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Performance of the Campelen 1800 Shrimp Trawl During the Northwest Atlantic Fisheries Centre 1995 Fall Groundfish Surveys

by

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Introduction

Bottom trawls are used in ocean environments to measure abundance, distribution and 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 during construction, repairs, deployment and retrieval and actual fishing practices could increase bias and 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 distributors over the years (Walsh and McCallum 1995). Complete standardization of trawl riggings, procurement, repairs and construction and fishing practices have been recently enforced at NWAFC through 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 for each vessel, 2) a Fishing Gear Checklist, and 3) a Quality Control Program which regulates procurement, construction and repairs (see McCallum and Walsh 1995 and Walsh and McCallum 1995 for details).

Trawl geometry and performance can vary from haul to haul and increase the variation around catchability. The use of trawl 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 1987; Engås 1994; Walsh and McCallum 1995). At NWAFC, the monitoring of trawl geometry and performance by use of SCANMAR acoustic trawl monitoring sensors attached to the fishing gear have proven valuable in measuring and reducing variability in trawl performance.

In 1995, NWAFC 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 fall surveys trawl performance data was recorded using SCANMAR acoustic trawl monitoring instruments. This paper presents a preliminary analysis of the performance of the Campelen 1800 shrimp trawl used in the 1995 fall surveys by both offshore research vessels: *R. V. Teleost and R.V. 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 equipped with a 35.6 m rockhopper footrope composed of 355 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 Figs. 1 and 2). A 7.0 m long knotless nylon liner of 12.5 mm mesh size was used in the codend.

Standardization Efforts

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

SCANMAR hydroacoustic trawl instrumentation was used onboard both vessels for each fishing set to measure trawl opening, door spread, and wing spread. All data were automatically logged at 5 second intervals using the NWAFC SeaTrawl data acquisition software (McCallum & Walsh 1995). The start of each fishing set was determined when SCANMAR indicated the trawl had touched down on the seabed. Tow duration was approximately 15 minutes at a towing speed of 3.0 knots as determined by 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 random and towards the next fishing station. Acoustic noise in the trawl performance data was 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 are used to remove SCANMAR generated duplicates and spikes from the data set.

At each fishing station the scope ratio (trawl warp length /fishing depth) was determined from the new NWAFC Scope Ratio list developed in July 1995 (unpubl. data) and the correct amount of trawl warps were deployed to achieve and maintain stable bottom contact of the trawl doors.

Bridle angles (Θ) for each Campelen trawl onboard both research vessels 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 half of the *W. Templeman's* survey, the fishing officers complained that the trawl doors were unstable in shallow water using the towing speed of 3.0 knots. This was not a problem onboard the *Teleost* which uses doors of the same dimensions, i.e. surface area and weight but are made by a different manufacturer. A decision was made to used the *Teleost* trawl doors on the *Templeman* Trip #179 and a door stability log sheet, recording position of shine on door shoes and mud deposit, was filled in after each tow. Based upon these results and the SCANMAR recordings and advice of fishing crew the *Teleost* doors were used on the last two legs of the survey and the problem seems to have been 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 *Templeman* data was analysed to look at differences in geometry and performance separately.

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.

A Kruskal-Wallis One Way ANOVA was used to test for significant difference in trawl geometry parameters.

Results and Discussion

Geometry

Table 2 presents the summary statistics for mean geometry values for the various combinations of the Campelen survey trawl used in the fall survey: the Templeman with old doors, 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.

Templeman - Table 2 shows the mean door spread and wing spread was 24 % and 14% higher when the old doors were replaced by the new doors from the *Teleost*. As expected the trawl opening also decrease with the increased spread with the new doors. Table 3 shows that these differences in geometry derived from using different trawl doors are 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 *Templeman data* (new doors), and all bottom depths out to 1200 m. Although there was no significant difference in wing spread ($\bar{x}$ = 17.0 m for *Templeman* and 16.7 m for *Teleost)*, at comparable depths, there was a significant difference in door spread ($\bar{x}$ = 48.8 m for *Templeman*, 51.4 m and *Teleost* respectively) and trawl opening ($\bar{x}$= 4.4 m, 4.1 m, respectively) (Table 3). This relationship holds true if we use all of depth data from the *Teleost* and compare it with the *Templeman*.

Figure 3 shows the regression of wing spread on door spread for the Teleost and the W. Templeman trawls. There is no significant relationship between these parameters in the Campelen trawl used onboard the Templeman. However, this is not the case for the Campelen used in the *Teleost* surveys where the regression and the intercept are highly significant *($p < 0.001$)*. A significant intercept indicates that wing spread is not directly proportional to door spread and the two measures of spread cannot be used interchangeably to calculate swept area estimates.

Performance

Figures 4 to 7 show the influence of fishing depth on trawl performance.

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 the results with the new doors. There is 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, Engel 145 otter trawl, used onboard the W. Templeman (Walsh and McCallum 1995).

Teleost - Figures 6 & 7 show the results of door spread, wing spread, trawl opening and bridle angles at two depth categories: less than 615 m and 86 to 1200 m. Door spread showed an increase with bottom depth beyond 615 m which accounts for the mean wing spread being somewhat higher. Preliminary analysis of fishing the Campelen trawl from depths of 48 to 1200 m onboard the Gadus Atlantica showed a highly significant relationship between door spread and bottom depth (Walsh and McCallum 1996).

Templeman-Teleost (Same Doors)- Examination of trawling performance of the Campelen trawl in the less than 615 m depths shows the door spread to be slightly more variable in particular for depths less than 400 m on the *W. Templeman* when compared to the *Teleost*. Table 3 shows that there is a statistically significant difference in door spreads in both trawls. There are several reasons for this difference, chief among them could be differences in bottom sediment type and bottom currents which affect door spread and overall performance of the gears. Walsh and McCallum (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 unless done so in a comparative fishing experiment. However, as seen in Table 2, average bridle angles of both trawls are very close in agreement, but statistically different at the 0.05 level due to the correlation between bridle angles and door spread. These similarities in bridle angles (19-21°) at comparable depths could indicate a similarity in sweep herding efficiency of fish. The bridle angle increases with depth in the *Teleost* and further survey work by the Templeman in deep water is necessary to see if these relationships hold together.

