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Size Selectivity and Trawling Efficiency of Two Sampling Trawls Used in Resource Surveys of Yellowtail Flounder on Grand Bank, NAFO Div. 3LNO

by

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Abstract

Bottom trawl sampling gear(s) are used to conduct annual groundfish surveys and the choice of size and design of a sampling trawl is generally based upon the objectives of the survey. In the fall of 1995, the objective of annual spring and fall groundfish surveys changed from estimation of recruited groundfish stock abundance indices to include pre-recruit indices. This necessitated consolidating the three sampling gears used in the surveys into one new standard trawl. Size selectivity and trawl efficiency of two shrimp trawls used in the surveys of the Grand Bank yellowtail flounder, *Pleuronectes ferruginea*, were analyzed from a series of comparative fishing tows. Little differences were found in the size selectivity of both trawls. Differences in trawl efficiency were related to differences in tow duration (15 min. vs. 30 min.).

Introduction

Annual stratified-random fall recruitment surveys of the Grand Bank, NAFO Div. 3LNO by the Northwest Atlantic Fisheries Centre (NAFC), in St. John's, began in 1985. The objectives of these surveys were to provide information on trends in population size, distribution, mortality and recruitment as well as biological data on size, age, growth, feeding for yellowtail flounder, American plaice, *Hippoglossoides platessoides*, and in later years, Atlantic cod, *Gadus morhua*. The sampling gear, a Yankee 41 shrimp trawl was chosen, after several fishing gear trials comparing groundgear design, mesh size, riggings, towing speed and tow duration, to conduct these surveys..

In the fall of 1995, a new survey trawl, the Campelen 1800 shrimp trawl was adopted as the "new standard trawl" which replace both the Yankee trawl and the "old standard trawl", Engel 145 otter trawl (McCallum and Walsh 1996; Brodie 1996). This switch in sampling trawls occurred after comparative fishing gear trials between the Campelen and Yankee trawls in 1992 and the Campelen and Engel trawls in 1994 (Walsh and McCallum, unpubl. data). In the fall of 1996, multi-species comparative fishing trials were carried out between the *FRV Wilfred Templeman* using the "old standard " recruitment survey trawl, a Yankee 41 shrimp trawl, and her sister ship the *FRV Alfred Needler* using the "new standard" survey trawl, a Campelen 1800 shrimp trawl. These trials were carried out on the southern Grand Bank, NAFO Div. 3NO during the regular fall survey. Similar trials were carried out between the Engel survey trawl and Campelen trawl (Warren 1996;Warren et al.1997). The objective of the 1996 comparative fishing trials was to derived conversion factors to re-calculate the 1986-94 bottom trawl indices from Yankee trawl units to Campelen trawl units.

This paper will examine the size selectivity and trawling efficiency of both small mesh sampling trawls for yellowtail flounder. Conversion of Yankee trawl indices, derived for the 1986-94 yellowtail flounder recruitment data into Campelen trawl units will be discussed.

Methods

The comparative fishing trials were carried out while the *Templeman* was conducting the annual fall groundfish survey using the Campelen survey trawl. Proceeding the start of the comparative trials and after any major tear-ups, both trawls were extensively measured to ensure they were rigged correctly using NAFC Fishing Gear Checklist to (see McCallum and Walsh 1995). Both ships fished at the same time and direction at each station, keeping within 0.5 nm of each other as described in Warren (1996) and Warren et al. (1997). The Campelen trawl was fished with the 'new standard time' of 15 minutes using a towing speed of 3.0 knots. The Yankee trawl was fished with the 'old standard time' of 30 minutes using a towing speed of 2.5 knots. These survey trawls are described in detail in Figs. 1-6 and Table 1. The performance of both fishing gears was monitored using SCANMAR acoustic trawl instrumentation which measured doorspread wingspread, trawl opening, bottom contact and trawl depth.

A total of 18 successful paired tows, in which one or the other trawl caught yellowtail flounder, were completed before the *FRV Templeman* developed mechanical problems and the trials were terminated. Twelve paired sets in Div 3N and 6 sets in Div. 30 were completed in a depth range of 42 to 209 m.

Results

Trawl geometry

Although there are differences in riggings of both trawls and towing speeds (Table 1) both trawls showed little differences in wing spread: Campelen 12.7 m vs. 13.8 m for the Yankee. (Table 2). Wingspread is a parameter in the swept area model to calculate biomass and abundance of yellowtail flounder on the Grand Bank. Trawl opening is larger in the Campelen than in the Yankee because of the extra side panels inserted in the Campelen, which gives it a larger opening (see Figs. 2 and 5; Table 2). Although the Campelen polyvalent trawl doors are heavier than the Yankee rectangular wooden doors and the towing speed used for the Campelen is faster than the Yankee, the higher doorspread in the Yankee trawl is due mainly to the long (117.7 m vs. 46.1 m) sweeps used (Tables 1 and 2).

Catches

Catches of yellowtail flounder were in sufficient numbers to examine differences in size selectivity and trawling efficiency between the Campelen and Yankee shrimp trawls (see Table 3). Catches were standardized to appropriate towing distances of 1.3 nm for the Yankee trawl and 0.8 nm for the Campelen trawl. The ratio of total catch of yellowtail flounder by the Campelen (8335 fish) to the total catch of the Yankee trawl (16258 fish) is 0.51 which is close to the ratio of tow distances, i.e. 0.60.

