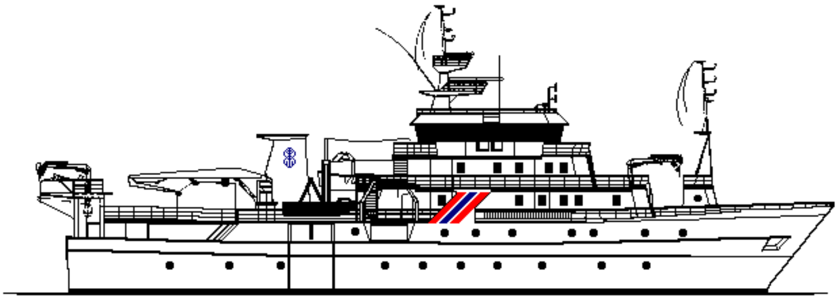

BENEFIT SURVEYS

Preliminary Cruise Report No 6/2001

EFFECTS OF BRIDLE LENGTH ON CATCH RATES OF HAKE
17 August – 1 September 2001

by
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1. INTRODUCTION

Objective

The main objective of the cruise was to collect information of the effect of different sweep lengths on the catch rates and length composition of hake.

The swept area of a trawl haul is a crucial parameter in swept area survey methodology, particular if the survey is meant to estimate total biomass of the stock and not just give an annual index. Most fish species are herded towards the net mouth area by the doors, sand clouds and sweeps/bridles, thus the effective swept area is larger than the net opening. The swept area for a fixed door spread, however, varies with different species and size groups. During the Dr. "Fridtjof Nansen" hake bottom trawl surveys a swept width of 18.5 m was used, slightly less than the wingspread of the trawl (approximately 22 m). Experiments carried out in Namibian and South African waters in 2000 indicated herding for hake, especially for larger fish, but the extent of it was highly variable between the working areas (cruise report no 2/2000). The reason for the difference is unknown but it was speculated that the oxygen level could have an important influence, since oxygen was the only measured environmental factor that varied significantly between the different areas. In order to establish a better understanding of the main factors controlling herding in hake, a new set of experiments were carried out in one area in Namibian waters with low oxygen level and in one area in South African waters with comparatively higher oxygen level.

Participation

The scientific staff consisted of the following:

From Namibia:

Titus Iilende, Espen Johnsen, John Kathena, Peter Schneider, Shaun Wells.

From South Africa:

Ralton Maree

From Norway:

Arill Engås, Terje Jørgensen, Tore Mørk, Ingvald Svellingen

Narrative

17 September	Departure Walvis Bay
29 September	Arrival Cape Town

2. MATERIAL and METHODS

Bridle length comparisons

The trawling experiments comparing different sweep lengths, 40 m and 100 m, were carried out off the coast of Namibia (area A) and South Africa (area B) (Figure 1a and b). The water depth was 370 m in area A and 470 m in area B. The seabed in the worked area in Namibian waters was classified from the echo-recordings to be softer than the working area in South African waters.

The standard sampling trawl, Gisund super (Figure 2a, b) used by “Dr. Fridtjof Nansen” for hake and 7.9 m^2 Thyborøn doors were used. The trawl was fished with door-spread restriction consisting of a 10 m rope between the warps 140 m in front of the doors to ensure stable door and wing spreads and to prevent the trawl from being overspread (Figure 3a, c).

The standard rigging of the survey trawl with 40 m bridles is shown in Figure 3a. The same rigging of the 100 m bridles was used as during the experiments in 2000, i.e. with bridles going all the way forward to the trawl doors (Figure 3b, c). A slightly higher (4.9 vs. 4.7 m) vertical trawl opening was obtained with this rigging compared to standard rigging.

In order to obtain approximately the same bridle angle with the two different riggings, the restrictor rope (10 m) was moved to a position 270 m in front of the doors when the 100m bridles were used (Figure 3 b).

The two bridle lengths were compared by alternate hauls. The duration of a tow was ½ h at a speed of 3 knots. The first trawl haul of the day was shot approximately at 0730 h, and the last at 1600h. All hauls of a pair were carried out in the same area, with towing direction the same. All trawl hauls were monitored by SCANMAR trawl sensors (door spread, wing spread, vertical opening and symmetry of the trawl). In addition, the distance of the restrictor rope from seabed when mounted 140 and 270 m in front of the trawl doors was measured. The warp length to depth ratio was from 2.5 to 3 depending on depth.

During all hauls a Simrad PI 30, mounted on the centre of the fishing line, was used to monitor bottom contact of the trawl.

Hydrography and meteorology

CTD stations were carried out in both working areas, early morning and late afternoon except for the two last days in working area B when CTD stations were done more frequently. Temperature, salinity, oxygen and light were measured. Two Niskin bottles were triggered for water samples on each station, one near the bottom (approximately 5 m from the bottom) and one near the surface (5 m depth). The oxygen content was determined using the Winkler method. Wind (speed and direction), air temperature, and sea surface temperature (5 m depth) were logged automatically throughout the cruise using an Aanderaa meteorological station and light intensity was recorded with a Li-Cor 1000.

Behavioural studies

A scanning sonar (FS 3300) was mounted on the centre of the headline during 2 hauls in area A (station number 1041 and 1055) and during one haul in area B (station number 1065) to record the position of fish in the net mouth area. Aggregation of fish within a particular area of the net mouth can indicate that hake respond to stimuli, i.e. that they are not caught by solely a passive sieving process

In addition, during three trawl hauls in area A (station number 1029, 1036 and 1048) and two hauls in area B (station number 1060 and 1070), a self-recording camera unit using artificial light was mounted in the net mouth area to observe the behaviour of fish in the area.

3. RESULTS

Area A

Trawl performance

An overview of the measured trawl geometry for the two riggings is given in Table 1. The ratio between the measured door-spreads, i.e., door-spread with long bridles divided by door-spread with short bridles, was approximately 1.6. The sweep angle with both bridles was calculated to be approximately 17-18 degrees. Based on measurements of the distance of the restrictor rope above seabed, the warp angle was estimated at approximately 18-20 degrees both with the restrictor rope 140 and 270 m in front of the trawl doors (assuming no sag of the warp).

Table 1.Trawl geometry measurement.

Bridle length (m)	Door spread (m)	Wing spread (m)	Vertical opening (m)
40	54	22	4.7
100	87	22	4.9

The Simrad PI 30 bottom sensor showed that the trawl lost bottom contact during some hauls, but only few times and for very short periods (Figure 4).

Comparison of catches

A total of 26 hauls (13 pairs) were taken in this area. Hakes made up the bulk of the catches (Appendix). Average catch rates were 200 kg for M. capensis and 100 kg for M. paradoxus. A plot of catch rates versus the time of the day when the haul was made did not reveal any clear diel pattern but a large variation between hauls (Figure 5).

The catch of M. capensis consisted mainly of fish in the size range 40-80 cm while the M. paradoxus comprised of fish in the range 20-40 cm (Figures 6 and 7). The size distributions of fish of a given species did not differ significantly between the two hauls of a pair.

The ratio of catch with 100 m bridles to that with 40 m bridles is plotted in Figure 8. The median value for the pairwise observations was 1.64 for M. capensis and 1.01 for M.

paradoxus (Table 2). Ratios were also calculated separately for each 5 cm length interval (Figure 9). No trend was found for the three size classes of M. paradoxus. For M. capensis the lowest size class (40-45 cm) had a considerably lower ratio than the larger size classes but otherwise no apparent trend was seen.

Table 2. Summary statistics for the calculated catch ratios in area A.

Species	Mean	Median	25% quantile	75% quantile	Range
M. capensis	1.63	1.64	1.07	1.84	0.92-3.34
M. paradoxus	1.11	1.01	0.75	1.41	0.33-2.77

Behavioural studies

With the catch consisting nearly of 100 % hake during the two hauls using the scanning sonar, we can be fairly sure that it was hake we observed by the scanning sonar. The main aggregation of fish was found to be in the central lower part of the trawl (Figure 10). A picture of the screen is presented in Figure 11. Few observations were made closer than 1 m from the headline. These observations indicated that the slightly higher vertical opening of the trawl with 100 m long bridles should not affect the comparisons.

Only during for station number 1029 was the visibility good enough to observe fish behaviour. More than 95 % of the catch during this haul consisted of the two hake species. The video observations clearly showed that fish (probably hake) did react to the approaching trawl. Most fish were observed close to the bottom and would react to the approaching footrope by initially swimming away from it in a zigzag pattern and then trying to look for a way to escape when they where overtaken by the trawl. In many cases it seemed like the hake managed to escape under the footrope. The video footage was however not clear enough to give an estimate of the percentage of fish that did manage to escape under the footrope. To what extend the use of artificial light affected the natural behaviour towards an approaching trawl is unknown.

Hydrography and meteorology

Temperature, salinity and oxygen levels within 10 m from the seabed are given in Table 3. Temperature dropped significantly during part of the sampling period, i.e. within the period with highest wind speed. A marginal decrease in salinity was observed during the same period.

Table 3. Temperature, salinity and oxygen levels approx. 10 m from the bottom in area A.

Date	Time	Station number	Temperature (°C)	Salinity	Oxygen (ml/l)
18.09.2001	15:27	731	8.71	34.87	1.19
19.09.2001	04:44	732	8.72	34.87	1.16
19.09.2001	17:32	733	8.59	34.86	1.18
20.09.2001	04:43	734	8.51	34.85	1.22
20.09.2001	16:33	735	7.42	34.77	1.41
21.09.2001	04:51	736	7.32	34.75	1.47
21.09.2001	18:12	737	7.61	34.78	1.25
22.09.2001	04:43	738	7.51	34.77	1.37
22.09.2001	16:49	739	8.16	34.84	1.24

Wind speed and sun radiation for the cruise are given in Figures 12 and current speed and direction at 315 m depth is shown in Figure 13**.**

Area B

Trawl performance

Measured trawl geometry for the two riggings was similar to the measurements obtained in area A. As in area A, the trawl lost bottom contact, but only few times and for very short periods (Figure 14).

Comparison of catches

After three days of comparative hauls with hake catches ranging between 600-2200 kg, a marked shift in fish distribution was observed on the fourth day (28 Sept) with hake catches falling to around 20 kg. The change was accompanied by significant changes in the characteristics of the water mass in the area, notably temperature (see below). Echo recordings also showed a marked change in fish distribution, with few echoes in the bottom layer after the change in water mass.

As the small hake catches were too low to make meaningful inferences regarding sweeping, only the data for the 10 hauls (5 pairs) collected during the first three days were used in the analyses.

A plot of catch rates versus the time of the day when the hauls were made indicated a diel pattern with highest catches around mid-day (Figure 15). M. paradoxus (mainly in the size range 20-40 cm) made up the bulk of the catches while catches of M. capensis was confined to a few large specimens per haul (Appendix). The size distributions of fish of a given species did not differ significantly between the two hauls of a pair (Figures 16 and 17).

The ratio of catch with 100 m bridles to that with 40 m bridles for M. capensis and M. paradoxus is plotted in Figure 8. The median value for the pairwise observations was 1.13 (Table 4). Ratios were also calculated separately for each 5 cm length interval for M. paradoxus. A plot of the values suggested a decline in ratio with increasing fish size (Figure 18).

Table 4. Summary statistics for the calculated catch ratios in area B.

Species	Mean	Median	25% quantile	75% quantile	Range
M. capensis	1.24	1.08	1.00	1.27	0.87-2.00
M. paradoxus	1.20	1.13	1.08	1.45	0.91-1.46

Hydrography and meteorology

Temperature, salinity and oxygen levels at a depth of approx. 10 m from the seabed are given in Table 5.

On the first CTD station in the morning of the 28 Sept. a marked change was observed in the characteristics of the water mass in the area. Temperature decreased throughout the entire water column, with more than two degrees at the surface and one degree at the bottom. Oxygen levels increased slightly and salinity levels decreased slightly.

Wind speed and sun radiation for the cruise are given in Figure 19 and current speed and direction in Figure 20.

Behavioural studies

Aggregation patterns observed during trawling by using the scanning sonar in Area B were similar to those observed in Area A. The majority of fish were distributed in the central, lower part of the trawl (Figure 20), with few observations within 1 metre of the headrope.

Table 5. Temperature, salinity and oxygen levels within ten meters from the bottom in area B

Date	Time	Station number	Temperature (°C)	Salinity	Oxygen (ml/l)
25.09.2001	16:40	740	6.09	34.54	4.05
26.09.2001	05:00	741	6.92	34.61	4.05
26.09.2001	15:06	742	6.93	34.61	4.02
27.09.2001	05:00	743	7.06	34.64	3.96
27.09.2001	15:17	744	6.69	34.61	4.06
28.09.2001	05:02	745	6.75	34.60	4.03
28.09.2001	07:47	746	6.04	34.54	4.08
28.09.2001	10:45	747	5.28	34.51	4.16
28.09.2001	13:30	748	5.00	34.49	4.16
28.09.2001	16:18	749	5.13	34.50	4.17
29.09.2001	05:00	750	5.04	34.48	4.28

Video observations in Area B were similar to those in Area A, showing that fish were actively responding close to the trawl gear. As observed in Area A, fish seemed to swim in a zig-zag pattern to avoid the approaching trawl. Escapement beneath the footrope was observed, but was difficult to quantify due to low visibility and the position of the camera.

4. Conclusions

The experiment was undertaken to investigate the effects of sweep length on the catch rates and catch size composition of hake in the Benguela ecosystem. Two areas, one in Namibia and the other one in South Africa were selected for the observations. The catches in Namibian waters were composed of large *M. Capensis* in the size range 40-80 cm and small *M. Paradoxus* in the size range 20-40 cm, while in South African waters the catches mainly consisted *M. Paradoxus*, the bulk fish in the size range 20-40 cm but also some larger fish up to 70 cm.

In Namibian waters a clear herding effect was found for the large *M. Capensis*, while there was no evidence for any herding of the small M. paradoxus. The results from South African waters showed no clear indication of herding for any of the size classes of M. paradoxus. The data for M. capensis was too scanty to make any inferences about herding for this species.

During the fishing experiments in South African waters, a pronounced decline in catch rates was observed from the 28 September. Catches fell from 1-2 tonnes to less than 30 kg. This change occurred at the same time as a marked change in the characteristics of the water mass in the area. The temperature dropped by almost 2 degrees Centigrade throughout the water column and oxygen levels close to the bottom increased slightly. The echo recordings showed that no fish aggregations below 250-300 meters. It is unclear if the majority of hake moved out of the area or into mid-water. Events like the one observed have a marked influence on hake distribution and its availability to the bottom trawl. If it is a regular feature in the area, it may significantly affect the stock estimates from bottom trawl surveys.

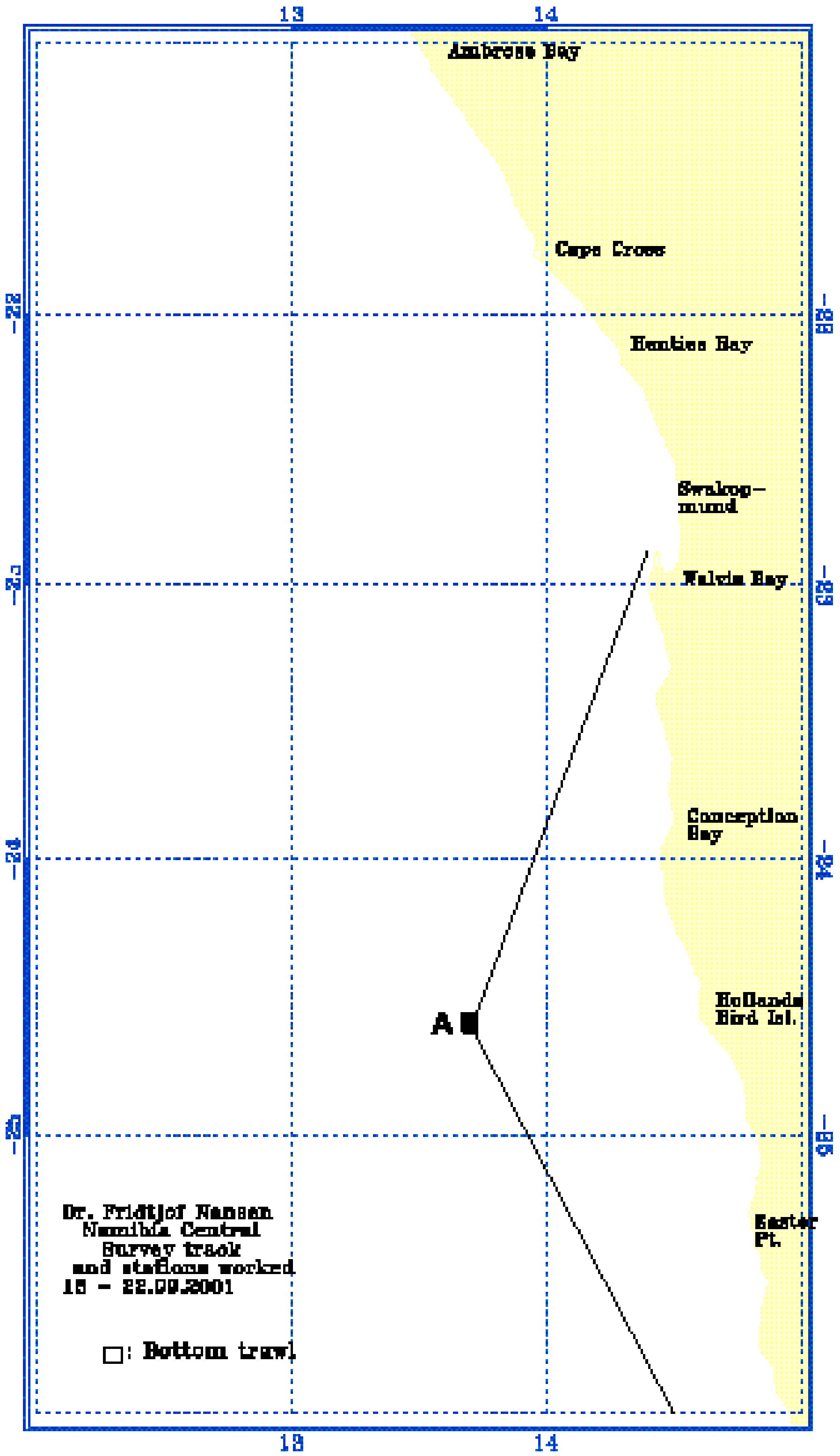


Figure 1a. Survey area A.

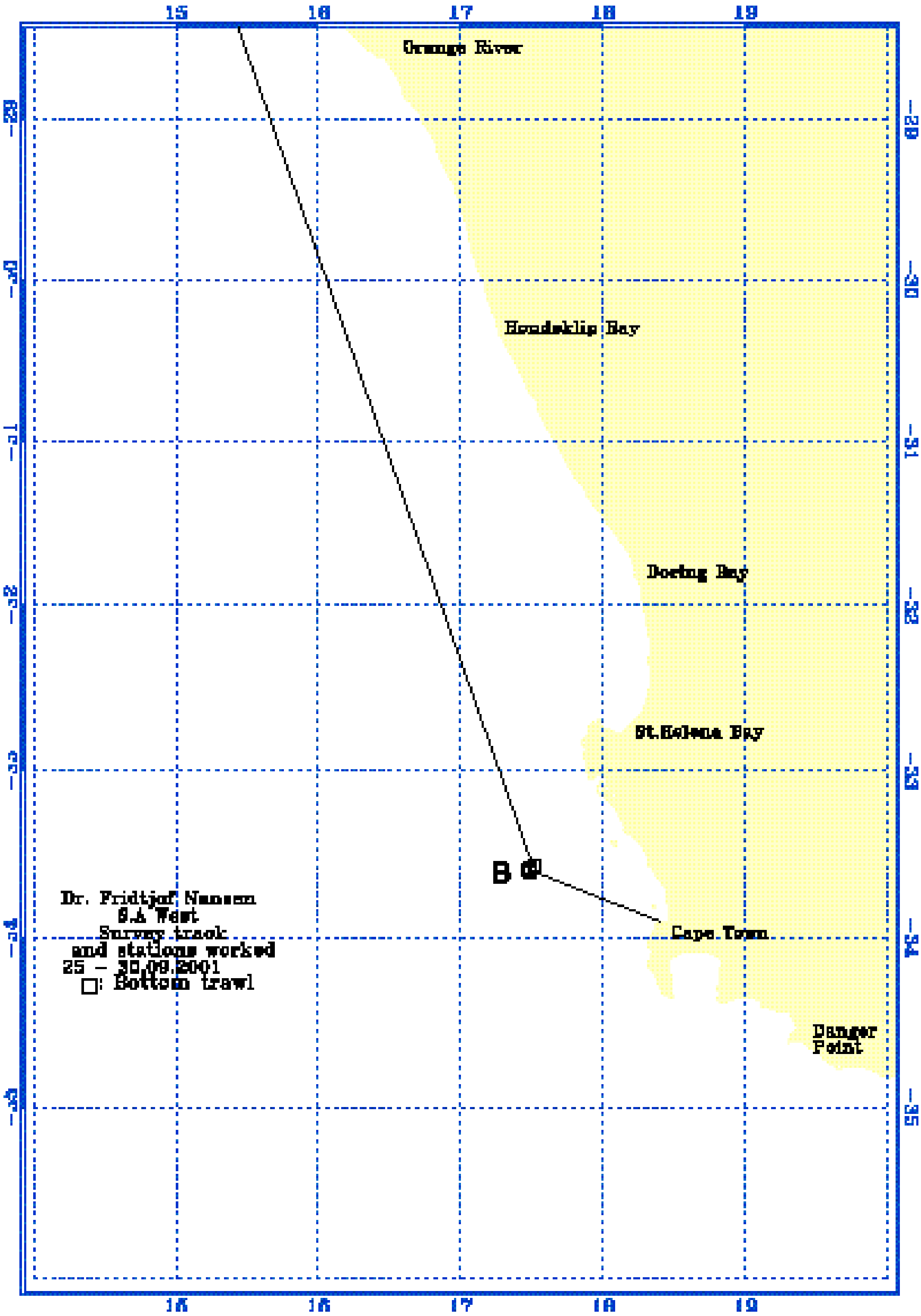
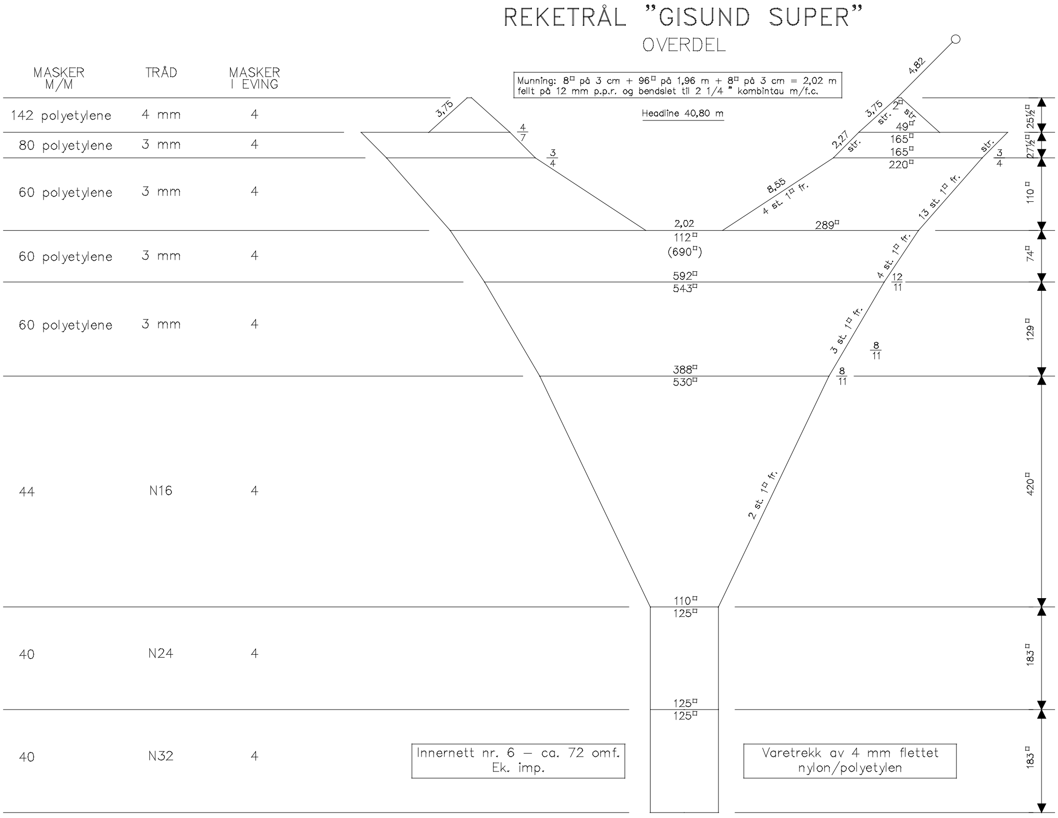


Figure 1b. Survey area B.



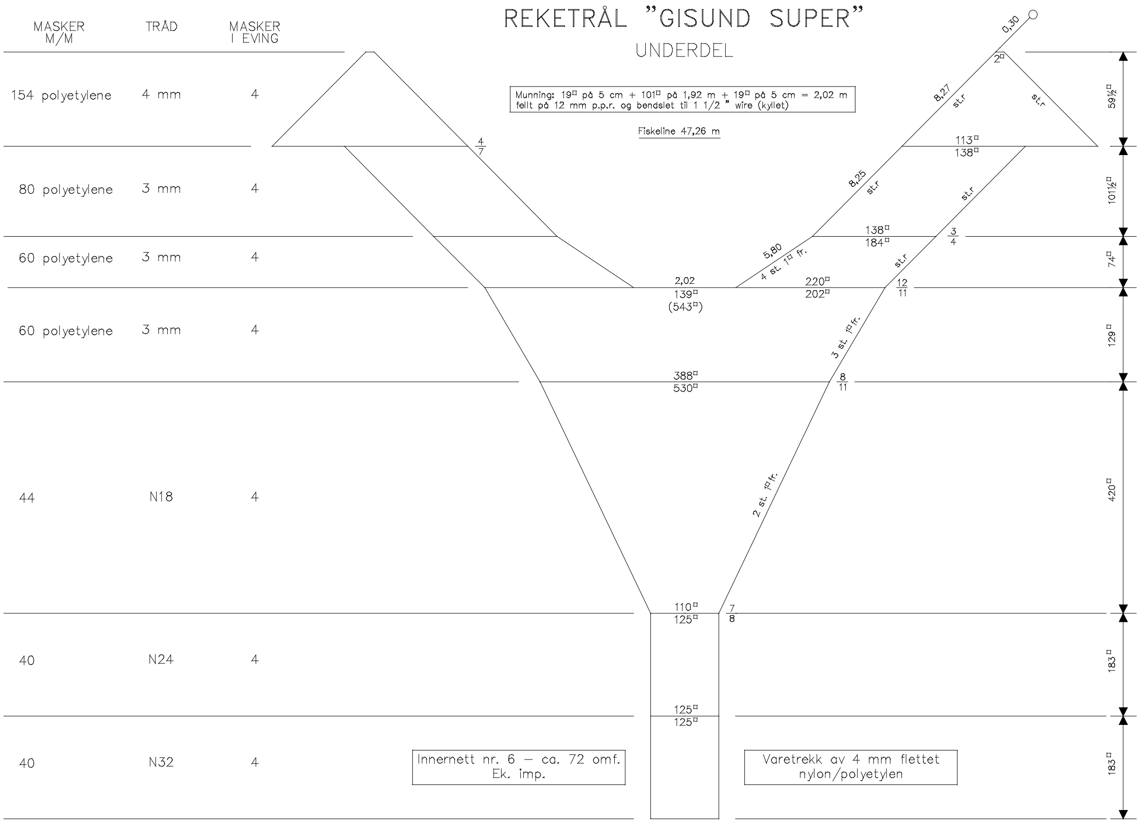


Figure 2a. Design of the trawl used.

Figure. 2b. Schematic drawing of the ground gear used in the experiments.

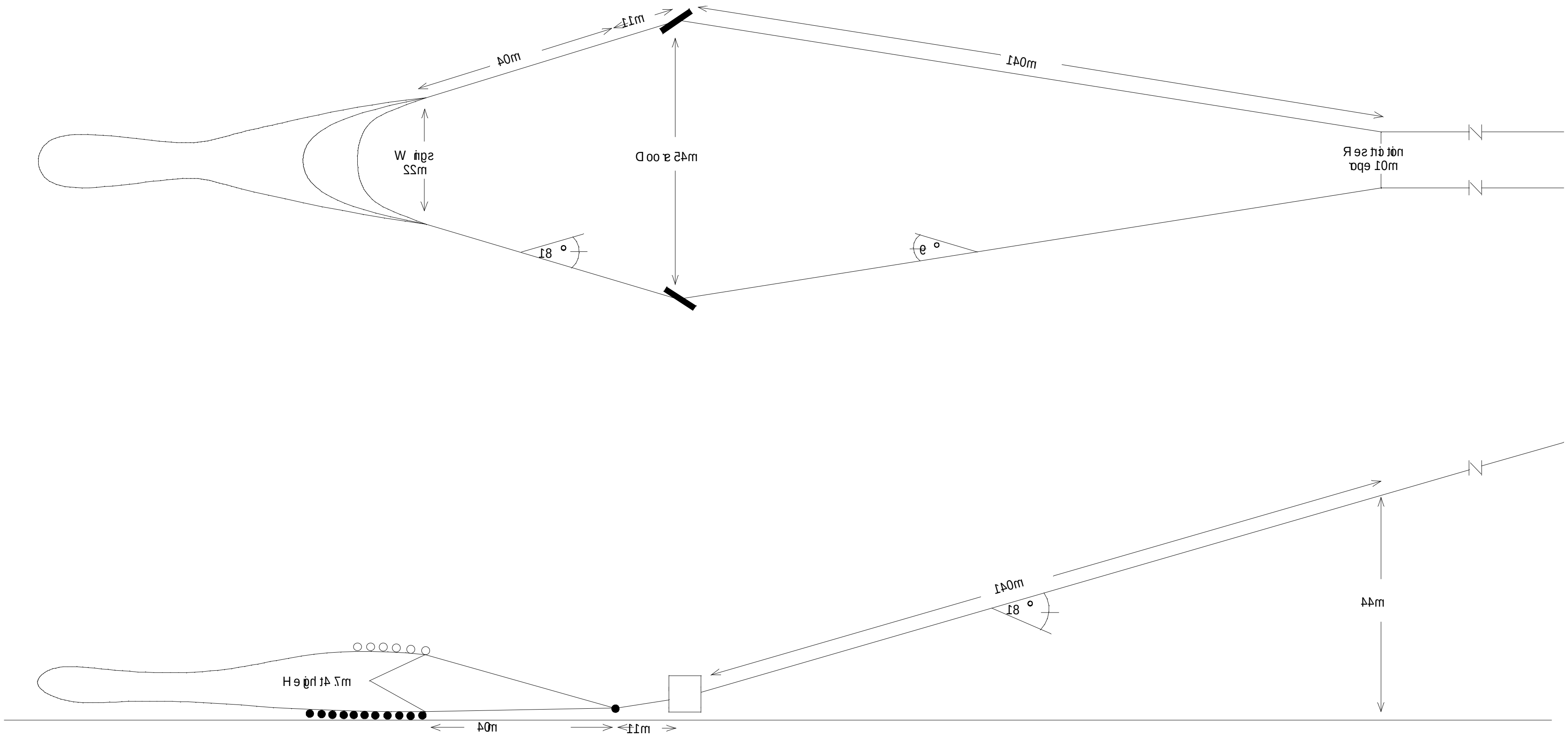


Figure 3a. Schematic presentation of trawl geometry with 40 m long bridles.

