackets adjustments or eye for lifting, etc.
Trawl, mounted :	The list of data to be supplied will depend on the supplier's skill and experience in mounting trawls ☐ trade name of a model considered to be typical and well known (e.g. size of opening lines followed or preceded by a trade name coded in letters and/or figures),

Fishing gear and accessories (continued)

or give a detailed drawing

or specify bottom trawl or high-opening bottom trawl, 2, 4 or more panels or pelagic trawl for one or two boats (pair trawl)

☐ intended use : power of trawler(s), species to be fished, for trawls in contact with the bottom : relationship of species fished with the bottom, nature of bottom, average trawling speed

☐ mesh size(s) (size of the bar or stretched mesh to be specified) in the fore part

☐ mesh size(s) (size of the bar or stretched mesh to be specified in the aft part)

☐ possibly material and twine size desired

☐ possibly length of headline and footrope

☐ nature, diameter and mounting of groundrope

☐ codend

— mesh size expressed in inside opening of the mesh (regulations in force) or size of the bar or stretched mesh

— length, stretched net

— possibly width

— possibly reinforcements (lines, beckets)

— strop, splitting strap

☐ possibly characteristics of the codend chafer or the double protection codend

☐ list of any accessories to be supplied with the trawl(s) and characteristics (rigging, shackles, swivels, hooks, etc.)

Twine, in spool :

(trade) name of texile (or usual abbreviation, PA, PE, etc.)

☐ twisted or braided, or monofilament or multi-monofilament

☐ size of the twine (in R tex or m/kg or denier, or diameter)

☐ breaking strength required

☐ colour

☐ natural or treated

Fishing gear and accessories (continued)

☐ quantity (weight of one spool or twine length on it, number of spools)

Warp :

Intended use and desired flexibility

☐ length ☐ diameter

☐ composition : number of wires and fibres, with or without core

☐ finish : galvanised or not (black or bright) or stainless stee

☐ required breaking strength

☐ right or left laid

☐ preparation of ends

☐ delivered in coils or on wooden reel

Deck equipment

Drum, for net or line :

Intended use : for trawl, seine, gillnet or longline

☐ pulling power required

☐ desired winding speed (with corresponding pull)

☐ capacity :

— for a trawl, seine or gillnet drum : estimated volume of net(s) with any accessories (floats, groundrope, chain, various sinkers, shackle, etc.)

— for a longline drum (storage of main line) : length and diameter of line; type of line, multifilament or monofilament

☐ possibly, in order to avoid crowding the deck : maximum overall dimensions

☐ source of power (main engine, auxiliary, PTO)

☐ means of power transmission

Hauler, for net. line or pot:

Intended use : gillnets or lines or pots hauler
— tonnage and possibly size of boat

— average depth of use

— best catches expected (expressed in weight) for a given length of gear

— average sea conditions

☐ pull and desired winding speed

☐ for line and pot hauler : diameter of main line

☐ for net hauler : height of gillnet(s) used, type of floats and sinkers

— possibly form of groove or throat preferred
☐ axle of hauler : vertical or horizontal

☐ source of power (main engine, auxiliary, PTO)
☐ means of power transmission

Power block :

Intended use :

— tonnage and size of seiner

— circumference of bunched seine when floatline and leadline have been joined

or, failing this, greatest height of seine (towards mid-length) expressed in number of meshes and twine size

Deck equipment (continued)

☐ means of power transmission

☐ possibly pull and hauling speed required

Winch for seine :

Intended use :

— tonnage and size of seiner

— main dimensions and weight of seine

— common sea conditions

— average behaviour of fish : stability of schools swimming speed, any tendency to dive, etc.

— stabilisation by bait or attraction to light

— day and/or night fishing

— any fishing on bottoms where the depth would be less than the height of the seine

☐ two or three drums

☐ with or without warp head(s)
☐ capacity of each drum

— winch with two drums (small and medium-sized seiners), length and diameter of the purseline

— winch with three drums (large seiners), length and diameter(s) of the purse line, if appropriate in several pieces, + length and diameter of tow line

☐ possibly : pull and speed

Winch for trawl :

Intended use :

— size of trawler and/or tonnage and/or power of main engine

— type of fishing : bottom trawling or pelagic trawling — average depth of the fishing grounds

a driving means : mechanical (power, nature and position of driving power) hydraulic or electric

☐ possibly power and/or pull and winding speed required

☐ monobloc (2 joined drums) or separate drums

☐ possibly supplementary bobbins

☐ capacity of each drum : expressed in length of warp of given diameter (if appropriate take into account rigging elements and accessories that could be put on the drum : chain, shackle, swivel, triangle, danleno, sweeps, etc.)

