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Performance of the Campelen 1800 Shrimp Trawl During the 1995 Northwest Atlantic Fisheries Centre Autumn Groundfish Survey

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Abstract

The use of SCANMAR acoustic trawl instrumentation and standardized fishing protocols on groundfish surveys has helped to minimize variation in towing speed, tow duration, bottom contact and reducing the number of malfunctioning (bad) tows. In 1995, the Northwest Atlantic Fisheries Centre (NAFC) adopted the Campelen 1800 shrimp trawl as the standard bottom trawl survey gear to replace the Engel 145 High Lift otter trawl on both offshore fisheries research vessels (FRV): FRV *Teleost* and FRV *Wilfred Templeman*. During the 1995 NAFC autumn survey SCANMAR hydroacoustic trawl instrumentation was used with each fishing set to measure and record trawl depth, opening, bottom contact, door spread and wing spread. The performance of the Campelen 1800 shrimp trawl during the 1995 autumn survey is discussed.

Keywords: SCANMAR, standardization, survey trawls, trawl performance

Introduction

Bottom trawls are used in ocean environments to measure abundance, distribution and the diversity of organisms which inhabit near-bottom waters. Bottom trawls are flexible structures that do not catch all fish in the area sampled during a fishing tow. Pope *et al*. (1975) noted that the catchability of a trawl depends on the type of trawl, how and when it is used, the behaviour of the individual fish in the population and the interaction of these intrinsic and extrinsic factors in the fish capture process.

Trawl efficiency can be affected by various aspects of gear design and construction which cause selectivity to be size and/or species dependent (see, for example, Walsh, 1992). In addition, changes in size and species dependent behaviour will also influence selectivity and hence catchability. Bias in the form of a systematic error can occur in the abundance estimate due to changes in the fishing power of the trawl as a result of changes in the vessel power, noise, crew, trawl design, and adherence to trawl construction specifications (Byrne *et al*., 1981; Walsh *et al*., 1993). A major area of uncertainty in trawl surveys is the effect of the changes in catchability on estimates of abundance due to changes in trawl geometry and performance (Carrothers, 1981). Minimizing these errors to an acceptable level must be the focus in any survey operation.

Minor variations in construction, repair, deployment and retrieval and actual fishing practices can increase bias and hence variability in survey indices. Efforts to minimize this bias by standardizing all survey trawl construction, repairs and fishing protocols have not always been successful because of unregulated changes by fishing crews and trawl manufacturers over the years (Walsh and McCallum, MS 1995). Complete standardization of trawl riggings, procurement, construction and repairs and fishing practices have been enforced at the Northwest Atlantic Fisheries Centre (NAFC) since the introduction, in 1993, of a three-fold rigorous program to "standardize" the survey trawls on both offshore research vessels. These programs introduced: 1) Internationally Standardized Trawl Plans, 2) a Fishing Gear Checklist to measure the trawl components before each cruise and after major tear-ups to ensure standardization, and 3) a Quality Control Program to regulate procurement, construction and repairs (see McCallum and Walsh, MS 1995; and Walsh and McCallum, MS 1995 for details).

Trawl geometry and performance can vary from haul to haul and increase variation in catchability. The use of acoustic instruments have allowed researchers to monitor trawl performance, identify gear malfunctions and estimate variability in trawl geometry (see for example Wathne, 1977; Stewart and Galbraith, MS 1987; Engås, 1994; Walsh and McCallum, MS 1995). At the NAFC, the monitoring of trawl geometry and performance by SCANMAR acoustic trawl monitoring sensors attached to the fishing gear have proven valuable in measuring and reducing variability in trawl performance.

In 1995, the NAFC adopted the Campelen 1800 shrimp trawl as the standard bottom trawl survey gear to replace the Engel 145 High Lift otter trawl onboard both offshore survey vessels. During the annual autumn surveys, trawl performance data were recorded using SCANMAR acoustic trawl monitoring instruments. This paper presents an analysis of the performance of the Campelen 1800 shrimp trawl on both offshore fisheries research vessels (FRV): FRV *Teleost* and FRV *Wilfred Templeman*.

Materials and Methods

The Campelen 1800 shrimp trawl is a three bridle trawl rigged with 4.3 m^2, 1400 kg polyvalent trawl doors, 40 m bridles and 6.1 m sweep wires. The trawl is rigged with a 35.6 m rockhopper footrope and uses 356 mm diameter rubber disks. Trawl construction is of 4.0, 3.0 and 2.0 mm diameter polyethylene twine varying in mesh size (knot centre) from 80 mm in the wings to 60 mm in the square and the first bellies and 40 mm in the remaining bellies, extension and codend (see Fig. 1 and 2). A 7.0 m long knotless nylon liner of 12.5 mm mesh size is used in the codend (see McCallum and Walsh, 1996, for details).

Standardization Efforts

The trawls onboard each research vessel were measured using the NAFC Survey Trawl Checklist (McCallum and Walsh, MS 1995) prior to the beginning of each segment of the survey and after any significant gear damage to ensure standardization of rigging.

SCANMAR hydroacoustic trawl instrumentation was used onboard both vessels for each fishing set to measure trawl depth, opening, bottom contact, door spread and wing spread. All data were automatically logged at 5 second intervals using the NAFC SeaTrawl data acquisition software (McCallum and Walsh, MS 1995). The start of each fishing set was determined when SCANMAR height and depth sensors, in combination, indicated the trawl had touched down on the seabed (see Appendix I). Tow duration was approximately 15 minutes at a towing speed of 3.0 knots as determined by the Global Positioning System (GPS). Bridge recordings of towing speed (every 3 minutes) and time of touch down and lift off were logged by vessel staff. Tow direction is generally towards the next fishing station. Acoustic noise in the trawl performance data were edited using range checks of 0–1200 m for depth, 0–85 m for door spread, 0–30 m for wing spread, 0–35 m for opening and 0–50 m for clearance. Additional filters were used to remove SCANMAR generated duplicates and spikes from each data set.

At each fishing station the scope ratio (trawl warp length /fishing depth) was determined using the new NAFC Scope Ratio table (Table 1) developed in July 1995 (McCallum and Walsh, unpublished data).The correct amount of trawl warp was deployed to achieve and maintain stable bottom contact of the trawl doors.