For the comparative analysis of length frequencies, zero catches in one of the pair tows resulted in elimination of that pair according to the method of Warren (1996) and Warren et al. (1997) (see Table 3). Three out of 4 of these zero sets were in depths greater than 100 m, outside the normal depth distribution of the majority of the stock (Walsh et al. 1998). Elimination of these small catches had no effect on the catch ratio. Length frequencies of the remaining 14 pair sets are found in Tables 4 and 5 and the ratios of catch by length are given in Table 6. A comparison of the overall length frequency for both trawls shows that there is very little difference in the size selectivity of both trawls (Fig. 7). A ratio (Campelen/Yankee) of the trawl catches per length group is plotted in Figure 7. With the exception of small yellowtail flounder in the size range of 8-11 cm where the Yankee selectivity is higher and large fish greater than 43 cm in which sample sizes were low, the ratio hovers around a mean of 0.57 for fish in the 12-42 cm size range (Table3).

Discussion

A target value of 200 paired sets was felt to be necessary to derive conversion factors for both trawls (Warren, pers.com.). In this comparative fishing experiment only 18 pairs were achieved. In deriving the conversion factors for yellowtail flounder from the 1996 comparison of the selectivity of an Engel 145 otter trawl and the Campelen 1800 shrimp trawl only 180 sets were completed (Warren et al. 1997). In that analysis, 38% of the Campelen and 37% of the Engel catches by each trawl had zero catches. In addition,

20% of the Campelen and 26 % of the Engel trawl sets had catches where the number of fish exceeded 40 yellowtail flounder. Although the number of paired sets was higher in the Warren et al. (1997) analysis, the overall catches of yellowtail flounder in were low, 5,118 fish for the Engel trawl and 6,787 fish in the Campelen trawl (Warren et al. 1997). In this present study, the number of paired sets are low but the catches of yellowtail flounder were much higher, i.e. 8,335 fish in the Campelen trawl (4/18 tows had zero catch) and 16,258 fish in the Yankee trawl (1 out 14 tows had zero catch). Many tows had catches in excess of 500 yellowtail flounder (see Table 3).

The similarity in the size selectivity and efficiency of both sampling trawls is evident. The overall differences in total catches are due to the difference in tow duration between the two trawls. Adjustment of the Campelen trawl catches by the ratio of tow duration (0.60) would bring the totals closer together. Similarly, an average adjustment factor of 0.57 could be applied to a major proportion of the Campelen length frequency to minimize the differences in catch-at-length. Size selectivity of sampling trawls are affected by many factors, chief among them is the size and design of the footgear which can influence escapement of flatfish underneath the gear (Walsh 1992; 1996; Godø and Walsh 1992; Munro et al 1997; Dahm 1997). Although the Campelen is rigged with rockhopper gear and the Yankee is rigged with rubber roller disk gear there is only a 3.9 cm difference in height of the footgear (see Table 1). In addition, the use of footgear disks made of rubber weighs heavier in water than hollow steel balls of similar size and ensures better ground contact thereby minimizing escapement of flatfish under both survey gears.

These similarities in size selectivity of Campelen and Yankee trawl catches of yellowtail flounder are also evident in another set of comparative experiments between both trawls, which were conducted in 1992 (Walsh and McCallum 1992: unpubl. data) using the *FRV Wilfred Templeman* (Fig. 9). The objective of this series of comparative fishing trials was to compare size and species selectivity of both trawls when towing speed, tow duration, and trawl doors were standardized. The resulting catches were based upon 14 paired tows on the Southeast Shoal using the alternate haul method over a 48-hour period. Other differences in methodology consisted of towing both trawls for 30 minutes, using the same towing speed of 3.0 knots and the same (Campelen) polyvalent trawl doors.

Conclusions

Although the target number of paired tows had not been reached because of mechanical problems with one of the two vessels, the catches of yellowtail flounder in this analysis are very large. The length frequency of both trawl catches covers the size range of the yellowtail flounder population on the Grand Bank, NAFO Divs. 3LNO. Converting the 1985-94 yellowtail flounder recruitment time series from Yankee trawl units into Campelen trawl units may be achieved by multiplying the former index by the mean ratio of 0.57, as a first approach, to scale the index down to the Campelen units. Further analyses are suggested.

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Table 1. Trawl design, rigging and geometry of Campelen 1800 and Yankee 41 shrimp trawls.

Parameter	Campelen 1800 shrimp trawl	Yankee 41 shrimp trawl
Riggings		
Doors	4.3m2/1400kg	4.5m2/590kg
Sweeps (m)	6.1	99.4
Bridles (m)	40	18.3
Bouyancy (kg)	226.5	129
Headline (m)	29.5	24.4
Fishing line (m)	19.5	31.8
Footgear		
Length (m)	35.6	31.7
Material	102 rubber disks (rockhopper)	6 rubber disks & 8 rubber bunts
Weight Air (kg)	501.3	470.3
Size (dia./cm)	35	30/11.5
Mesh size (mm)		
Wings/square	80/60	38
bellies	60/44	38
Codend	44	38
Liner	12.7	12.7
Material	Polyethylene	Polyethylene
Geometry		
Doorspread (m)	45 to 55	45 to 55
Wing spread (m_	15 to 17	10 to 15
Opening (m)	4 to 5	2 to 3
Towing speed (knots)	3.0k	2.5k
Abundance Model		
Tow duration (min)	15	30
Tow distance (nm)	0.75	1.25
Average wingspread (m)	18.23	14.52
Swept area (m2)	0.00727	0.00941

Table 2 Comparison of average trawl geometry during 14 comparative tows as measured by Scanmar trawl acoustic instrumentation.