Towing speeds

Figure 8 shows the towing speeds used onboard the Templeman and the Teleost. The 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. The doppler speed log data is recorded by SeaTrawl at 5 second intervals. During the Templeman survey, the towing speeds ranged from 2.2 to 4.2 kt. in both the GPS and doppler speed logs, however the GPS logged average tow speed ($\bar{x}$ = 3.2 kt) was somewhat higher than the doppler speed log ($\bar{x}$ = 2.9 kt).

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

Tow duration

There are two sources of data to examine tow duration :1) from SCANMAR and 2) the trawl mounted CTD. Table 3 shows the summary statistics for the on-bottom times of the trawl as measured by both systems for each vessel. In the 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%).

Figure 9 shows a plot of the differences of tow duration (CTD-SCANMAR) for both vessels. Although the mean differences of both vessels are relatively close the Templeman data is more variable (CV=328%) than the Teleost (CV=191%). This higher variability is probably related to the reported difficulty in determining bottom touchdown and achieving trawl lift off onboard the Templeman.

Conclusions

The use of SCANMAR acoustic trawl instrumentation and standardized fishing protocols on all groundfish surveys has help mimimize variation in towing speeds, bottom contact, tow duration and malfunctioning (bad) tows. The active use of SCANMAR to determine touchdown eliminates those "water tows" due either to the trawl never touching bottom or on bottom only for part of the tow in deep waters as reported for the old standard trawl (Engel) (Walsh and McCallum). Lack of fishing sets in deep water with the Wilfred Templeman precludes the comparisons of data with the Teleost. This will be resolved in the 1996 surveys.

Caution is insisted when interpretating conclusions about fishing power of both trawls due to the fact that the trawl data was recorded during different times and on different grounds.

Acknowledgements

We are indebted to the crews of the FRVs *Teleost* and *Wilfred Templeman* whose dedication and assistance permitted the surveys to be a success. Special thanks to the NWAFC scientific staff who assisted in technical operations and Mick Veitch who assisted in pre-cruise SCANMAR operations.

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Table 1. 1995 NWAFC scope ratios used onboard the RV. W. Templeman and RV Teleost to stnadardized 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	3.26
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	2.96	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	2.08	2.07	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 RV. W. Templeman and RV. Teleost during the 1995 fall groundfish surveys.

Trawl Rig	Variable	No. Obs.	$\bar{x}$	CV (%)	Min.	Max.
Temp/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
Temp./New doors	Depth	169	285.4			
	Doors	169	48.8	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	4.0	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 fall surveys by the RV. W. Templeman and RV Teleost. Since the analysis for each variable was highly significant *($p<0.001$)* only the Pairwise Comparisons based on the Dunn method for the Templeman data using old trawl doors; Templeman using new doors and Teleost (in depths less than 615 m) are presented.