Bridle angles (θ) for the Campelen trawl were calculated using the following equation:

$$sin\,\theta = \frac{\frac{1}{2}(ds - ws)}{bl}$$

where *ds* is the door spread,
ws is the wing spread, and
bl represents the bridle length (sum of sweeps + ground warps + door legs and extensions).

Trawl Doors

During the first segment of the *W. Templeman*'s survey, the fishing officers observed that the trawl doors were unstable in shallow water using a towing speed of 3.0 knots. This was not a problem onboard the *Teleost* which used doors of the same dimensions, i.e. surface area and weight but were made by a different manufacturer. A decision was made to use the spare *Teleost* trawl doors and a door stability log sheet, recording position of shine on door shoes and mud deposit, was filled out after each tow. Based upon these results, the SCANMAR recordings and the advice of fishing crew, the *Teleost* doors were used on the last two segments of the survey and the problem was corrected. A total of 278 tows were made with the old doors onboard the *W. Templeman* and 154 tows were made with the new (*Teleost*) trawl doors. Consequently the *W. Templeman* data were analysed to look at differences in geometry and performance separately based on door type. A Kruskal-Wallis One Way ANOVA was used to test for significant difference in trawl geometry parameters.

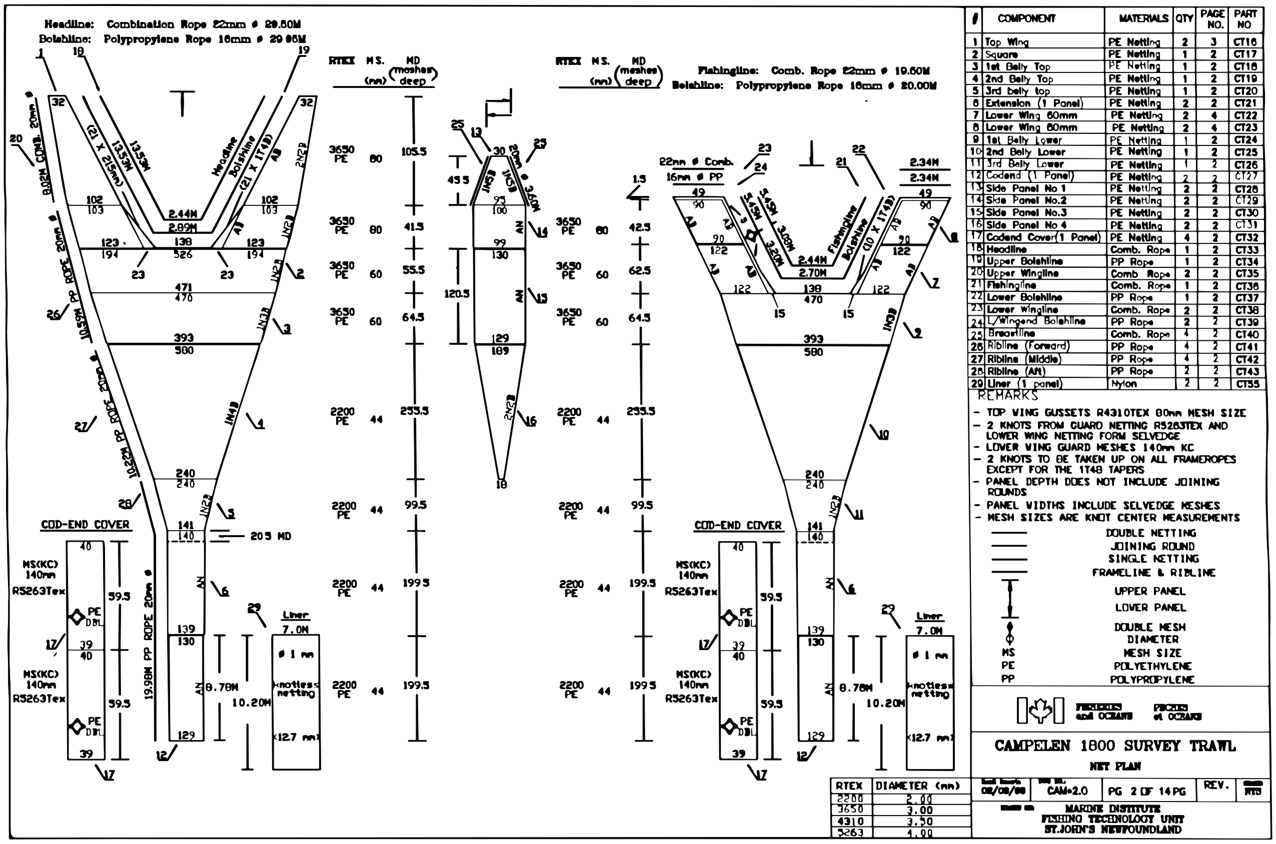


Fig. 1. Trawl plan of the Campelen 1800 survey trawl.

Results and Discussion

A total of 552 fishing sets were made with the new Campelen survey gear, 432 sets on the *W. Templeman* and 120 sets on the *Teleost*.

Geometry

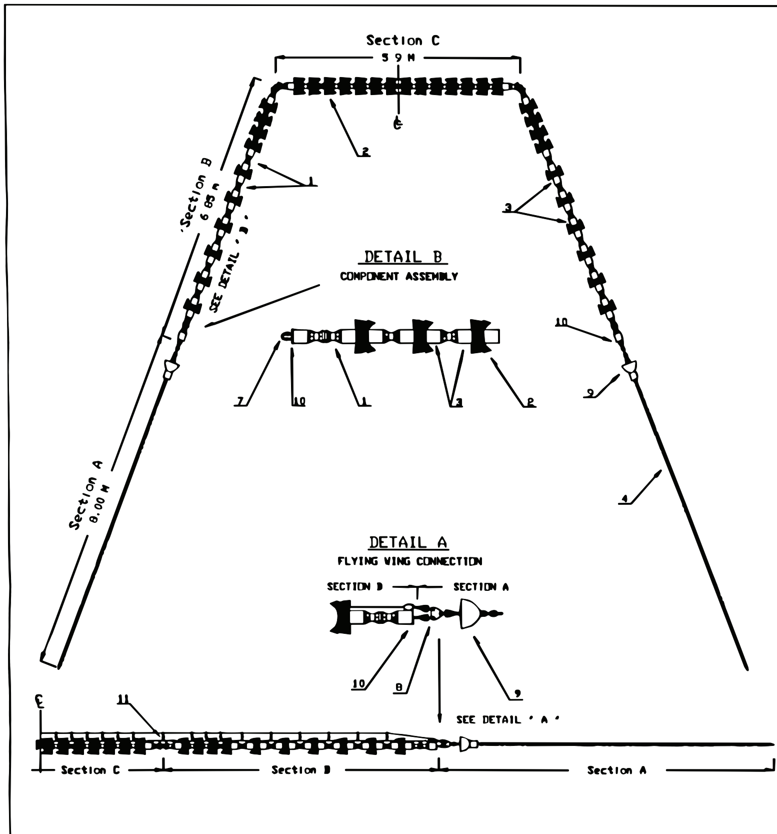
Table 2 presents the summary statistics for mean geometry values for the various combinations of the Campelen survey trawl used in the autumn survey: the *W. Templeman* with old doors, the *W. Templeman* with new doors and the *Teleost*. Table 3 presents the results of the Kruskal-Wallis One Way Analysis of Variance on Campelen trawl geometry.

