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FULL-SCALE INSTRUMENTED GEAR TRIALS ON THE ICES YOUNG FISH SAMPLING TRAWL (CHALUT GOV 36/47)

by

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SUMMARY

Engineering performance measurements were carried out on the 36/47 GOV trawl on FRV "Scotia" in 1985 using polyvalent otterboards, two different sweep lengths and three different groundgears. A preliminary analysis of the data has been made and values of selected parameters at the standard towing speed of four knots are tabulated.

INTRODUCTION

A review of the fishing gear used by ICES nations participating in the International Young Fish Survey revealed that for various reasons not all countries use the recommended rigging as specified in the manual (ICES, 1985) advising on the operation of the survey gear, Chalut GOV 36/47. Trials with a 1:10 scale model of this gear in the Flume Tank at the North Sea Centre, Hirtshals (Wileman, 1984) demonstrated that the different rigging arrangements used cause significant changes in gear geometry and hence fishing capability.

The Gear and Behaviour Working Group meeting subsequently in June 1984 made recommendations to standardise as far as possible the rigs used on the various survey vessels (Stewart, 1984). They also recommended that performance data based on full-scale measurements (especially the dependence of headline height, wingend spread and door spread on towing speed) be published.

The Marine Laboratory is currently undertaking a project on trawl and groundgear drag. As the young fish sampling trawl is used with three different groundropes (Fig. 1) it was considered that fully instrumented trials would be both a useful source of data for drag studies and an opportunity to measure the engineering performance of Chalut 36/47 fished with the recommended doors and rig (Fig. 2). A cruise to attain these twin objectives was carried out on board FRV "Scotia" in June 1985.

Fishing Gear

One of the standard polyethylene survey nets was used, similar in virtually all respects to the trawls previously operated from the side trawler "Explorer" (Galbraith, 1982). As "Scotia" is a stern trawler the problems previously experienced no longer applied, and the operation of the gear as specified proved troublefree. The codend was fitted with a 20 mm blinder and netting chafer. 1100 kg polyvalent doors (3.02 m x 1.89 m) obtained from J Morgère, St Malo, were fished with 4.5 m twin backstrops and 8.5 m extensions. Thus the recommended 40 m three bridle rig used with 47 m sweeps in shallow water (<70 m) and 97 m sweeps in deep water (>70 m) gives overall wire lengths of 100 m and 150 m respectively between doors and net.

Headline uplift was provided by an "Exocet" kite (0.83 m x 0.83 m) together with 60 aluminium deep sea floats. Assuming a static uplift of 2.9 kg each the floats would provide a total buoyancy of 174 kg.

The three groundgears used are set out in Figure 1. On both bobbin rigs the bosom and bunt bobbins were strung on 16 mm drag alloy chain with the rubber discs threaded on 18 mm wire. Extra lengths of 35 kg chain were added to the standard groundrope (Groundgear A) where indicated. The adjusting chain was set at 2 m overall (including triangle) on all three footropes.

Instrumentation

Vessel speed relative to the water was measured by the ship's electro-magnetic log and recorded on the DEC PDP 11/34 mini computer permanently installed on the vessel for navigational purposes. This log was calibrated at the start of the cruise. Water depth and Decca positions were also logged on this machine at 30 second intervals. Problems with warp tension meters meant that only starboard warp load measurements were made when possible using an in-line strain gauge load cell. This parameter was logged on a 128 K, 8 bit micro-computer which was also used for processing data from the underwater instruments.

All underwater instrumentation was self-contained, battery powered and consisted of load cells, depthmeters, net logs and spreadmeters. Apart from the acoustic spreadmeters, which measure distances such as door spread, net spread and headline height (Urquhart, 1981) these instruments store data in a solid state memory. This is output directly to the micro-computer mentioned above at the end of each haul and can be stored on disk for subsequent analysis.

Loads in the gear were measured by shear pin tension meters shackled into the wire rig between net and bridles, with further "back-up" load cells between sweeps and bridles. The depthmeters, based on hydrostatic pressure transducers, registered depth relative to the surface at various points on the net and doors. Gear water speed was measured using an impeller log mounted above the headline. A second log was also used in case of instrument failure for this extremely important parameter. The logs were positioned on the centre headline on either side of the kite.