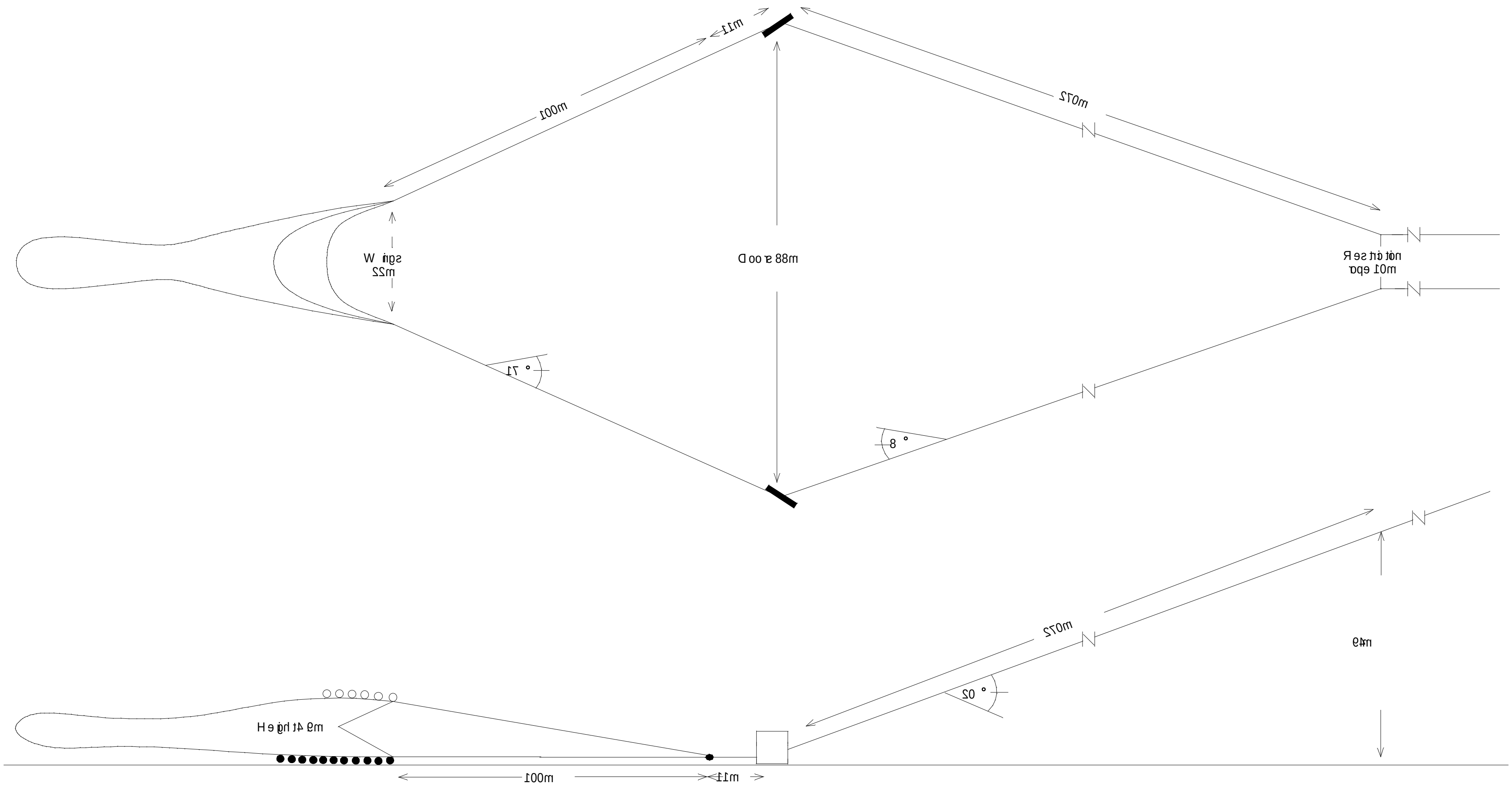


Figure 3b. Schematic presentation of trawl geometry with 100 m long bridles.

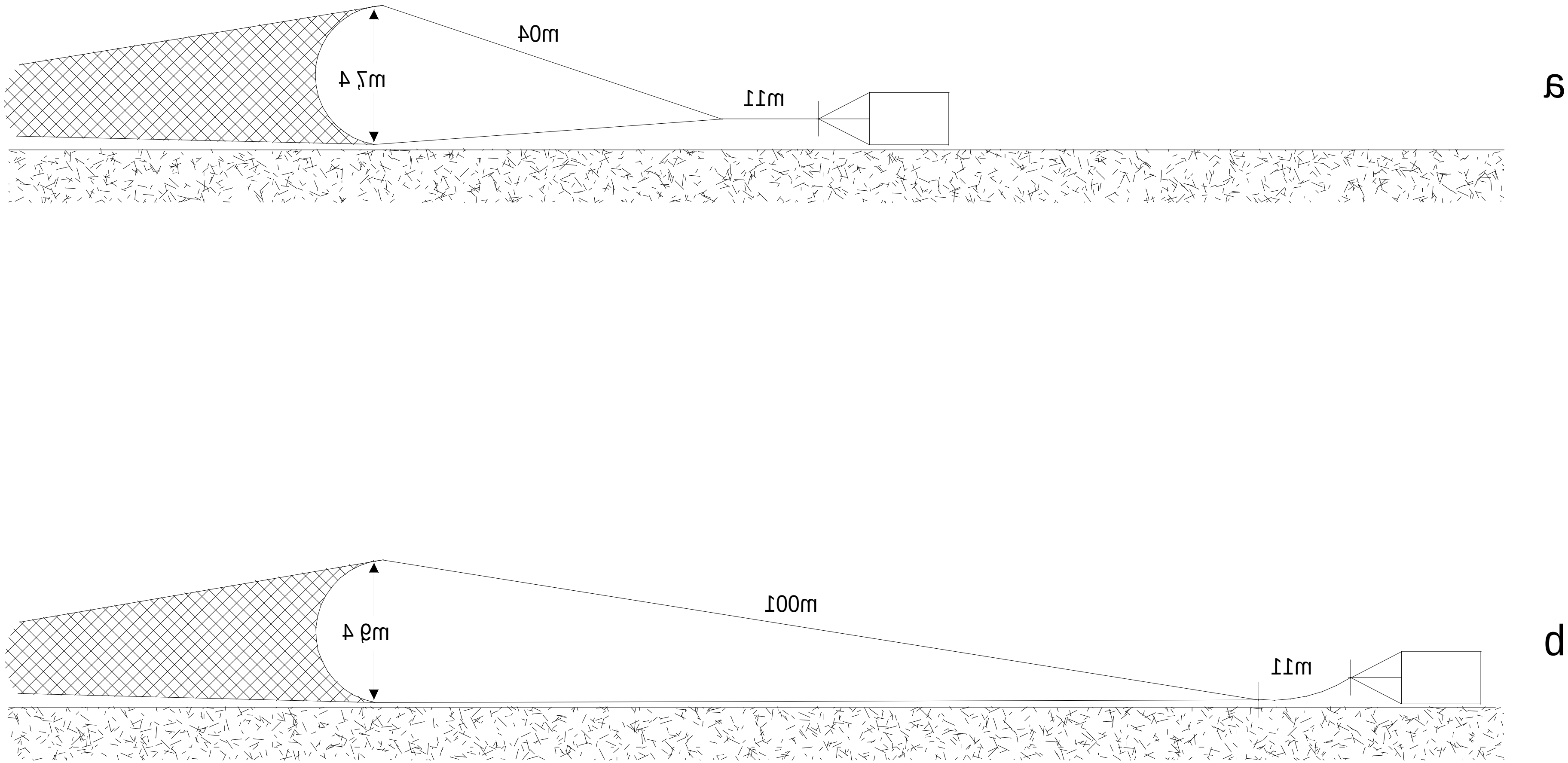


Figure 3c. Schematic presentation of the bridle/sweep designs..

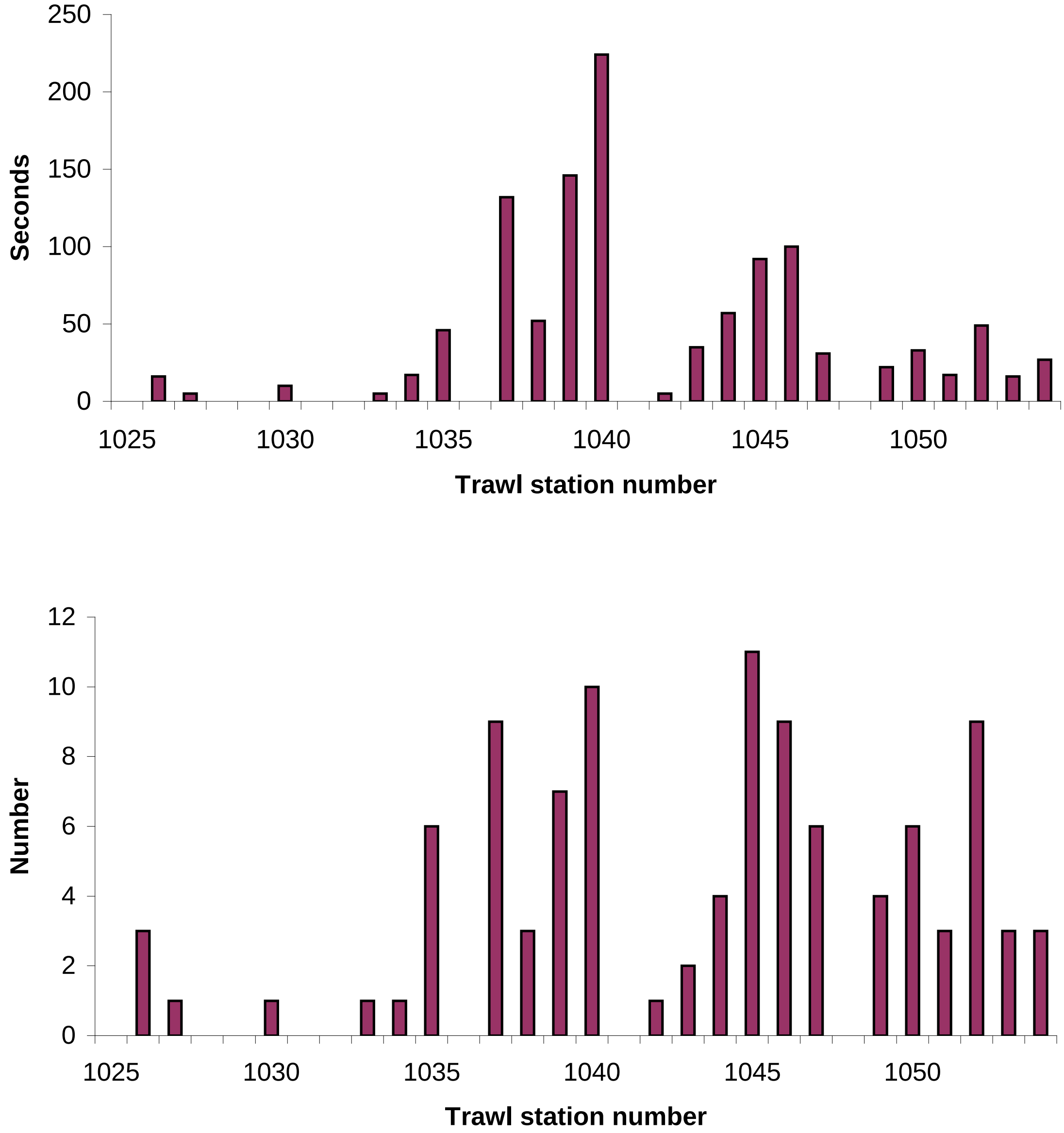


Figure 4. Data collected with the SIMRAD PI30 bottom contact sensor in area A. Upper graph shows the total time during a haul the sensor reported loss of contact and lower graph shows the number of times per haul the sensor reported loss of contact.

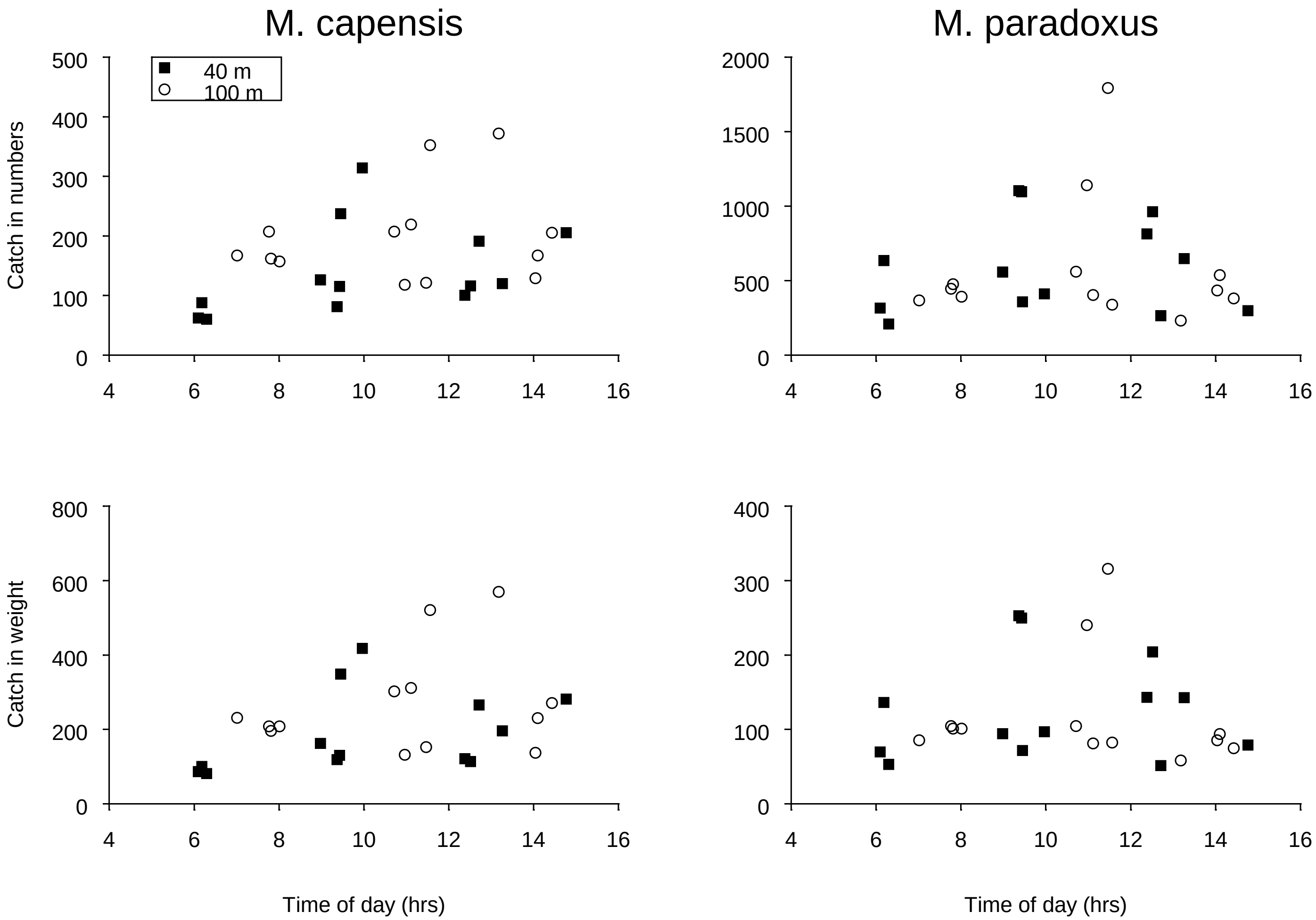


Figure 5. Diel variation in catch rates for the two hake species in area A. Time refers to the start of the haul.

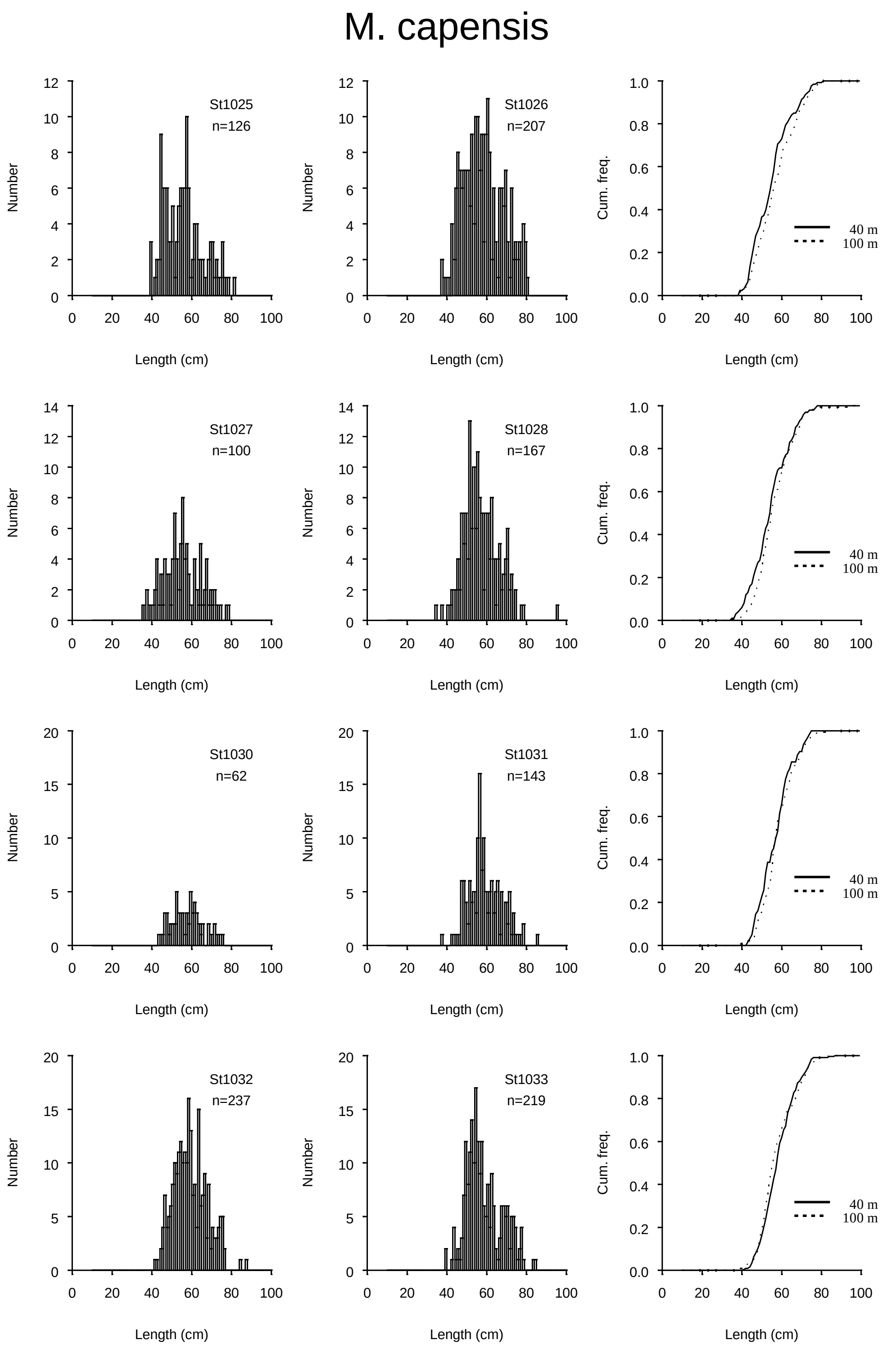


Figure 6. Length frequency distribution for the catch of M. capensis in area A. Each row of graphs represents the data for one pair of hauls.

M. capensis

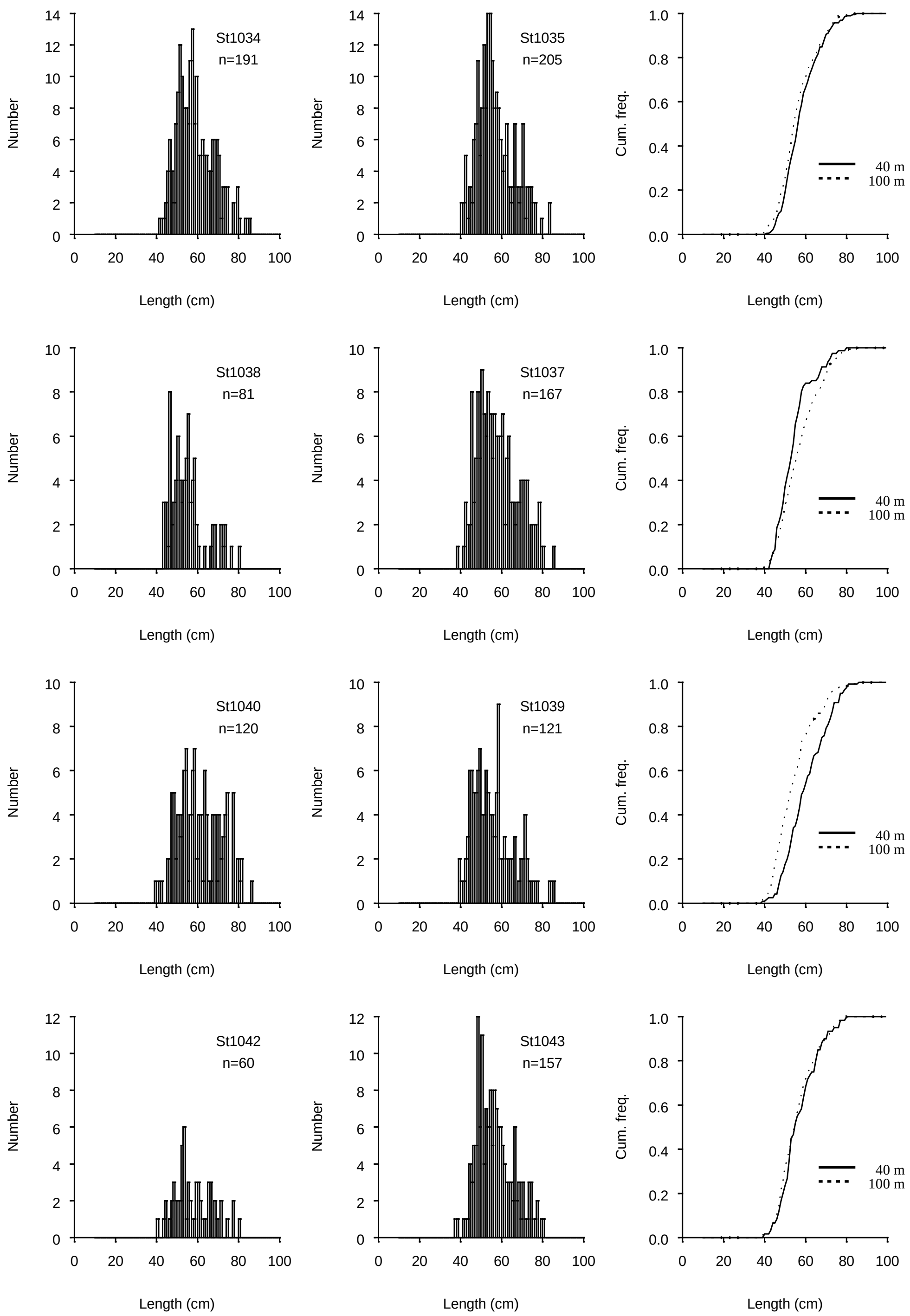


Figure 6. Continued.

M. capensis

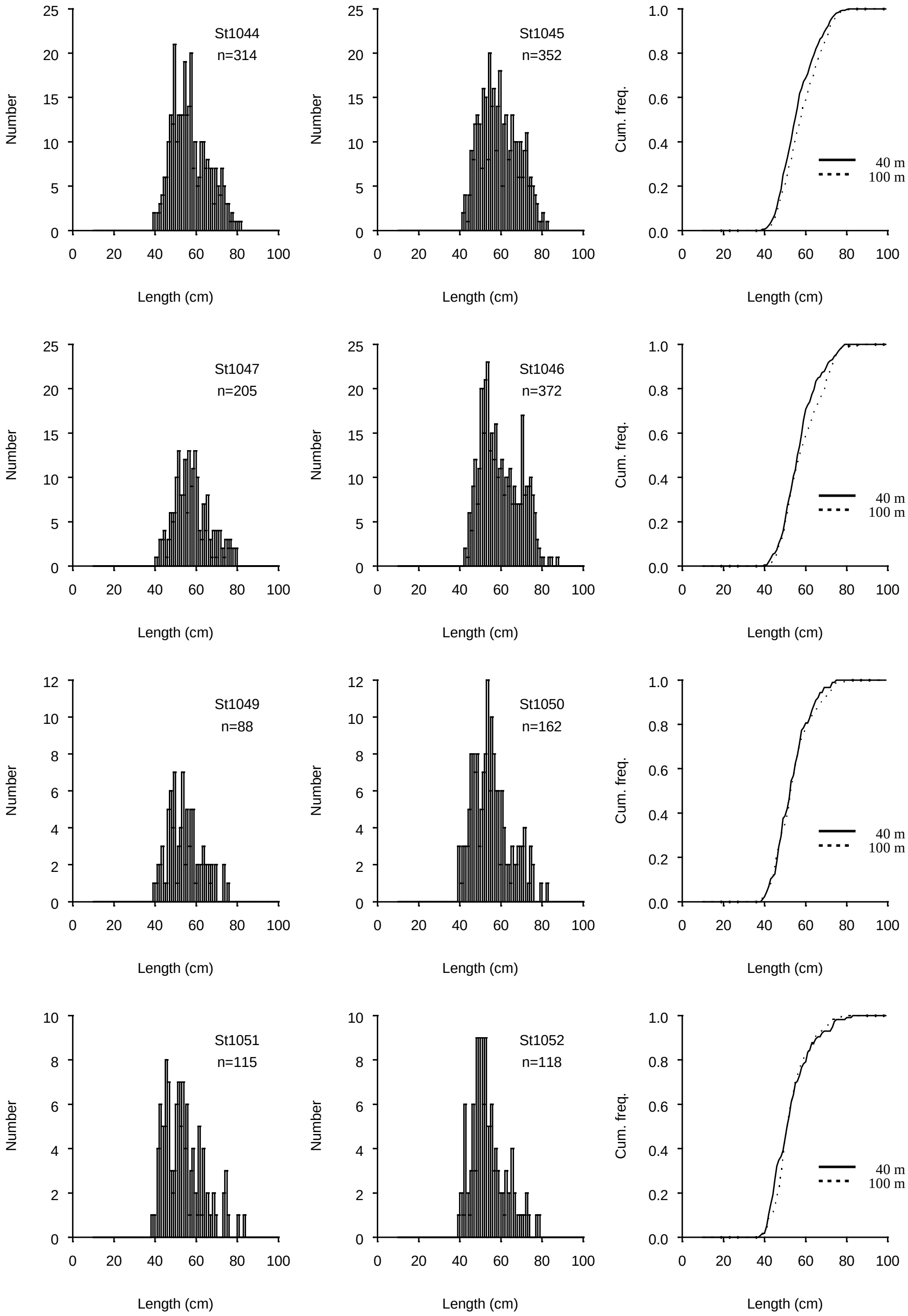


Figure 6. Continued.

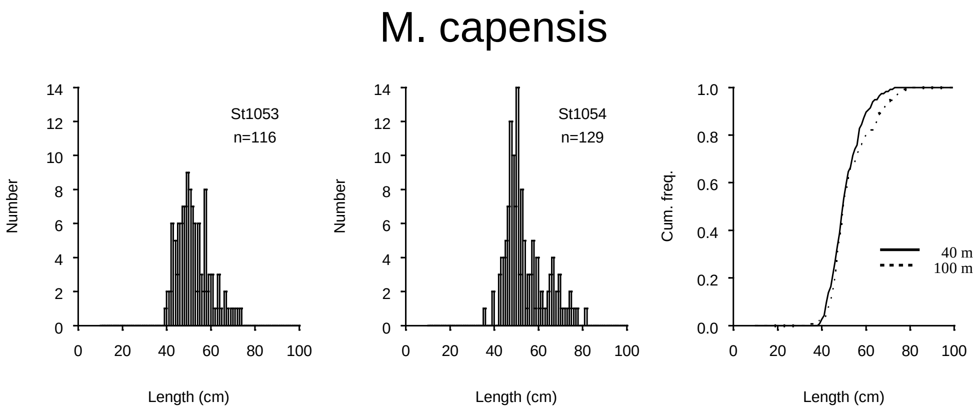


Figure 6. Continued.