Deck equipment (continued)

☐ warp head : one, two or none

☐ manual or automatic warp guide (spooling, level-wind)

Forged accessories, tools

Chain, shackle, anchor, bobbin, etc.:	Intended use clearly indicated (junction, lifting, etc) □ elements (nature, size, breaking strength) expected on each side of the accessory □ estimated maximum use load □ nature of steel (semi-hard, very high resistance, etc.) □ finish : black, galvanised or stainless steel □ main dimensions and characteristics (e.g. opening of a shackle, forelock, counter sunk, eye screw pin, diameter of eye of a swivel, etc.) or choice from catalogue (give the name of the supplier), indicating exact trade name of accessory and code number or the calibre corresponding to the main dimensions and necessary breaking load (breaking strength = 6 times the estimated maximum use load

Index

A

Accounting; see Bookkeeping
Anchors
Angle of attack of otter board
Apparent Nominal Power, of trawler
Area, formulae for calculation
Area, see also Twine surface area
Area, units of measurement

B

Backstrop, of otter board
Bait
Ballast, of purse seine
Bar (of net mesh)
Beach seme
Beach seine, bridles and ropes
Beach seine, materials and hanging
Beach seine, types of
Bobbins, rubber
Bobbins, steel
Bollard pull, of trawler
Bookkeeping
Bottom seine
Bottom seines, dimensions
Bottom seines, operation
Bottom seines, ropes
Bottom traw; see also Trawls
Brake horsepower, BHP
Breaking strength, breaking load
.Bulldog grips; see Cable damps
Bunt, for trawl groundrope
Bunt* of purse seine
Buoy; see float
Buoyancy, of fibres and materials
Buoyancy, of floats
Buoyant force, and gravity

C

Cable clamps (wire rope clips)
Cable, see Wire rope
Chain
Circumference, formulae for calculation
Clips
Codendcip
Connectors, steel
Conversion, units of measurement
Cookies, for trawl groundrope

D

Danish seine
Deck equipment
Deck equipment, information for ordering
Denier
Density of materials
Depressor, for trolling
Depth of midwater pair trawl, estimation
Diving board, for trolling
Door, see Otter board
Dredges
Drum, information for ordering
Drum, purse seine
Drum, traw! net drum
Dutch clip (codend clip)

E

Echo-sounders, characteristics
Echo-sounders, choice of
Edge, net webbing
Entangling nets

Index

F

Fish finders; see echo-sounders
Fish hooks, information for ordering
Fishhooks, knots for tying
Fish hooks, principal types
Fish hooks, terms for describing
Floats, estimating buoyancy of
Floats, estimating number needed for seine
Foots, for gillnets and seines
Floats, for marking stationary gear
Floats, for seine
Floats, for trawls
Floats, information for ordering
Floats, ring-shaped
Floats, spherical, buoyancy
Flotation; see Buoyancy
Footrope, of trawl
Force, units of measurement
Fork rigging of trawl
Formulae
Fresh water consumption
Fuel consumption of engine
Fushi

G

G links
Gillnet, information for ordering
Gillnets
Gillnets, choosing meshsize
Gillnets, choosing twine
Gil nets, flotation and ballast
Gillnets, hanging, rigging
Gillnetting, speed of operations
Gravity and buoyant force
Groundrope, of trawl
Groundrope, trawl:
Examples

H

Handlines; see Vertical line fishing
Hanging net panels
Hanging ratio
Hardware
Hardware, hooks and G links
Hardware, steel, for joining
Hauler, information for ordering
Haulers, ine haulers
Haulers, net haulers
Haulers, pot/trap haulers
Head ine height of traw
Headline, of traw
Height of mounted net
Hold, fish hold
Holds, capacity
Hooks, hardware
Hooks, see Fish hooks
Horsepower, HP

I

Ice, amount required
Inclination, of traw warps, measurement

J

Jigs

K

Kites, for trawl
Knots, for fish hooks
Knots, for longlines
Knots, for stoppers and mooring
Knots, net webbing
kW, kilowatts