Parameter	Yankee Shrimp trawl		Campelen shrimp trawl	
	Mean	CV (%)	Mean	CV(5)
Wingspread (m)	13.8	14	12.7	17
Doorspread (m)	60	1 point	38.9	9
Opening (m)	3.3	25	5.7	7

Table 3. Comparison of trawl catches in number of yellowtail flounder by gear from 1996 comparative fishing between Campelen and Yankee shrimp trawls.

set no.	Campelen	Yankee
37	553	656
38	27	776
40	330	676
50	0	5
51	300	167
56	1960	1934
57	1112	2131
58	1943	3731
59	989	3092
61	966	2758
62	0	3
63	0	0
85	1	6
86	5	34
87	46	15
88	94	166
89	9	80
93	0	28
Total	**8335**	**16258**

Table 4. Catches of yellowtail flounder by Yankee trawl during 1996 comparative fishing with Campelen. Sets 50,62,63,and 93 deleted because of zero catches.

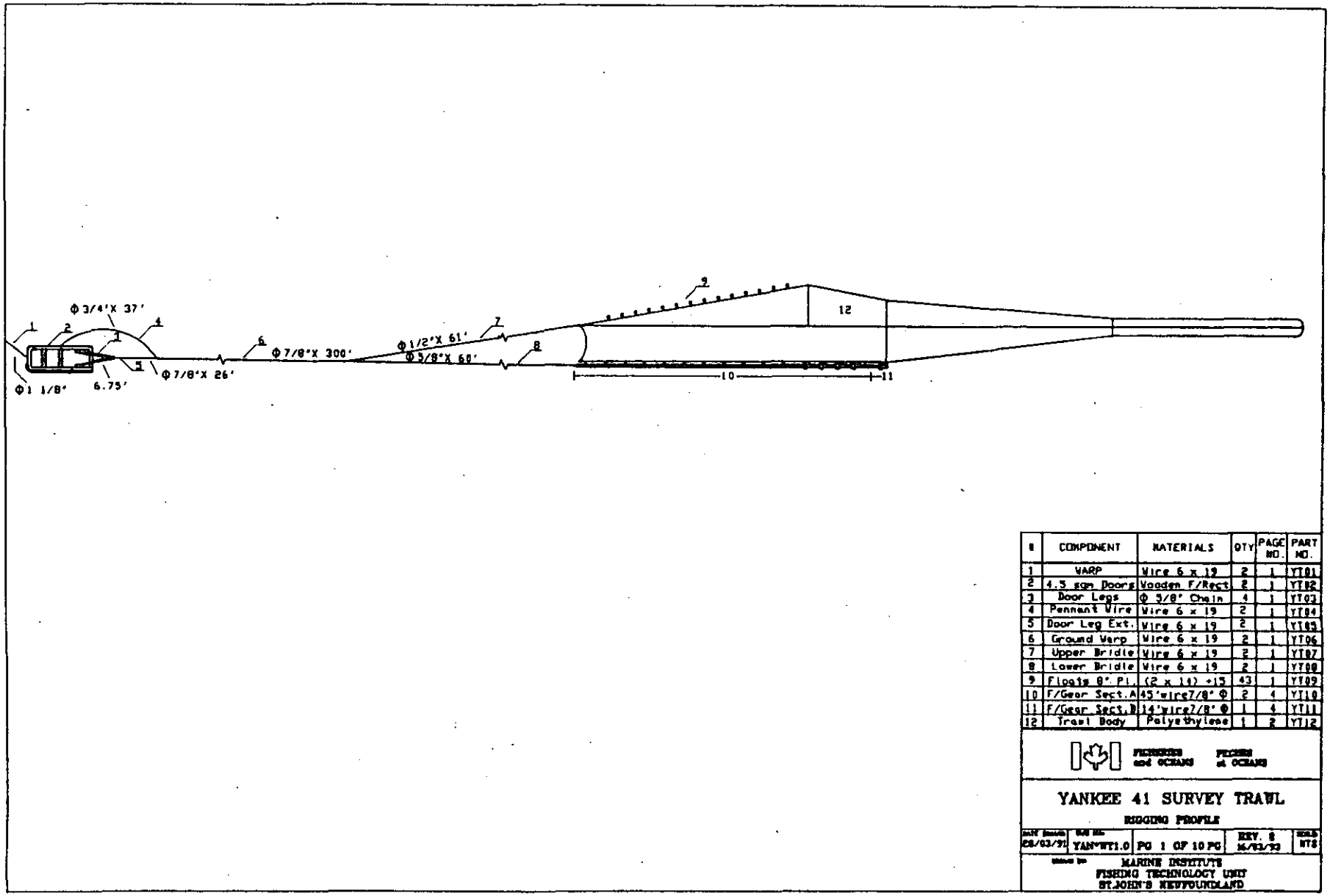
LENGTH	37	38	40	51	56	57	58	59	61	85	86	87	88	89
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	1	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	2	2	0	5	5	0	0	0	0	0	0	0	0	0
9	5	2	0	0	23	5	0	8	0	0	0	0	0	0
10	4	4	2	3	23	0	0	8	0	0	0	0	0	0
11	10	4	0	6	14	0	0	15	6	0	0	0	0	0
12	6	10	0	10	9	5	0	23	12	0	0	0	0	0
13	15	12	0	14	18	0	0	62	6	0	0	0	0	0
14	10	12	0	17	32	21	0	39	19	0	0	0	0	0
15	25	14	2	16	32	21	38	77	25	0	0	0	0	0
16	28	20	0	19	27	27	38	70	12	0	0	0	0	0
17	21	18	2	15	27	59	38	77	37	0	0	0	0	0
18	21	8	4	11	59	69	0	178	37	0	0	0	0	0