METHODS AND PROCEDURES

The deep water trials with the longer sweeps were carried out in 110-120 m water depth on the Balta grounds east of the Shetland Isles. Warp lengths of 500 m were used, as recommended in the manual, giving a scope ratio in excess of 4:1. The shallow water work with short sweeps took place off Start Point, Orkney Isles in water depths of 60-70 m. Here 350 m of warp were paid out, again as recommended, for a scope ratio of approximately 5:1. Hauls with all three types of groundgear were made in both areas and consisted of up to eight blocks (15 minute periods while towing at constant RPM) at systematically varied speeds.

Although net water speed was measured directly the reciprocal tow method (ie towing with and against the tide) as recommened by ICES, 1981 was used for the majority of the deep water hauls. On the Orkney grounds, however, tidal conditions were such that the vessel could not easily be turned on to a reciprocal course and all shallow water hauls were made in one direction only. At the time this was not considered important, as gear speed relative to the water was successfully measured by one or both netlogs throughout the trials, but subsequent analysis of the data has shown that this may not be the case.

RESULTS

The computer analysis for several hauls in both deep and shallow water are set out in Tables 1 and 2. Blocks at either end of the speed range have been excluded when the gear has either (a) lifted off the bottom at high speeds or (b) otterboard spread has collapsed at the slower speeds. Selected parameter values at a towing speed of four knots are listed for all three groundrope types at both water depths (Table 3).

Parameters such as gear drag are calculated by summing warp loads and resolving both horizontally and vertically in the direction of tow. Net drag is computed in a similar manner using bridle loads. Heights and spread are measured directly with the bridle angles calculated on the assumption that the sweeps are straight and that the gear is symmetrical. When the horizontal bridle angle is not available due to instrument failure a default value of 16.5 degrees has been substituted in order to calculate net drag.

Headline height, wingend spread, door spread and net drag have been plotted against speed for the three groundrope cases in both deep and shallow water (Fig. 3). Total bridle tension distribution in relation to speed is also presented (Fig. 4). In all cases gear water speed derived from direct netlog measurements has been used.

DISCUSSION

As expected, the inclusion of polyvalent doors in the rig considerably increased horizontal spreads in comparison to the 1981 "Explorer" trials when rectangular flat otterboards were used. On the deep water tow an extra shackle was used in the top backstrops of the polyvalent doors but was not required with the shorter warp length. The wingend spread of around 20 m compares favourably with that obtained on "Thalassa" (Brabant, 1983) but headline height for the most part remained below 5 m, in spite of an extra 10 floats being used.

When net drags are compared using the three groundropes in deep water that obtained with Groundgear A is substantially less than when using the two bobbin footropes. Lower bridle tensions suggest ground contact may have been less with the standard rubber disc rig. In the shallow water case, however, Groundgear B, with 305 mm bobbins, has both less net drag and lower bridle tensions than the other two.

Bridle tension distribution also raises several questions. In deep water the lower bridle load exceeded the upper for both bobbin groundropes with Groundgear A having a greater load on the headline than on the footrope. In shallow water the exact opposite is the case. Both Groundgears B and C have a higher tension on the headline than footrope while the load on the headline is less than that on the footrope in the case of Groundgear A. On the "Explorer" trials using Groundgear B tension was fairly evenly split between headline and footrope with the latter taking marginally more of the load. Although different doors, sweeps and warp length were used on this occasion one would not expect net tension distribution to be markedly different, given that no change was made to the bridle rig.

Unfortunately, no warp tension measurements are available for the deep water hauls and only one warp load could be measured with the shorter warps. Gear drag is therefore calculated using twice the single tension value, and can only be regarded as an approximation at best, especially as the vessel towed in one direction only. However when one compares these values in Table 3 it is the Groundgear A case which is lowest whereas Groundgear B has the least net drag (Fig. 3).

As the two sets of results appear to be in contradiction the part played by the extremely strong tidal currents encountered on the shallow water tow must be taken into account; currents strong enough to prevent a reciprocal leg being made on all the hauls carried out in this area. With the standard groundrope (Groundgear A) the underwater tension measurements indicated net assymetry varying from block to block, which suggests that a complicated pattern of currents, rather than a unitary stream, was acting on the gear.