M. paradoxus

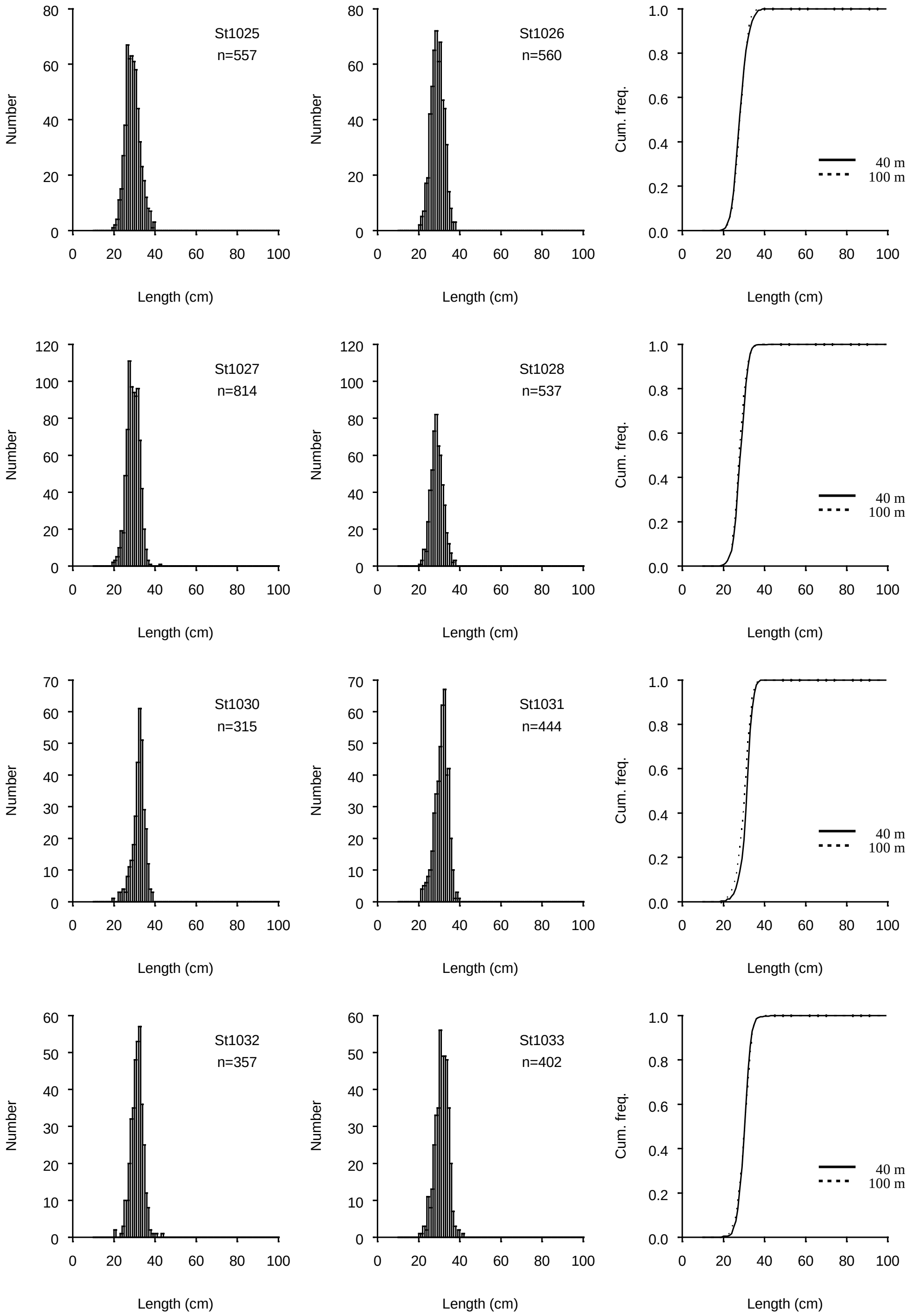


Figure 7. Length frequency distribution for the catch of M. paradoxus in area A. Each row of graphs represents the data for one pair of hauls.

M. paradoxus

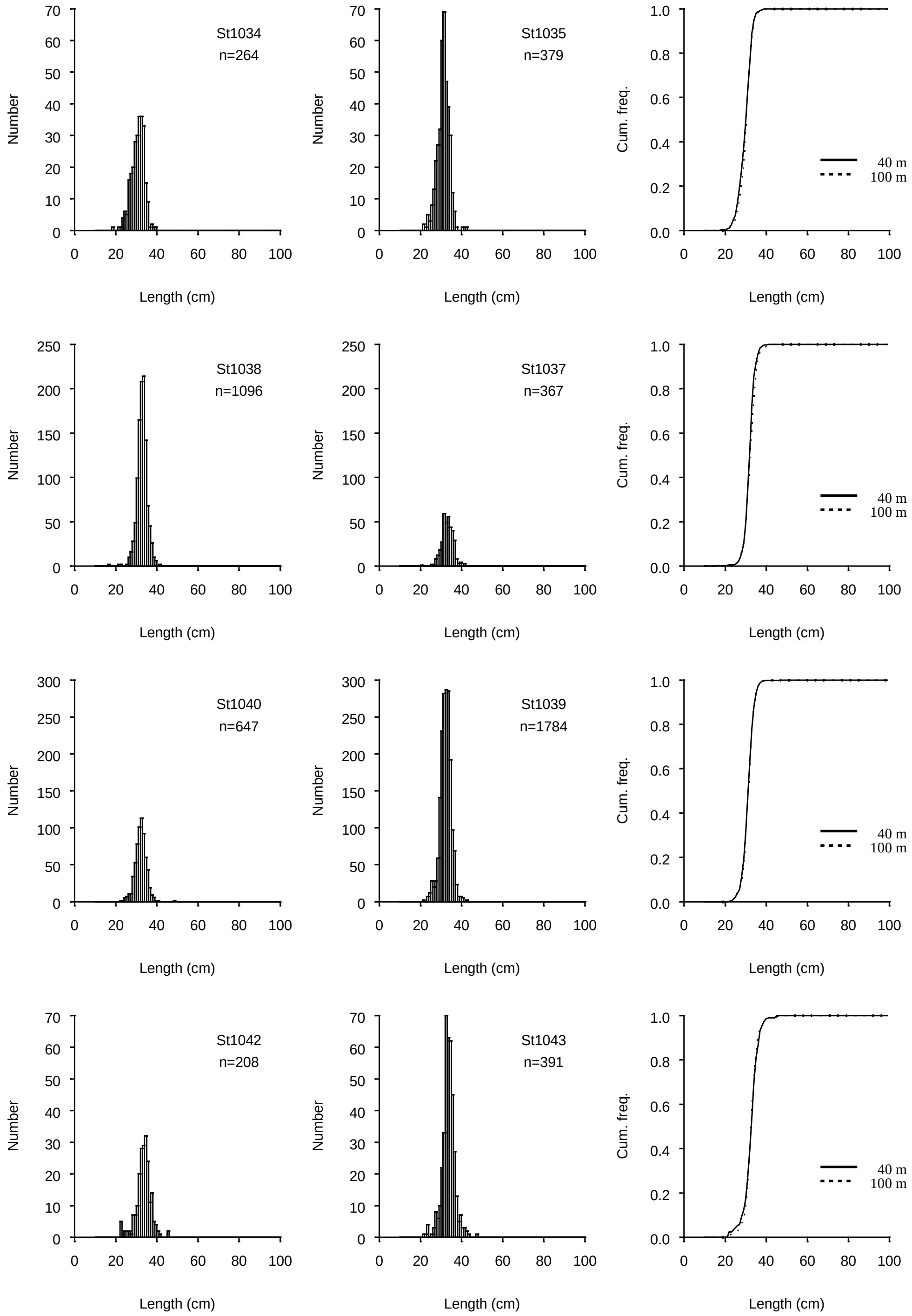


Figure 7. Continued.

M. paradoxus

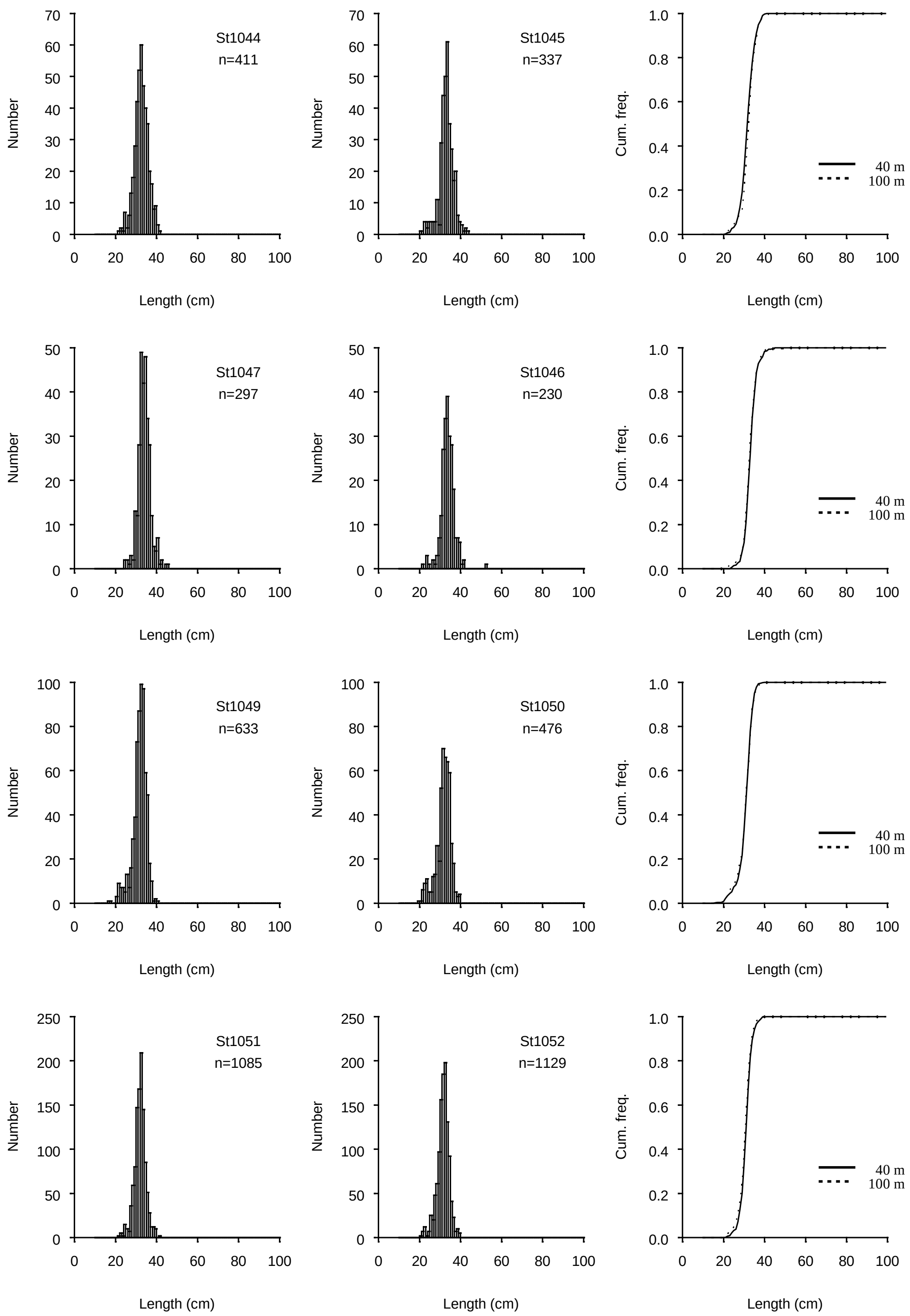


Figure 7. Continued.

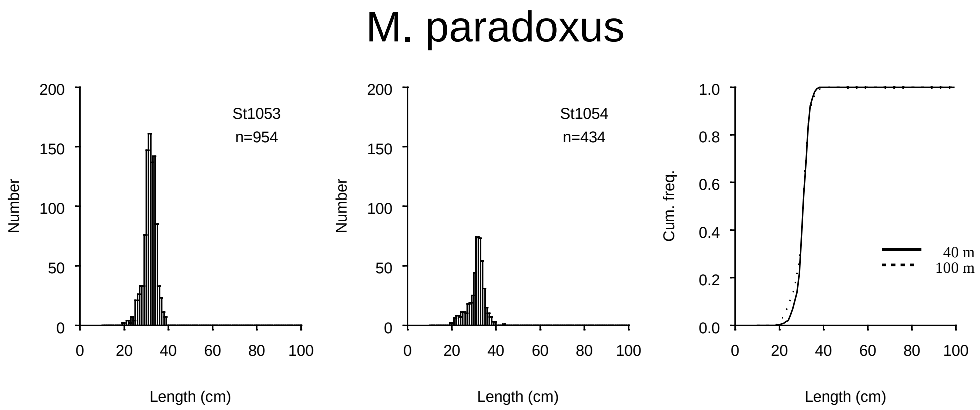


Figure 7. Continued.

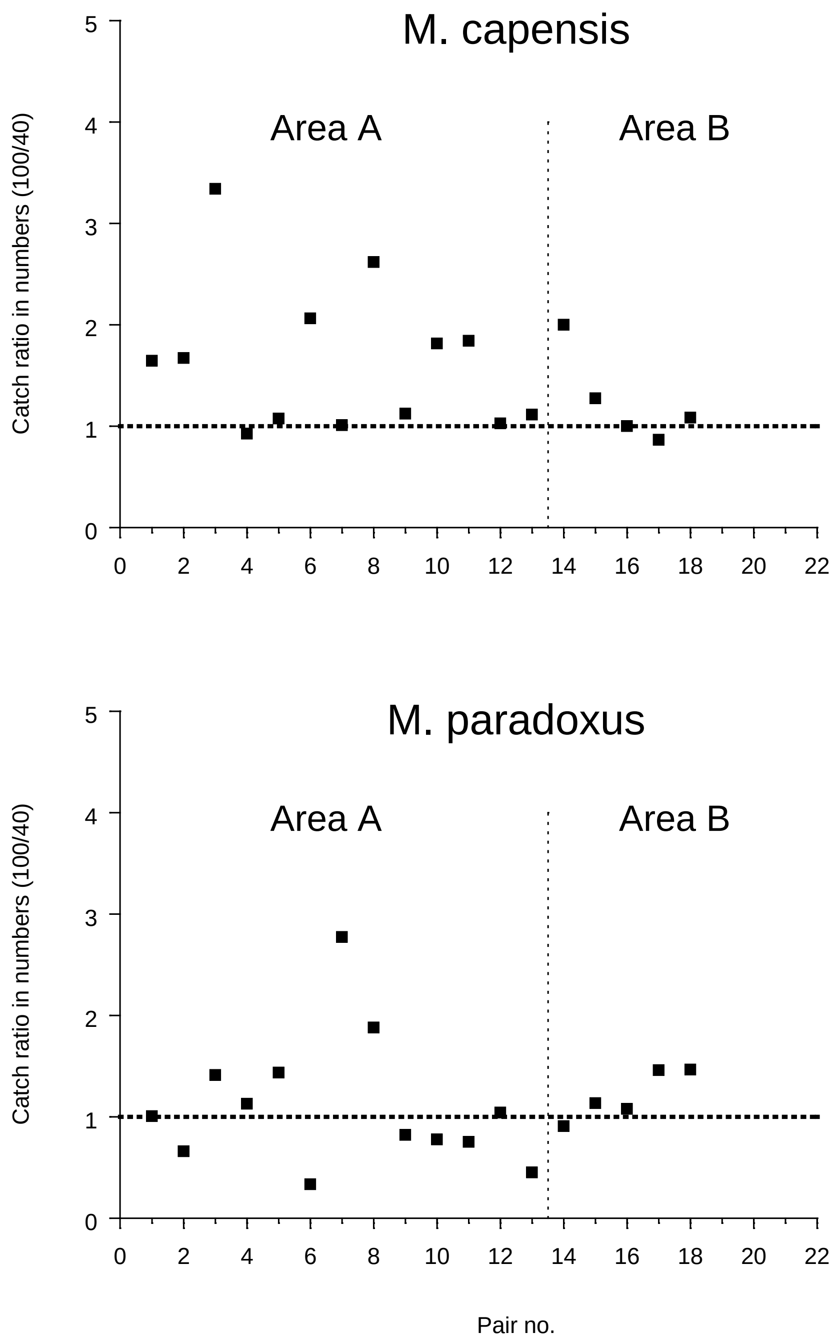


Fig. 8. Ratio of catch in number with 100 m and 40 m long bridles for each pair of hauls. The ratios were calculated separately for the two hake species M. capensis (upper panel) and M. paradoxus (lower panel).

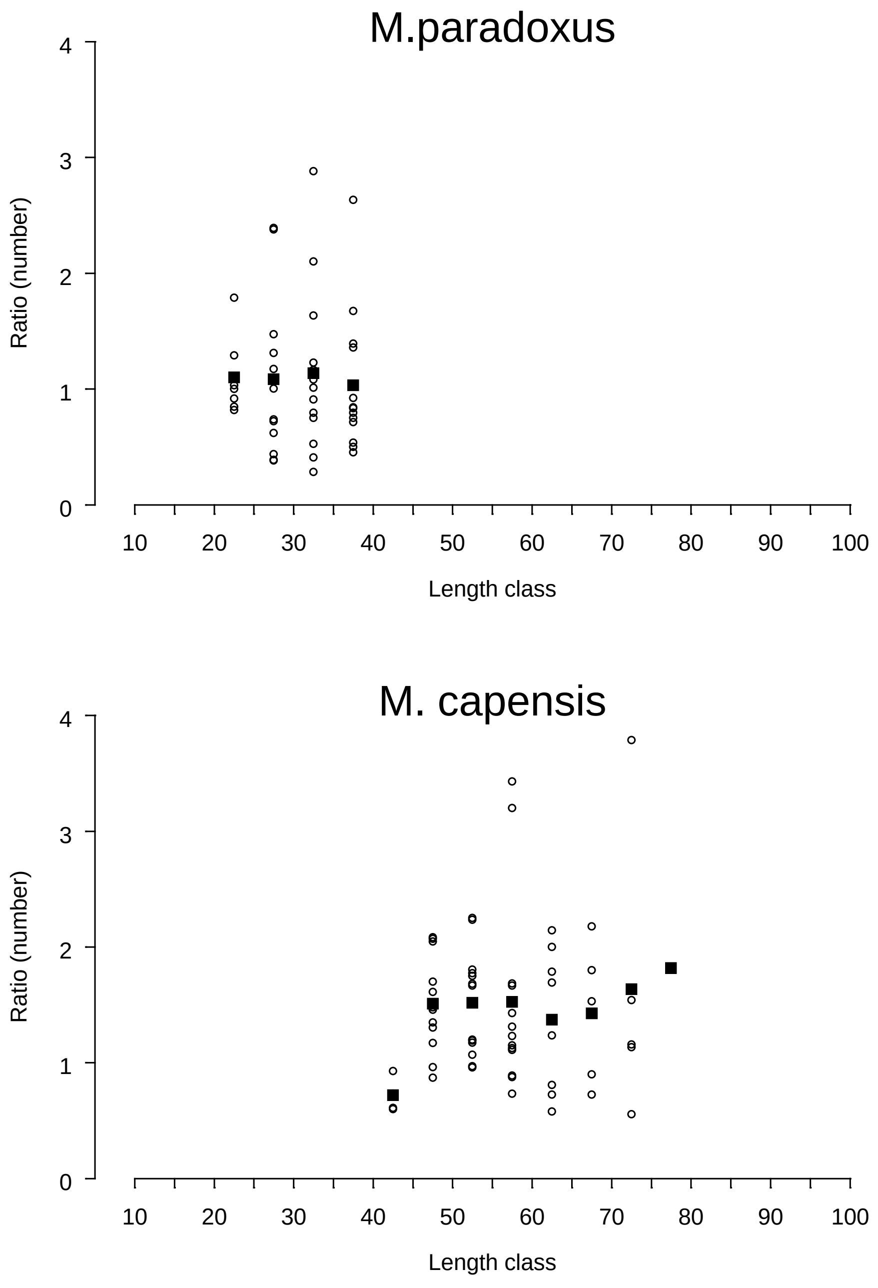
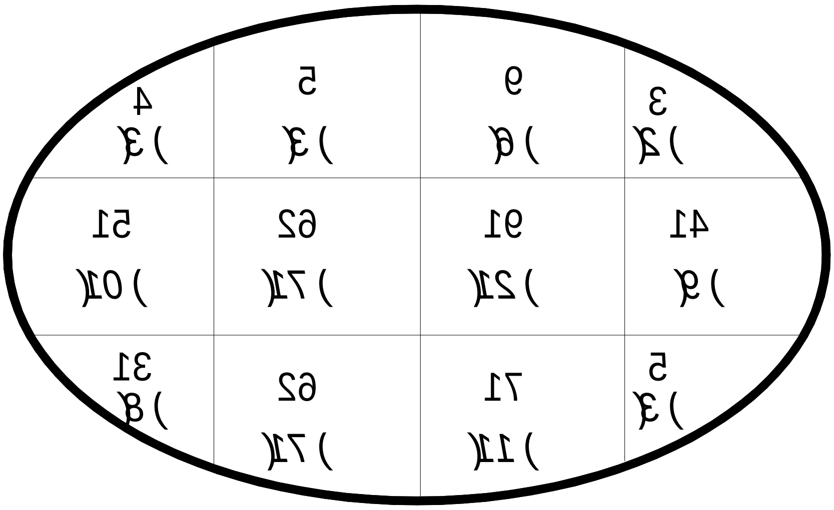


Fig. 9. Catch ratio by length class. Filled squares are the median value of the individual pair-wise observations (small open circles). For each pair of hauls, the observation for a length classs was only included if there was at least 10 fish in that length class for both the paired hauls.



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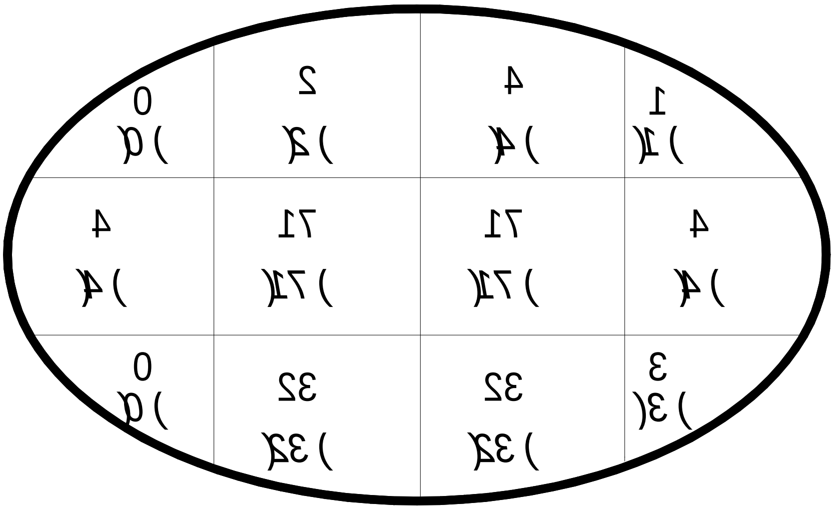


BT1055

Figure 10. Number of fish observed with the scanning sonar during trawl stations 1041 and 1055. Figures in brackets are percentages.

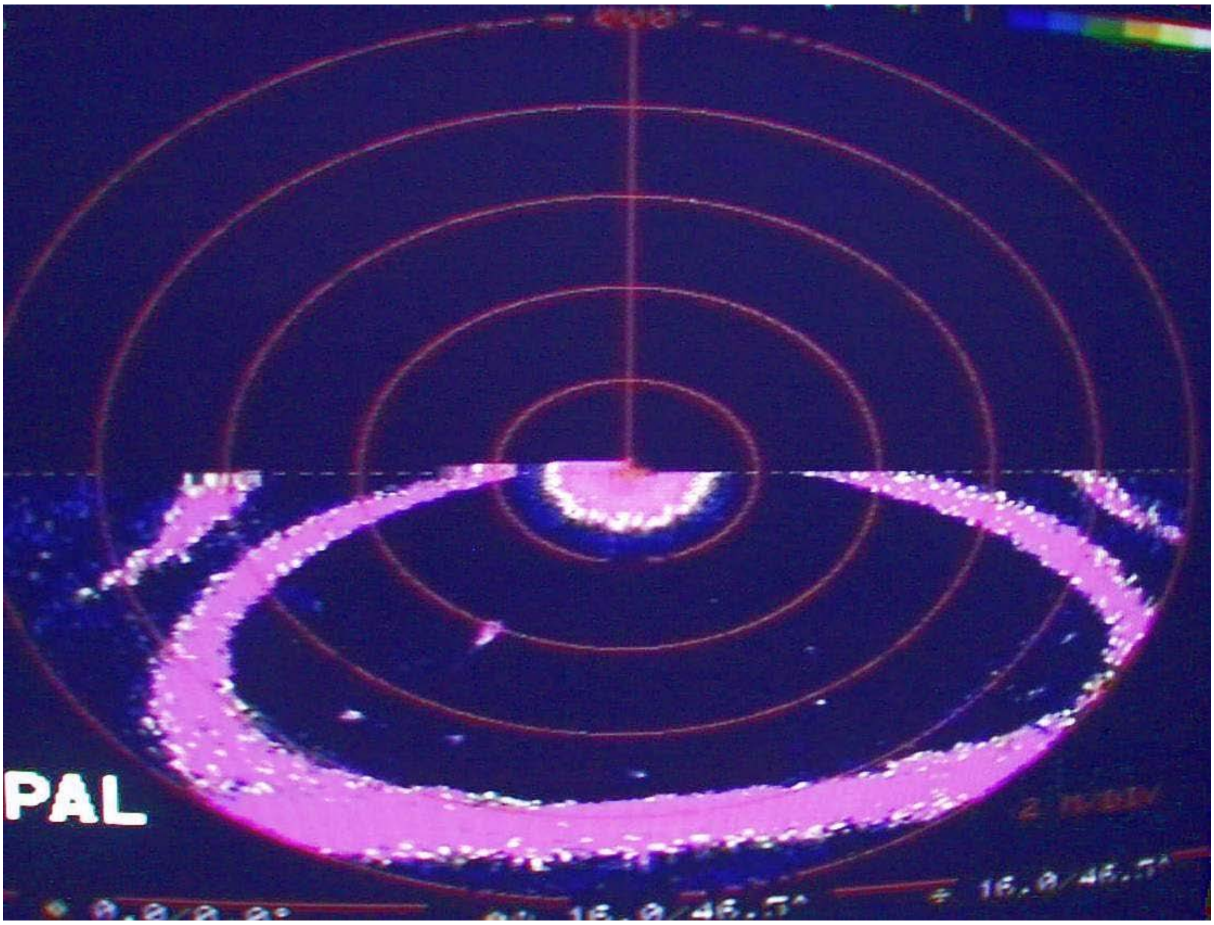


Figure 11. A copy of the scanning sonar display recorded during haul 1041.

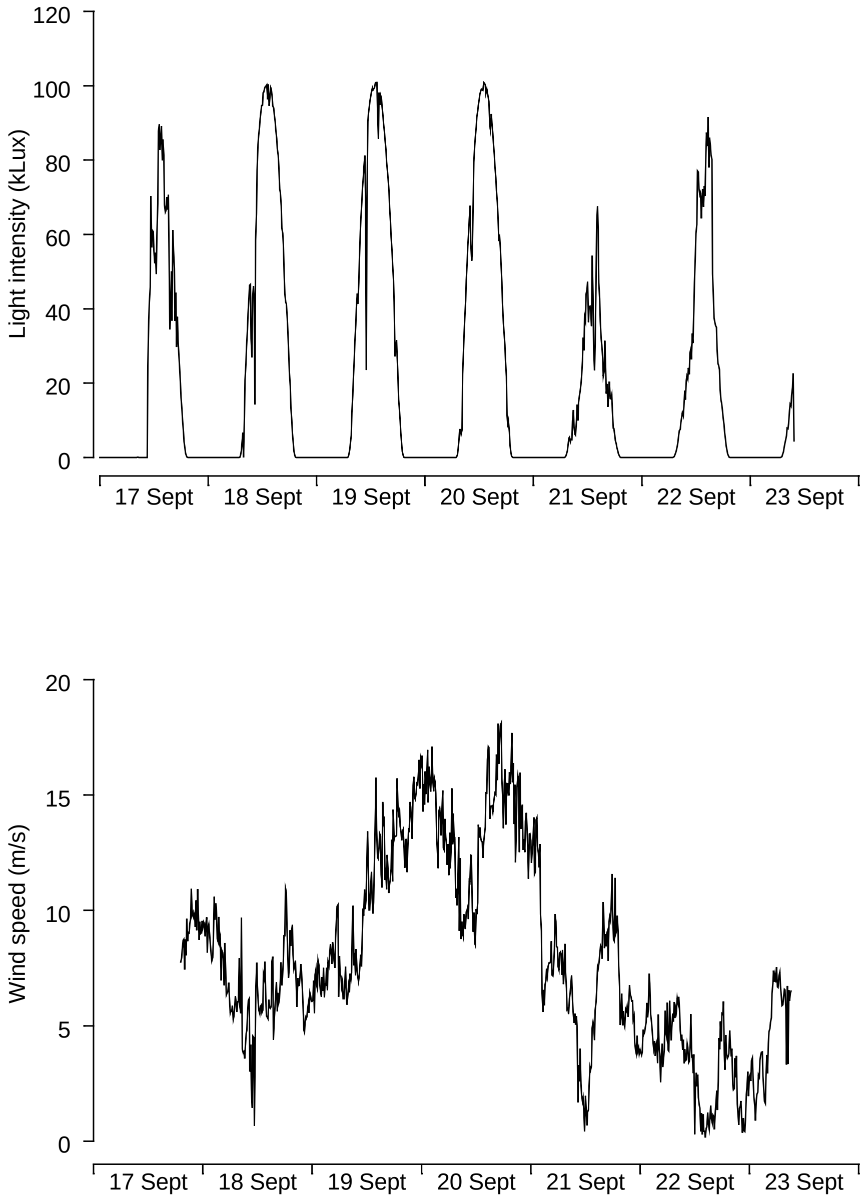


Figure 12. Observed light intensity (upper panel) and wind speed (lower panel) in fishing area A.