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

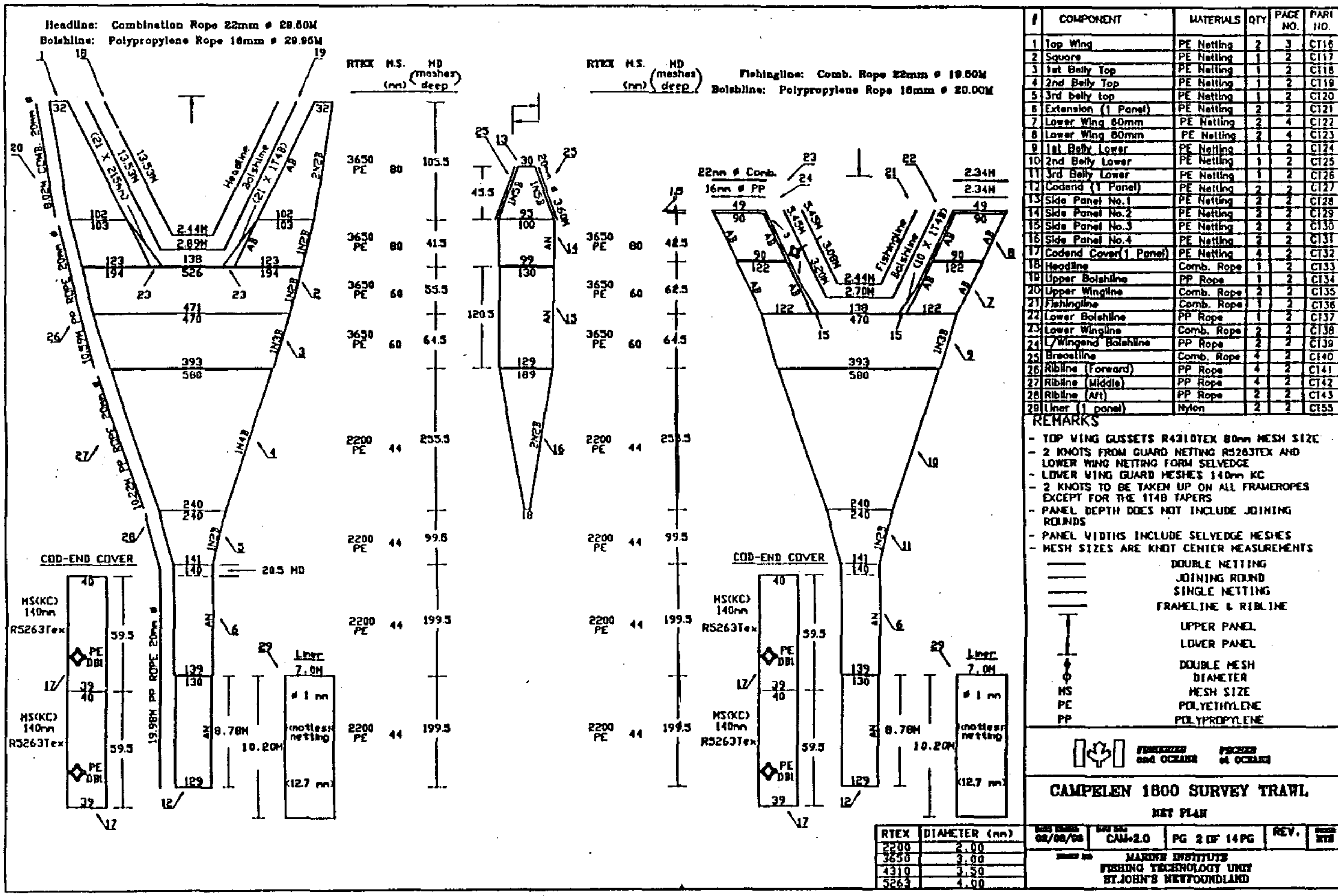
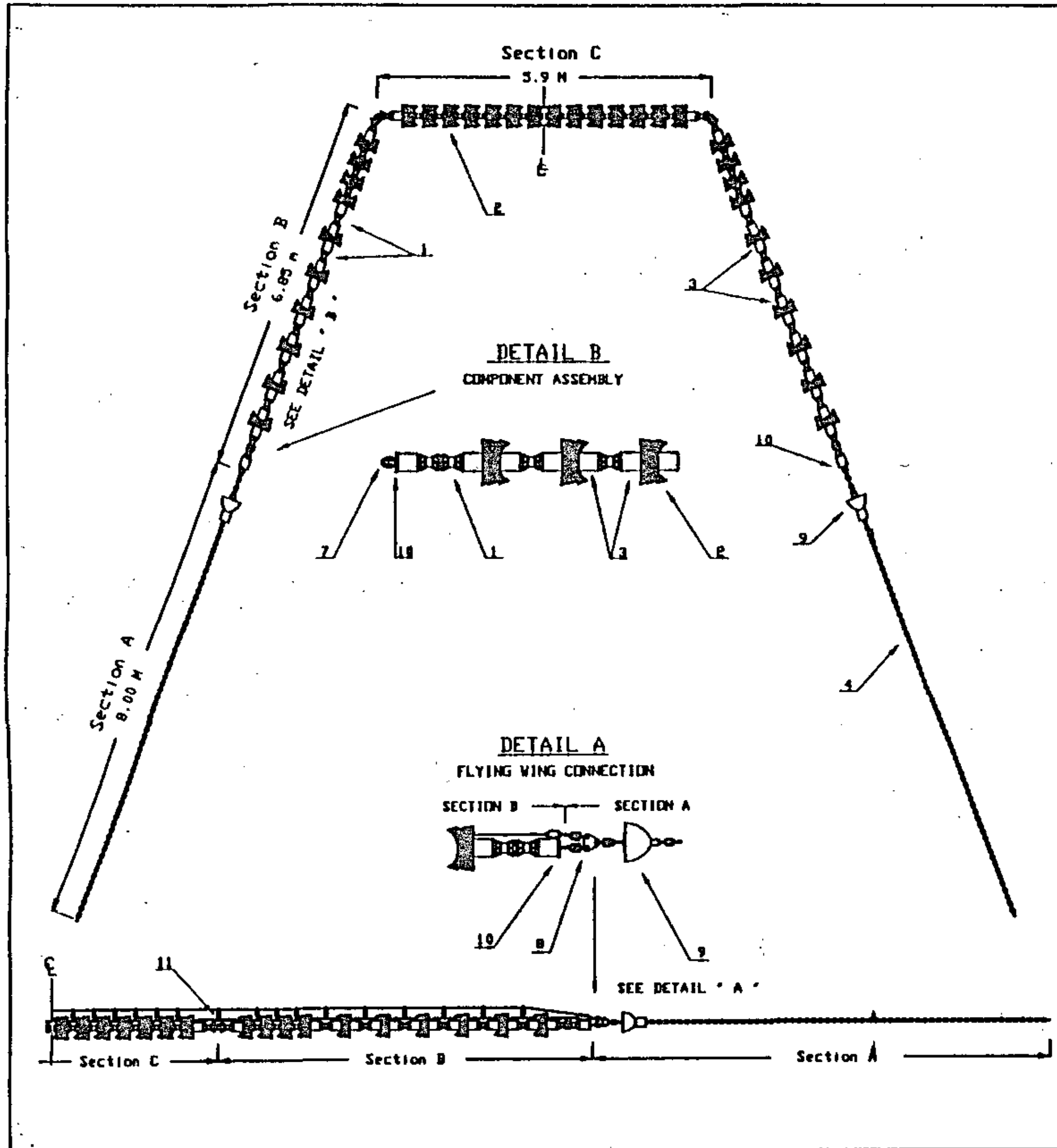


Fig. 1 Trawl plan of the Campelen 1800 survey trawl.



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) UNIT	TOTAL	NUMBERS TOTAL	SECT. A	SECT. B	SECT. C	Page NO.	PART NO.
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" (178MM) Rubber Spacer	0.43	14.62	34	2X1	2x15	1x2	10	CT46
4	5/8" (16mm) Mid Link Chain	4.96/M	74.30	14.98	2x7.49m				CT12
5	5/8" (16mm) Mid Link Chain	4.96/M	66.96	13.5m		2x6.75m			CT13
6	5/8" (16mm) Mid Link Chain	4.96/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						