REFERENCES

Brabant, J.C. 1983. Comparison d'observations du Chalut GOV 36/47. ICES CM1983. Fish Capture Committee.

Galbraith, R.D. 1982. Performance trials on Chalut 36/47 GOV constructed in both nylon and polyethylene twine. ICES CM1982/B:21. Fish Capture Committee.

ICES Coop. Res. Rep. 1981. Guide to experimental procedure in fishing gear research and development.

ICES 1985 Manual for the International Young Fish Surveys in the North Sea, Skagerrak and Kattegat. Second Revision, January 1985. ICES CM1985/H:23.

Stewart, P.A.M. (Rapporteur). 1984. Report on the Working Group on Fishing Technology and Fish Behaviour. ICES CM1984/B:13.

Urquhart, G. 1981. Fishing gear instrumentation. Institution of Electronic and Radio Engineers, International Conference on Electronics for Ocean Technology, University of Birmingham, 1981.

Wileman, D.A. 1984. Model testing of the 36/47 GOV Young Fish Sampling Trawl. Dansk Fiskeriteknologisk Institut.

TABLE 1 – DEEP WATER HAULS

Haul : S85.178 CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR A – RUBBER DISC FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
4	4.33	503	112.1	4.49	99.3	19.4	5.2	15.7	5.5	6712	3759	508	2723	179
5	3.21	503	123.4	4.07	103.7	20.0	4.6	16.5	4.8	4356	2530	274	1748	107
6	4.35	503	111.6	4.51	107.1	19.9	4.6	17.2	4.9	7555	4450	539	2936	189
8	3.83	503	111.6	4.51	104.9	20.0	4.6	16.8	4.9	6049	3516	376	2439	149

Haul : S85.180 NET & GROUNDGEAR AS ABOVE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.51	503	117.9	4.26	0.0	22.4	4.6	16.5	4.8	5289	3018	325	2184	127
3	4.14	503	120.4	4.18	0.0	20.6	4.3	16.5	4.5	6555	3597	488	2764	142
4	2.91	503	112.7	4.46	0.0	20.3	4.6	16.5	4.8	3569	1930	345	1453	82
5	3.28	503	121.2	4.15	0.0	19.4	4.6	16.5	4.8	4425	2337	488	1798	99
6	4.54	503	120.1	4.19	0.0	19.4	4.3	16.5	4.5	8102	4247	1036	3180	167
8	3.75	503	111.9	4.50	0.0	19.4	4.3	16.5	4.5	5427	2977	589	2103	117

NET LOG SPEED HAS BEEN USED

Haul : S85.181 CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR B – NORTH SEA FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.20	503	127.9	3.93	90.0	18.6	4.9	14.0	5.1	5296	1930	467	3068	86
2	4.40	503	125.2	4.02	103.4	19.4	4.3	16.6	4.5	9572	3820	955	5222	151
3	2.75	503	123.5	4.07	84.8	18.1	4.6	13.1	4.8	3905	1402	366	2245	58
4	3.88	503	115.9	4.34	96.5	18.5	4.6	15.4	4.8	7427	2906	833	3973	122
5	3.73	503	126.0	3.99	99.3	19.7	4.3	15.7	4.5	7133	2682	569	4166	105
6	2.59	503	112.7	4.46	119.8	18.2	4.6	20.2	4.9	3534	1260	244	2266	54
7	4.28	503	115.7	4.35	100.3	19.4	4.3	15.9	4.5	9057	3190	853	5385	125
8	3.17	503	111.1	4.53	99.3	19.4	4.3	15.7	4.5	5393	1951	406	3251	77

NET LOG SPEED HAS BEEN USED

Haul : S85.186 CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR C – HEAVY BOBBIN FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.48	503	113.4	4.44	99.3	25.0	4.9	14.6	5.1	6038	2195	467	3587	98
2	4.44	503	111.6	4.51	111.8	26.1	4.9	16.9	5.2	9271	3363	813	5527	152
3	4.08	503	113.4	4.44	99.3	24.7	4.6	14.7	4.8	7991	2794	752	4725	117