Index

L
Lamps, (or fish attraction
Leads
Length, units of measurement
Lifting, slings and tackles
Light, fishing with
Light, units of measurement
Line fishing
Line fishing accessories
Line, see Twine, Rope
Link, half-cut
Link, riveted
Longlines
Longlines, automation
Longlines, bottom longline plan and rigging
Longlines, components
Longlines, drifting
Longlines, set
Longlining, speed of operations
Lures

M
Marking buoys
Mass, units of measurement
Mesh opening
Mesh size, for purse seine
Mesh size, stretched
Midwater pair trawl, estimating depth
Midwater trawl
Monofilament; see also Twine
Mounting net panes
Mouth opening, of bottom seine

N
Net webbing, common cutting rates
Net webbing, cutting rates
Net webbing, definition of cuts
Net webbing, estimation of weight
Net webbing, hanging ratio
Net webbing, information for ordering
Net webbing, joining panels
Net webbing, knots, edges, selvedges
Net webbing, meshes, definition
Net webbing, mounted height
Net webbing, mounting panels
Net webbing, surface covered
Net webbing, systems of measuring
Net webbing, twine surface area
Net webbing, twine surface in trawl

O
Omfar
Ordering equipment, data needed
Otter boards, adjustment
Otter boards, angle of attack
Otter boards, estimating spread
Otter boards, proportions
Otter boards; types, weight, surface area
Otter trawl, see Trawl

P
Pair trawl, midwater
Pair trawling, engine RPM
Pair trawls, rigging
Pelagic trawls; see Trawls, midwater
Polyamide (PA); see Synthetic fibres, Twine

Index

Polyester (PES); see Synthetic fibres, Twine
Polyethylene (PE); see Synthetic fibres, Twine
Polypropylene (PP); see Synthetic fibres, Twine
Pots; see Traps and pots
Power block
Power block, information for ordering
Power, of trawlers
Power, units of measurement
Prawn trawls; see Shrimp traw s
Pressure, underwater
Pressure, units of measurement
Propulsion
Puling power of trawler
Purse line
Purse rings
Purse seine
Purse seine, buoyancy of floats
Purse seine, depth
Purse seine, dimensions, twine
Purse seine, hanging ratio
Purse seine, plan and rigging
Purse seine, weight of sinkers
Purse seining, speed of operations

R

Regulations, local fisheries
Rings, for net ballast
Rings, for purse seine
Rings, for trawl groundrope
Rope, combination wire (1)
Rope, combination wire (2)
Rope, floa (lines and leadlines
Rope, knots for joining and loops
Rope, knots for stoppers and mooring
Rope, loss of breaking strength due to knots and splices
Rope, synthetic fibre
Rope, vegetable fibre
Rtex, Resultant tex

S

Safe working load
Safety factor
Seine, anchor or Danish
Seine; see also Bottom seine
Selvedge
Setsu
Settling; see Bookkeeping
Shackles
Shearing depressor, for troling
Shrimp (prawn| trawls
Sinkers
Sinking speed of purse seine
Slings
Snaps, for long line.
Sounders; see Echo-sounders
Spacers, for groundrope
Speed, units of measurement
Spread, horizontal spread of traw
Sguare roots, tables
Stainless steel; see Wire rope
Strength of hardware
Stretched mesh
Surface covered by netting
Swivels
Synthetic fibres, commercial names
Synthetic fibres, identification
Synthetic fibres, physical properties

T

Tackles
Tanks, live

Index

Temperature, units of measurement
Thimbles
Tow line, of purse seine
Trammel net, example of plan and rigging
Trammel nets
Trammel nets, flotation and weight
Traps and pots
Traps and pots, dimensions
Traps and pots, entrances
Traps and pots, examples
Traps and pots, materials
Trave board, information for ordering
Trawl door; see Otter board
Trawl groundropes
Trawling speed
Trawls; (see also Pair trawls)
Trawls, bottom trawl plan
Trawls, bottom, meshsize and twine size
Trawls, buoyancy and weight
Trawls, choosing size for vessel hp
Trawls, fork rigging
Trawls, midwatertrawl plan
Trawls, midwater, meshsize and twine size
Trawls, opening of bottom trawl
Trawls, opening of midwater trawls
Trawls, rigging
Trawls, twine surface area
Trolling
Twine
Twine size, for purse seine
Twine size; see also Twine number
Twine surface area in trawl
Twine, common, for netting
Twine, equivalents, numbering systems
Twine, information for ordering
Twine, measurement
Twine, number, tex, denier, runnage, diameter
Twine, nylon, monofilament, multimonofilament
Twine, polyester, polyethylene, polypropylene
Twine, Rtex
Twine, runnage
Twine, tex
Two-boat trawls; see Pair trawls