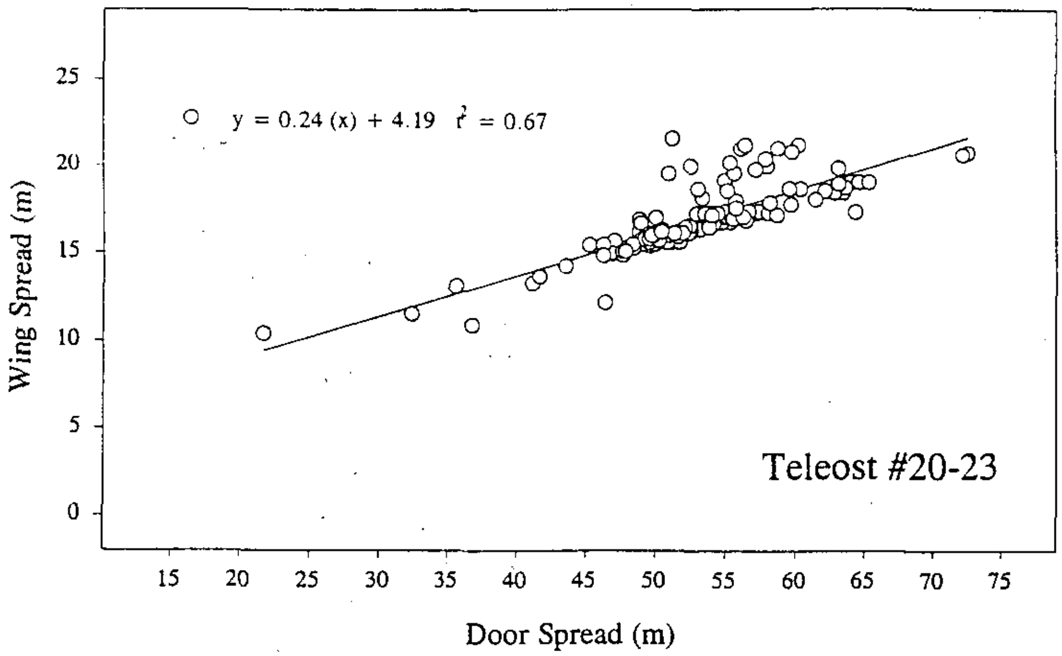
Fisheries and Oceans / Pêches et Océans

CAMPELEN 1800 SURVEY TRAWL
GROUND GEAR

02/08/93 | CAM-3.0 | 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.



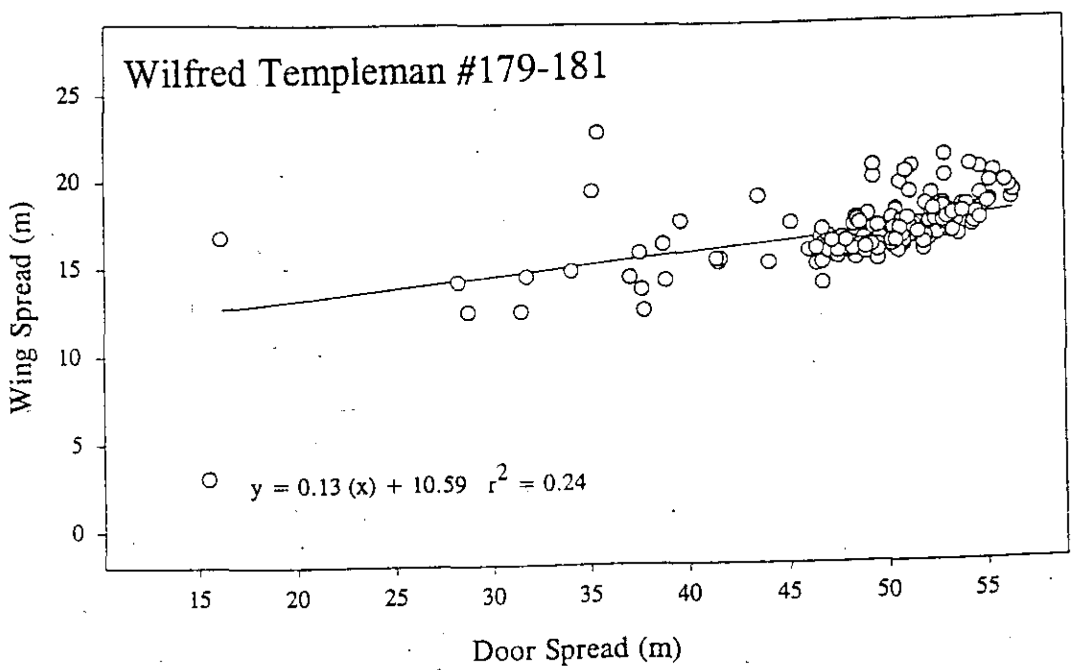


Fig. 3 Relationship between wing spread and door spread for the Teleost and Wilfred Templeman trawls.