W. Templeman. Table 2 shows the mean door spread and wing spread were 24% and 15% higher when the old doors were replaced by the new doors from the *Teleost*. The trawl opening decreased with the increased spread of the new doors. Table 3 shows that these differences in geometry derived from using different trawl doors were statistically significant (p<0.001).

Teleost. Table 2 shows the trawl geometry data divided into 2 groups based on bottom fishing depth ranges: less than 640 m to make data comparable to *W. Templeman* data (new doors), and all bottom depths ranging to 1 200 m. Although there was no significant difference in wing spread ($\bar{x}$ =17.1 m for *W. Templeman* and 16.7 m for *Teleost*), at comparable depths, there was a significant difference in door spread ($\bar{x}$ =48.8 m for *W. Templeman*, 51.4 m and *Teleost*, respectively) (Fig. 3) and trawl opening ($\bar{x}$ = 4.4 m, 4.1 m, respectively) (Table 3). Again the results are similar when all data from the *Teleost* were used and compared with the *W. Templeman* data. It is noteworthy that many more of the *W. Templeman*'s sets, when compared to those of *Teleost* were in depths less than 100 m which probably contributed to lower door spreads.

Performance

W. Templeman – Figure 4 shows the results of door spread, wing spread, trawl opening and bridle angles with the old trawl doors and Figure 5 shows



DRAWING NOTES:
- GROUND GEAR IS SYMMETRICAL ABOUT CENTERLINE.
- LENGTHS FOR SECTION B & C ARE MEASURED FROM CENTRE HAMMERLOCK TO CENTRE HAMMERLOCK.
- LENGTH OF SECTION A IS MEASURED FROM CENTRE HAMMERLOCK TO END OF CHAIN (SEE DETAIL A).

#	COMPONENT	WEIGHT (KGS) (IN SEAWATER)		NUMBERS				Page NO.	PART NO.
		UNIT	TOTAL	TOTAL	SECT. A	SECT. B	SECT C		
1	8' (200mm) Iron Spacer	5.29	206.31	39	0	2x12	1x15	8	CT44
2	14' Rockhopper Sets of 3 Disk	0.55	56.1	34X3	0	2x10	1x14	9	CT45
3	7' (170MM) Rubber Spacer	0.43	14.62	34	2X1	2x15	1x2	10	CT46
4	5/8' (16mm) Mid Link Chain	.96/M	74.30	14.98	2x7.49m				CT12
5	3/8' (16mm) Mid Link Chain	.96/M	66.96	13.5m		2x6.75m			CT13
6	5/8' (16mm) Mid Link Chain	.96/M	28.76	5.80m			1X5.80m		CT14
7	5/8' (16mm) Hammerlock	1.0	12	10	2x4	2x2	0		CT48
8	Delta Plate (362mm)	4.76	9.52	2	2	0	0	11	CT49
9	14'(356mm) Rubber Bunt Bobbin	4.98	9.96	2	2	0	0	12	CT50
10	6' (152mm) Washer	0.42	3.36	8	2x1	2x2	1x2	13	CT51
11	15.5' (393mm) Bobbin Chain	0.58	19.14	33	0	2x10	1x13	14	CT52
	TOTAL WEIGHT		501.03						

CAMPELEN 1800 SURVEY TRAWL
GROUND GEAR

02/08/93 | CAMe3.0 | PG 7 OF 14 PG | REV. | NTS

MARINE INSTITUTE
FISHING TECHNOLOGY UNIT
ST.JOHN'S NEWFOUNDLAND

Fig. 2. Footgear details of the Campelen 1800 survey trawl.

the same parameters with the new doors. There was no obvious trend in door spread with depth in either data set. In contrast, there was a predictive relationship between depth and door spread for the old standard survey gear, the Engel 145 otter trawl, used onboard the *W. Templeman* prior to 1995 (Walsh and McCallum, MS 1995).

Teleost. Figures 6 and 7 show the results of door spread, wing spread, trawl opening and bridle angles for two depth categories: less than 615 m and less than 1 200 m. Door spread showed an increase with bottom depth beyond 615 m which accounts for the mean wing spread being somewhat higher in the latter data set. Preliminary analysis of fishing the Campelen trawl in depths of 48–1 200 m onboard the FRV *Gadus Atlantica* showed a highly significant relationship between door spread and bottom depth (Walsh and McCallum, MS 1996). It is uncertain if this is explained by a vessel effect.

***W. Templeman–Teleost* (Same Doors)**. Examination of trawling performance of the Campelen trawl in depths less than 615 m shows the door spread to be slightly more variable on the *W. Templeman* when compared to the *Teleost*. Table 3 shows that there was a statistically significant difference in door spreads in both trawls. There could be several reasons for this difference, chief among them would be area differences in bottom sediment type and bottom currents which can individually or together affect door spread and overall performance of the gears. Walsh and McCallum (MS 1996) have shown that trawl width variation can be minimized by physically restraining the trawl doors of the Campelen trawl in an effort to standardized swept area estimates.

It is difficult to compare the fishing power of these two trawls from these data. Fishing power should only be derived in a comparative fishing experiment. However, as seen in Table 2, average bridle angles of both trawls were very close in agreement, but statistically different at the 0.05 significance level due to the correlation between bridle angles and door spread. These similarities in bridle angles (19–21°) at comparable depths should indicate a similarity in sweep herding efficiency of fish. This bridle angle increased with depth in the *Teleost* analysis and further survey work is needed by the *W. Templeman* in deep water to see if these relationships hold together.