19	26	12	8	6	113	112	38	248	56	0	0	0	0	0
20	32	34	8	6	225	155	263	240	130	0	0	0	0	0
21	46	40	18	2	122	256	300	286	222	0	0	0	0	0
22	36	50	18	4	212	160	363	286	216	1	0	0	0	0
23	49	28	14	4	104	176	425	371	352	0	0	0	2	0
24	41	74	22	3	81	229	238	263	346	0	0	0	0	0
25	35	58	20	3	104	139	325	255	272	0	1	0	1	0
26	24	76	16	1	113	181	275	162	321	0	0	0	0	0
27	26	36	26	0	122	197	250	108	185	0	1	0	0	0
28	19	22	26	0	104	85	275	147	130	0	0	0	0	0
29	23	24	28	0	68	53	275	62	117	0	0	0	1	0
30	20	42	34	0	59	32	175	39	68	0	0	0	2	0
31	14	24	36	0	54	37	88	0	43	0	0	0	1	0
32	16	20	48	1	32	37	75	0	62	0	0	1	5	0
33	10	22	38	0	45	11	75	0	12	0	0	0	12	0
34	10	20	52	1	0	16	0	0	12	0	1	0	14	2
35	14	16	52	1	18	16	38	15	12	1	2	0	12	4
36	11	18	52	0	5	0	50	0	12	0	2	4	17	4
37	17	14	38	2	18	16	25	15	12	0	5	2	10	10
38	11	12	42	0	14	0	0	0	6	0	4	4	20	9
39	5	10	18	0	23	0	0	23	6	2	1	0	17	5
40	6	4	10	0	5	11	25	0	6	0	1	1	13	7
41	5	2	8	3	0	5	0	15	0	1	2	0	7	8
42	3	4	8	4	0	0	13	0	0	0	3	0	9	8
43	4	2	12	3	9	0	0	0	6	0	3	2	4	7
44	1	2	4	2	5	0	13	0	0	0	4	0	4	6
45	1	0	2	0	5	0	0	0	0	0	1	0	5	2
46	2	0	0	3	0	0	13	0	0	1	2	0	4	3
47	0	4	8	0	0	0	0	0	0	0	0	0	2	3
48	0	0	0	1	5	0	0	0	0	0	1	0	3	0
49	1	0	0	1	0	0	0	0	0	0	0	1	1	1
50	0	0	0	0	0	0	0	0	0	0	0	0	0	1
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0
total	656	776	676	167	1934	2131	3731	3092	2758	6	34	15	166	80