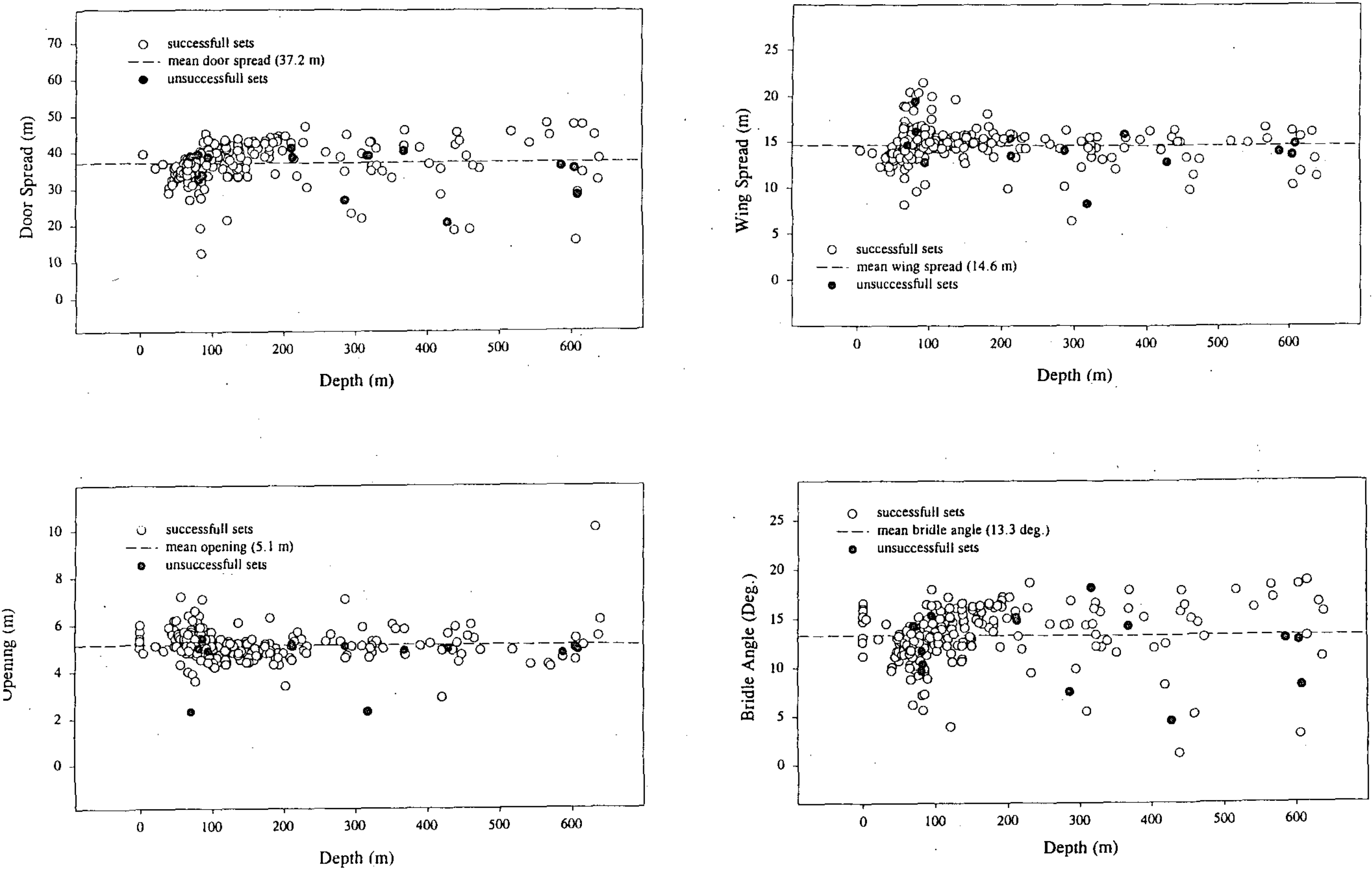


Fig. 4 Relationship of Wilfred Templeman (old doors) door spread, wing spread, opening and bridle angle with depth.

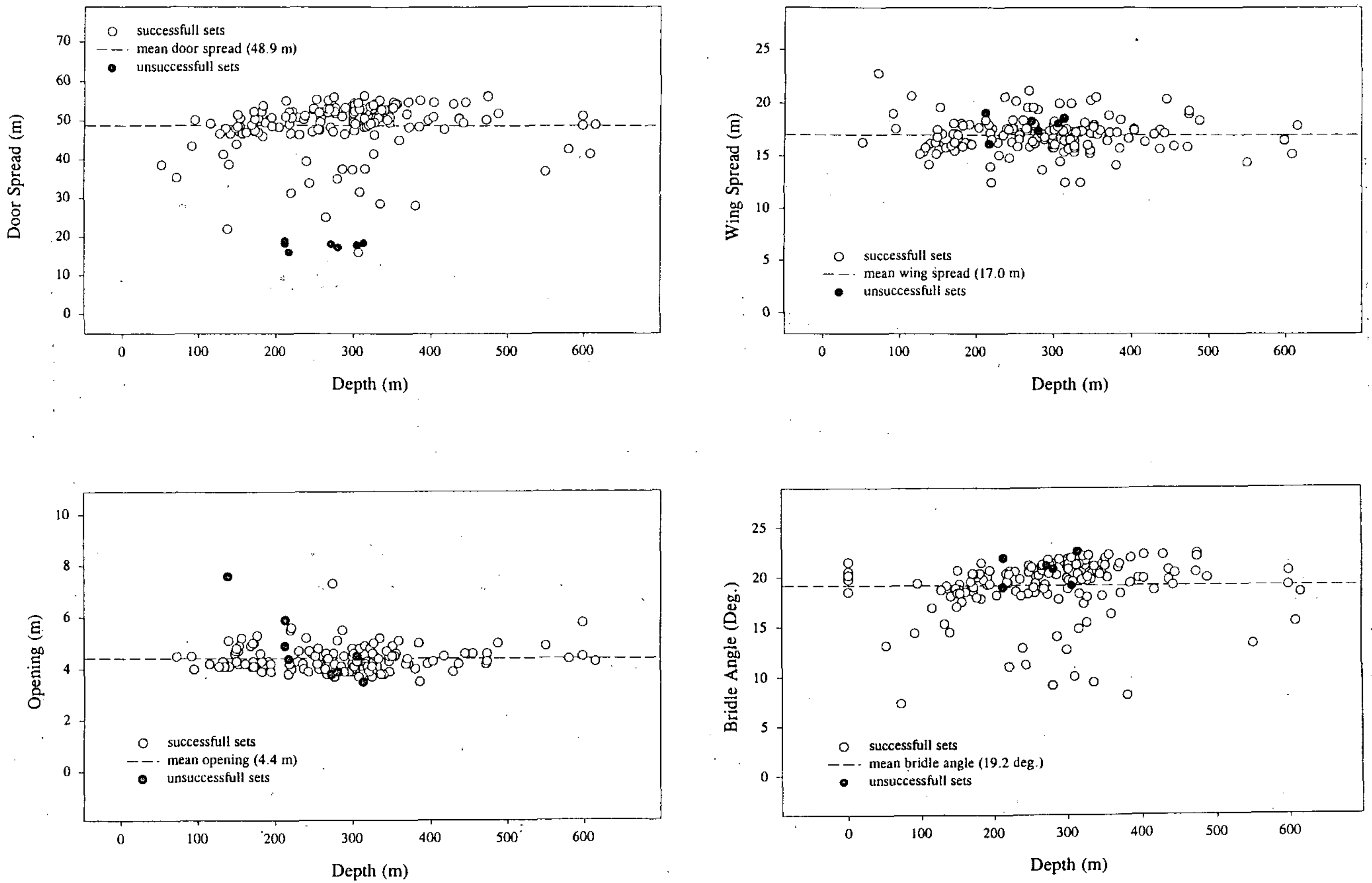


Fig. 5 Relationship of Wilfred Templeman (new doors) door spread, wing spread, opening and bridle angle with depth.