TABLE 1. 1995 NAFC scope ratios used onboard the FRV *Templeman* and FRV *Teleost* to standardized fishing operations.

	Warp Ratio Table									
Depth (m)	0	1	2	3	4	5	6	7	8	9
0										
10	3.37	3.37	3.36	3.36	3.36	3.36	3.36	3.35	3.35	3.35
20	3.35	3.34	3.34	3.34	3.34	3.34	3.33	3.33	3.33	3.33
30	3.32	3.32	3.32	3.32	3.32	3.31	3.31	3.31	3.31	3.31
40	3.30	3.30	3.30	3.30	3.29	3.29	3.29	3.29	3.29	3.28
50	3.28	3.28	3.28	3.28	3.27	3.27	3.27	3.27	3.27	3.28
60	3.26	3.26	3.26	3.25	3.25	3.25	3.25	3.25	3.24	3.24
70	3.24	3.24	3.24	3.23	3.23	3.23	3.23	3.23	3.22	3.22
80	3.22	3.22	3.22	3.21	3.21	3.21	3.21	3.21	3.20	3.20
90	3.20	3.20	3.19	3.19	3.19	3.19	3.19	3.18	3.18	3.18
100	3.18	3.18	3.17	3.17	3.17	3.17	3.17	3.16	3.16	3.16
110	3.16	3.16	3.15	3.15	3.15	3.15	3.15	3.14	3.14	3.14
120	3.14	3.14	3.13	3.13	3.13	3.13	3.13	3.12	3.12	3.12
130	3.12	3.12	3.11	3.11	3.11	3.11	3.11	3.10	3.10	3.10
140	3.10	3.10	3.10	3.09	3.09	3.09	3.09	3.09	3.08	3.08
150	3.08	3.08	3.08	3.07	3.07	3.07	3.07	3.07	3.06	3.06
160	3.06	3.06	3.06	3.05	3.05	3.05	3.05	3.05	3.04	3.04
170	3.04	3.04	3.04	3.04	3.03	3.03	3.03	3.03	3.03	3.02
180	3.02	3.02	3.02	3.02	3.01	3.01	3.01	3.01	3.01	3.00
190	3.00	3.00	3.00	3.00	3.00	2.99	2.99	2.99	2.99	2.99
200	2.98	2.98	2.98	2.98	2.98	2.98	2.97	2.97	2.97	2.97
210	2.97	2.96	2.96	2.96	2.96	2.96	2.95	2.95	2.95	2.95
220	2.95	2.95	2.94	2.94	2.94	2.94	2.94	2.93	2.93	2.93
230	2.93	2.93	2.93	2.92	2.92	2.92	2.92	2.92	2.92	2.91
240	2.91	2.91	2.91	2.91	2.90	2.90	2.90	2.90	2.90	2.90
250	2.89	2.89	2.89	2.89	2.89	2.88	2.88	2.88	2.88	2.88
260	2.88	2.87	2.87	2.87	2.87	2.87	2.87	2.86	2.86	2.86
270	2.86	2.86	2.86	2.85	2.85	2.85	2.85	2.85	2.84	2.84
280	2.84	2.84	2.84	2.84	2.83	2.83	2.83	2.83	2.83	2.83
290	2.82	2.82	2.82	2.82	2.82	2.82	2.81	2.81	2.81	2.81
300	2.81	2.81	2.80	2.80	2.80	2.80	2.80	2.80	2.79	2.79
310	2.79	2.79	2.79	2.79	2.78	2.78	2.78	2.78	2.78	2.78
320	2.77	2.77	2.77	2.77	2.77	2.77	2.76	2.76	2.76	2.76
330	2.76	2.76	2.75	2.75	2.75	2.75	2.75	2.75	2.74	2.74
340	2.74	2.74	2.74	2.74	2.73	2.73	2.73	2.73	2.73	2.73
350	2.73	2.72	2.72	2.72	2.72	2.72	2.72	2.71	2.71	2.71
360	2.71	2.71	2.71	2.70	2.70	2.70	2.70	2.70	2.70	2.70
370	2.69	2.69	2.69	2.69	2.69	2.69	2.68	2.68	2.68	2.68
380	2.68	2.68	2.67	2.67	2.67	2.67	2.67	2.67	2.67	2.66
390	2.66	2.66	2.66	2.66	2.66	2.66	2.65	2.65	2.65	2.65
400	2.65	2.65	2.64	2.64	2.64	2.64	2.64	2.64	2.64	2.63
410	2.63	2.63	2.63	2.63	2.63	2.62	2.62	2.62	2.62	2.62
420	2.62	2.62	2.61	2.61	2.61	2.61	2.61	2.61	2.61	2.60
430	2.60	2.60	2.60	2.60	2.60	2.60	2.59	2.59	2.59	2.59
440	2.59	2.59	2.59	2.58	2.58	2.58	2.58	2.58	2.58	2.58
450	2.57	2.57	2.57	2.57	2.57	2.57	2.57	2.56	2.56	2.56
460	2.56	2.56	2.56	2.56	2.55	2.55	2.55	2.55	2.55	2.55
470	2.55	2.54	2.54	2.54	2.54	2.54	2.54	2.54	2.53	2.53
480	2.53	2.53	2.53	2.53	2.53	2.52	2.52	2.52	2.52	2.52
490	2.52	2.52	2.52	2.51	2.51	2.51	2.51	2.51	2.51	2.51
500	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.50	2.49	2.49
Depth (m)	0	10	20	30	40	50	60	70	80	90
600	2.38	2.37	2.36	2.34	2.33	2.32	2.31	2.30	2.29	2.28
700	2.27	2.26	2.25	2.24	2.23	2.22	2.21	2.20	2.20	2.19
800	2.18	2.17	2.16	2.15	2.15	2.14	2.13	2.13	2.12	2.11
900	2.10	2.10	2.09	2.09	2.09	2.08	2.07	2.06	2.06	2.05
1000	2.05	2.04	2.04	2.03	2.03	2.03	2.02	2.02	2.01	2.01
1100	2.01	2.00	2.00	2.00	2.00	1.99	1.99	1.99	1.99	1.99
1200	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98
1300	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.98	1.99	1.99
1400	1.99	1.99	1.99	2.00	2.00	2.00	2.00	2.01	2.01	2.01
1500	2.02	2.02	2.03	2.03	2.03	2.04	2.04	2.05	2.05	2.06

TABLE 2. Summary statistics of trawl geometry parameters for the Campelen 1800 shrimp trawl used by the FRV *W. Templeman* and FRV *Teleost* during the 1995 autumn groundfish surveys.