Table 5. Catches of yellowtail flounder by Campelen trawl during 1996 comparative fishing with Yankee shrimp trawl. Sets 50,62,63 and 93 deleted because of zero catches.

LENGTH	37	38	40	51	56	57	58	59	61	85	86	87	88	89
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	2	2	4	7	20	0	0	14	0	0	0	0	0	0
11	9	2	0	35	7	0	0	11	7	0	0	0	0	0
12	4	0	0	24	7	0	7	14	0	0	0	0	0	0
13	4	1	1	35	0	0	7	7	4	0	0	0	0	0
14	2	3	1	40	13	7	7	14	11	0	0	0	0	0
15	9	2	1	57	20	14	27	11	4	0	0	0	0	0
16	4	1	2	24	27	25	27	11	14	0	0	0	0	0
17	4	0	1	14	40	25	27	39	18	0	0	0	0	0
18	0	0	0	12	100	60	27	39	11	0	0	0	0	0
19	9	0	2	9	93	53	27	39	28	0	0	0	0	0
20	16	0	4	19	173	75	133	79	63	0	0	0	0	0
21	13	0	5	12	173	132	147	93	42	0	0	0	1	0
22	20	1	11	2	167	121	207	97	84	0	0	0	2	0
23	29	0	2	5	167	121	173	115	77	0	0	0	0	0
24	38	1	7	5	93	100	87	111	98	0	0	0	0	1
25	51	2	7	0	120	89	147	100	81	0	0	0	1	0
26	22	2	8	0	100	92	113	39	88	0	0	0	0	0
27	22	1	7	0	167	75	153	54	88	0	0	0	0	0
28	33	1	12	0	120	36	140	47	70	0	0	0	0	0
29	27	0	8	0	100	36	120	21	56	0	0	0	0	0
30	29	2	9	0	67	14	87	4	25	0	0	0	0	0
31	18	1	19	0	53	0	107	0	21	0	0	1	3	0
32	22	0	18	0	13	14	27	7	14	0	0	1	3	0
33	20	0	20	0	33	0	33	0	4	0	1	3	7	0
34	20	0	26	0	7	0	27	0	4	0	0	2	6	0
35	18	0	27	0	13	0	13	0	7	1	0	3	4	1
36	2	0	40	0	13	7	13	0	11	0	0	7	10	0
37	27	0	26	0	7	4	13	4	0	0	2	4	8	0
38	7	0	21	0	7	0	20	7	11	0	0	4	7	1
39	13	1	12	0	27	4	7	4	11	0	0	4	7	1
40	18	2	11	0	13	4	13	0	7	0	1	3	7	1
41	11	2	7	0	0	4	0	0	0	0	0	7	8	0
42	9	0	5	0	0	0	7	0	7	0	0	1	6	1
43	2	0	2	0	0	0	0	4	0	0	0	2	5	2
44	2	0	2	0	0	0	0	0	0	0	0	2	3	1
45	0	0	1	0	0	0	0	0	0	0	0	0	3	0
46	9	0	0	0	0	0	0	4	0	0	0	2	1	0
47	2	0	1	0	0	0	0	0	0	0	0	0	1	0
48	2	0	0	0	0	0	0	0	0	0	0	0	1	0
49	2	0	0	0	0	0	0	0	0	0	0	0	0	0
50	2	0	0	0	0	0	0	0	0	0	0	0	0	0
51	0	0	0	0	0	0	0	0	0	0	1	0	0	0
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	553	27	330	300	1960	1112	1943	989	966	1	5	46	94	9

Table 6. Length distributions of yellowtail flounder from 1996 comparative fishing trials (14 pairs) with Campelen and Yankee shrimp trawls.
Sets 50,62,63 and 93 deleted because of zero catches.

LENGTH	Campelen	Yankee	Ratio Campelen/Yankee
8	0	14	0
9	0	43	0
10	49	44	1.11
11	71	55	1.29
12	56	75	0.75
13	59	127	0.46
14	98	150	0.65
15	145	250	0.58
16	135	241	0.56
17	168	294	0.57
18	249	387	0.64
19	260	619	0.42
20	562	1093	0.51
21	618	1292	0.48
22	712	1346	0.53
23	689	1525	0.45
24	541	1297	0.42
25	598	1213	0.49
26	464	1169	0.40
27	567	951	0.60
28	459	808	0.57
29	368	651	0.57
30	237	471	0.50
31	223	297	0.75
32	119	297	0.40
33	121	225	0.54
34	92	128	0.72
35	87	201	0.43
36	103	175	0.59
37	95	184	0.52
38	85	122	0.70
39	91	110	0.83
40	80	89	0.90
41	39	56	0.70
42	36	52	0.69
43	17	52	0.33
44	10	41	0.24
45	4	16	0.25
46	16	28	0.57
47	4	17	0.24
48	3	10	0.30
49	2	5	0.40
50	3	1	3.00
Total	**8335**	**16221**	



#	COMPONENT	MATERIALS	QTY	PAGE NO.	PART NO.
1	WARP	Wire 6 x 19	2	1	YT01
2	4.5 sqm Doors	Wooden F/Rect	2	1	YT02
3	Door Legs	Φ 5/8" Chain	4	1	YT03
4	Pennant Wire	Wire 6 x 19	2	1	YT04
5	Door Leg Ext.	Wire 6 x 19	2	1	YT05
6	Ground Warp	Wire 6 x 19	2	1	YT06
7	Upper Bridle	Wire 6 x 19	2	1	YT07
8	Lower Bridle	Wire 6 x 19	2	1	YT08
9	Floats 8" Pl.	(2 x 14) +15	43	1	YT09
10	F/Gear Sect.A	45'wire7/8" Φ	2	4	YT10
11	F/Gear Sect.B	14'wire7/8" Φ	1	4	YT11
12	Trawl Body	Polyethylene	1	2	YT12

FISHERIES and OCEANS — PÊCHES et OCÉANS

YANKEE 41 SURVEY TRAWL

RIGGING PROFILE

DATE	DWG No.	PG 1 OF 10 PG	REV. 0	SCALE
28/03/91	YAN*WT1.0		16/03/93	NTS

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Fig. 1 Rigging diagram of the Yankee 41 shrimp trawl