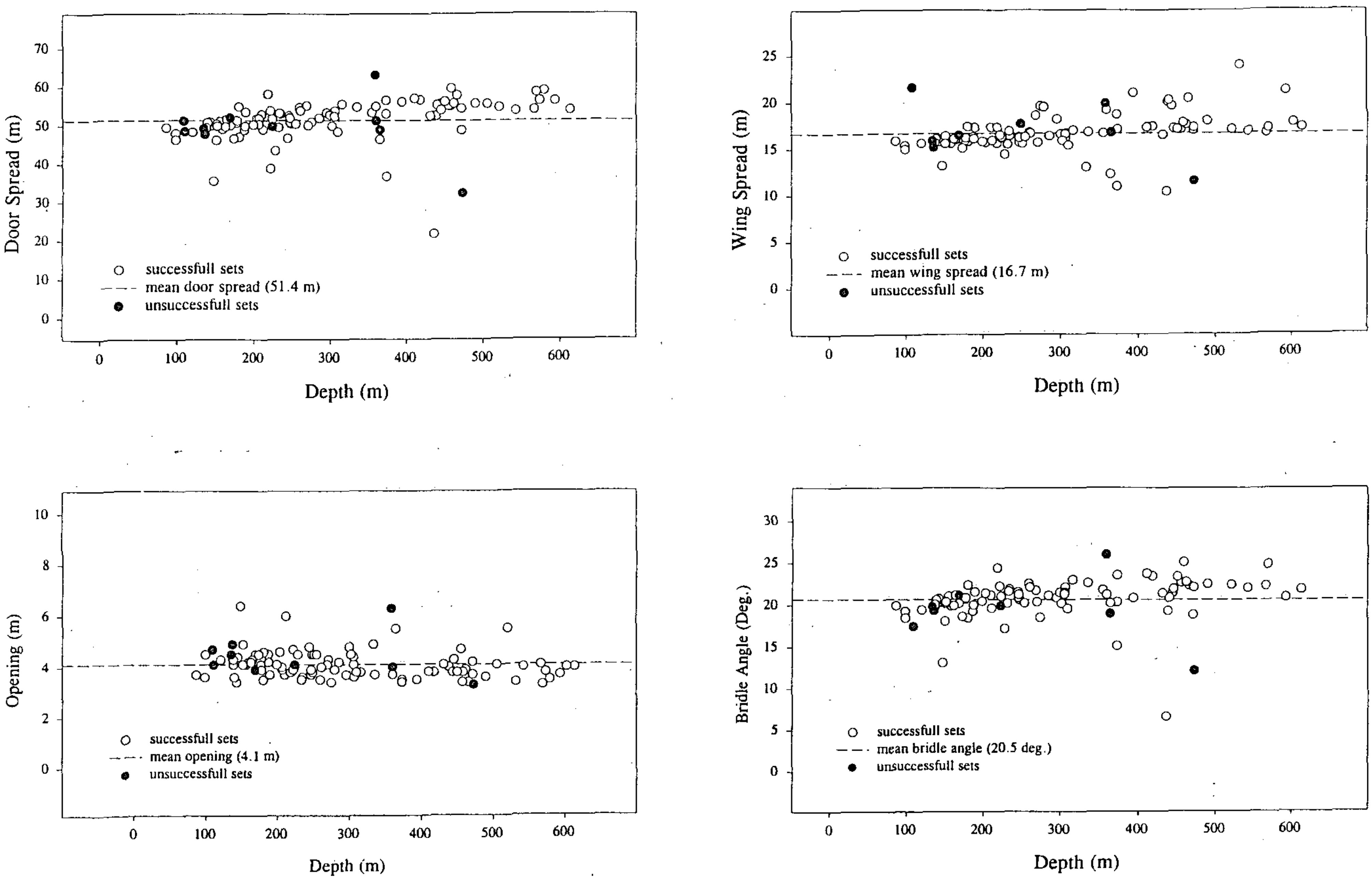


Fig. 6 Relationship of Teleost door spread, wing spread, opening and bridle angle for depths less than 600 m.