Trawl Rig	Variable	Number of Observations	Mean	CV (%)	Min.	Max.
Templeman/Old doors	Depth	272	161.9			
	Doors	269	37.2	14	12.4	47.6
	Wings	280	14.6	13	6.4	21.5
	Opening	267	5.1	14	0.0	10.1
	Bridle Angle	266	13.3	14	1.2	18.8
Templeman/New doors	Depth	169	285.4			
	Doors	169	48.9	13	16.1	56.4
	Wings	167	17.1	9	12.5	22.8
	Opening	161	4.4	13	3.5	7.6
	Bridle Angle	161	19.2	15	7.4	22.6
Teleost (<615m)	Depth	111	298.8			
	Doors	103	51.4	11	21.7	63.1
	Wings	104	16.7	12	10.4	24.0
	Opening	104	4.1	14	3.3	6.4
	Bridle Angle	94	20.5	12	6.0	26.1
Teleost (86–1200 m)	Depth	139	418.6			
	Doors	140	53.0	13	21.7	72.6
	Wings	137	17.0	12	10.4	24.0
	Opening	142	4.1	15	2.2	6.4
	Bridle Angle	126	21.5	15	6.6	31.8

TABLE 3. Results of the Kruskal-Wallis one way analysis of variance on Campelen trawl geometry parameters measured during the 1995 autumn surveys by the FRV *W. Templeman* and FRV *Teleost*. Because each parameter in the analysis was highly significant (p <0.001) only the Pairwise Comparisons, using the Dunn method, are presented for the *W. Templeman* data using old trawl doors; the *W. Templeman* data using new doors and for the *Teleost* data for depths less than 615 m.

Parameter	Comparison	Diff. of ranks	Q	P <0.05
Doors	*Teleost*/*W. Templeman*–old doors	268.7	14.8	yes
	Teleost/*W. Templeman*–new doors	48.6	2.5	yes
	W. Templeman–old doors/new doors	220.2	14.3	yes
Wings	*Teleost*/*W. Templeman*–old doors	182.3	9.9	yes
	Teleost/*W. Templeman*–new doors	30.5	1.5	no
	W. Templeman–old doors/new doors	212.9	13.8	yes
Opening	*Teleost*/*W. Templeman*–old doors	242.8	13.7	yes
	Teleost/*W. Templeman*–new doors	67.5	3.5	yes
	W. Templeman–old doors/new doors	175.3	11.4	yes
Bridle Angle	*Teleost*/*W. Templeman*–old doors	271.1	15.0	yes
	Teleost/*W. Templeman*–new doors	62.0	3.2	yes
	W. Templeman–old doors/new doors	209.1	13.9	yes

Towing speeds

Figure 8 shows the towing speeds used onboard the *W. Templeman* and the *Teleost*. The *W. Templeman* has a doppler speed log in addition to the GPS, while the *Teleost* has only the GPS. The 1995 survey protocols states that towing speeds are to be recorded using the GPS and data logged onto a deck sheet by the bridge officers every 3 minutes

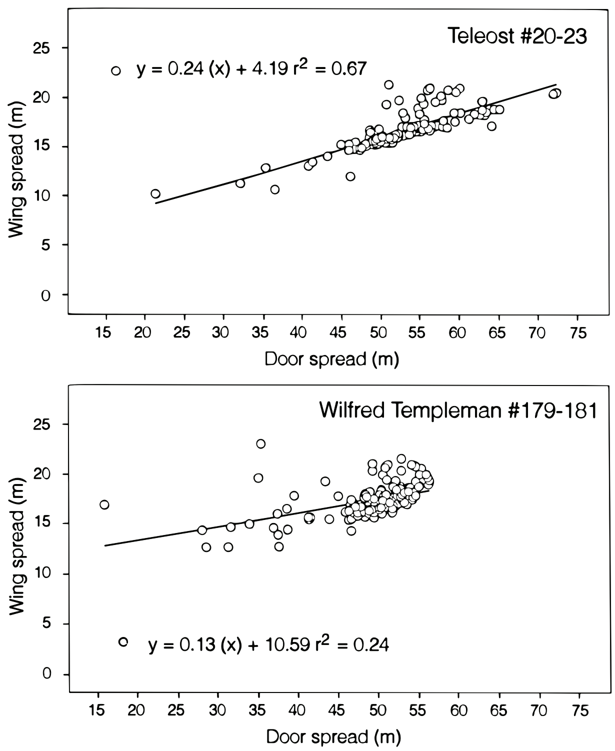


Fig. 3. Relationship between wing spread and door spread for the *Teleost* and *W. Templeman* survey trawls.

(see Appendix II). The doppler speed log data were recorded by SeaTrawl at 5 second intervals. During the *W. Templeman* survey, the towing speeds ranged from 2.2 to 4.2 knots in both the GPS and doppler speed logs, however the GPS logged average tow speed ($\bar{x}$ = 3.2 knots) was higher than the doppler speed log ($\bar{x}$ = 2.9 knots).

A comparison of the GPS towing speeds recorded by hand by the bridge officers on both vessels shows that the range of speeds were similar and there was little difference in average towing speeds ($\bar{x}$ = 3.1 to 3.2 knots). Average speeds were very close to the desired target speed of 3.0 knots.

Tow duration

There were two sources of data to examine tow duration: one from SCANMAR and the other from the trawl mounted CTD. In the *W. Templeman* data, the average recorded tow duration was slightly higher using the CTD ($\bar{x}$ = 15.7 min; CV = 8%) when compared to SCANMAR ($\bar{x}$ = 15.1 min; CV = 10%). Similarly, in the *Teleost* data the average tow duration was higher using the CTD ($\bar{x}$ = 15.3 min; CV = 16%) when compared to the SCANMAR data ($\bar{x}$ = 15.1 min: CV = 8%).