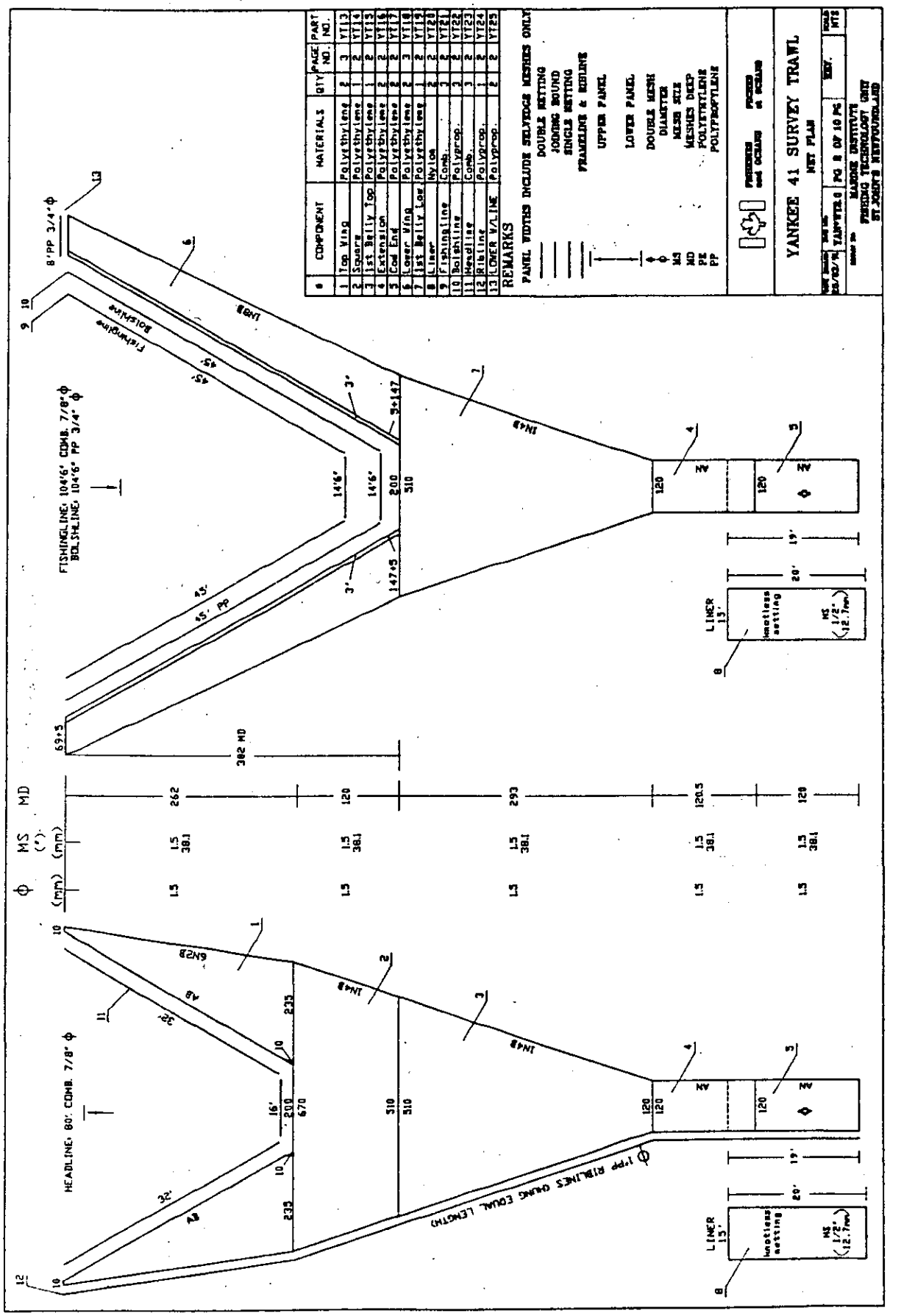


Fig. 2 Trawl plan of the Yankee 41 shrimp trawl

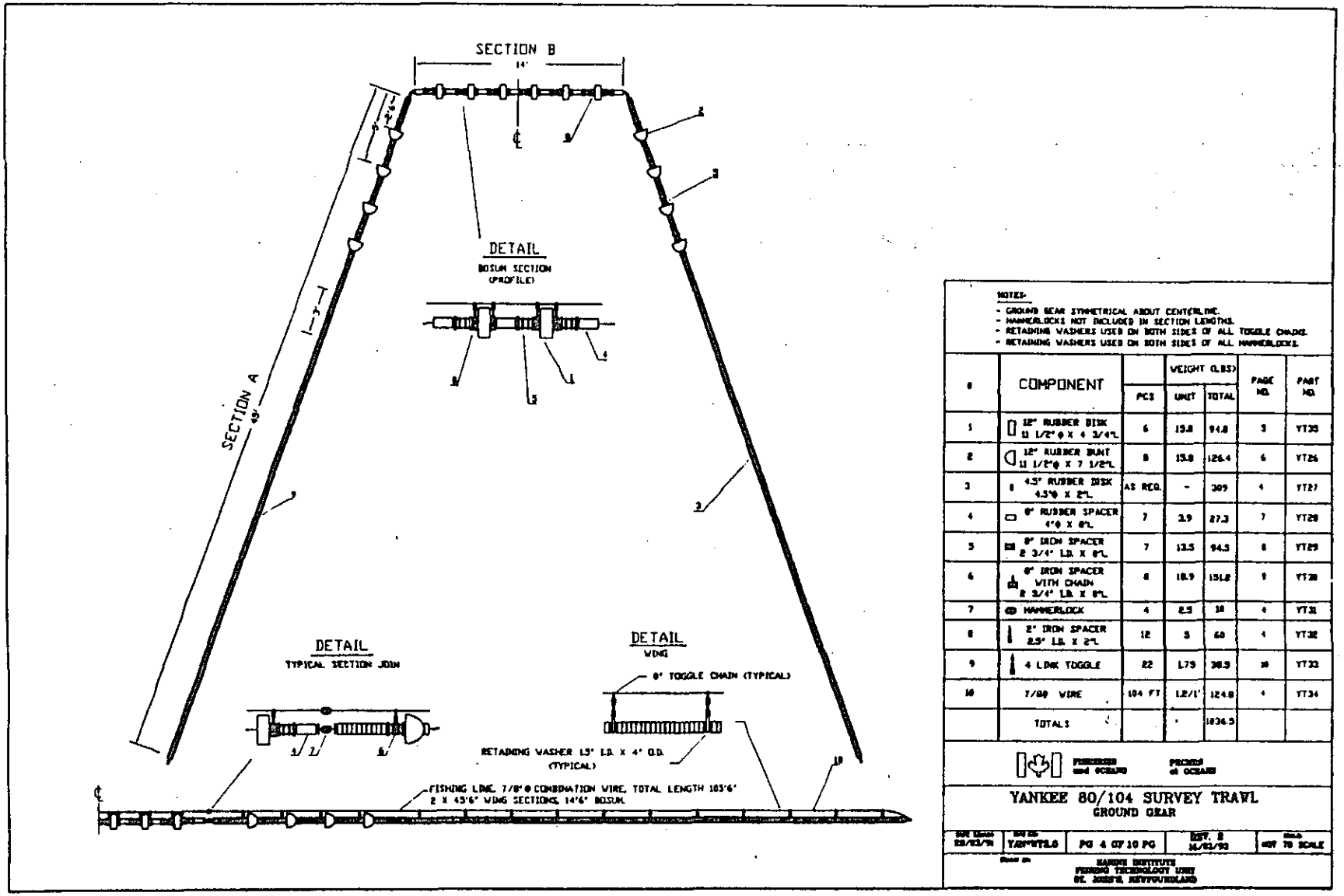


Fig 3 Rigging of the footgear of the Yankee 41 shrimp trawl

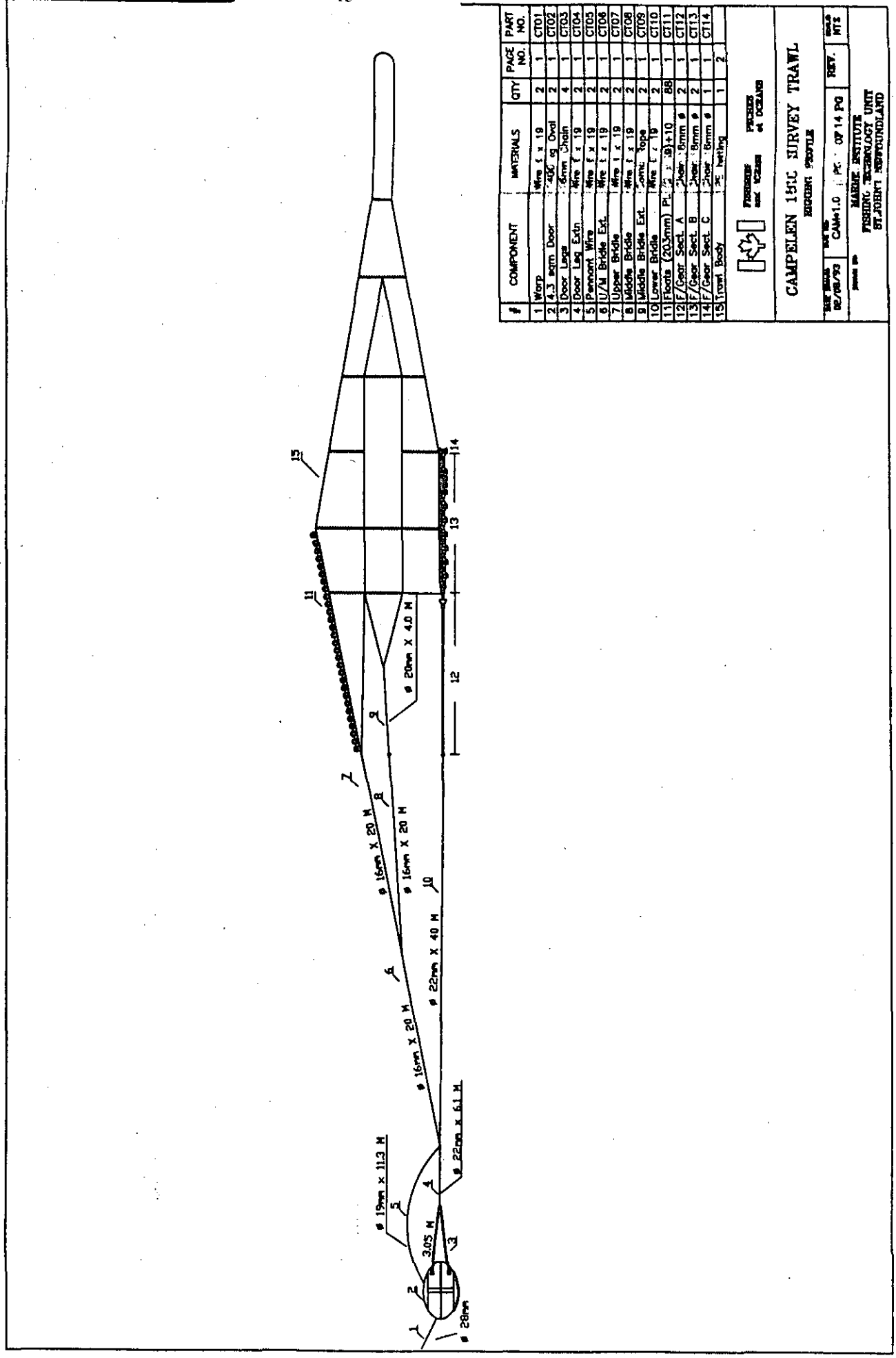