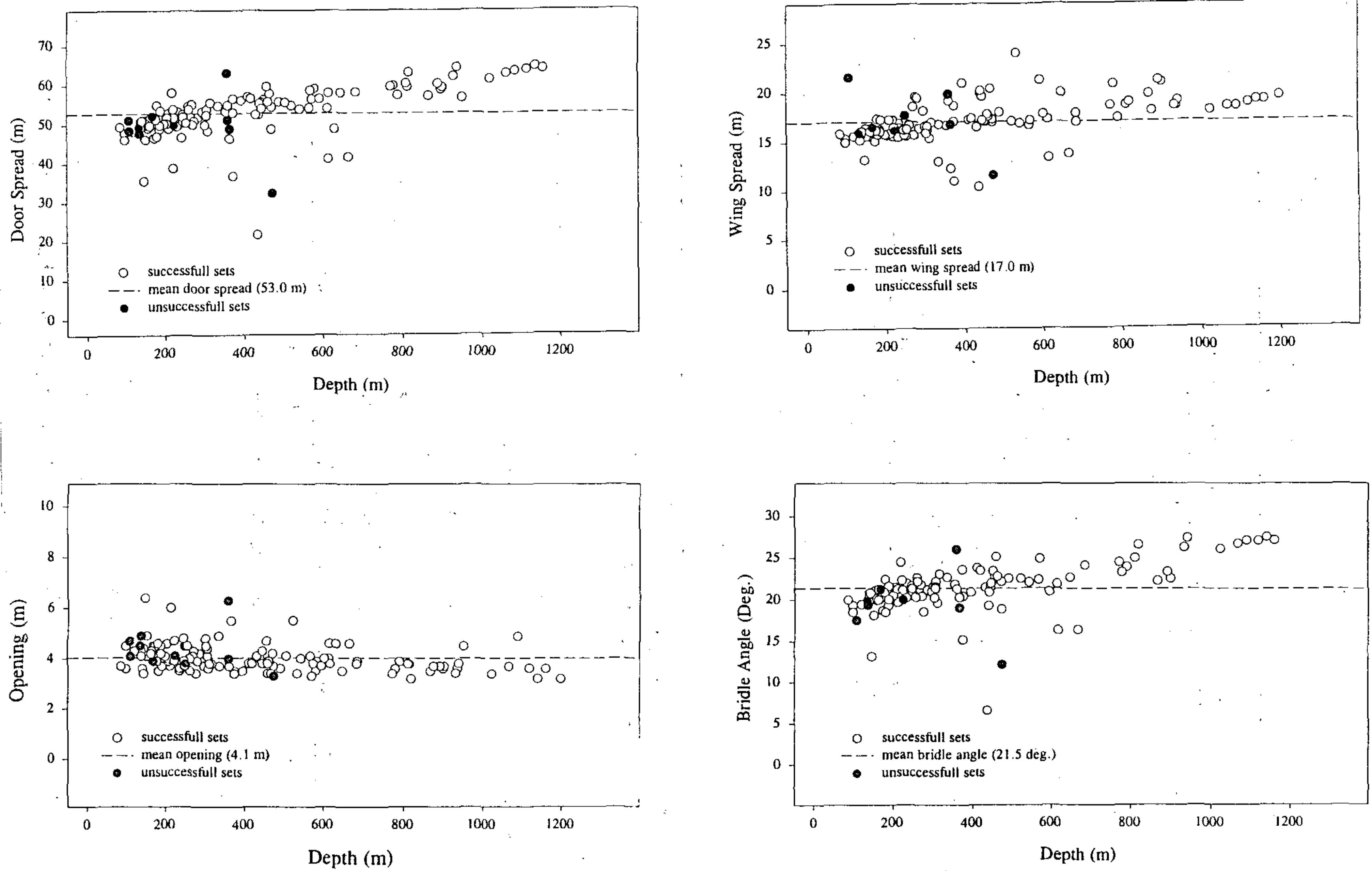
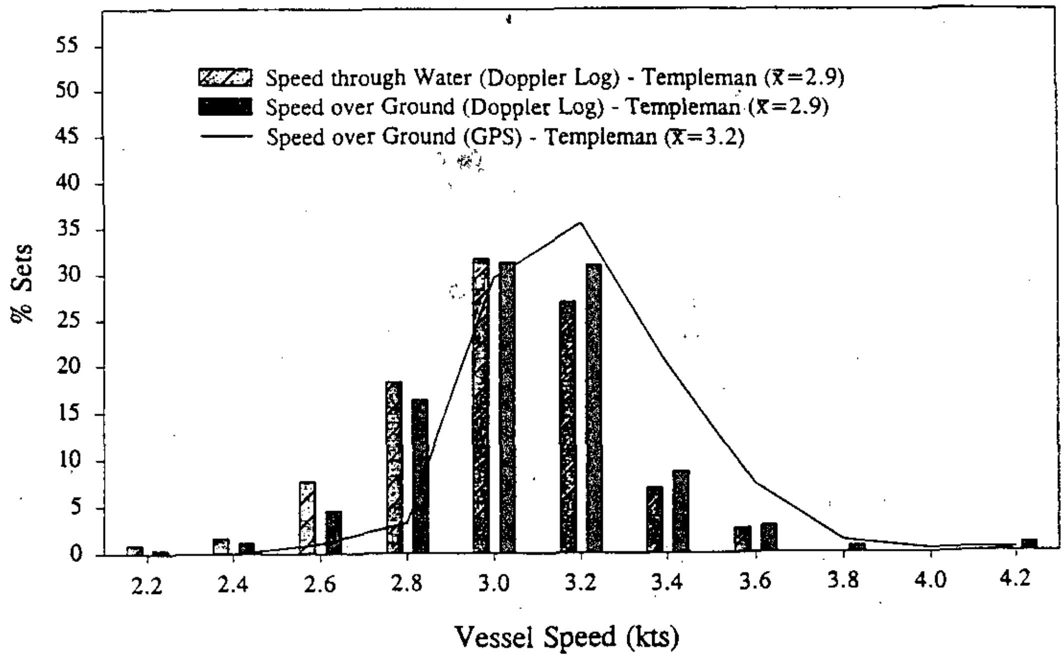


Fig. 7 Relationship of Teleost door spread, wing spread, opening and bridle angle for depths to 1200 m.