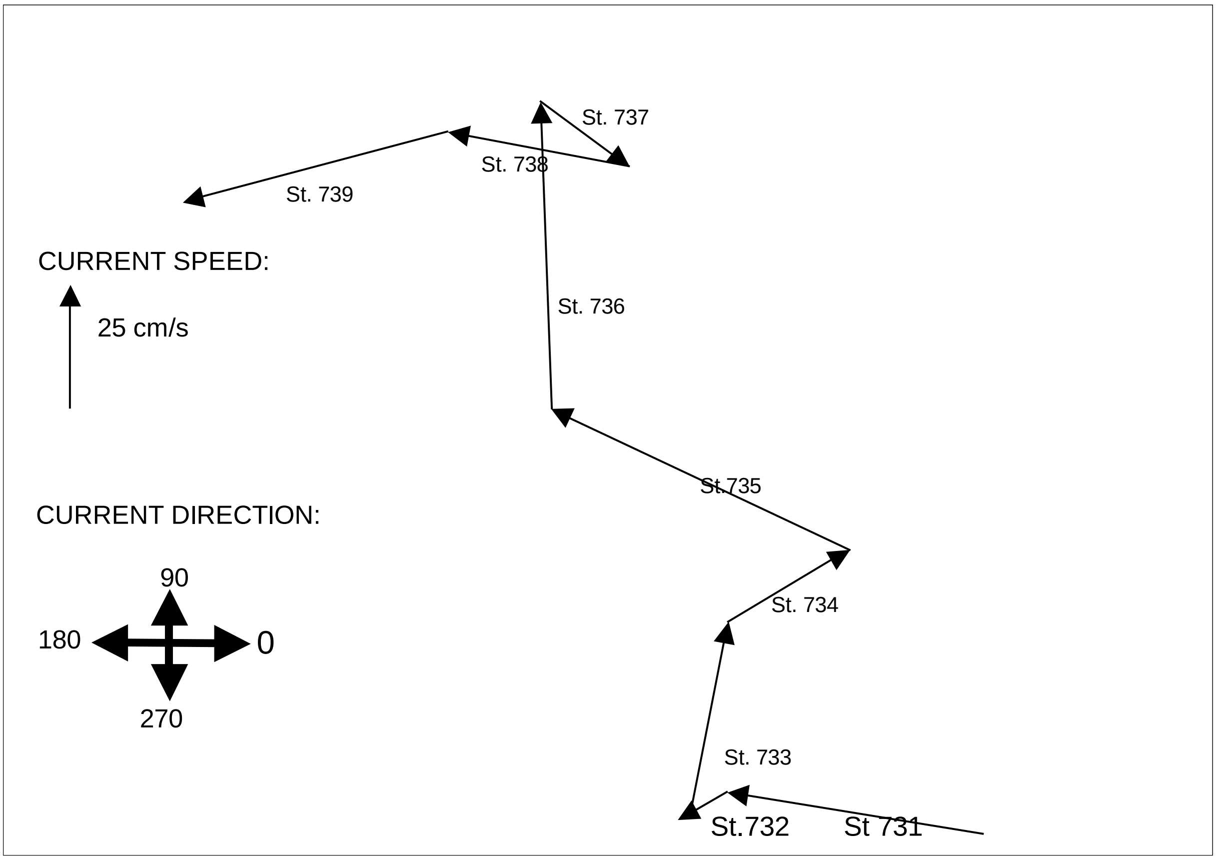
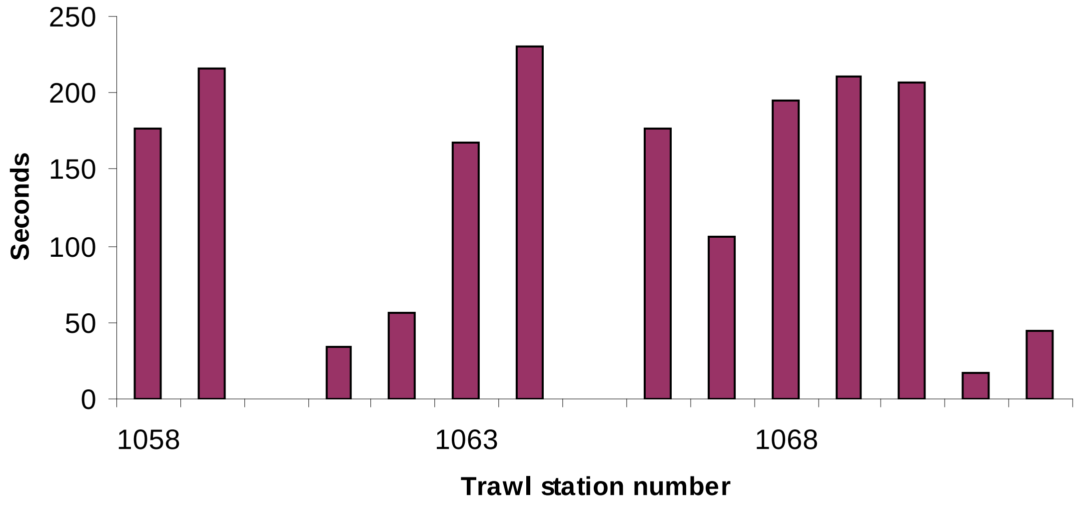


Figure 13. Current speed and direction measured at 315 m depth in area A in the period 17-23 September. See Table 3 for date and time for the different stations.



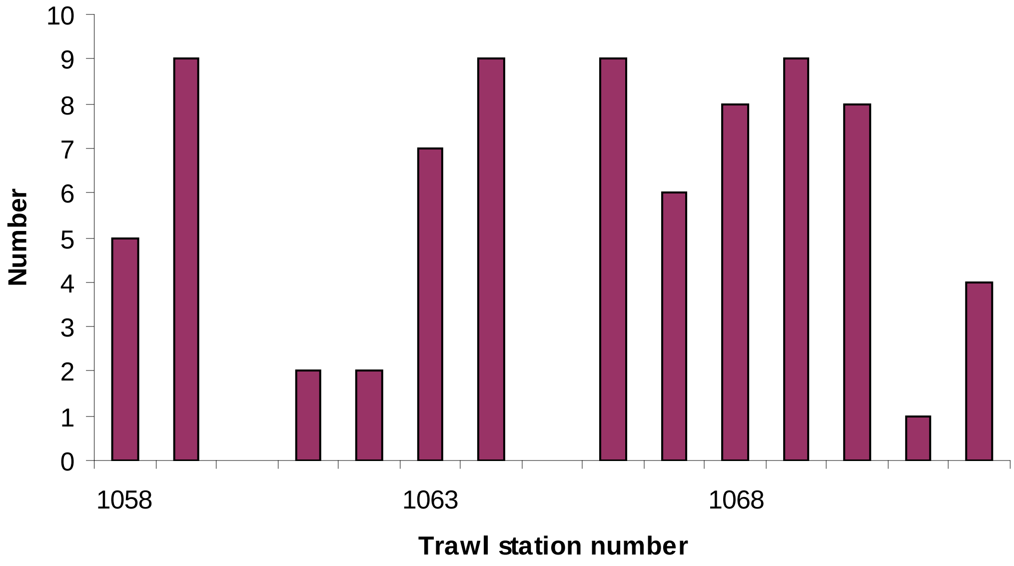


Figure 14. Data collected with the SIMRAD PI30 bottom contact sensor in area B. Upper graph shows the total time during a haul the sensor reported loss of contact and lower graph shows the number of times per haul the sensor reported loss of contact
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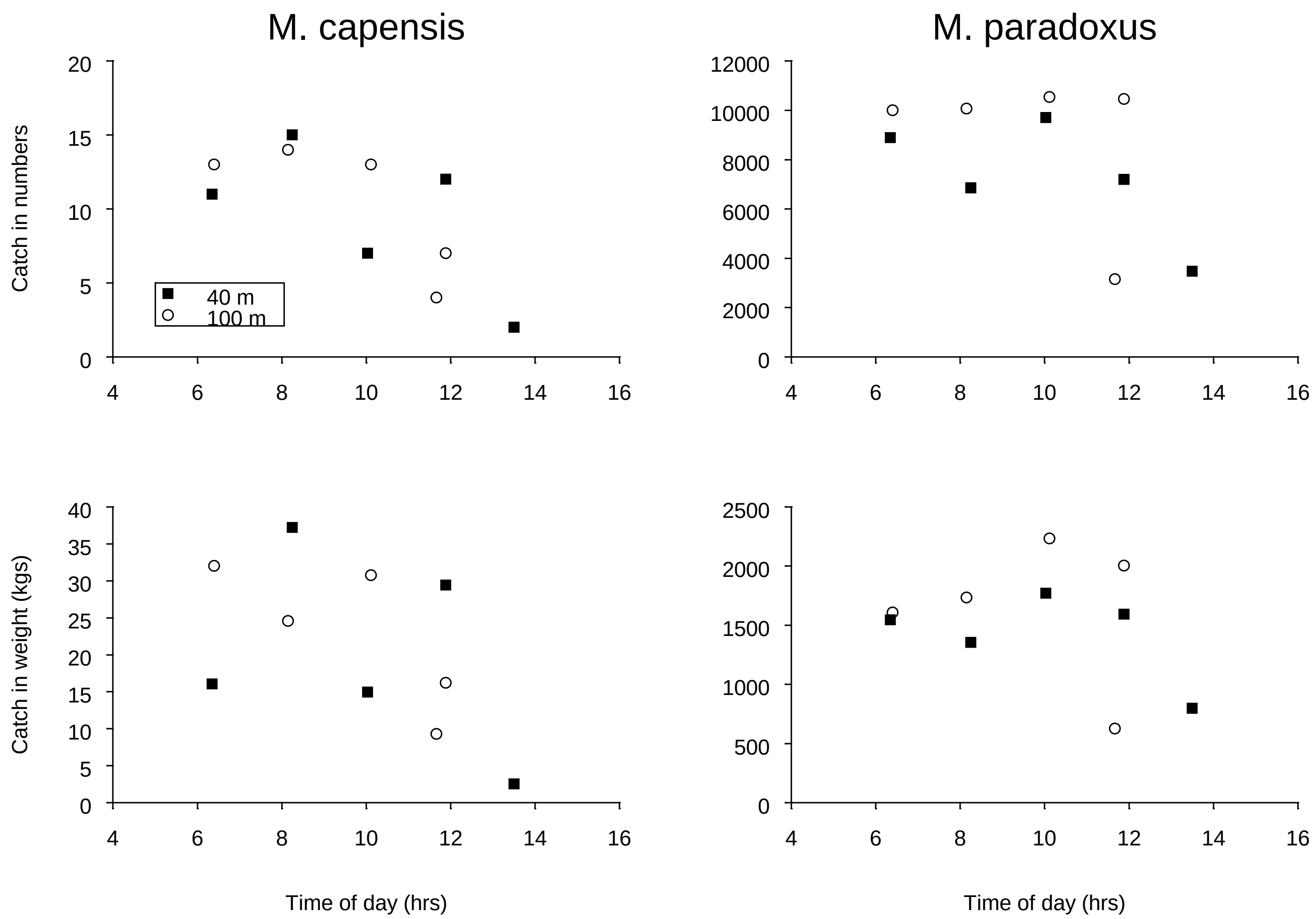


Figure 15. Diel variation in catch rates for the two hake species in area B. Time refers to the start of the haul.

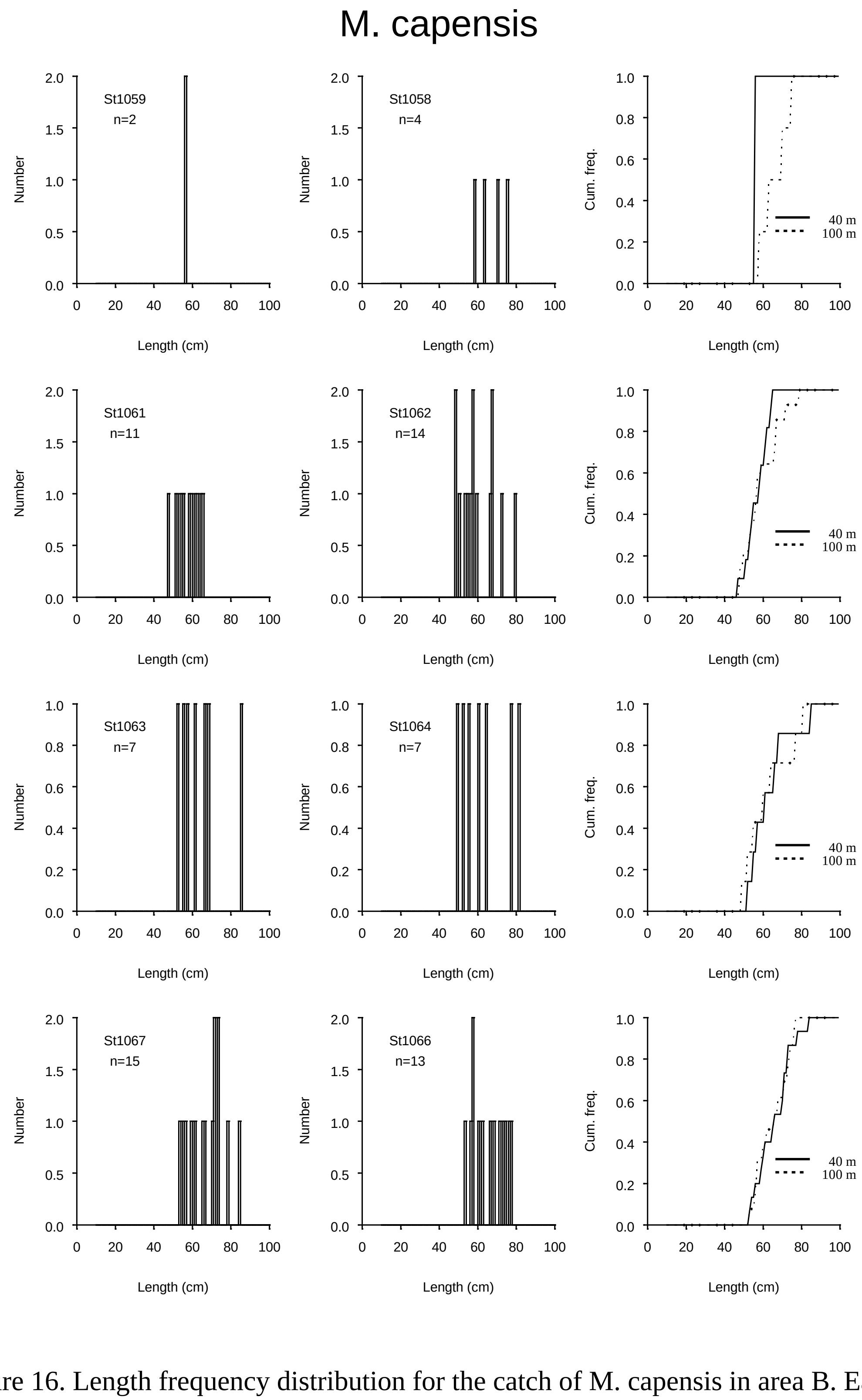


Figure 16. Length frequency distribution for the catch of M. capensis in area B. Each row of graphs represents the data for one pair of hauls

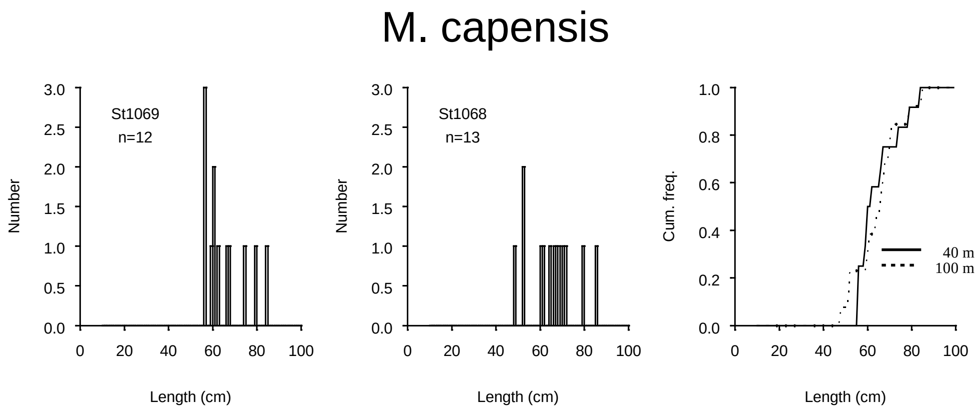


Figure 16. Continued.

M. paradoxus

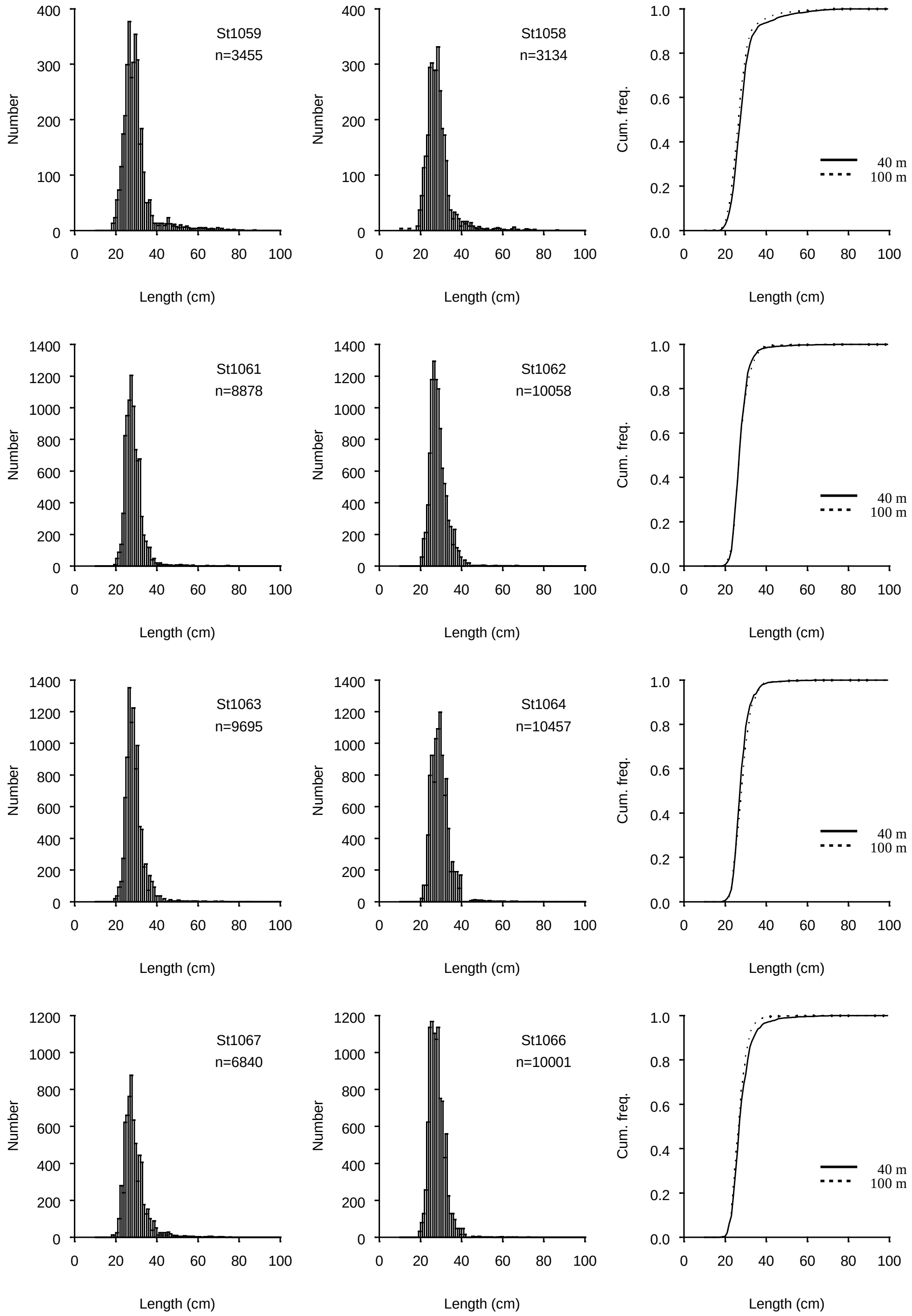


Figure 17. Length frequency distribution for the catch of M. paradoxus in area B. Each row of graphs represents the data for one pair of hauls

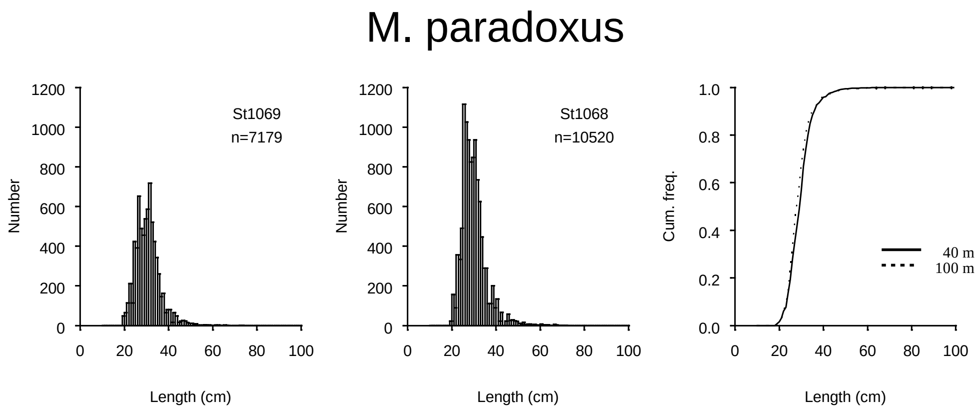


Figure 17. Continued.

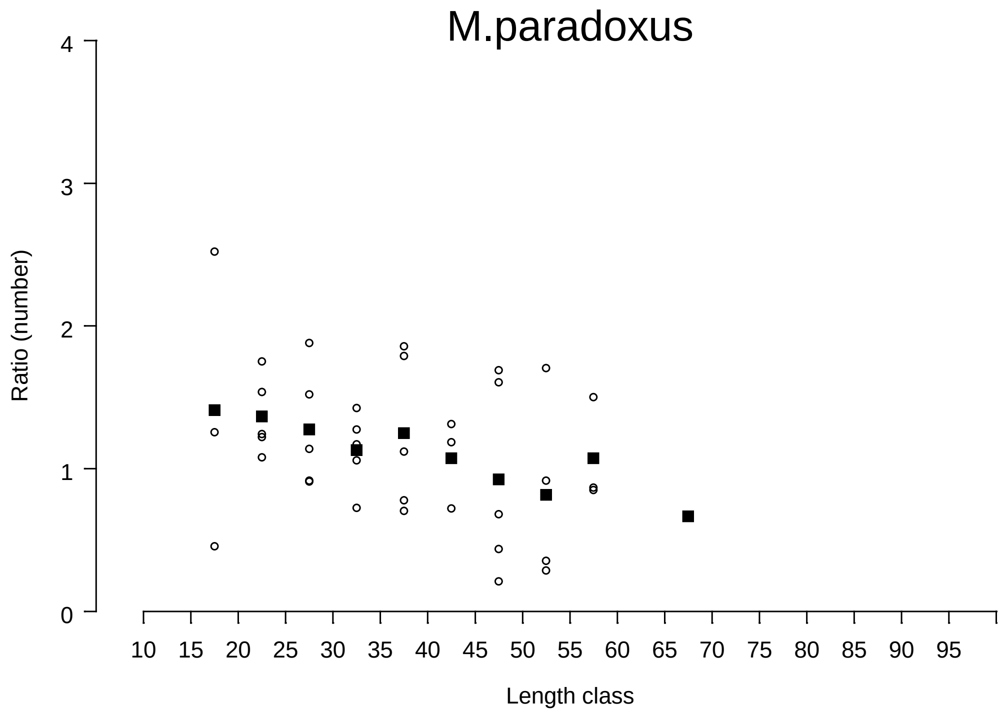


Fig. 18. Catch ratio by length class for M. paradoxus. Filled squares are the median value of the individual pair-wise observations (small open circles). For each pair of hauls, the observation for a length classs was only included if there was at least 10 fish in that length class for both the paired hauls.

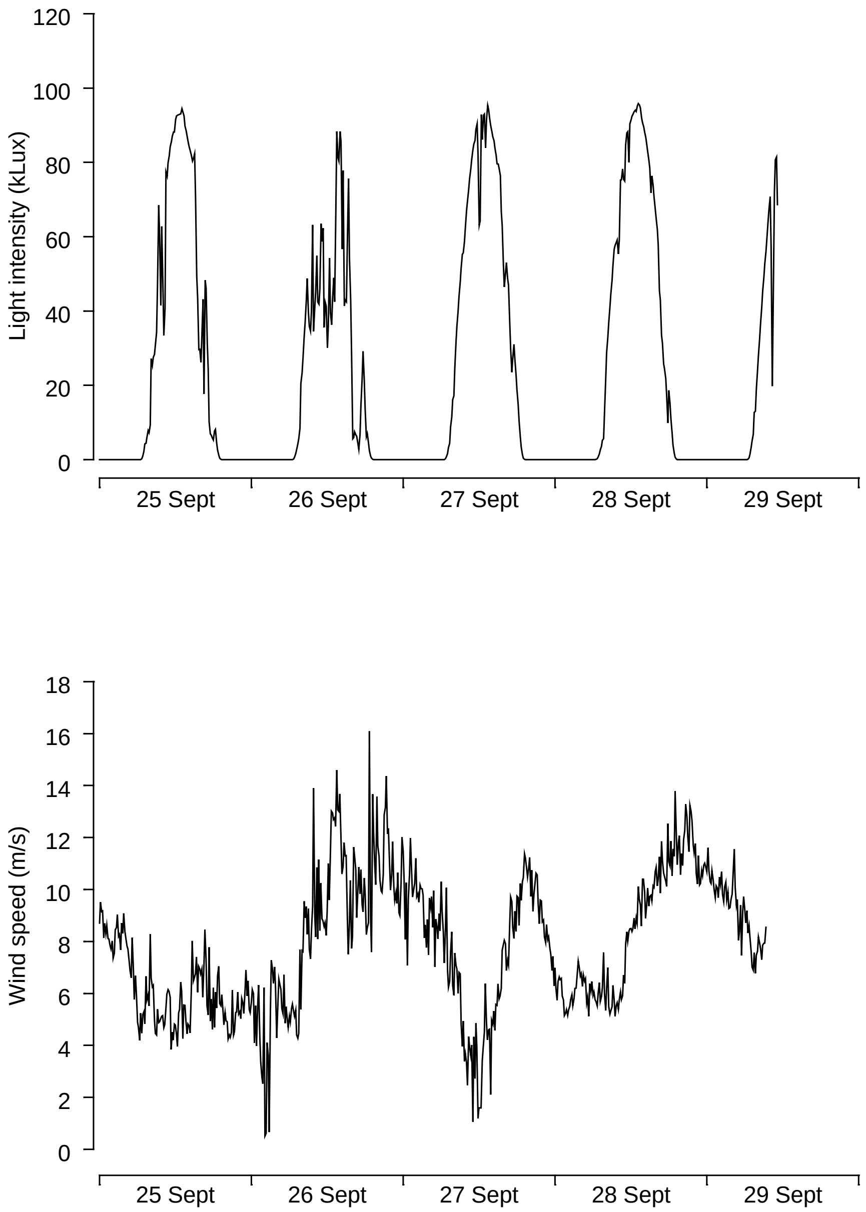


Figure 19. Observed light intensity (upper panel) and wind speed (lower panel) in fishing area B.

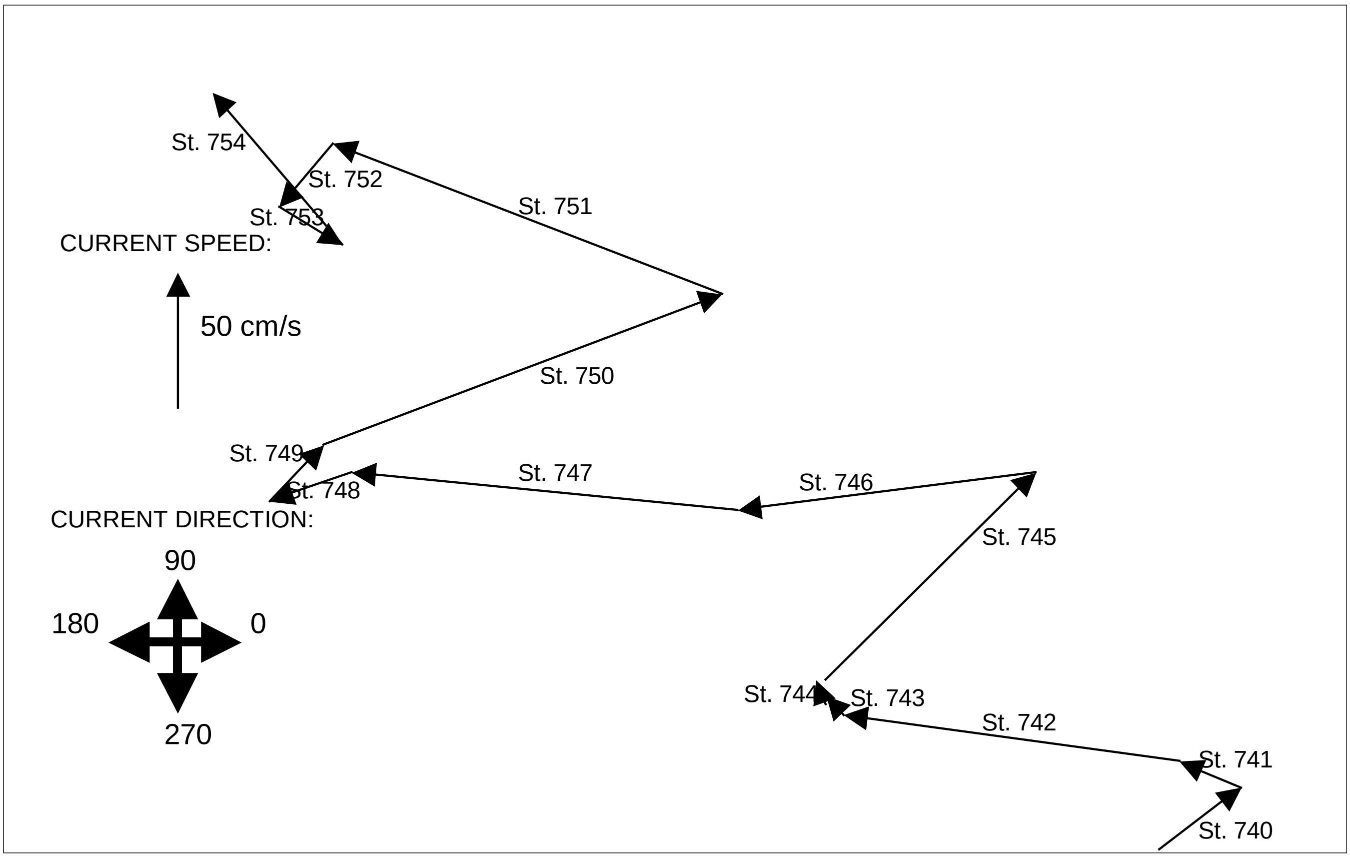
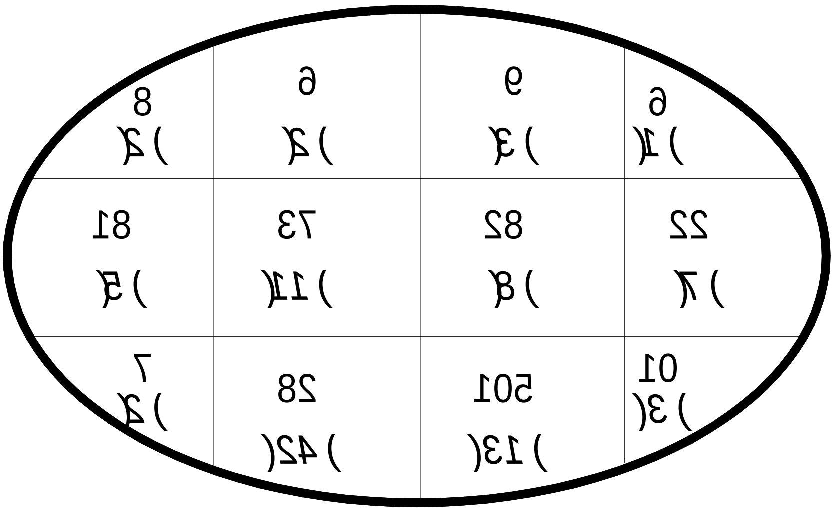


Figure 20: Current speed and direction measured at 315 m depth in area B in the period 25-29 September. See Table 5 for date and time for the different stations.