Haul : S85.187 NET & GROUNDGEAR AS ABOVE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.37	503	102.4	4.91	97.2	20.1	4.9	15.2	5.1	5748	2144	406	3414	96
2	4.48	503	122.5	4.10	104.9	20.3	4.6	16.7	4.9	8913	3312	569	5436	140
3	2.69	503	124.4	4.04	84.8	18.7	4.9	13.0	5.1	3876	1382	325	2276	61
4	3.88	503	113.4	4.44	98.4	19.4	4.3	15.5	4.5	7295	2632	671	4278	103
5	3.55	503	106.1	4.74	96.2	19.5	4.9	15.1	5.1	6152	2195	772	3414	98
6	4.65	503	109.7	4.58	97.2	18.5	4.6	15.5	4.8	9917	3566	1097	5639	150
7	2.94	503	109.7	4.58	82.9	17.5	4.3	12.8	4.4	4414	1575	467	2489	61
8	4.11	503	109.7	4.58	97.2	19.1	4.9	15.4	5.1	7896	2865	853	4481	128

NET LOG SPEED HAS BEEN USED

TABLE 2 - SHALLOW WATER HAULS

Haul : S85.194

CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR A - RUBBER DISC FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.10	351	64.0	5.49	70.7	20.4	4.9	15.0	5.1	5343	1697	427	3414	76
2	4.28	351	64.0	5.49	81.4	20.5	4.6	18.2	4.9	7623	3028	782	4227	129
4	3.61	351	67.7	5.19	74.5	19.1	4.6	16.5	4.8	5846	2174	671	3262	92
5	2.97	351	69.5	5.05	65.1	17.7	5.2	14.1	5.4	3995	1473	539	2113	70
6	4.15	351	65.8	5.33	73.6	19.1	4.6	16.3	4.8	7092	2835	935	3627	120
8	3.51	351	65.8	5.33	72.6	18.8	4.4	16.0	4.7	5901	2113	671	3363	86

NET LOG SPEED HAS BEEN USED

Haul : S85.199

CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR B - NORTH SEA FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.68	351	70.6	4.97	82.0	24.2	4.6	17.3	4.9	5172	2682	599	2144	114
3	3.27	351	64.7	5.42	75.1	24.0	4.6	15.2	4.8	4130	2063	539	1687	87
4	4.24	351	64.9	5.41	82.7	24.5	4.3	17.4	4.5	6738	3505	853	2713	139
5	3.47	351	64.9	5.41	75.1	23.4	4.6	15.4	4.8	4821	2439	711	1859	103
6	0.00	351	64.7	5.42	82.9	24.5	4.3	17.5	4.5	8070	4257	1057	3160	169
8	3.87	351	60.2	5.84	81.7	25.5	4.3	16.8	4.5	6177	3312	752	2398	131

NET LOG SPEED HAS BEEN USED

Haul : S85.192

CHALUT GOV 36/47 WITH 1100 KG POLYVALENT DOORS
GROUNDGEAR C - HEAVY BOBBIN FOOTROPE

BL NO	GEAR SPEED KT	WARP LENGTH M	DEPTH M	SCOPE	DOOR SPREAD M	WINGEND SPREAD M	HEADLINE HEIGHT M	UPPER BRIDLE ANGLES HORIZ DEG	UPPER BRIDLE ANGLES VERT DEG	NET DRAG KG	2xUPPR BRIDLE LOAD KG	2x MID BRIDLE LOAD KG	2xLOWR BRIDLE LOAD KG	H/LINE DOWN PULL KG
1	3.30	351	64.0	5.49	75.1	20.0	5.5	16.4	5.8	5256	3272	417	1809	166
2	4.47	351	65.8	5.33	83.6	20.5	5.5	18.9	5.9	8499	5151	650	3211	254
3	3.23	351	65.8	5.33	75.1	19.7	5.2	16.5	5.5	4867	2947	376	1763	141
4	4.08	351	65.8	5.33	79.2	19.3	4.9	17.9	5.2	7243	4379	559	2693	199
5	4.71	351	71.3	4.92	83.7	19.8	4.6	19.1	4.9	9549	5883	691	3555	251
6	3.56	351	73.2	4.80	75.1	20.0	4.6	16.5	4.8	5757	3465	457	2093	146
7	4.40	351	78.6	4.47	75.2	20.0	4.6	16.5	4.8	8460	5019	721	3099	212