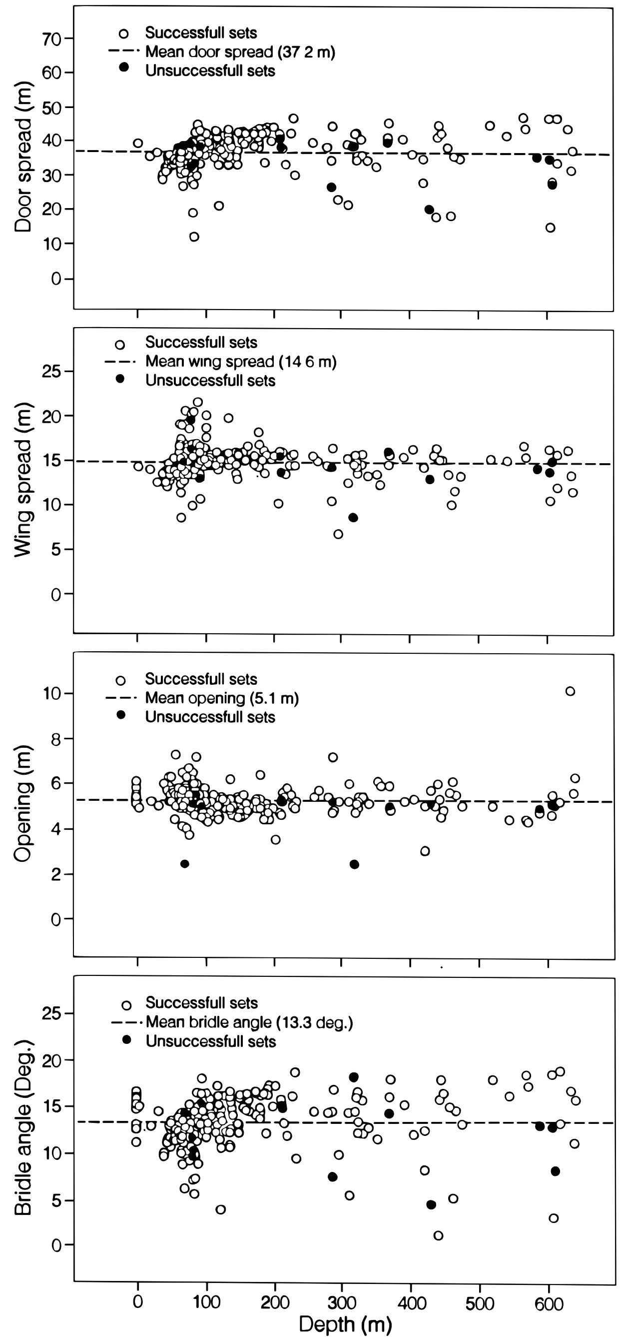


Fig. 4. Relationship of *W. Templeman* (old doors) door spread, wing spread, opening and bridle angles with depth.

Figure 9 shows a plot of the differences of tow duration (CTD-SCANMAR) for both vessels. Although the mean differences of both vessels were relatively similar, the *W. Templeman* data were more variable (CV = 328%) than the *Teleost* (CV = 191%). This higher variability was probably related to the frequent reporting of difficulty in determining bottom

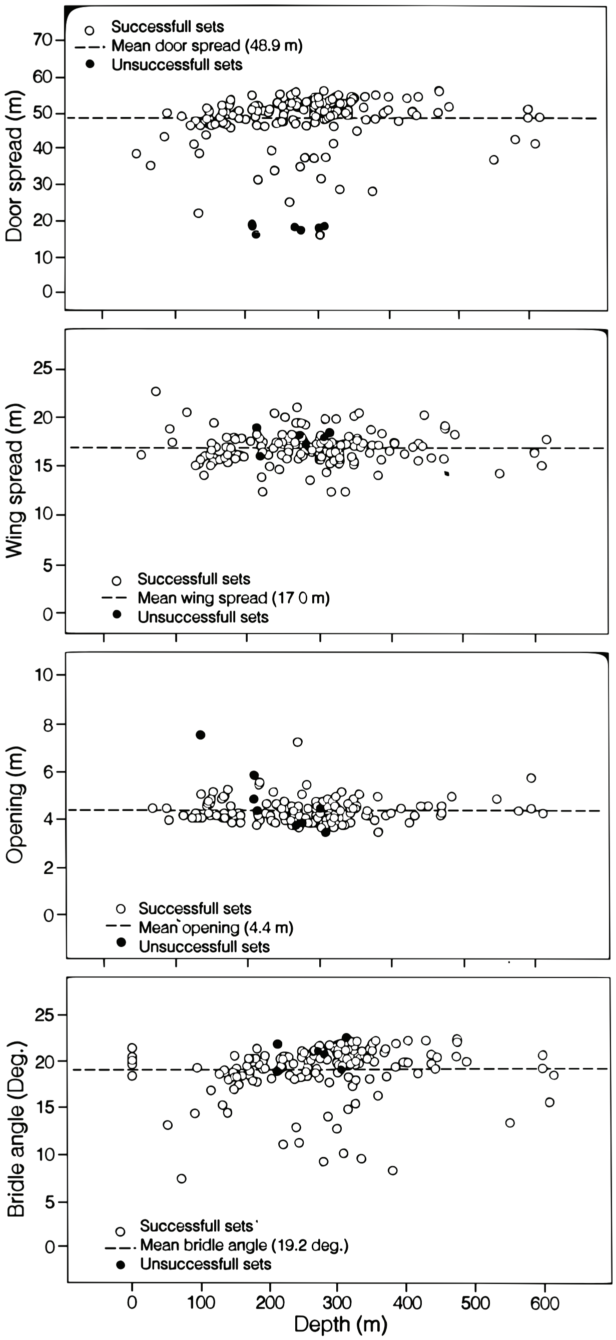


Fig. 5. Relationship of *W.Templeman* (new doors) door spread, wing spread, opening and bridle angle with depth.