Bt1065

Figure 21. Number of fish observed with the scanning sonar during trawl stations 1065. Figures in brackets are percentages.

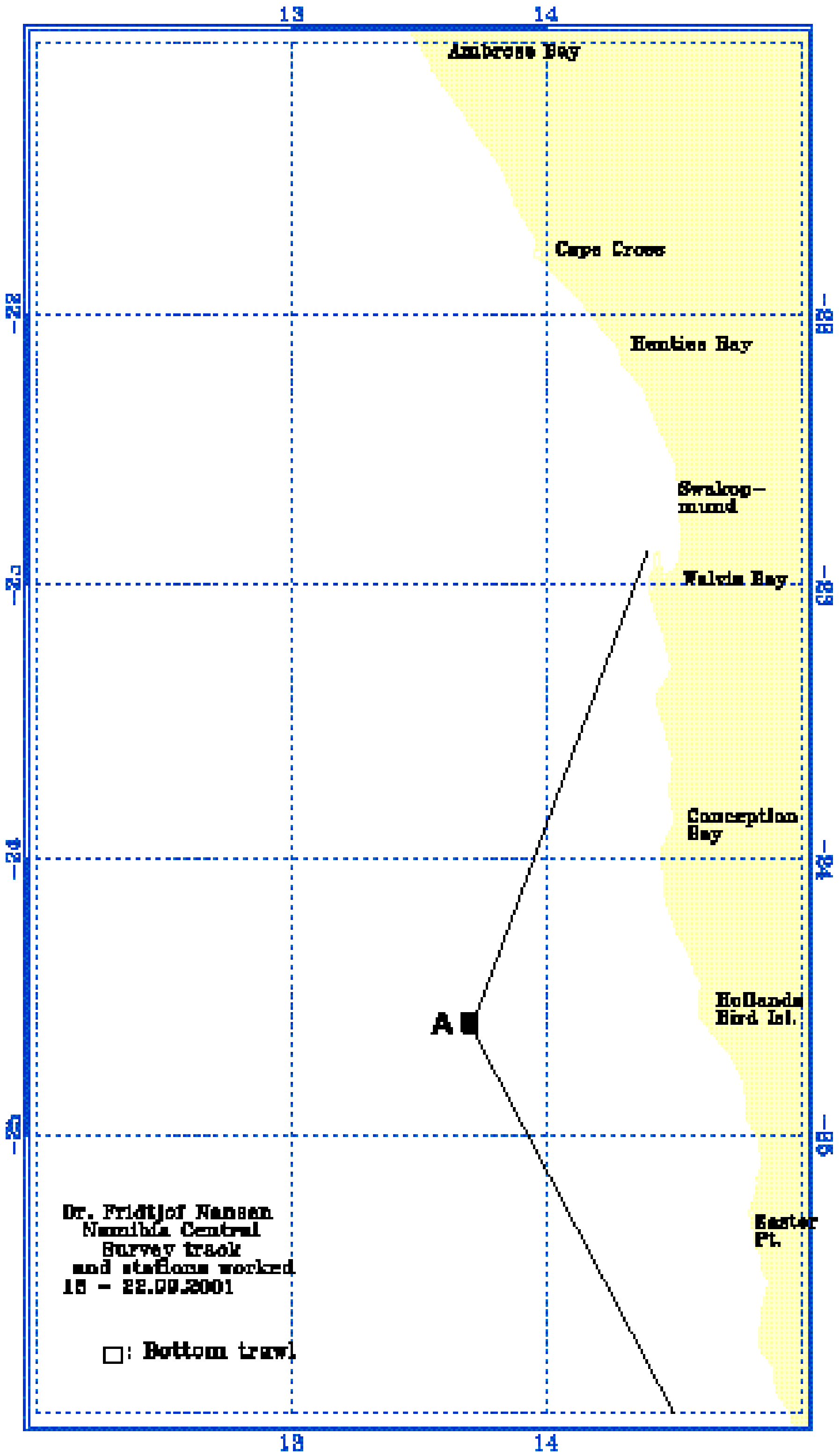


Figure 1a. Survey area A.

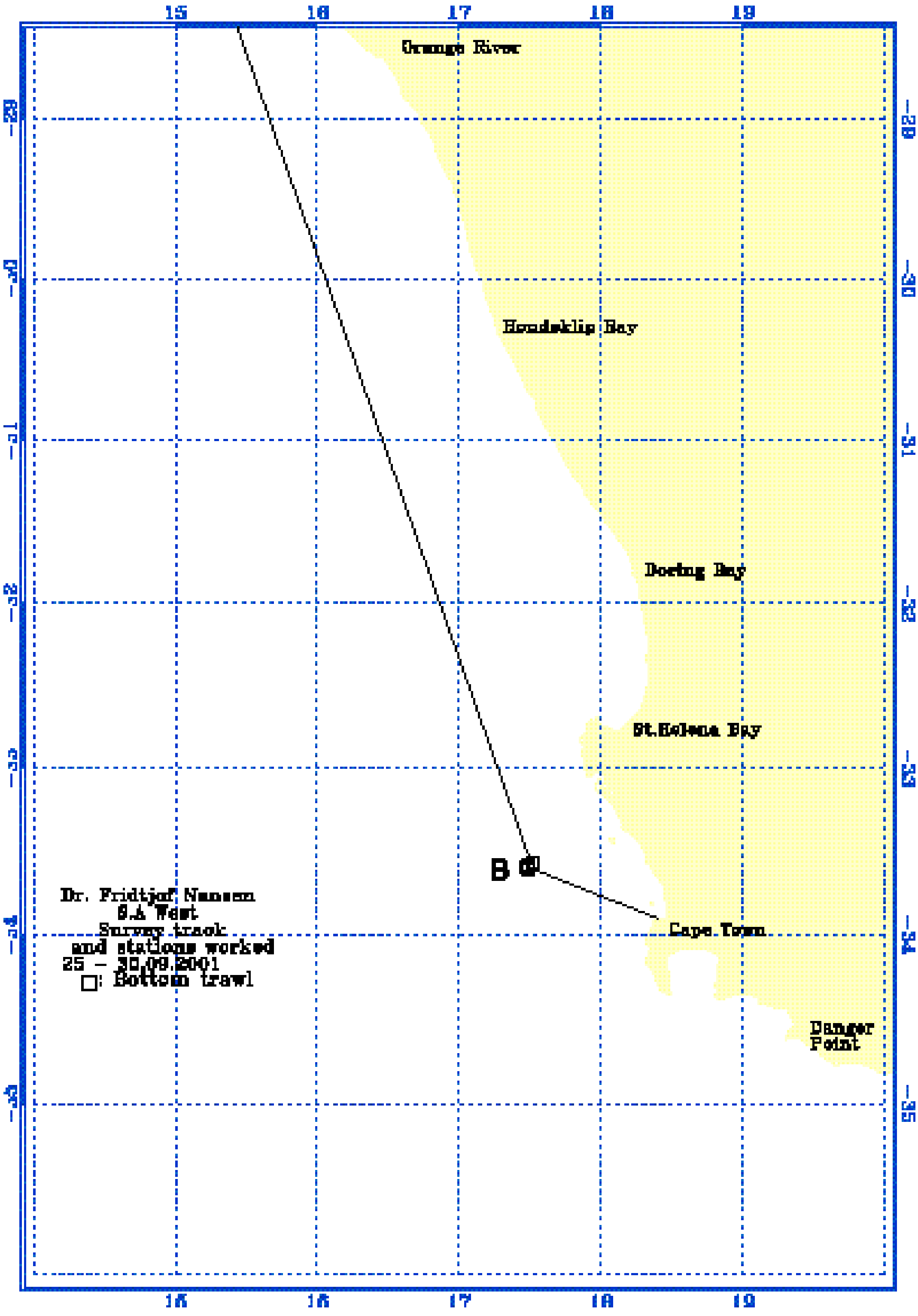


Figure 1b. Survey area B.

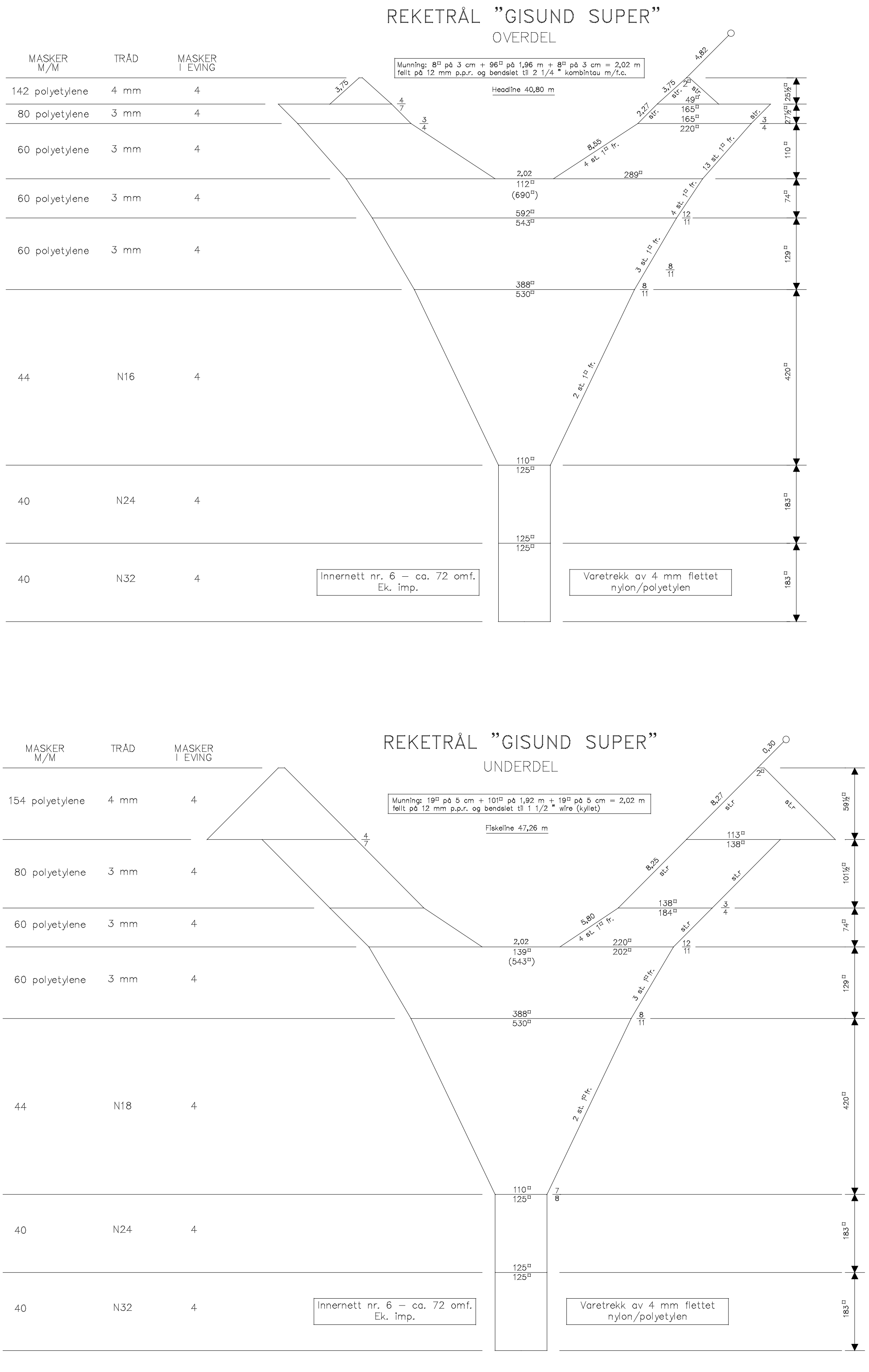


Figure 2a. Design of the trawl used.

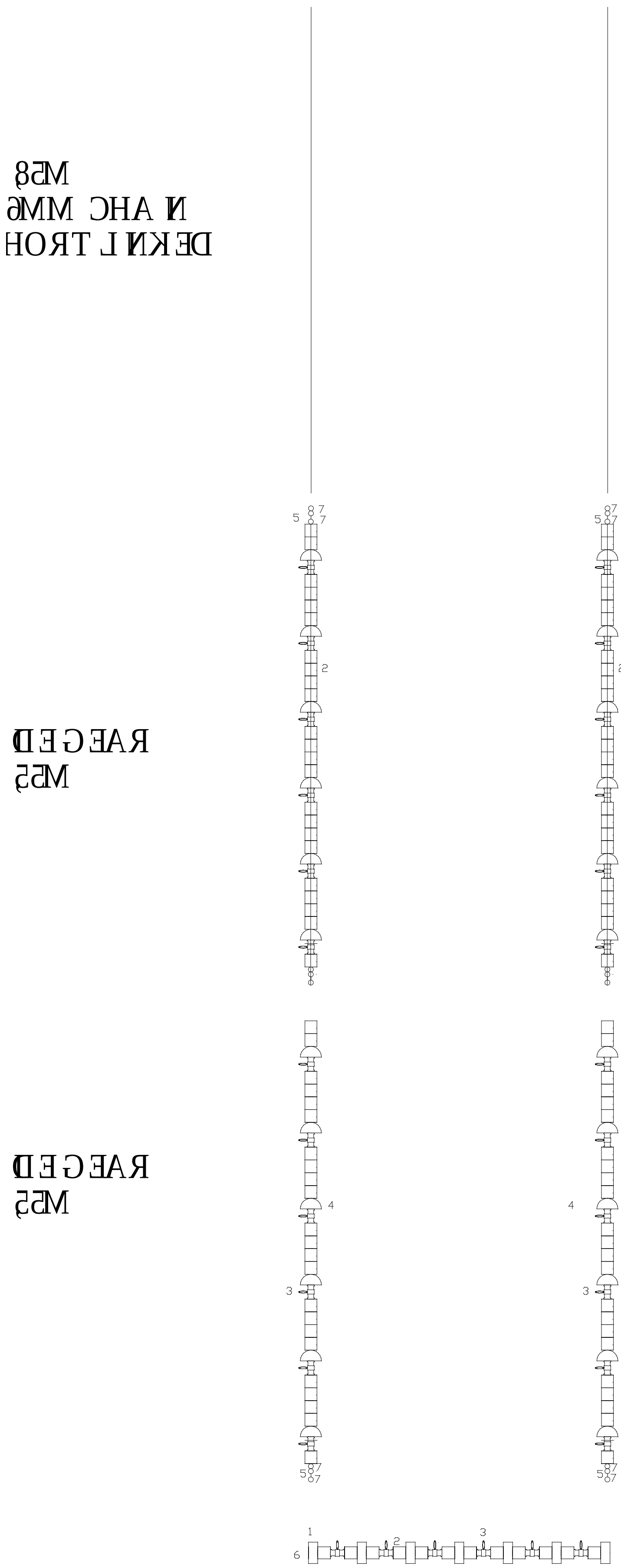


Figure. 2b. Schematic drawing of the ground gear used in the experiments.

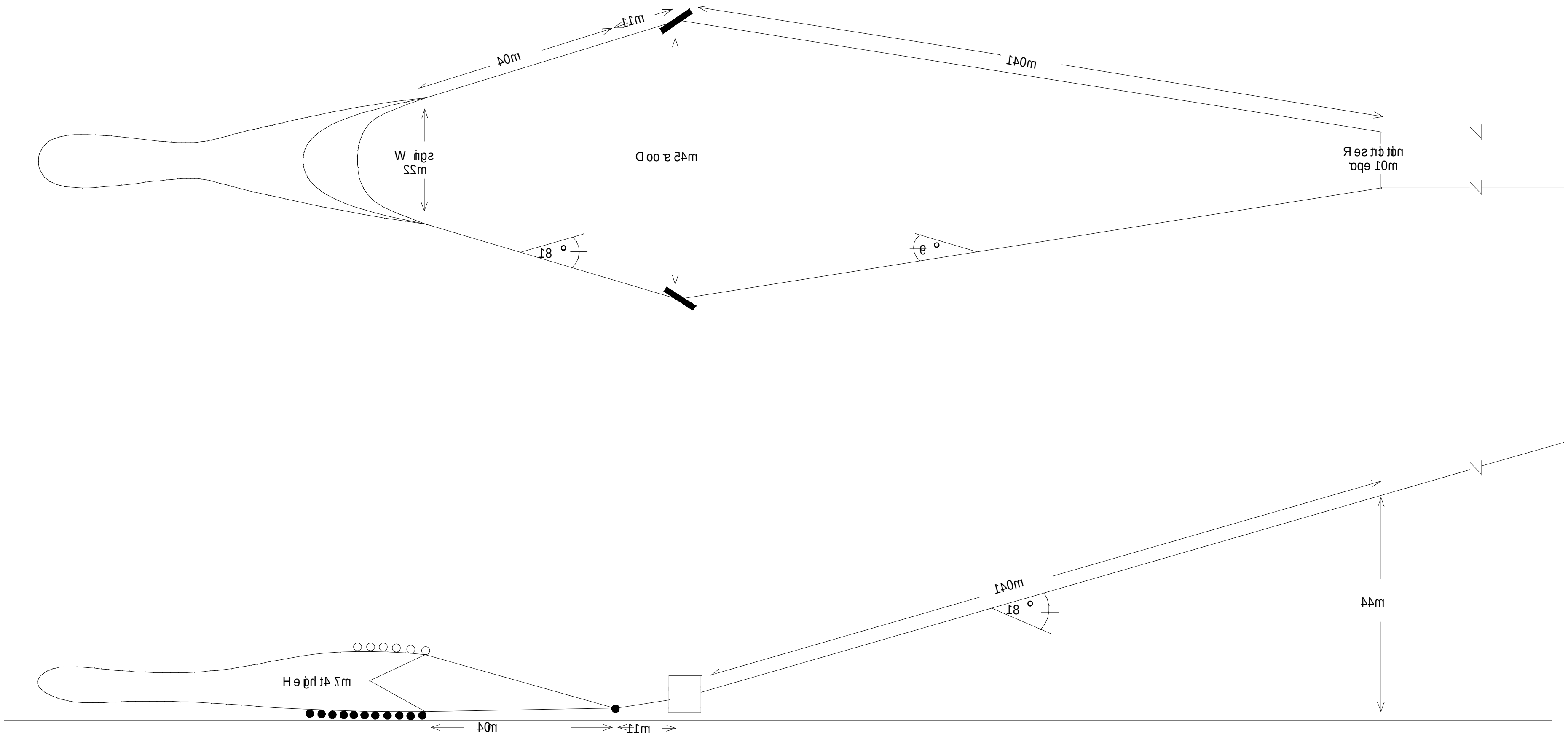


Figure 3a. Schematic presentation of trawl geometry with 40 m long bridles.

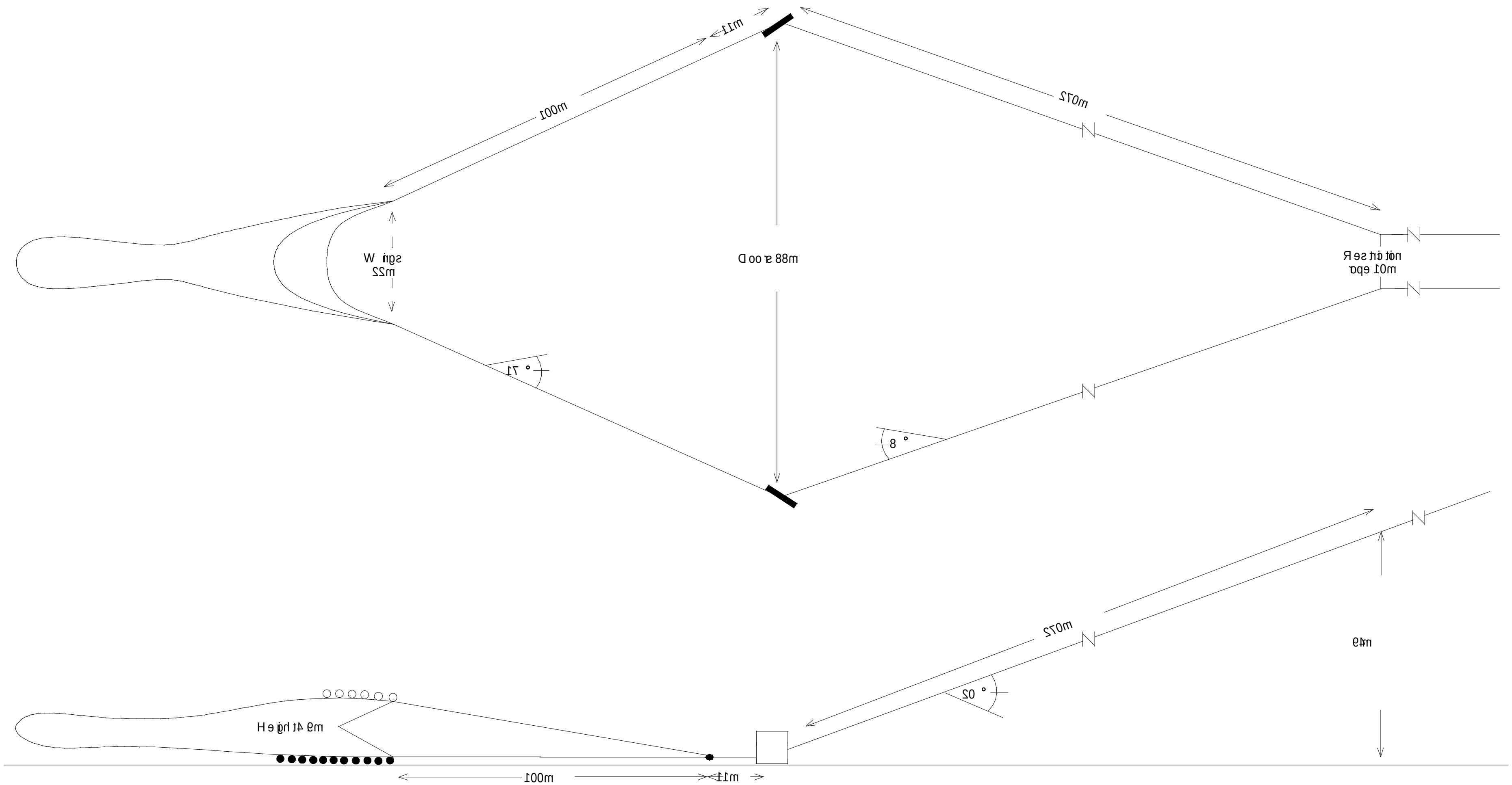


Figure 3b. Schematic presentation of trawl geometry with 100 m long bridles.

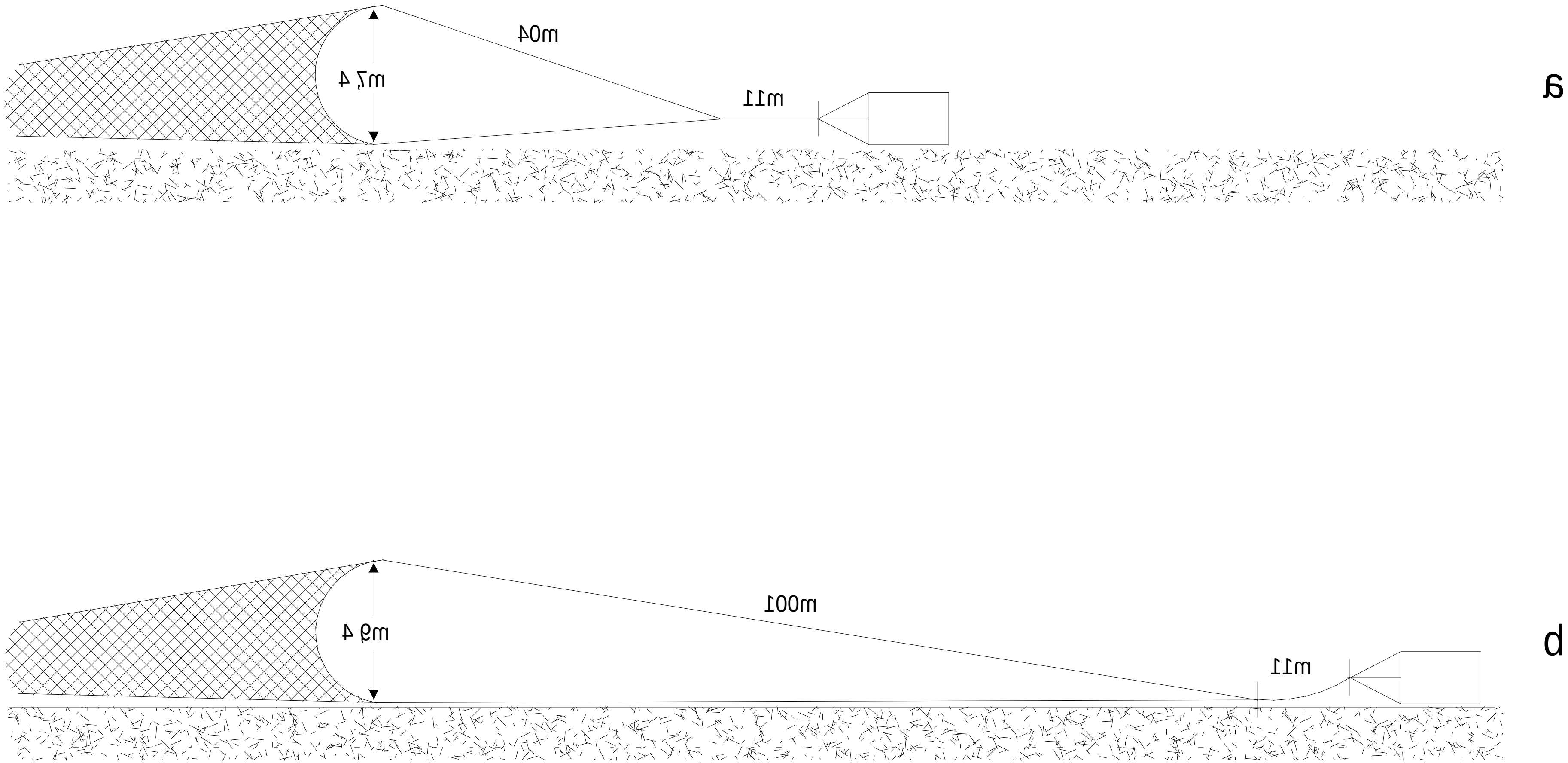


Figure 3c. Schematic presentation of the bridle/sweep designs..

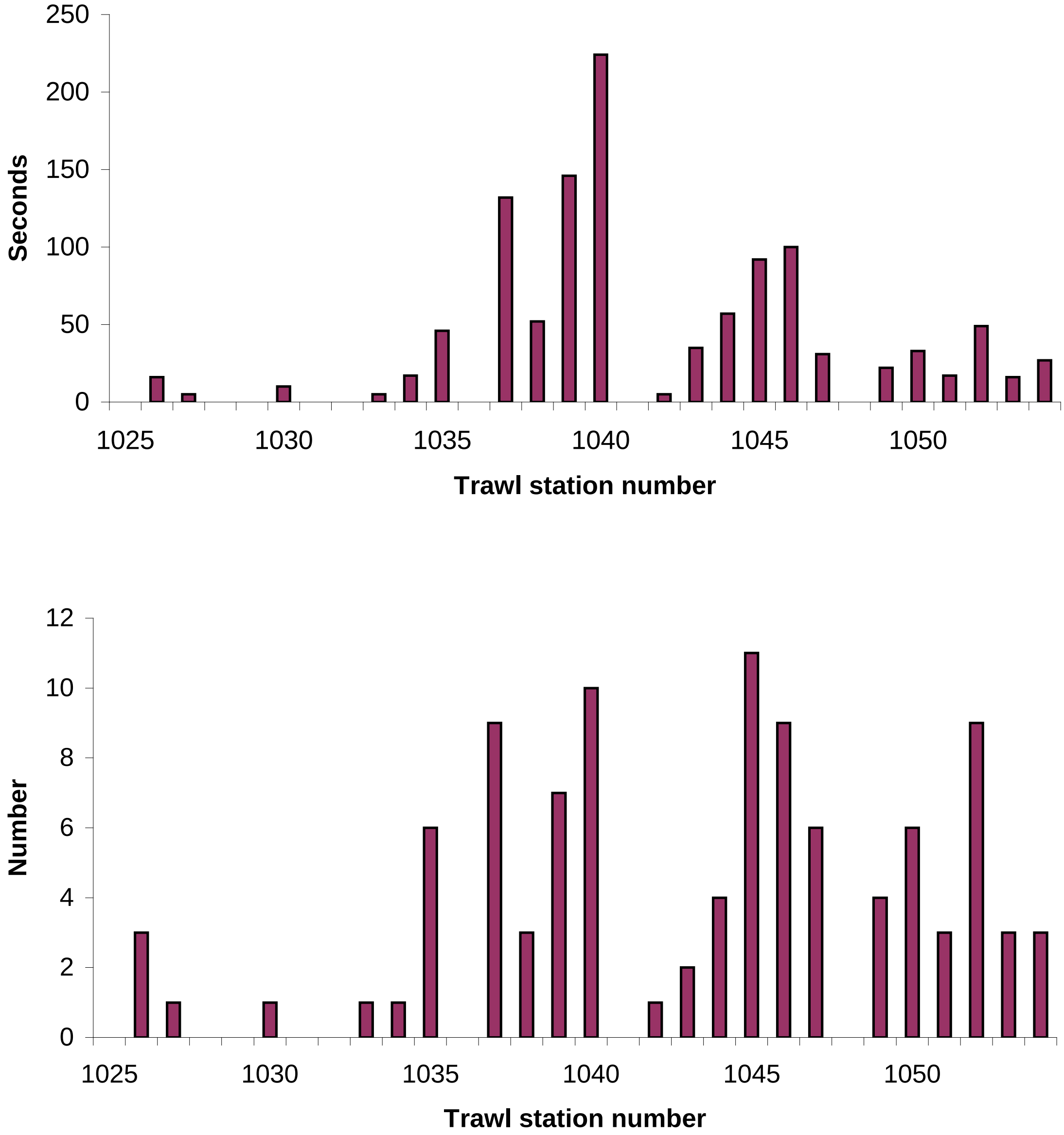


Figure 4. Data collected with the SIMRAD PI30 bottom contact sensor in area A. Upper graph shows the total time during a haul the sensor reported loss of contact and lower graph shows the number of times per haul the sensor reported loss of contact.