NET LOG SPEED HAS BEEN USED

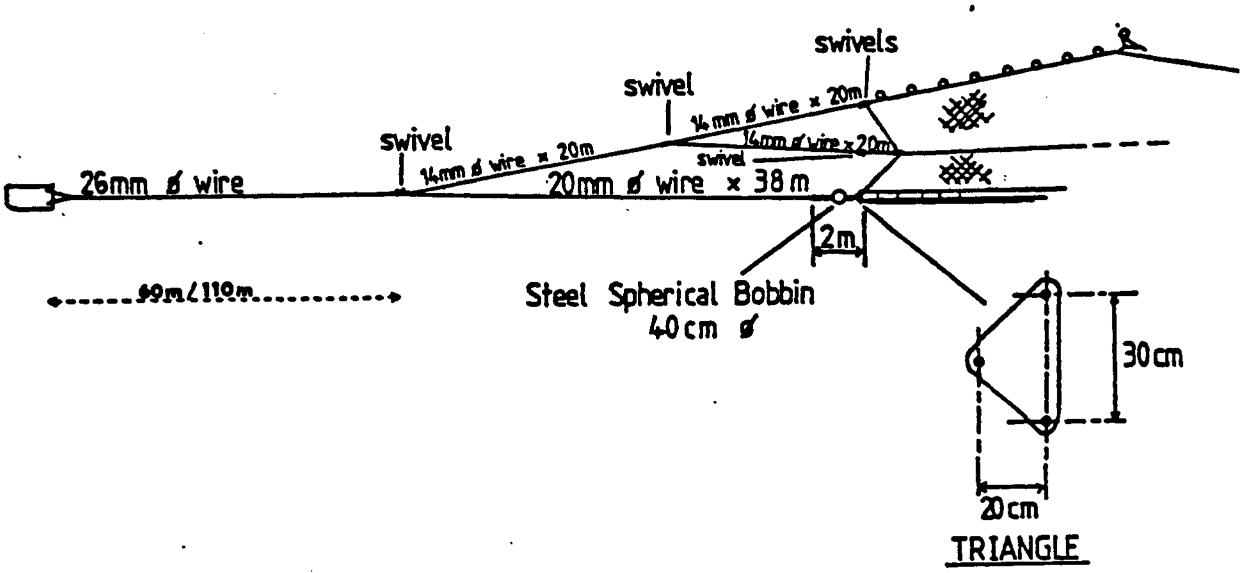
TABLE 3

SELECTED PARAMETER VALUES AT 4 KNOTS TOWING SPEED

	DEEP WATER			SHALLOW WATER		
GROUNDGEAR	A	B	C	A	B	C
Headline height (m)	4.5	4.3	4.7	4.6	4.3	5.0
Door spread (m)	104	99	99	76	82	78
Wingend spread (m)	20.0	19.2	21.1	19.6	24.7	19.9
Bridle angle (deg)	16.5	15.7	15.4	17.0	17.1	17.5
Total upper bridle load (kg)	3546	3052	2785	2675	3258	4368
Total mid bridle load (kg)	555	774	715	790	776	561
Total lower bridle load (kg)	2551	4575	4502	3752	2482	2647
Net drag (kg)	6363	8072	7696	6889	6217	7198
Gear drag (kg)*	-	-	-	8687	9140	8923
Gear kW*	-	-	-	177	185	186

* Calculated from single (starboard) warp tension measurement

FIGURE 2 – RIG (not to scale)