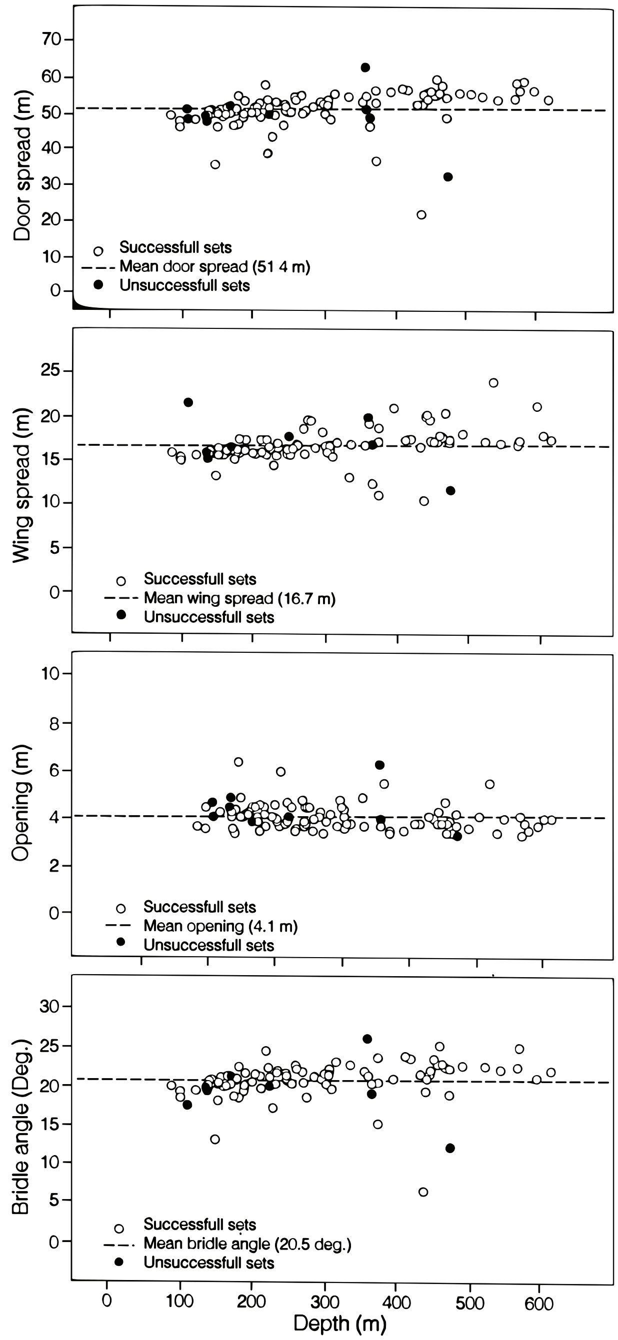


Fig. 6. Relationship of *Teleost* door spread, wing spread, opening and bridle angle for depths less than 600 m.

touchdown and achieving trawl lift off onboard the *W. Templeman*.

Conclusions

The use of SCANMAR acoustic trawl instrumentation and standardized fishing protocols on all groundfish surveys has helped minimize variation in towing speeds, bottom contact, tow duration and malfunctioning (bad) tows on board both survey vessels. The active use of SCANMAR to determine touchdown eliminates those "water tows" due either to the trawl never touching bottom

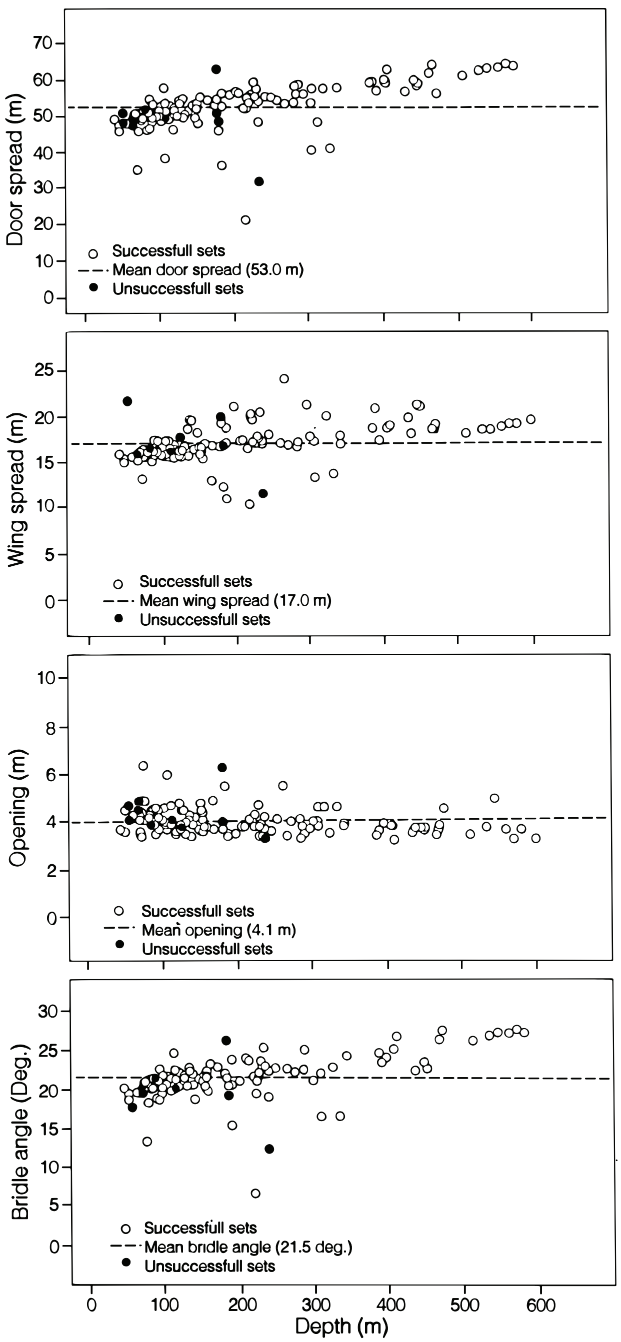


Fig. 7. Relationship of *Teleost* door spread, wing spread, opening and bridle angle for depths to 1 200 m.

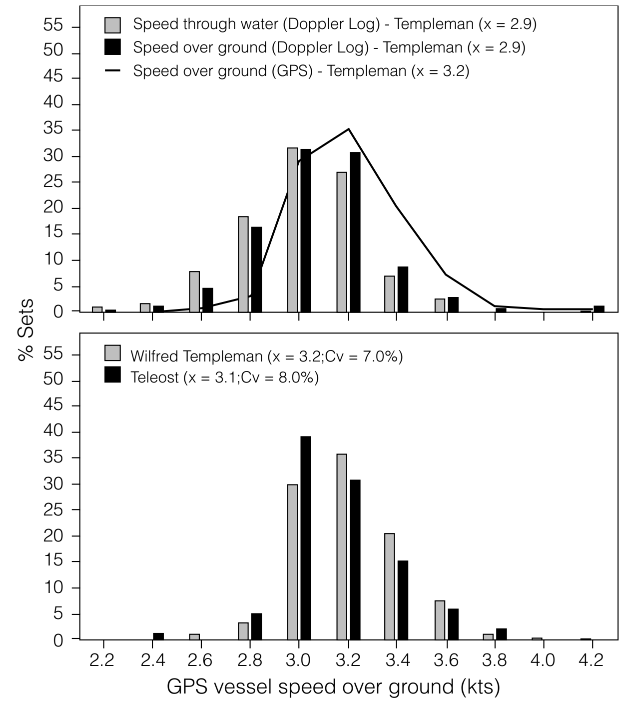


Fig. 8. Frequency distribution of *Teleost* and *W. Templeman* towing speed observations.