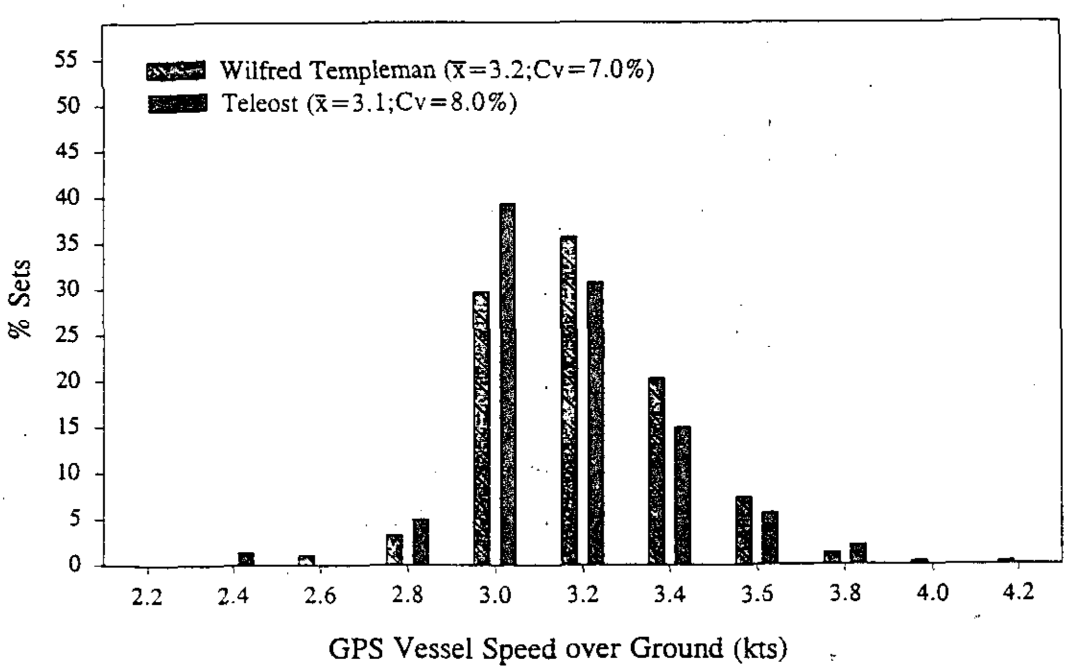
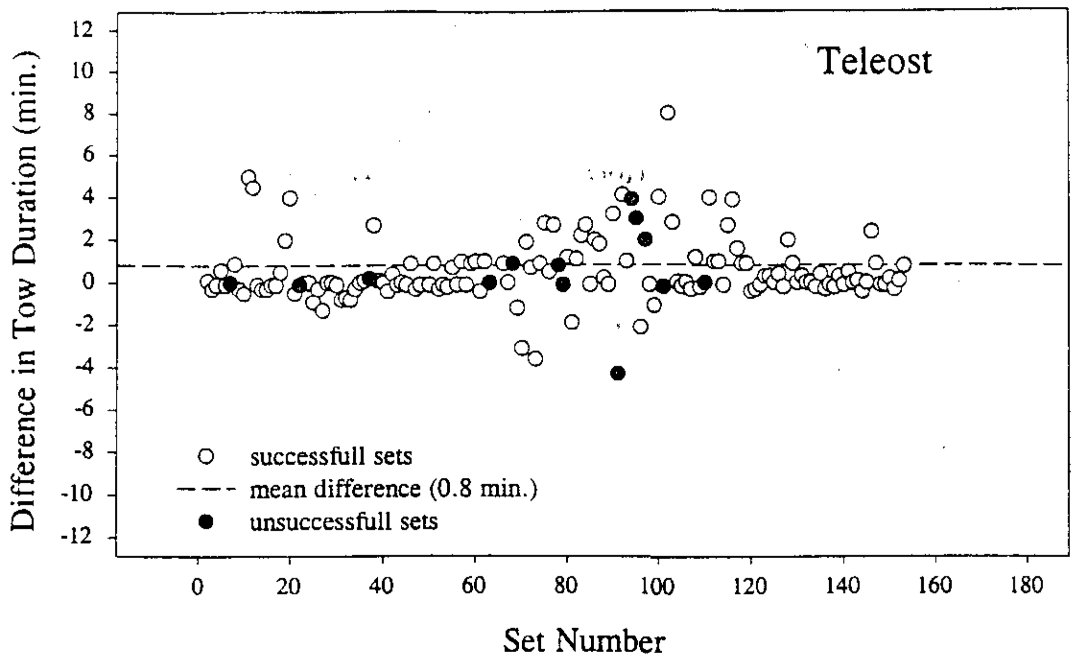


Fig. 8 Frequency distribution of Teleost and Wilfred Templeman towing speed observations



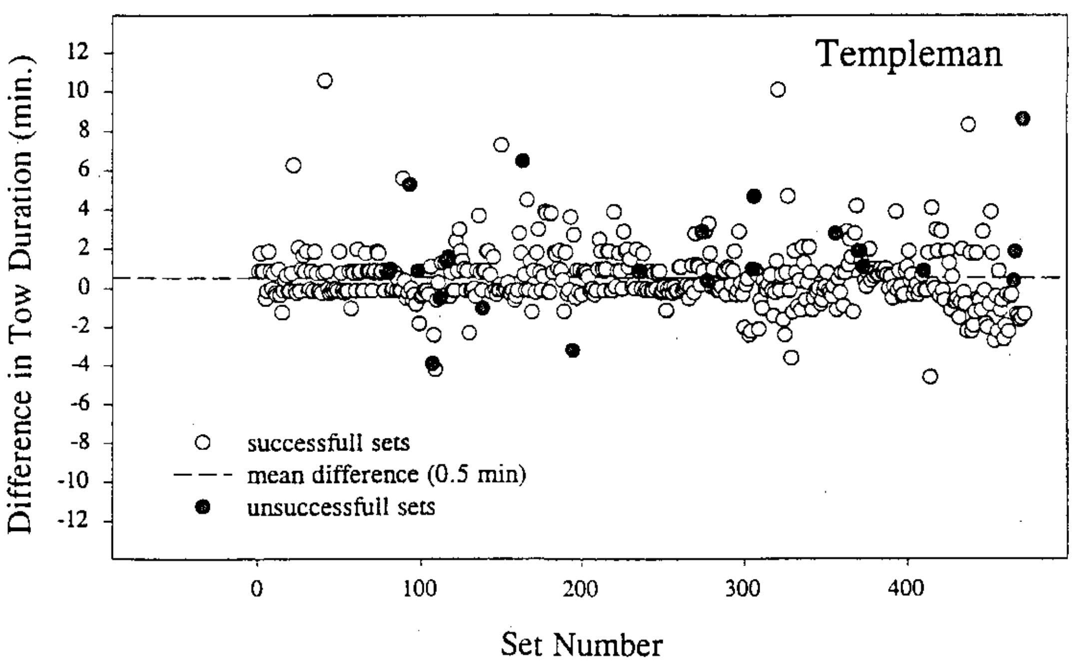


Fig. 9 Difference in tow duration (CTD-Seatrawl) between the CTD and Seatrawl.