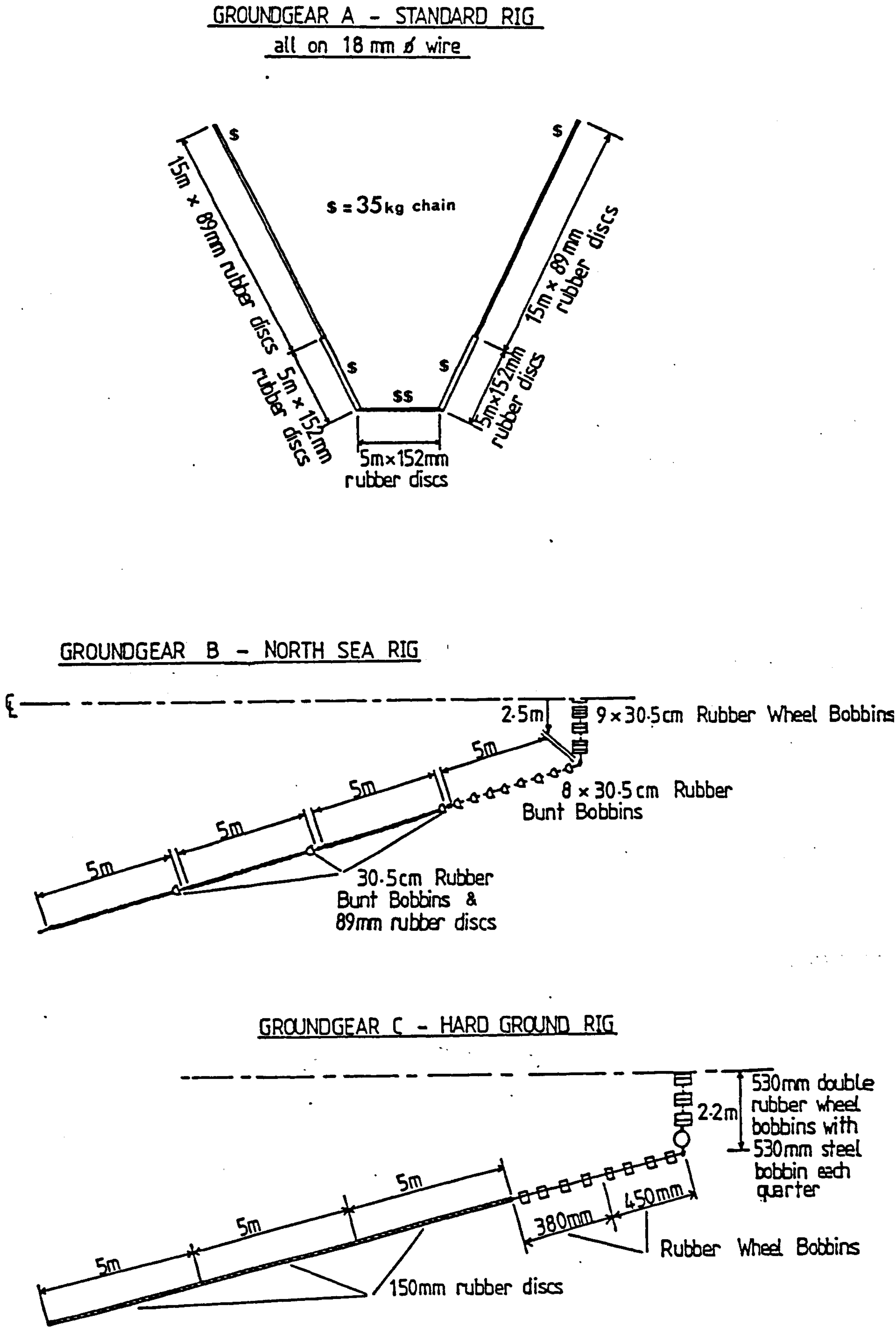

GROUNDGEAR A - STANDARD RIG
all on 18 mm ø wire
$ = 35kg chain
15m x 89mm rubber discs
5m x 152mm rubber discs
$
$$
5m×152mm rubber discs
15m x 89mm rubber discs
5m×152mm rubber discs
GROUNDGEAR B - NORTH SEA RIG
2·5m
9×30·5cm Rubber Wheel Bobbins
5m
8 × 30·5 cm Rubber Bunt Bobbins
30·5cm Rubber Bunt Bobbins & 89mm rubber discs
GROUNDGEAR C - HARD GROUND RIG
530mm double rubber wheel bobbins with 530mm steel bobbin each quarter
2·2m
5m
380mm
450mm
Rubber Wheel Bobbins
150mm rubber discs