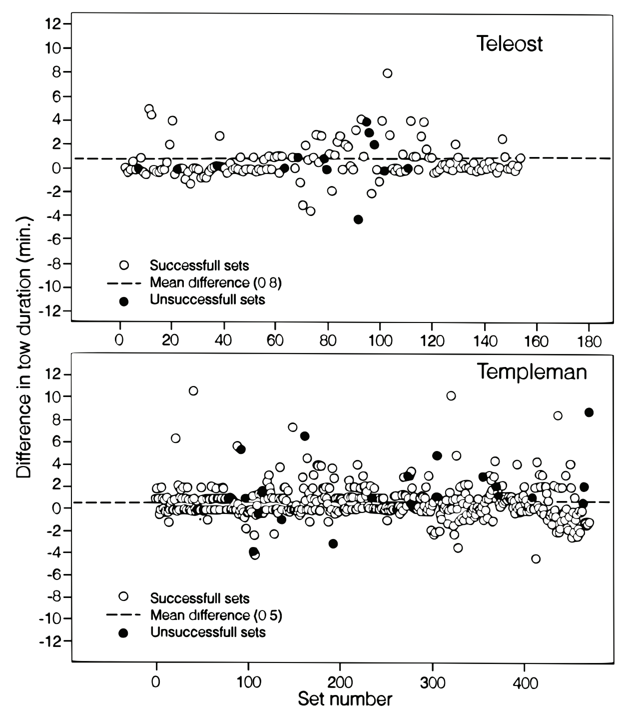


Fig. 9. Differences in tow duration (CTD-Seatrawl) between the CTD and Seatrawl.

(deep water) or being on bottom for only part of the tow. Lack of fishing sets in deep water by the *W. Templeman* precludes some comparisons of data with the *Teleost*. This will be resolved during the 1996 surveys.

Caution is required in the interpretation of conclusions about fishing power of both trawls due to the fact that the trawl data were recorded during different times and on different grounds.

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Appendix 1. Shipboard Guidelines for the Use of SCANMAR in Determining Bottom Contact/Lift Off

New survey protocols adopted for use on FRV *Teleost* and FRV *Wilfred Templeman* require in part that a survey tow begins once the trawl has touched the bottom and ends at lift off approximately 15 minutes later. Gear geometry, i.e. wingspread, doorspread, headline height and depth, are to be monitored throughout the tow. SCANMAR instrumentation can be used to reliably determine trawl touchdown and liftoff during a survey tow.

In general it is best to use a combination of the depth sensor and the trawl sounder to determine the trawls position in the water column and relative to the bottom. The trawl sounder will determine trawl opening i.e. distance from headline to footgear, and clearance, i.e. distance from footgear to the bottom but is limited to a 150 m range. It is therefore best to follow the trawls progress down through the water column with the depth sensor. During sinking a properly configured gear will yield doorspreads from 40 to 60 m, wingspreads from 12 to 20 m and an opening from 4 to 7 m. As the gear comes within 100 m of the bottom the trawl sounder will begin to indicate footrope clearance which will steadily decrease as the trawl falls toward the seabed. A clearance of 0.0 m or "touchdown" should not be taken as the trawl being on bottom but rather the first indication of a decrease in headline height as the trawl settles after the touchdown signal.

End the tow by "flying" the trawl off bottom. This is achieved by increasing the towing speed to a maximum allowable under the present conditions and hauling back. Experience with the Campelen on *Teleost* has shown that in water depths less that 500 m it takes approximately 1minute to get the trawl off bottom and up to 3 minutes in water over 1 000 m. This can vary with weather conditions and tow direction. Liftoff is initially determined by an increase in clearance and then confirmed by a decreasing depth.

SCANMAR depth sensors come in two versions, rated for depths to 600 m or 1 200 m. Both sensors when correctly calibrated are limited to an accuracy of ± 1% of full scale or ± 6 m and ± 12 m, respectively. Because of this limitation and the fact that the trawl is not immediately underneath the vessel the depth sensor should not be referenced with the vessel's sounder to determine bottom contact.

Appendix 2. Standardization of Survey Procedures

1. **Measure survey gear**
    - before leaving port or before first fishing set of trip
    - after every major tear-up
2. **Scope ratio**
    - strict adherence to new scope ratio
    - record amount of warp out for very tow
3. **Speed of tow**
    - 3 knots – always use GPS
    - bridge officer to record actual speed every 3 minutes in new log
4. **Duration of tow**
    - 15 minutes, record actual value in set details.
    - bottom contact determined by SCANMAR – bridge officer to record start and end times, as well as sink time in new log
    - power lift-off around 14 minute mark (varies with depth)
    - tows less than 10 minutes are not valid
    - for tows were SCANMAR signals are not received, use sink times from previous tows in similiar depths to estimate bottom contact
5. **Direction of tow**
    - towards next station when possible
    - along contour on slope
    - in high winds tow is made with or against the wind
    - in high cross currents, alter course to tow into or with the current
6. **Untrawlable bottom**
    - search for good bottom, if unavailable use alternate tow
    - if untrawlable areas are known prior to survey, exclude from selection
7. **Gear damage and repeat criteria**
    - tows less than 10 minutes
    - severe damage to large sections of lower wings, bellies and codends
    - broken bridles, groundropes and footgear
    - two of more tears comprising 20% of the meshes in that panel
    - anything that impairs the fishing effeciency of the trawl
    - no SCANMAR sensors working at the beginning – usually indicates foul gear
    - if full gear lost then drag for trawl – obtain lost position from SCANMAR
8. **Selection of starting position**
    - one mile from station – shoot towards station
9. **Bottom topography**
    - use RoxAnn seabed profiler