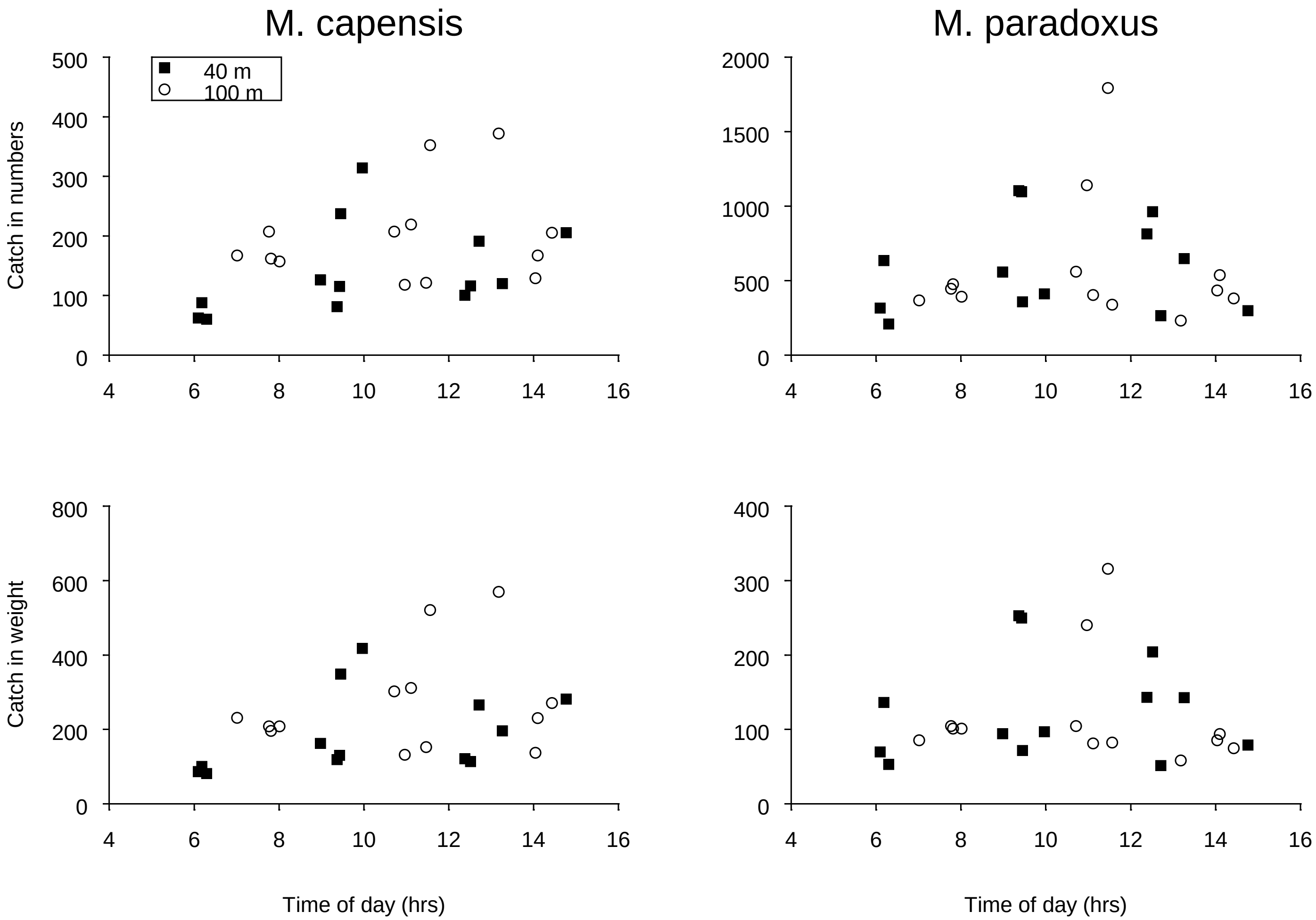


Figure 5. Diel variation in catch rates for the two hake species in area A. Time refers to the start of the haul.

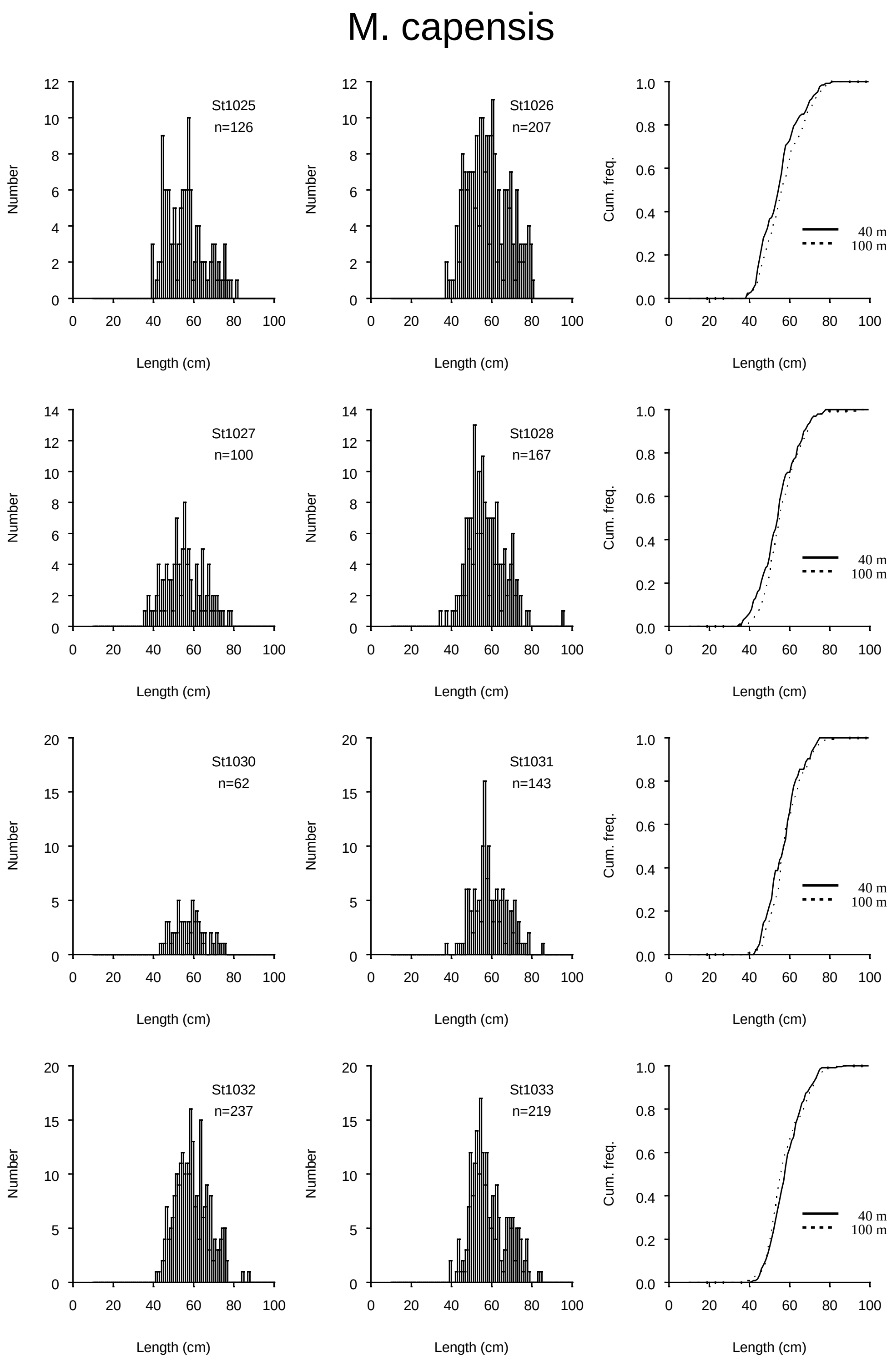


Figure 6. Length frequency distribution for the catch of M. capensis in area A. Each row of graphs represents the data for one pair of hauls.

M. capensis

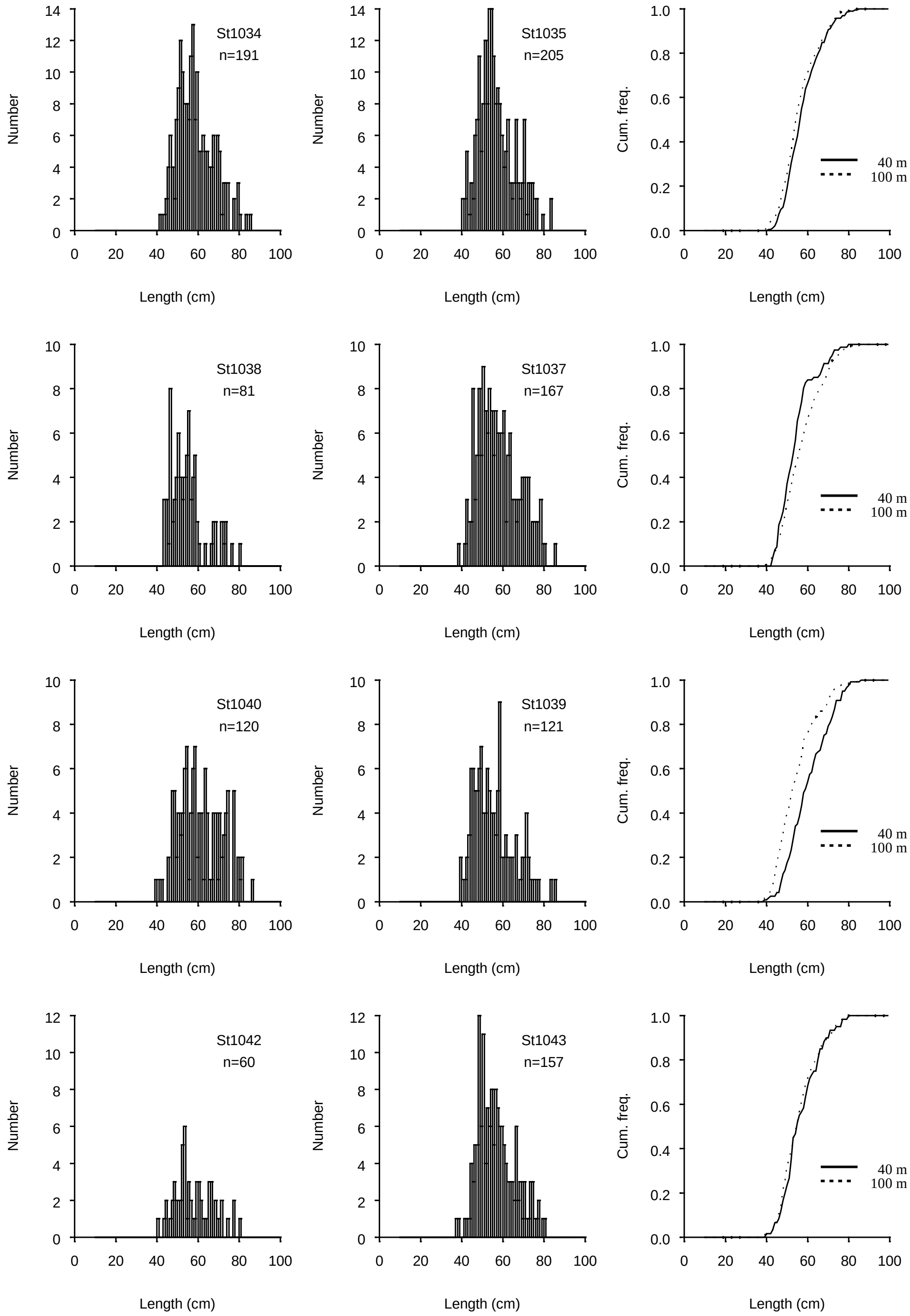


Figure 6. Continued.

M. capensis

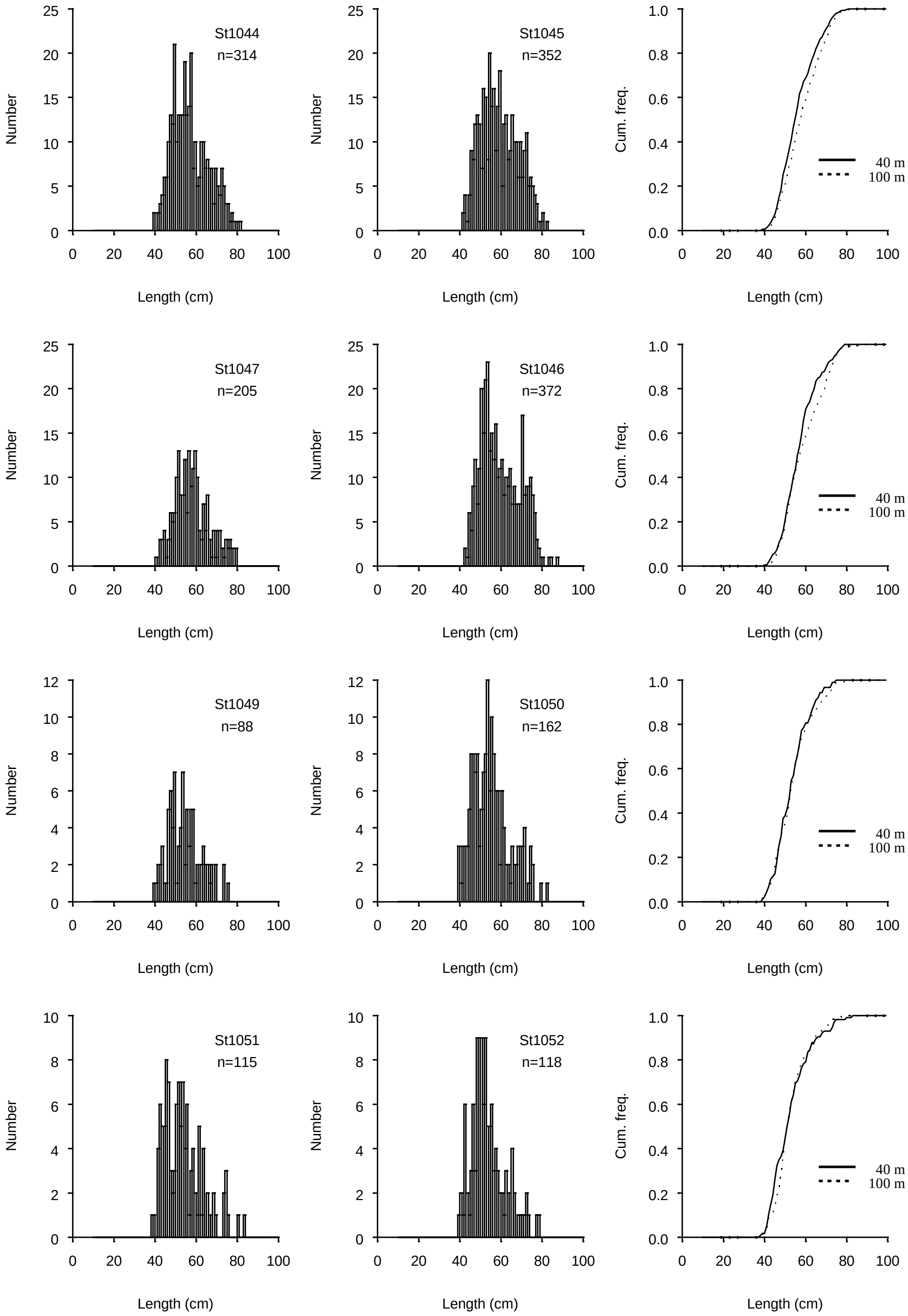


Figure 6. Continued.

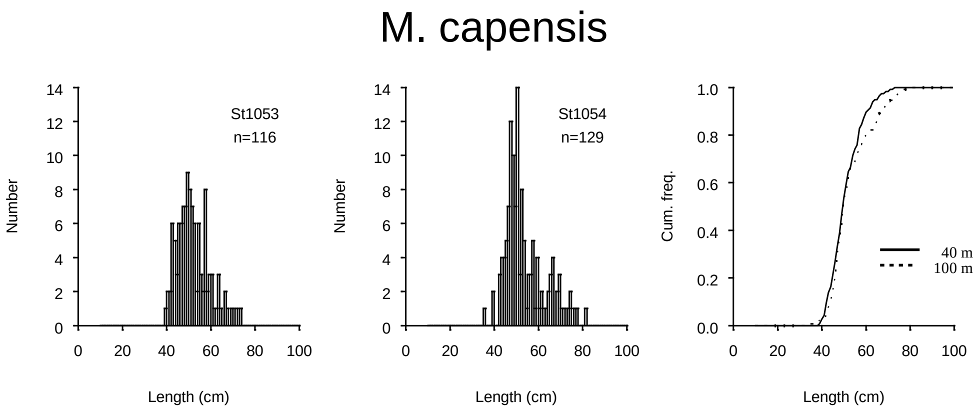


Figure 6. Continued.

M. paradoxus

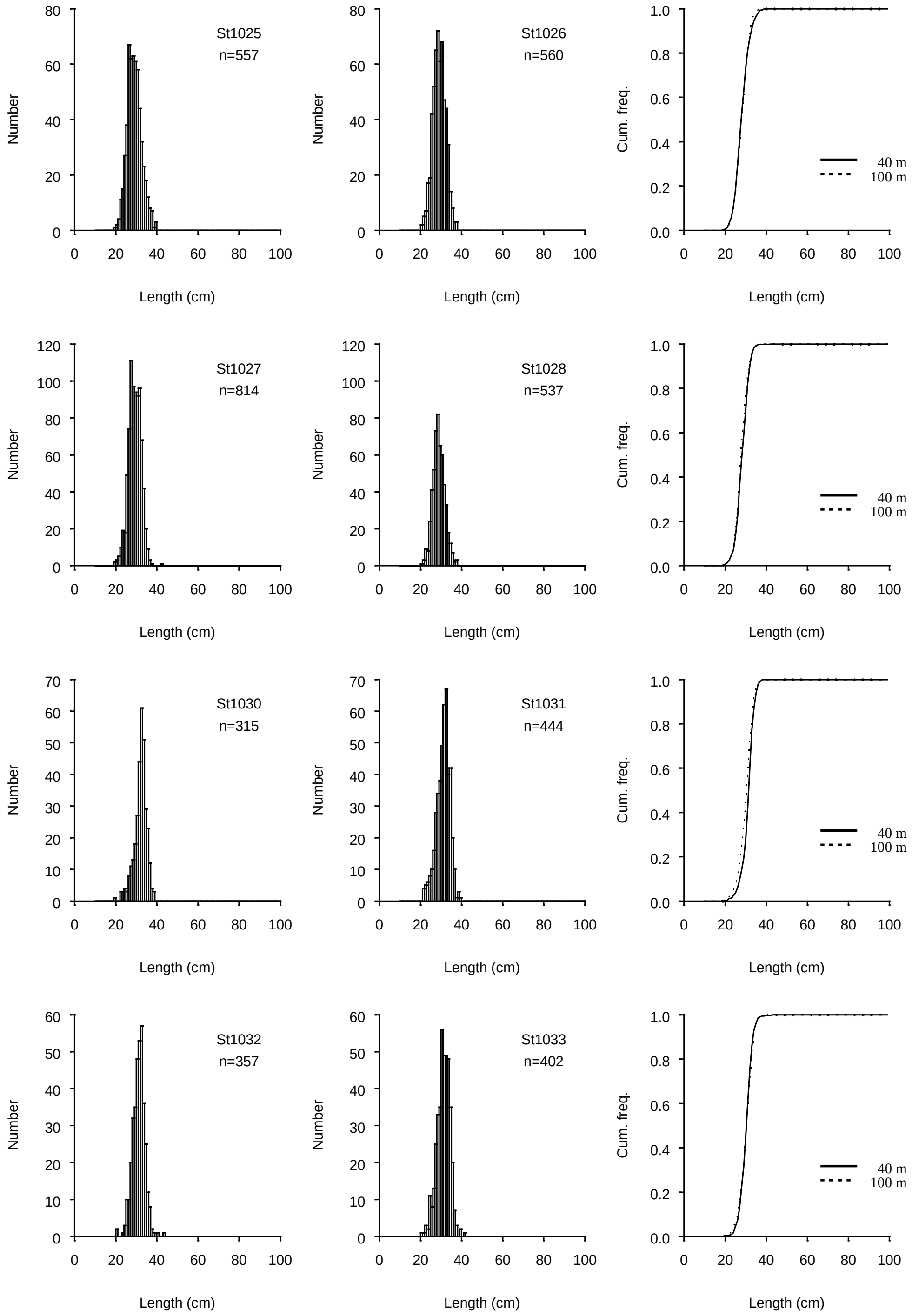


Figure 7. Length frequency distribution for the catch of M. paradoxus in area A. Each row of graphs represents the data for one pair of hauls.

M. paradoxus

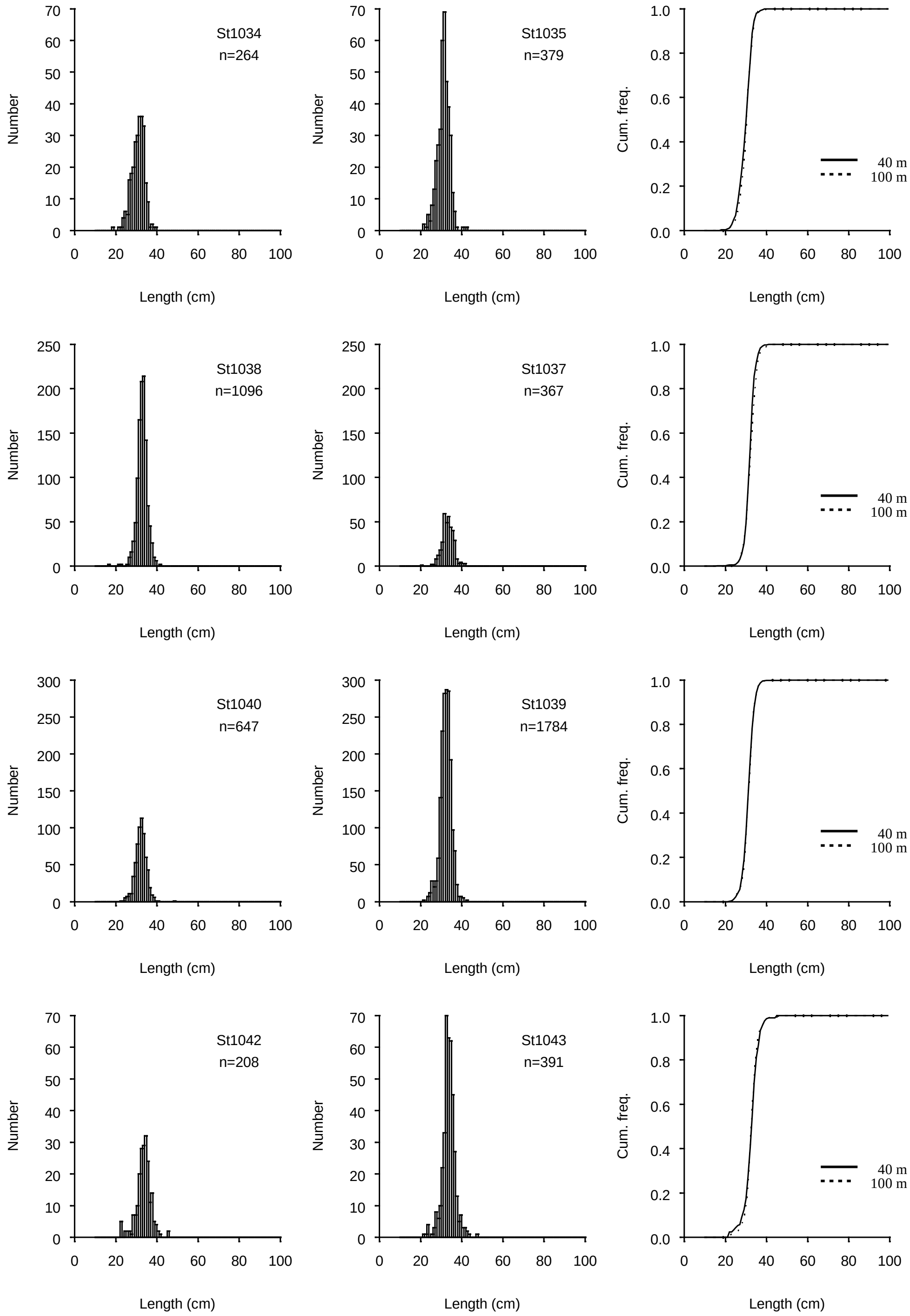


Figure 7. Continued.

M. paradoxus

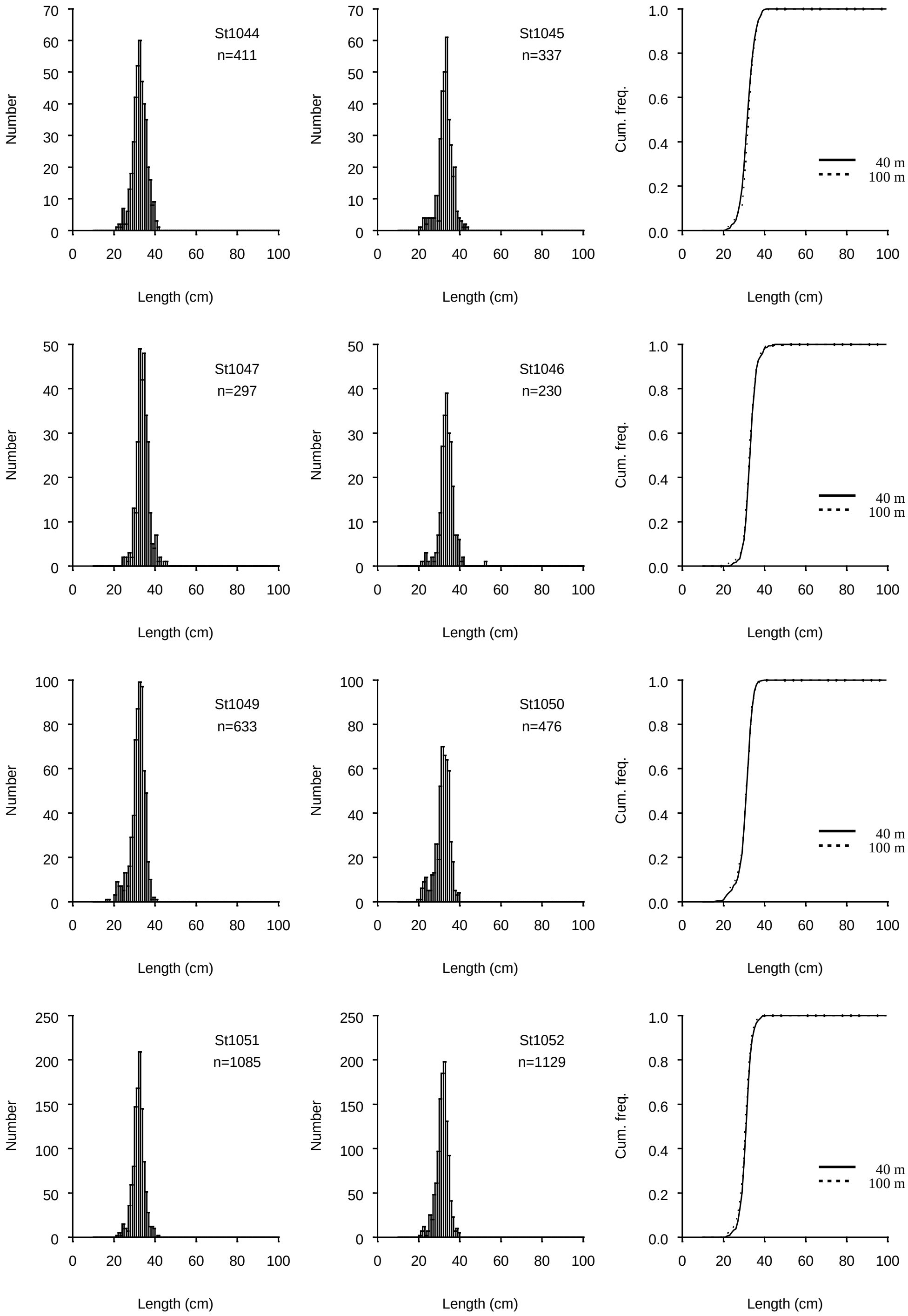


Figure 7. Continued.

M. paradoxus

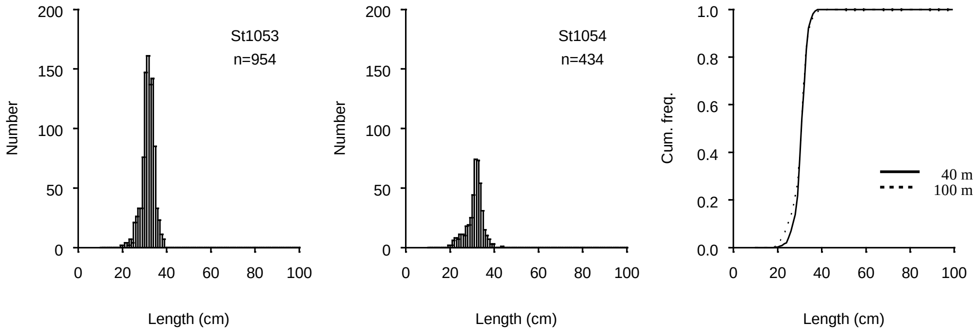


Figure 7. Continued.