FIG. 1

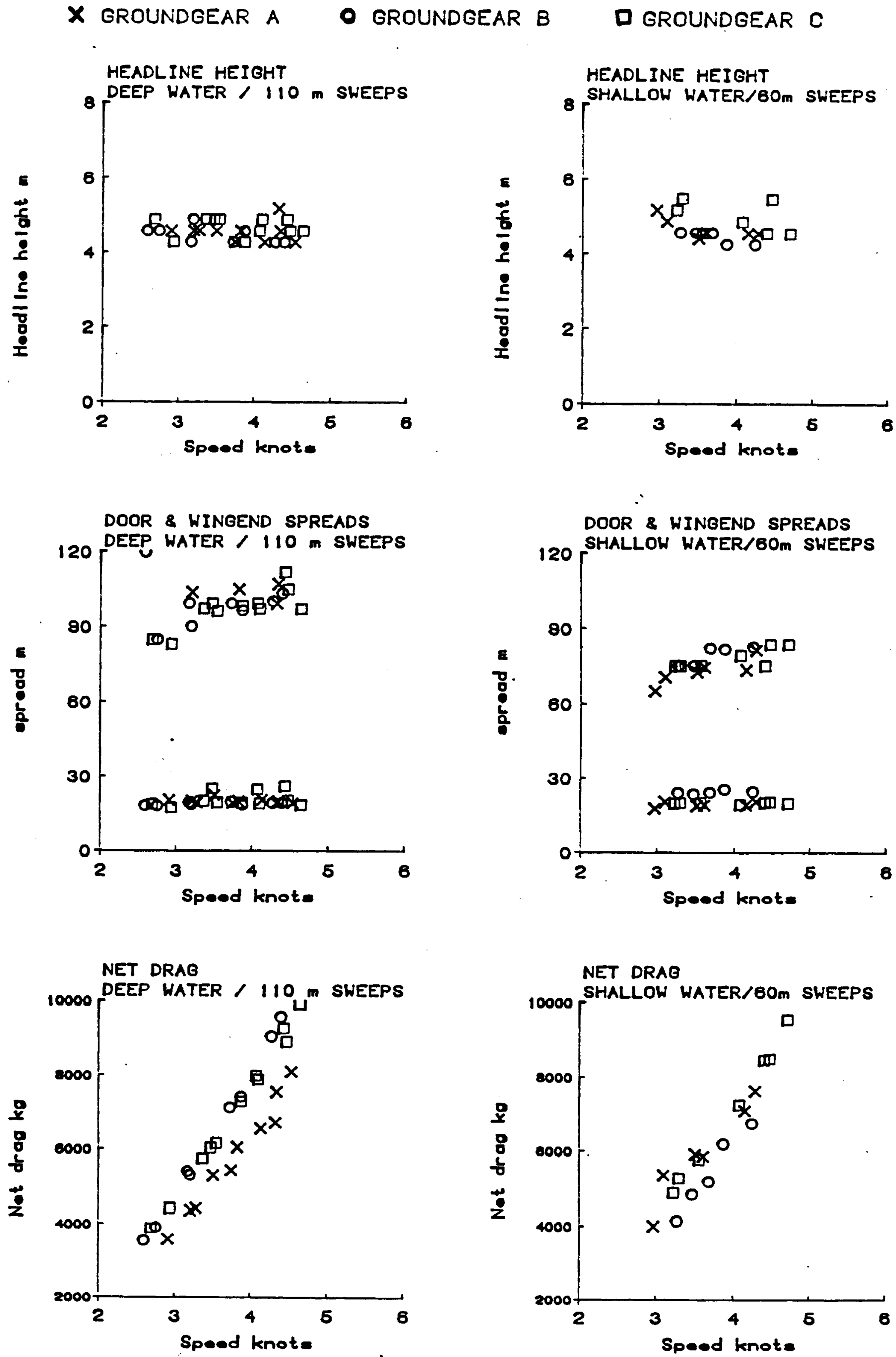

X GROUNDGEAR A
O GROUNDGEAR B
□ GROUNDGEAR C
HEADLINE HEIGHT
DEEP WATER / 110 m SWEEPS
Headline height m
Speed knots
HEADLINE HEIGHT
SHALLOW WATER/60m SWEEPS
Headline height m
Speed knots
DOOR & WINGEND SPREADS
DEEP WATER / 110 m SWEEPS
spread m
Speed knots
DOOR & WINGEND SPREADS
SHALLOW WATER/60m SWEEPS
spread m
Speed knots
NET DRAG
DEEP WATER / 110 m SWEEPS
Net drag kg
Speed knots
NET DRAG
SHALLOW WATER/60m SWEEPS
Net drag kg
Speed knots