V

Vertical line fishing
Volume, formulae for calculation
Volume, units of measurement

W

Warp, information for ordering
Warp angle, vertical, . measurement
Warps, trawl; diameter, length
Weight in water
Wells, live
Winch, information for ordering
Winch, pull, power, speed
Winch, purse seine
Winch, trawl
Wire rope clips
Wire rope, galvanized steel

Index

Wire rope, handling

Wire rope, matching drums and sheaves
Wire rope, small diameter
Wire rope, stainless steel

Wire rope, structure and use 24

Y
Yarn; see also Twine

Books published by

Fishing News Books

Free catalogue available on request

- Advances in fish science and technology
- Aquaculture in Taiwan
- Aquaculture: principles and practice
- Aquaculture training manual
- Aquatic weed control
- Atlantic salmon: its future
- Better angling with simple science
- British freshwater fishes
- Business management in fisheries and aquaculture
- Cage aquaculture
- Calculations for fishing gear designs
- Carp farming
- Commercial fishing methods
- Control of fish quality
- Crab and lobster fishing
- The crayfish
- Culture of bivalve mollusks
- Design of small fishing vessels
- Developments in electric fishing
- Developments in fisheries research in Scotland
- Echo sounding and sonar for fishing
- The economics of salmon aquaculture
- The edible crab and its fishery in British waters
- Eel culture
- Engineering, economics and fisheries management
- European inland water fish: a multilingual catalogue
- FAO catalogue of fishing gear designs
- FAO catalogue of small scale fishing gear
- Fibre ropes for fishing gear
- Fish and shellfish farming in coastal waters
- Fish catching methods of the world
- Fisheries oceanography and ecology
- Fisheries of Australia Fisheries sonar
- Fisherman's workbook
- Fishermen's handbook
- Fishery development experiences
- Fishing and stock fluctuations
- Fishing boats and their equipment
- Fishing boats of the world 1
- Fishing boats of the world 2
- Fishing boats of the world 3
- The fishing cadet's handbook

Fishing ports and markets

Fishing with electricity

Fishing with light

Freezing and irradiation of fish

Freshwater fisheries management

Glossary of UK fishing gear terms

Handbook of trout and salmon diseases

A history of marine fish culture in Europe and North America

How to make and set nets

Inland aquaculture development handbook

Intensive fish farming

Introduction to fishery by-products

The law of aquaculture: the law relating to the farming of fish and shellfish in Great Britain

The lemon sole

A living from lobsters

The mackerel

Making and managing a trout lake

Managerial effectiveness in fisheries and aquaculture

Marine fisheries ecosystem

Marine pollution and sea life

Marketing in fisheries and aquaculture

Mending of fishing nets

Modern deep sea trawling gear

More Scottish fishing craft

Multilingual dictionary of fish and fish products

Navigation primer for fishermen

Net work exercises

Netting materials for fishing gear

Ocean forum

Pair trawling and pair seining

Pelagic and semi-pelagic trawling gear

Penaeid shrimps — their biology and management

Planning of aquaculture development

Refrigeration of fishing vessels

Salmon and trout farming in Norway

Salmon farming handbook

Scallop and queen fisheries in the British Isles

Seine fishing

Squid jigging from small boats

Stability and trim of fishing vessels and other small ships

Study of the sea

Textbook of fish culture

Training fishermen at sea

Trends in fish utilization

Trout farming handbook

Trout farming manual

Tuna fishing with pole and line

A handy tool for reference on land or sea, this book contains the essential information commercial fishermen need to choose and use fishing equipment. It contains guidelines and recommendations drawn from many years' experience in professional fishing compiled at the Fishing Technology Service of the FAO, covering:

- **Materials and accessories**
- **Fishing gear and operations**
- **Equipment for deck and wheelhouse**
- **Fishing vessel operation**

All the information is highly illustrated, and there are also many useful formulae and tables for conversions between different systems of measurement.

Fishing News Books
specializes in books on a wide range of subjects connected with world-wide commercial fisheries including aquaculture and the management of fresh waters. A detailed catalogue is available free on request from:

Fishing News Books,
Osney Mead,
Oxford OX2 0EL
England

ISBN 0-85238-163-8

9 780852 381632

[illegible]