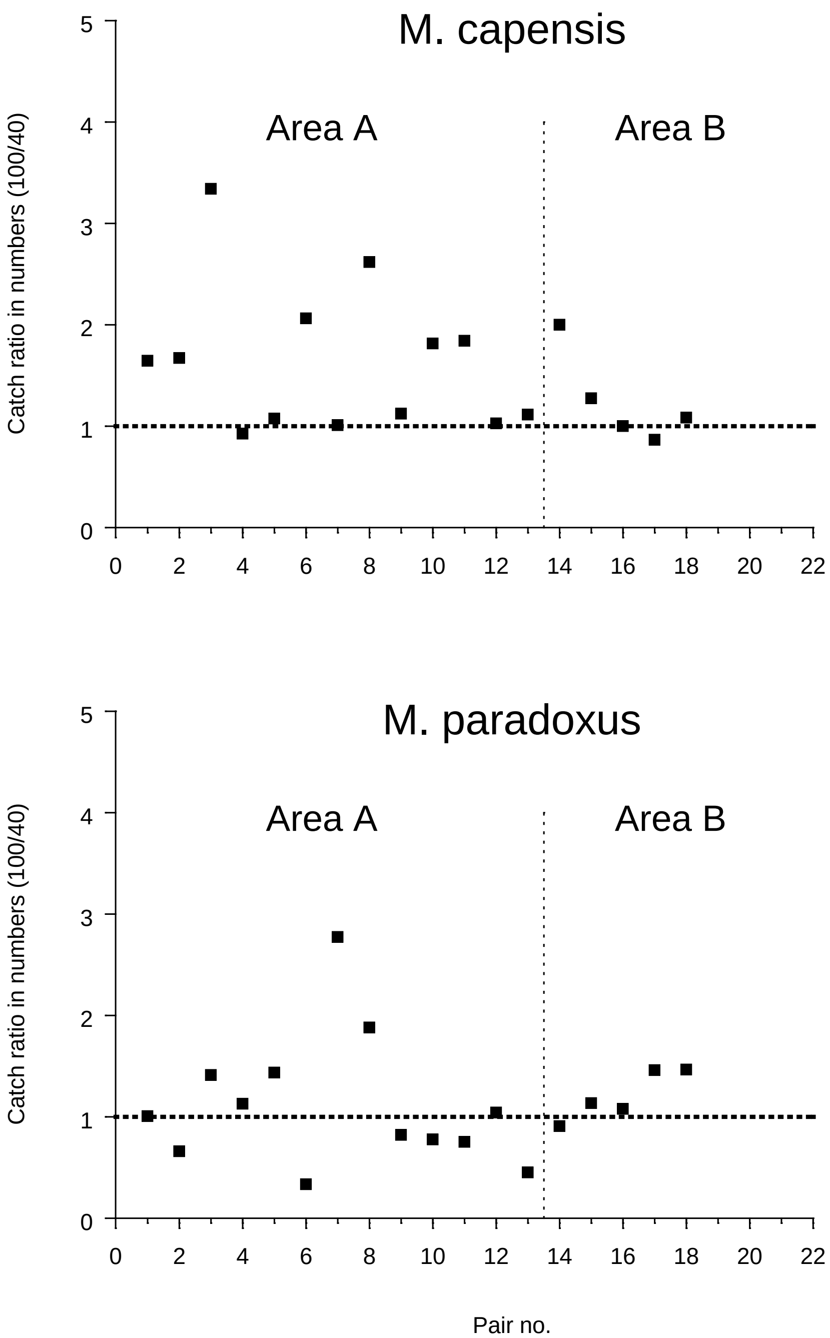


Fig. 8. Ratio of catch in number with 100 m and 40 m long bridles for each pair of hauls. The ratios were calculated separately for the two hake species M. capensis (upper panel) and M. paradoxus (lower panel).

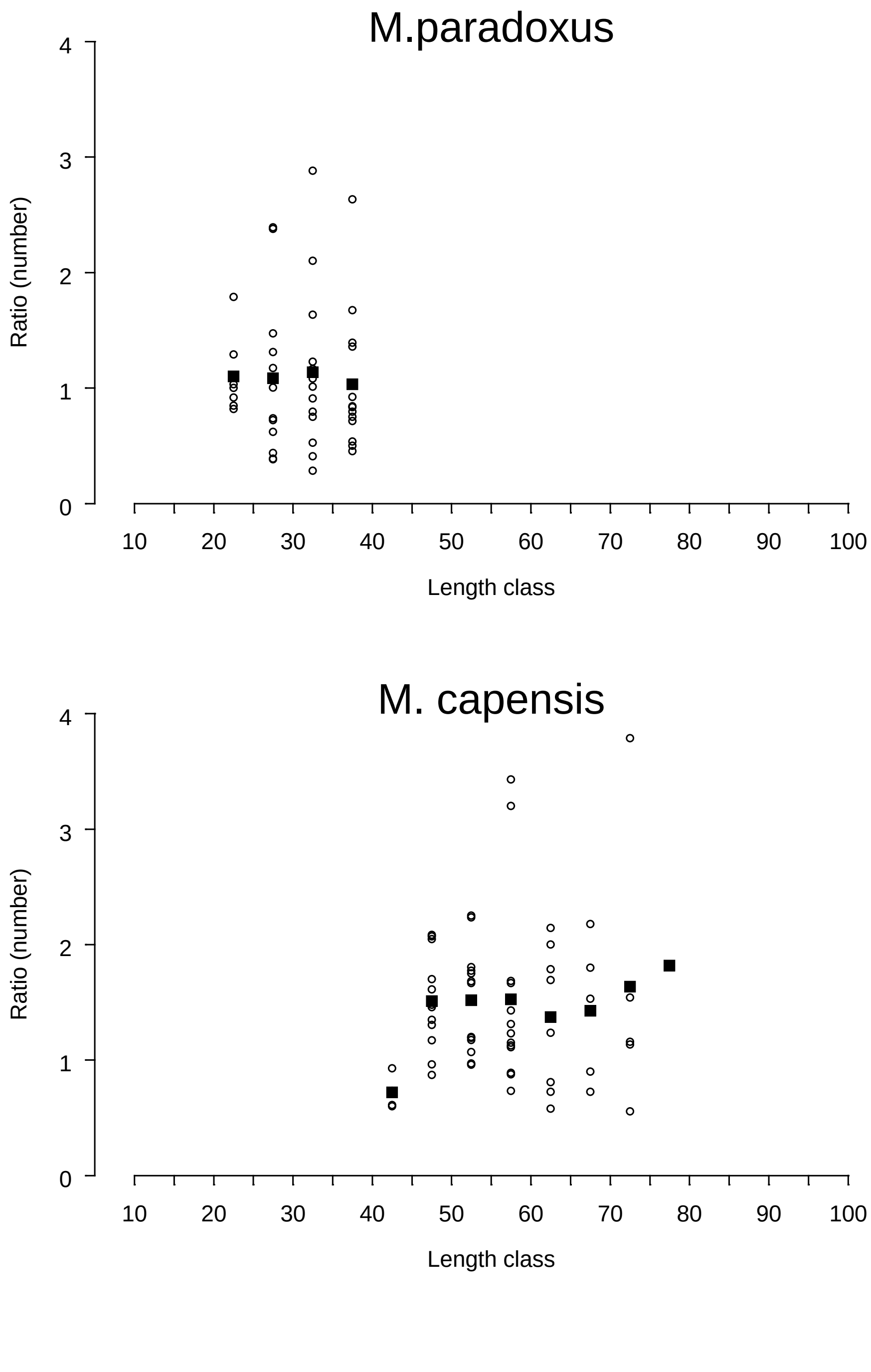
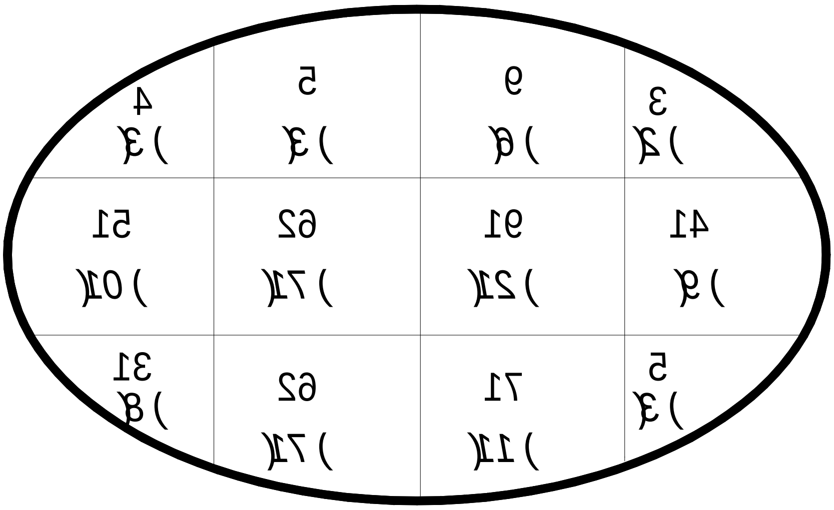
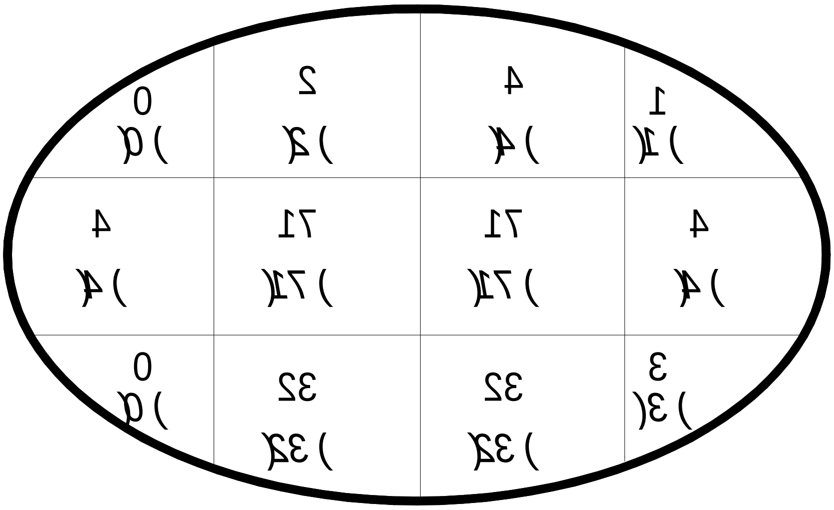


Fig. 9. Catch ratio by length class. Filled squares are the median value of the individual pair-wise observations (small open circles). For each pair of hauls, the observation for a length classs was only included if there was at least 10 fish in that length class for both the paired hauls.



BT1041



BT1055

Figure 10. Number of fish observed with the scanning sonar during trawl stations 1041 and 1055. Figures in brackets are percentages.

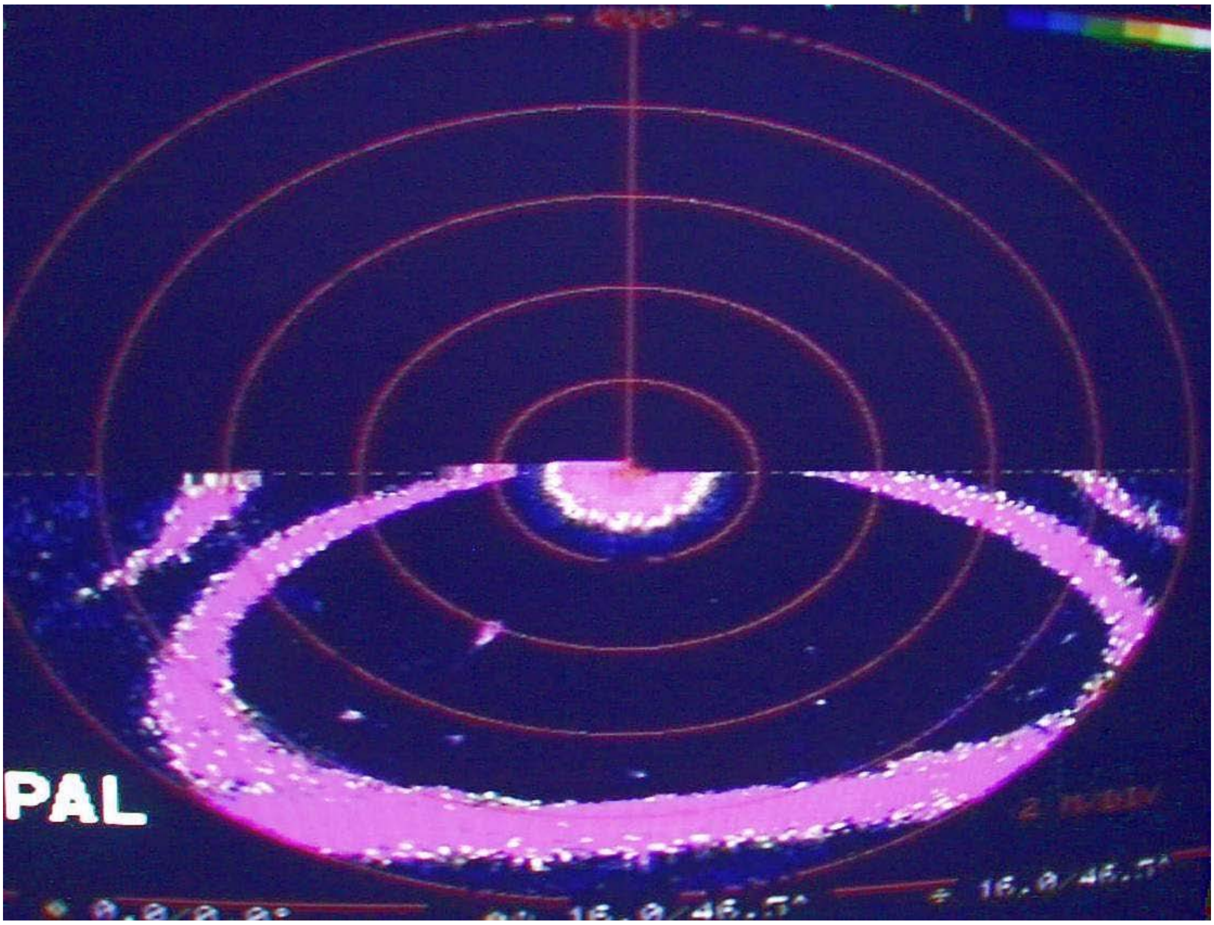


Figure 11. A copy of the scanning sonar display recorded during haul 1041.

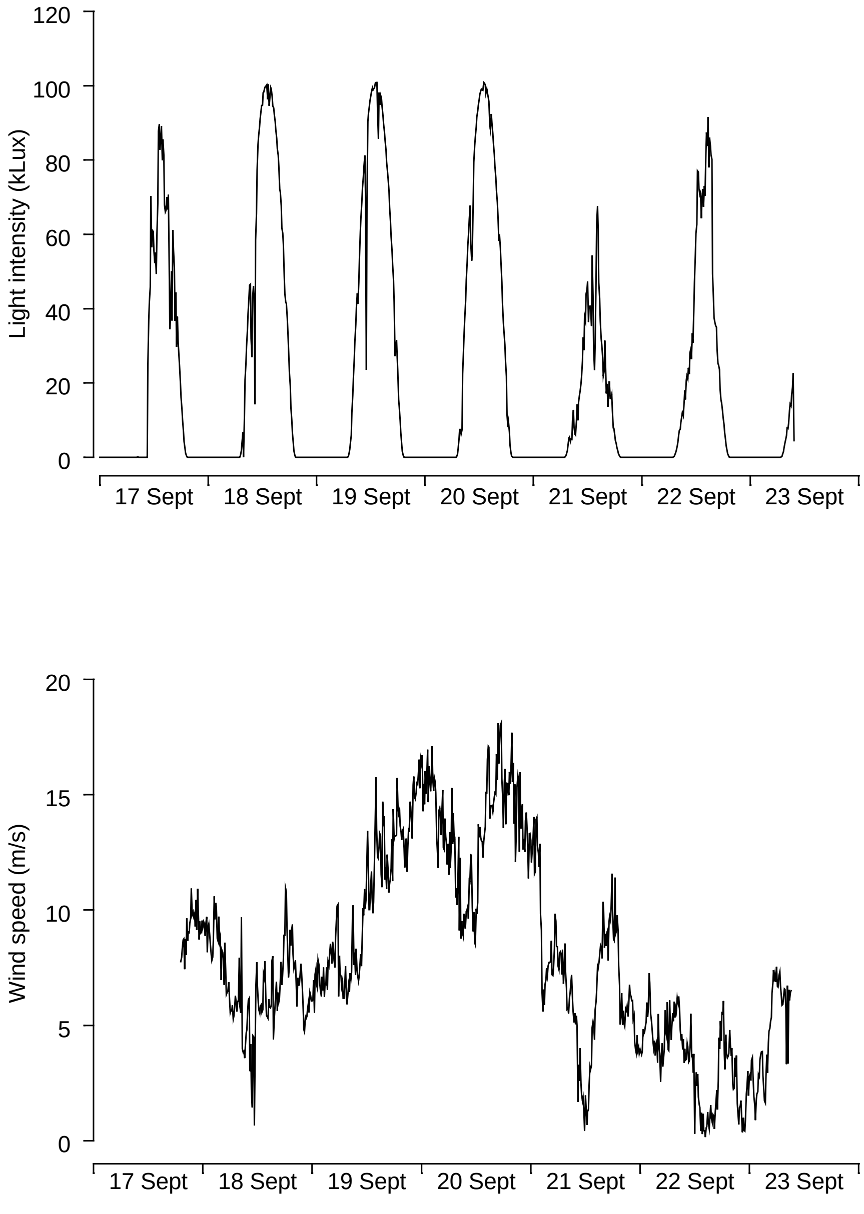


Figure 12. Observed light intensity (upper panel) and wind speed (lower panel) in fishing area A.

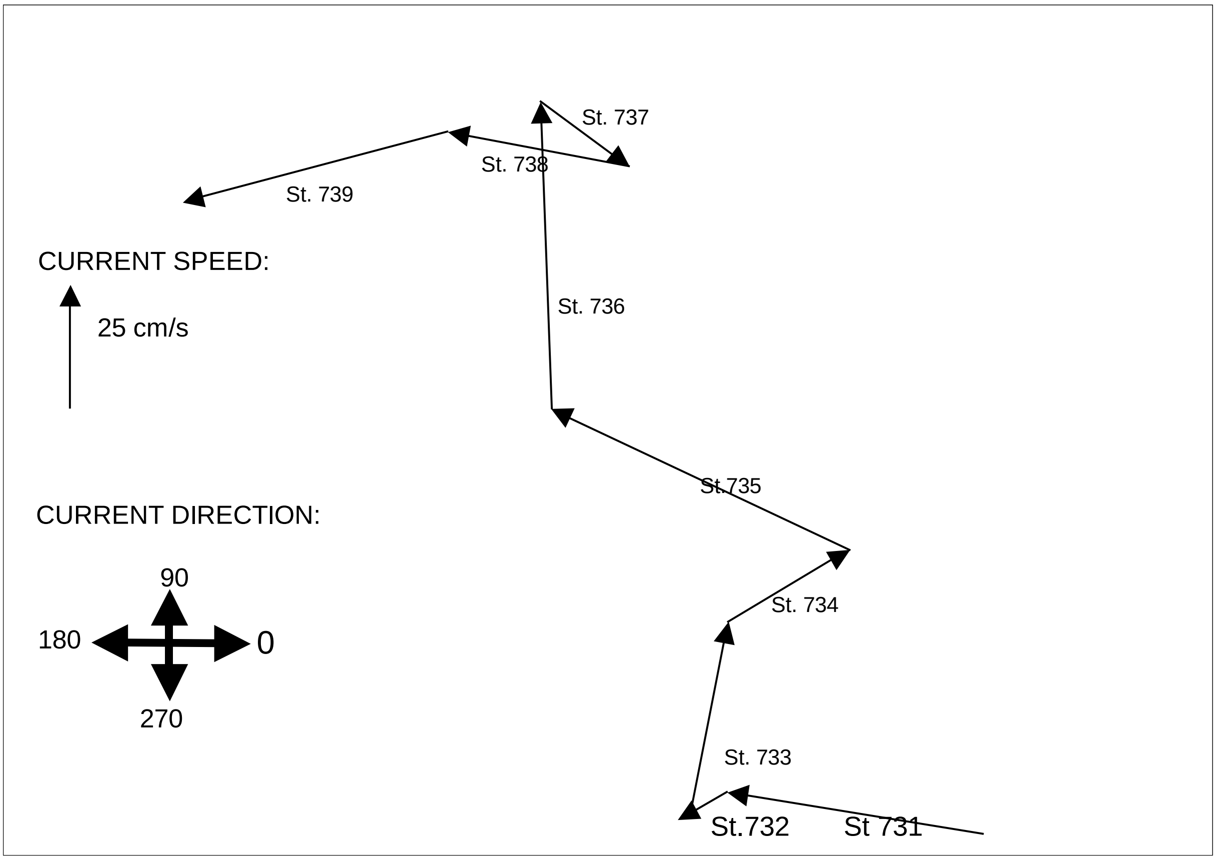
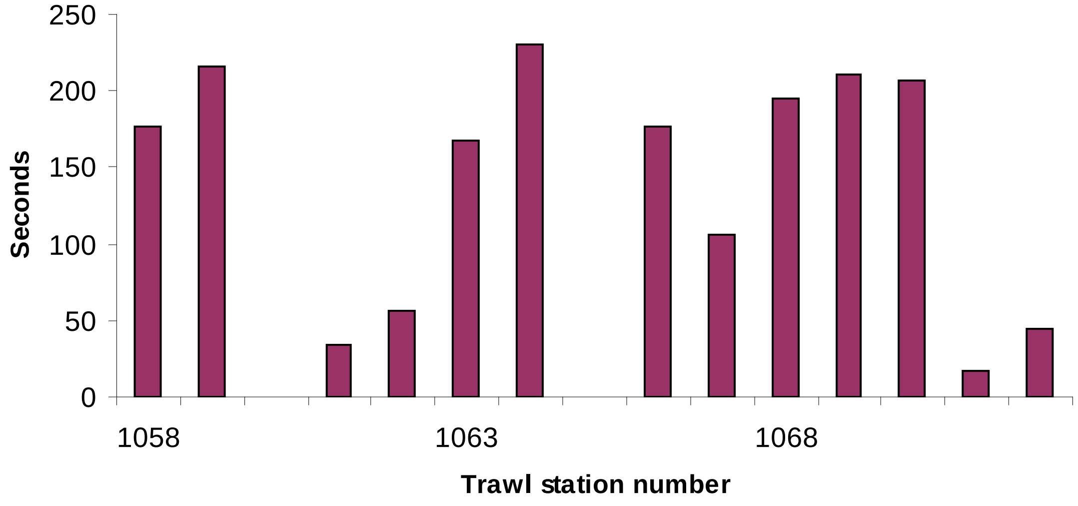


Figure 13. Current speed and direction measured at 315 m depth in area A in the period 17-23 September. See Table 3 for date and time for the different stations.



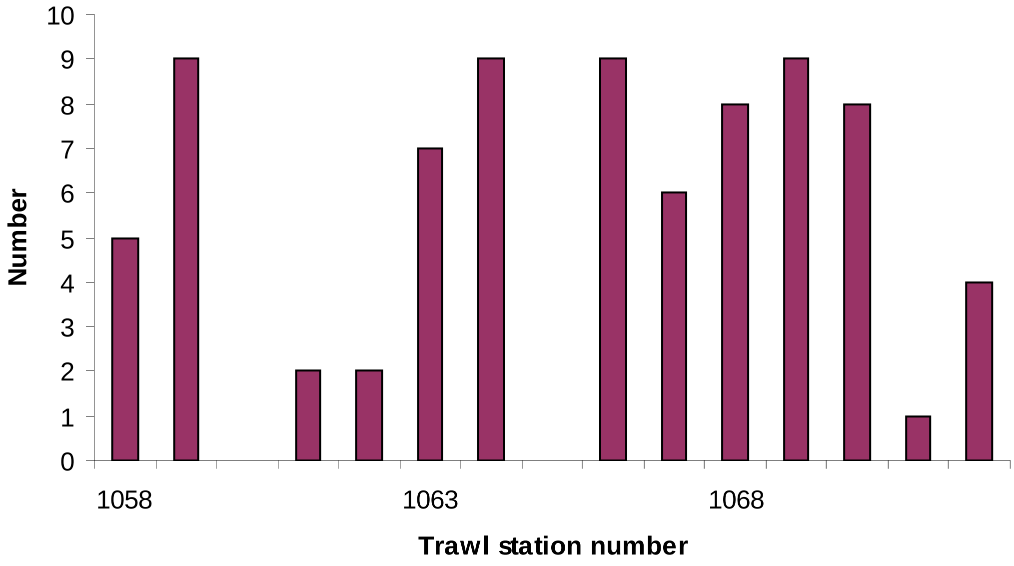


Figure 14. Data collected with the SIMRAD PI30 bottom contact sensor in area B. Upper graph shows the total time during a haul the sensor reported loss of contact and lower graph shows the number of times per haul the sensor reported loss of contact

.

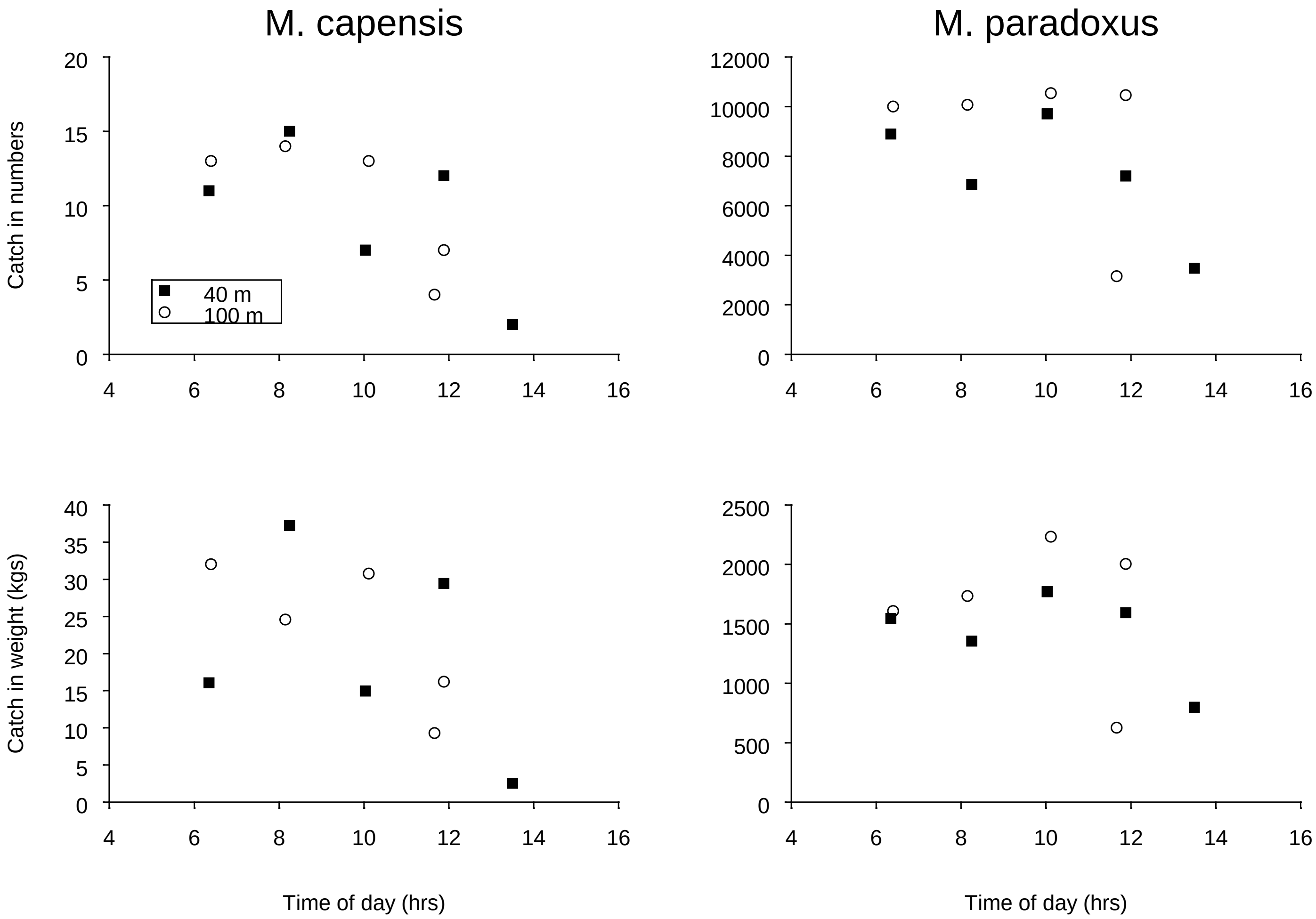


Figure 15. Diel variation in catch rates for the two hake species in area B. Time refers to the start of the haul.

M. capensis

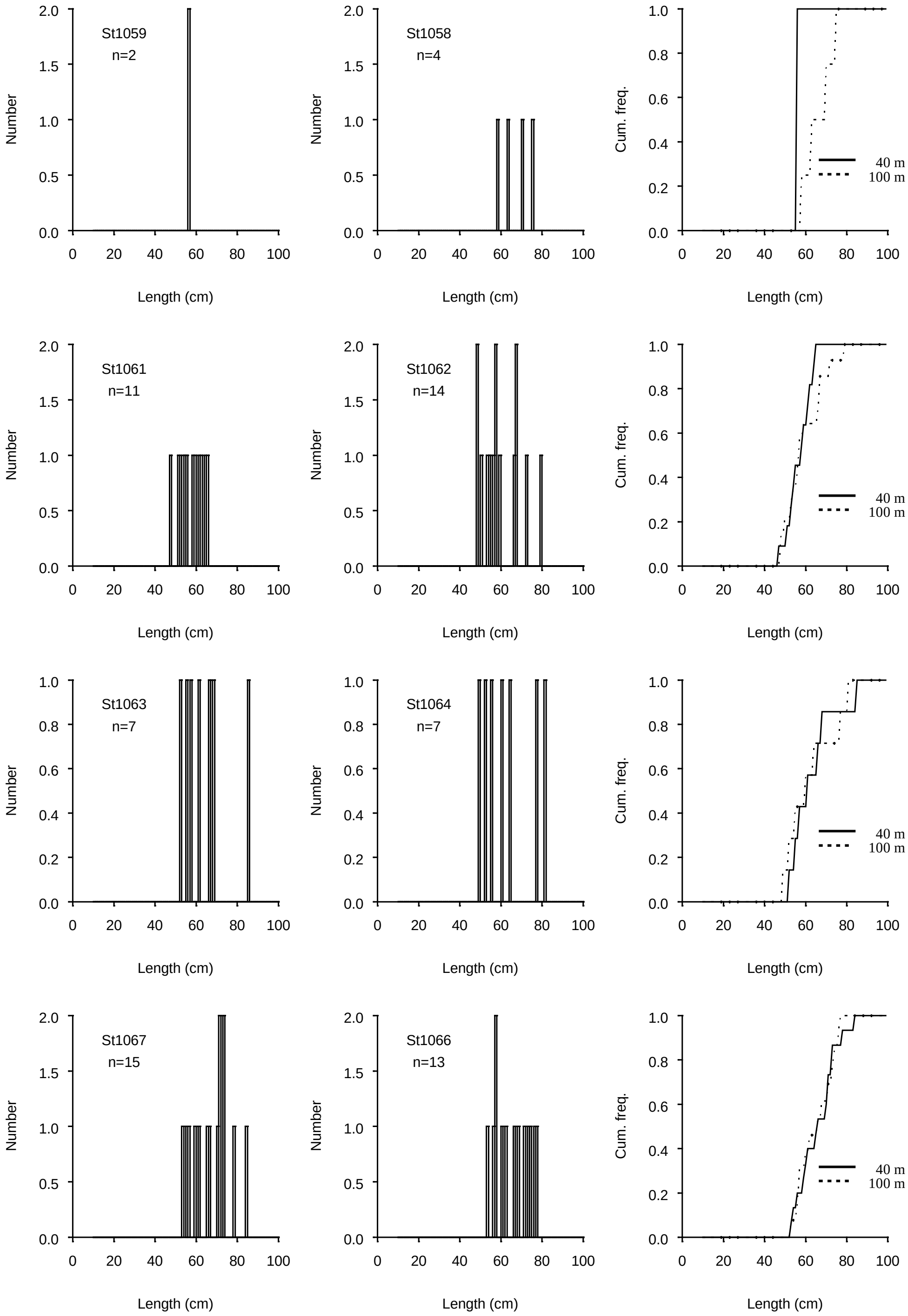


Figure 16. Length frequency distribution for the catch of M. capensis in area B. Each row of graphs represents the data for one pair of hauls

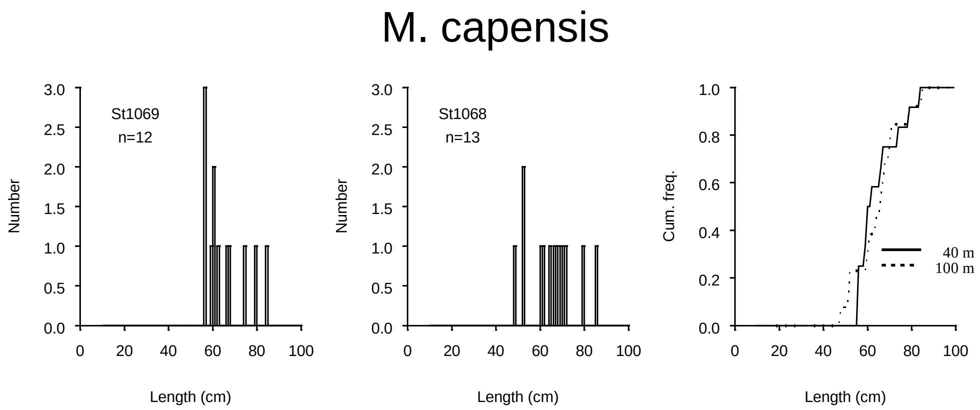


Figure 16. Continued.