FIG-3

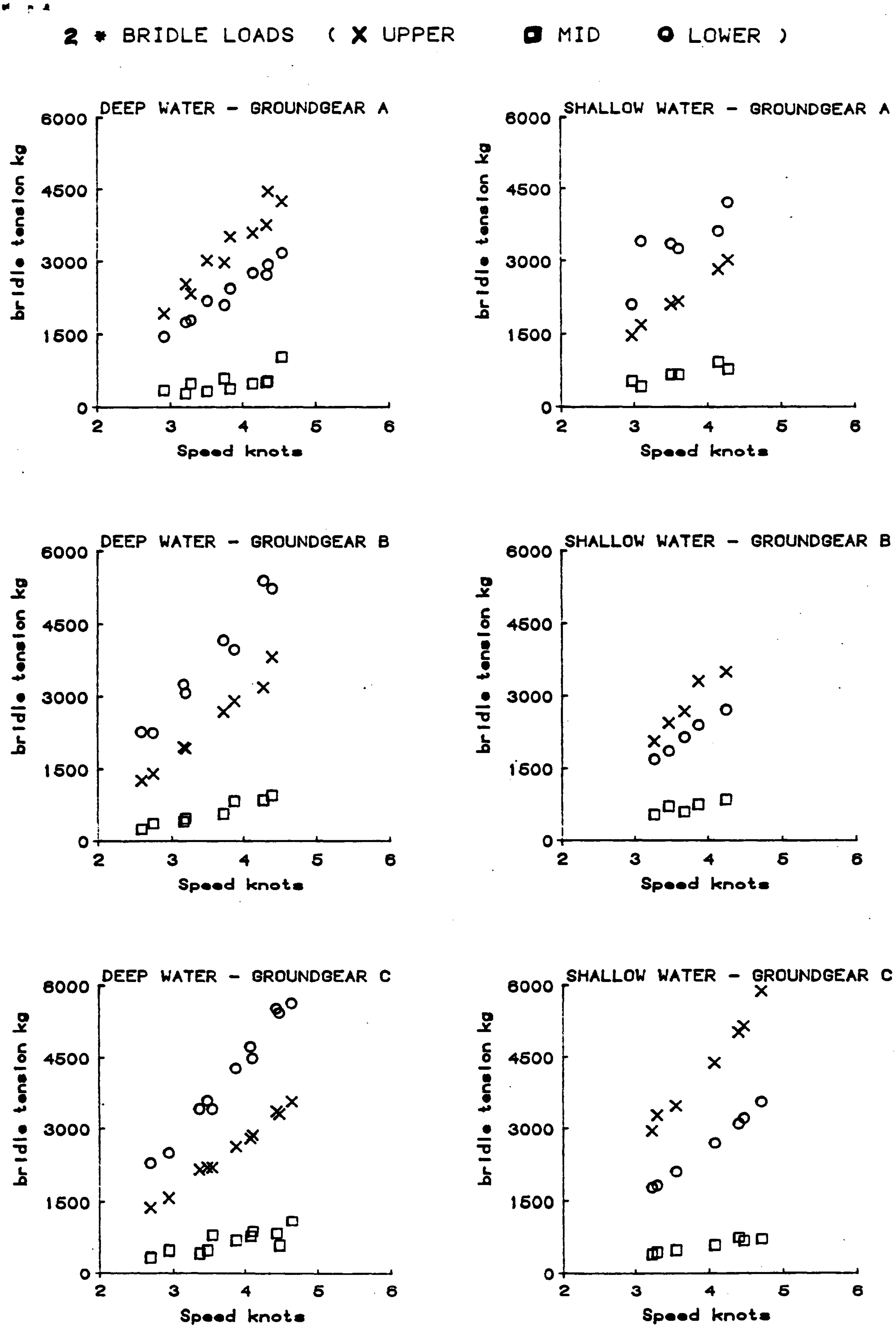

2 * BRIDLE LOADS (X UPPER □ MID ○ LOWER)
DEEP WATER - GROUNDGEAR A
SHALLOW WATER - GROUNDGEAR A
DEEP WATER - GROUNDGEAR B
SHALLOW WATER - GROUNDGEAR B
DEEP WATER - GROUNDGEAR C
SHALLOW WATER - GROUNDGEAR C
bridle tension kg
0
1500
3000
4500
6000
Speed knots
2
3
4
5
6

FIG. 4