M. paradoxus

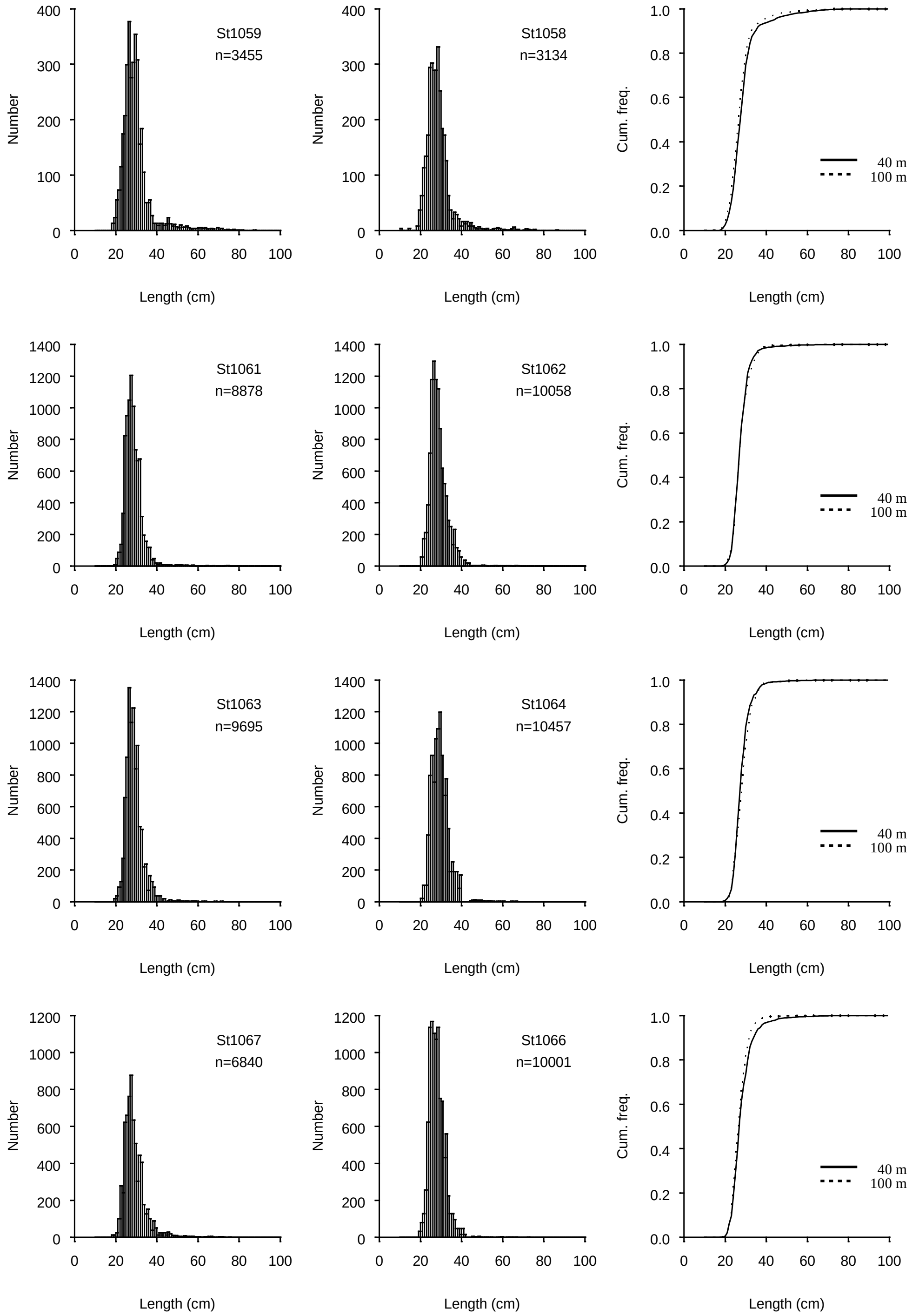


Figure 17. Length frequency distribution for the catch of M. paradoxus in area B. Each row of graphs represents the data for one pair of hauls

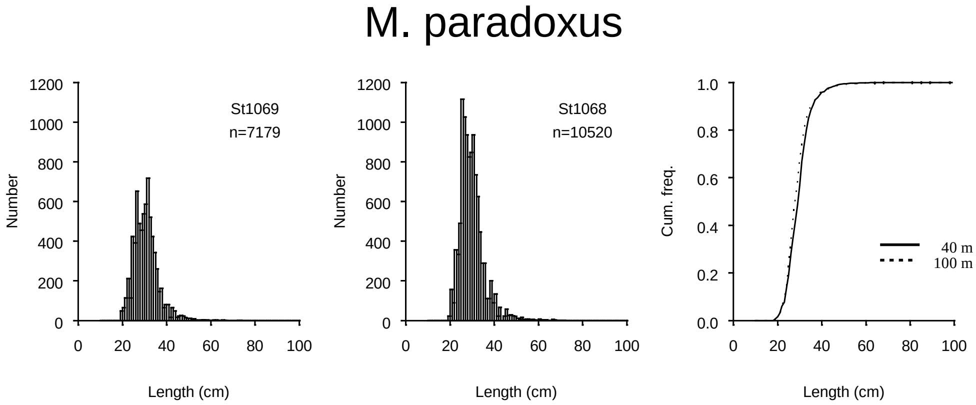


Figure 17. Continued.

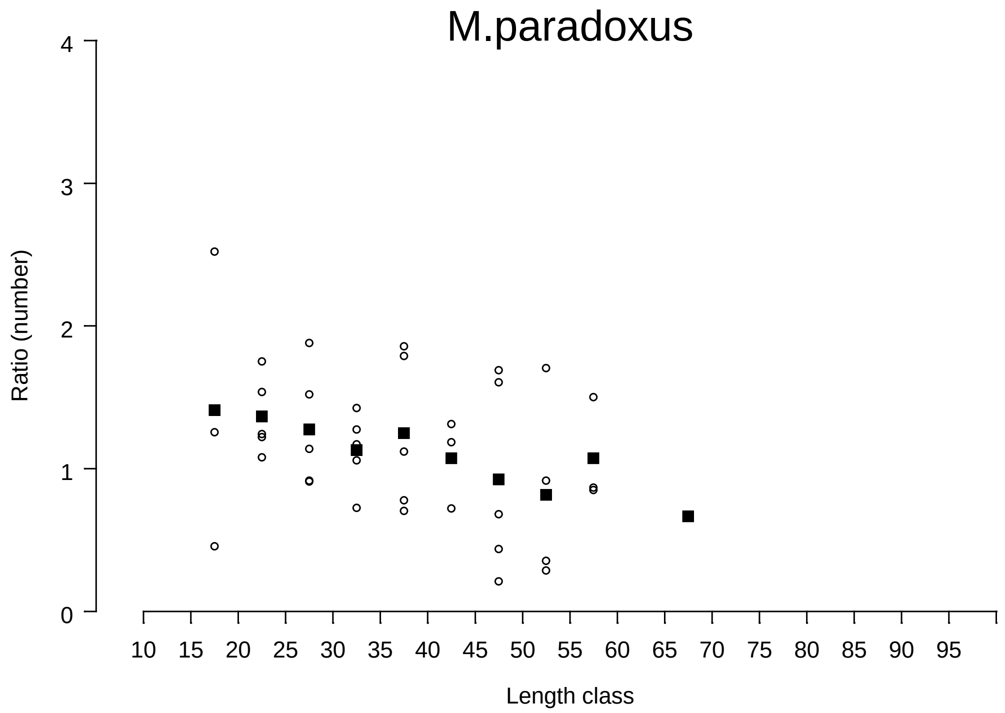
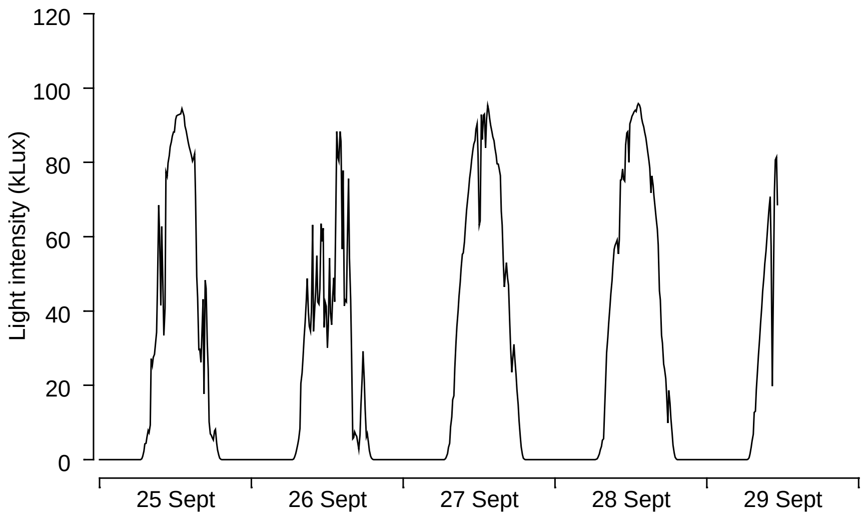


Fig. 18. Catch ratio by length class for M. paradoxus. Filled squares are the median value of the individual pair-wise observations (small open circles). For each pair of hauls, the observation for a length classs was only included if there was at least 10 fish in that length class for both the paired hauls.



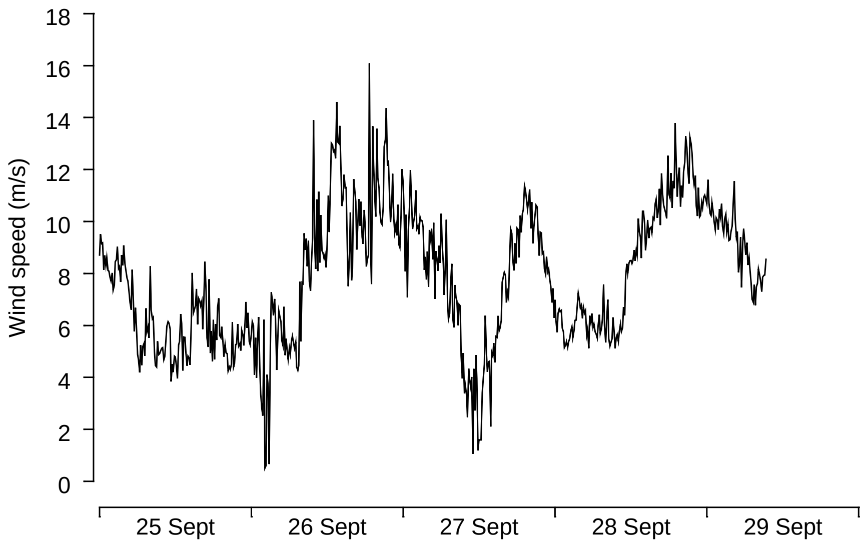


Figure 19. Observed light intensity (upper panel) and wind speed (lower panel) in fishing area B.

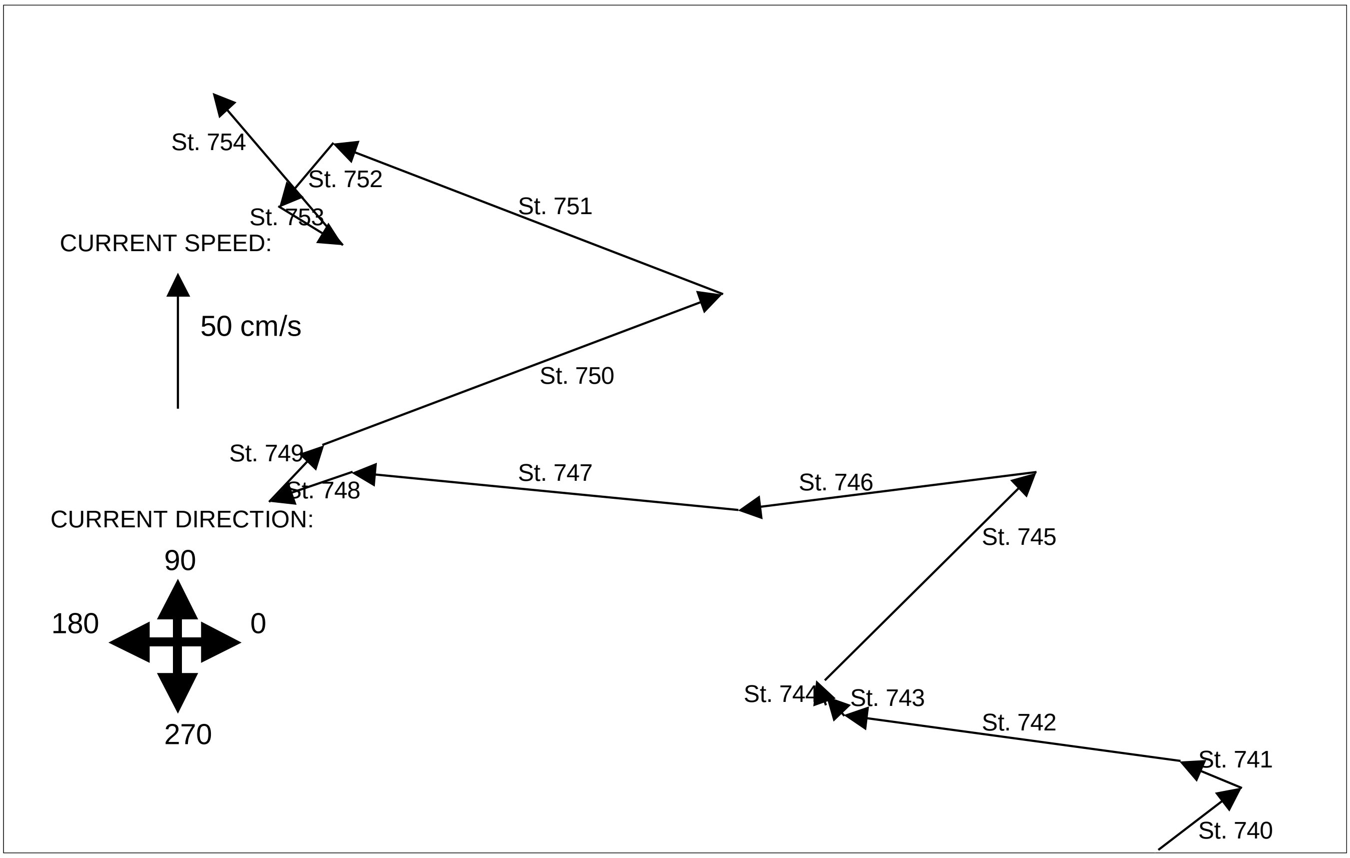
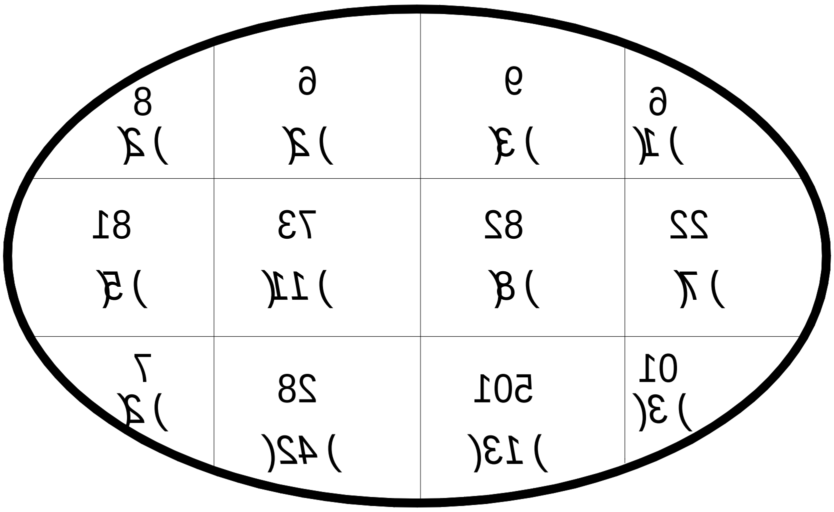


Figure 20: Current speed and direction measured at 315 m depth in area B in the period 25-29 September. See Table 5 for date and time for the different stations.



Bt1065

Figure 21. Number of fish observed with the scanning sonar during trawl stations 1065. Figures in brackets are percentages.

Appendix

Summary of trawl station information as well as Kg's of various species caught. Hauls 1025 to 1055 were made in area A, the remaining in area B.

Station	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035	1036	1037	1038	1039	1040	1041	1042
Sweep Length (m)	40	100	40	100	40	40	100	40	100	40	100	100	100	40	100	40	40	40
Date	18/9/01	18/9/01	18/9/01	18/9/01	18/9/01	19/9/01	19/9/01	19/9/01	19/9/01	19/9/01	19/9/01	19/9/01	20/9/01	20/9/01	20/9/01	20/9/01	20/9/01	21/9/01
Time (GMT)	8:59	10:43	12:23	14:06	16:42	6:06	7:46	9:27	11:07	12:43	14:26	16:17	7:01	9:22	11:28	13:16	15:18	6:18
Depth (m)	367	367	368	370	370	372	367	369	371	369	370	369	370	369	372	370	369	369
Duration (min)	0:29	0:31	0:30	0:30	0:28	0:28	0:29	0:29	0:30	0:30	0:30	0:28	0:29	0:29	0:30	0:28	0:29	0:29
Number of species	13	14	12	13	15	11	12	15	10	12	11	11	17	15	14	16	17	16
Merlucius capensis	162.3	301.7	121.25	230.3	46.45	86.35	207.7	348.3	311.2	265.55	270.55	68.2	230.7	118.85	152	196.05	141.7	81.15
Merluccius paradoxus	94	104.2	142.75	93.85	40.3	69.7	89.15	71.58	80.95	51.15	74.55	6.4	85.15	252.5	315.55	142.55	46.2	52.95
Lophius vomerinus	5.25	13.5	11.75	31.1	1.25	18.6	3.3	20.2	22.05	18.7	23.25	8.05	7.25	1.65	21.75	25.8	2.65	4.2
Genypterus capensis	3.75	2.1	4.90	1.85	2.75	3.95	2.25	0.95	3.3	2.8	2.7	0.65	1.8	2.3	0.6	1	0.8	0.95
Coelrinchus fasciatus	27.9	20.8		22.72	12.4	8.5	15.6	9.25	20.3	4.6	5.8	4.2	17.85	10.5	10	5.6	2.45	10.2
Galues polli	0.4	1.6	0.88	6.72	3.12	5.52	1	2	3.5	1.4			9.78	6.25	4.75	3.6	1.5	1
Helicolinus dactylopterus	34.2	43.04	35.75	21.6	23.2	23.14	1.8	25.75	38.5	12.8	17.6	21.6	30.18	18.5	27.75	4.8	4.1	10.6
Lithodes ferox	1.5		22.55	3.35								1.6	6.8					
Nontacantus sexpinis	1.5	2.4	0.66		0.92	3.32	1.5	0.5		0.6		1.4	20.4	5.75	16.75	6.4	3.5	9.2
Selachophidium guentheri	0.6		3.41	4	1.2			0.75		0.4			0.085	0.5		0.4	0.1	6
Squilia calmari	4.8		26.4	13.44	2.32	3.66	3.6	12.75	20.3	8	4.4	6.4	3.83	4.25	4.5	6	3.1	6
Todarodes saggitatus	6.1	17.6			5.28			2.25		1.2	4.6	2	1.28	14	10	6.4	7.6	2
Trachurus capensis	1.2	1.6	3.41	1.7	3.2		2.7						2.98	0.9			0.2	
Nezumia spp		34.4																
Coelrinchus calmani		6.4																
Bathynectus priperitus			3.19	4.96	2	1.02	1.2	4.5	5.6	2.8	3.8		1.28	1.75	1.5	2.8	0.15	1.6
Nezumia micronychodon				9.28	5.84	13.6	9.9	8.25	47.6	1.2	0.8	1	27.54	5.5	14.5	13.8	1.95	29.4
Ebenania costecanarie					1.04								1.7			0.6	0.1	0.4
Lepidotes caudatus								1.25										
Todaropsis eblanae								0.5										
Raja spp											2.2							
Epigonus telescopus													2.13	1.25	0.75	0.8	0.4	1
Beryx splendens															0.75			
Deep sea mix																	17.75	
Photichthys spp																		0.2
Torped mobiliana																		
Schidophilus huttoni																		
Sqaulus megalops																		
Emmelichthys mitidus																		
Bassanago albescence																		
Gnathopis capensis																		
Soleno Africana																		
Etmopterus lucifer																		
Myxine capensis																		
Zeus capensis																		
Zenopris concifer																		
Lyvothensis diadema																		
Trachyrinchus scabrus																		
Etrumens whiteheadi																		
Sardinops ocellatus																		
Myctophids																		
Shrimps																		

Appendix continued

Station	1043	1044	1045	1046	1047	1048	1049	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060
Sweep Length (m)	100	40	100	100	40	100	40	100	40	100	40	100	100	100	100	100	40	40
Date	21/9/01	21/9/01	21/9/01	21/9/01	21/9/01	21/9/01	22/9/01	22/9/01	22/9/01	22/9/01	22/9/01	22/9/01	22/9/01	25/9/01	25/9/01	25/9/01	25/9/01	25/9/01
Time (GMT)	8:01	9:58	11:34	13:11	14:46	16:55	6:11	7:49	9:26	10:58	12:31	14:02	15:42	6:20	8:53	11:40	13:30	15:26
Depth (m)	369	368	369	370	369	369	369	368	369	369	369	370	369	426	277	468	468	467
Duration (min)	0:31	0:30	0:30	0:30	0:30	0:29	0:30	0:31	0:30	0:29	0:30	0:29	0:29	0:29	0:30	0:30	0:30	0:29
Number of species	15	15	14	15	15	15	15	14	15	16	15	15	14			13	14	8
Merlucius capensis	208.3	416.85	520.65	569.2	281.1	53.7	100.35	195.85	129.9	131.25	113.4	136.9	66			9.3	2.55	5.3
Merluccius paradoxus	101	96.75	82.05	58.1	78.9	16.25	136.2	101	249.65	239.95	203.95	85.16	61.75			627.05	797.2	198.45
Lophius vomerinus	21.85	26.2	5.75	6.85	1.3	8.25	5.7	24.6	13.25	8	6.45	14.95	15.95			29.4	9.85	5.45
Genypterus capensis	2.45	4.2	2.25	2.05	0	1.95	0	0	0	0	0	1.55	0			8.4	0	0
Coelrinchus fasciatus	22.5	21	13.4	6.2	4.5	10.9	15	16.2	7.8	8.85	9.4	5.4	4			53.76	48.3	
Galues polli	6	1.4	1	1	0.3	3	1.6	2.4	0.3		0.44	0.4						
Helicolinus dactylopterus	14.5	42	12.2	7	3.75	40.5	2.6	10	3.3	6.9	7	12.8	20.7			8.2	17.48	5.6
Lithodes ferox																		
Nontacantus sexpinis	6	9.8	4.4	2.6	2.4	6.75	7	2	0.9	0.6	1.6	0.4	0.39			8.4	35.88	18.4
Selachophidium guentheri	2.5		10.2	0.2		0.75	0.44		0.15	0.45								
Squilia calmari	10	16.8		11.8	10.8	3.38	3.4	6.2	7.05	6.6	12.4	17.6	3.5					
Todarodes saggitatus	26.5	4.55	5	1	6	3.75	5.2		6	10.2	26.8	7.4	6.8					
Trachurus capensis							1.4			1.8						4.62		
Nezumia spp																		
Coelrinchus calmani																		
Bathynectus priperitus	2.5	4.55	2.2	3.8	2.4	3	1.4	4.5	2.25	2.1	1.44	4.4	0.46					
Nezumia micronychodon	86	23.8	24.6	23	4.95	24.4	20.4	16.8	1.2	1.8	2	0.28	0.08					
Ebenania costecanarie	2.5	0.7				0.75	0.88	0.52			0.16	1.6						
Lepidotes caudatus																		
Todaropsis eblanae																21	2.76	11.6
Raja spp																		
Epigonus telescopus	2.5	1.75	1.8	3	4.35	3.75	0.6	0.24	0.9	0.45	0.2	2.8	0.1					
Beryx splendens																		
Deep sea mix											52	36.8	12.15			1.85		
Photichthys spp					0.03													
Torped mobiliana		4.55		1.4														
Schidophilus huttoni			9.6															
Sqaulus megalops					1.5				1.05	1.35						6.3		
Emmelichthys mitidus																29.4	1.84	
Bassanago albescence																2.52	8.51	6
Gnathopis capensis																8.4		
Soleno Africana																4.37	2.99	6
Etmopterus lucifer																1.09	12.65	13.2
Myxine capensis																	0.69	
Zeus capensis																	2.3	
Zenopris concifer																	2.07	
Lyvothensis diadema																		
Trachyrinchus scabrus																		
Etrumens whiteheadi																		
Sardinops ocellatus																		
Myctophids																		
Shrimps																		

Appendix continued

Station	1061	1062	1063	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075
Sweep Length (m)	40	100	40	100	100	100	40	100	40	40	40	40	0	0	0
Date	25/9/01	26/9/01	26/9/01	26/9/01	26/9/01	27/9/01	27/9/01	27/9/01	27/9/01	27/9/01	28/9/01	28/9/01	28/9/01	28/9/01	29/9/01
Time (GMT)	6:21	8:09	10:02	11:53	13:56	6:24	8:15	10:07	11:53	14:07	6:19	9:43	11:56	14:48	6:17
Depth (m)	457	455	459	465	465	456	458	463	460	463	459	458	250	420	456
Duration (min)	0:29	0:30	0:30	0:31	0:30	0:00	0:30	0:30	0:31	0:30	0:30	0:30	0:46	0:00	0:32
Number of species	10	11	11	12	9	11	11	9	10	11	16	15	8	6	14
Merlucius capensis	16.05	24.55	14.95	16.2	17.75	32	65.45	30.75	29.4	0	4.8	0	0	0	0
Merluccius paradoxus	1545.9	1732.2	1769.4	2003.3	789.6	1605.7	1354.6	2231.8	1592.4	283.7	17.9	35.8	10	17.65	18.8
Lophius vomerinus	18.9	8.55	26.3	18.95	11.7	7.25	9.6	5.85	17.45	3.1	8.4	18.45	0	0	0.65
Genypterus capensis	0	2.5	0	0.85	3.5	1.6	6.15	1.85	1.3	4.7	1.85	0.5	0	0	0
Coelrinchus fasciatus	52.92	97.45	77.78	55.65	23.6	59.2	30.48	114.85	34.23	12.75	20.2	24.5			21.65
Galues polli															
Helicolinus dactylopterus	8.33	10.62	10.98	43.05	12.15	6.4	13.34	79.17	2.45	4.95	11.3	15.45			12.3
Lithodes ferox															
Nontacantus sexpinis	1.47	8.69	4.58				1.02	3.35		2.3	2.85	5.35			3.1
Selachophidium guentheri															
Squilia calmari															
Todarodes saggitatus															
Trachurus capensis		6.76	6.4									1.05			
Nezumia spp															
Coelrinchus calmani															
Bathynectus priperitus															
Nezumia micronychodon															
Ebenania costecanarie	1.47										0.7	1.16			0.1
Lepidotes caudatus											0.5				
Todaropsis eblanae			8.97	9.45			6.35		2.45	7.75	1.85	0.04			
Raja spp															
Epigonus telescopus					0.54										
Beryx splendens															
Deep sea mix											4.8	4			5
Photichthys spp					0.81					0.5		0.14	1.15	1.15	0.25
Torped mobiliana	28.42		335.81	2.1											
Schidophilus huttoni															
Sqaulus megalops															
Emmelichthys mitidus		9.65				6.88							0.55		
Bassanago albescence		39.57	25.62	24.15	7.43	8	2.54		5.22	6.75	7.85	12.5			5.9
Gnathopis capensis	3.43	13.51				14.4		4.46		2	3.4	5.5			1.35
Soleno Africana	1.96					0.48	11.43	2.23	16.18	0.65	7.3	7.75	4.5	13.4	
Etmopterus lucifer															0.55
Myxine capensis											0.45	1.3			0.1
Zeus capensis															
Zenopris concifer															
Lyvothensis diadema						0.8							0.85	0.45	
Trachyrinchus scabrus									1.3		1.25				1.1
Etrumens whiteheadi											4.5		14.65	1.35	
Sardinops ocellatus											1.8		1.9		
Myctophids													48.5	22.25	
Shrimps															6.45