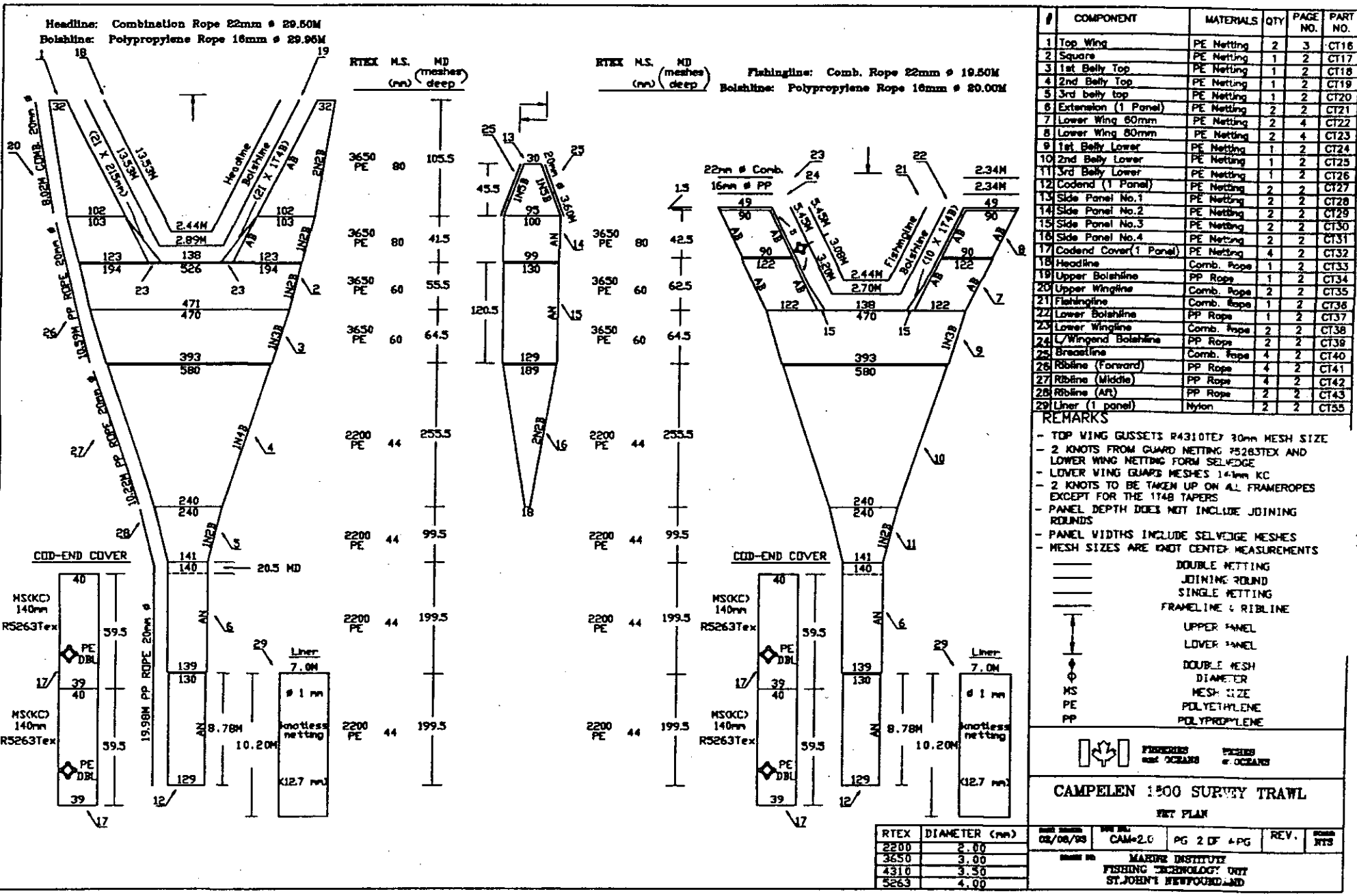


Fig. 4 Rigging diagram of the Campelen 1800 shrimp trawl



#	COMPONENT	MATERIALS	QTY	PAGE NO.	PART NO.
1	Top Wing	PE Netting	2	3	CT16
2	Square	PE Netting	1	2	CT17
3	1st Belly Top	PE Netting	1	2	CT18
4	2nd Belly Top	PE Netting	1	2	CT19
5	3rd belly top	PE Netting	1	2	CT20
6	Extension (1 Panel)	PE Netting	2	2	CT21
7	Lower Wing 60mm	PE Netting	2	4	CT22
8	Lower Wing 80mm	PE Netting	2	4	CT23
9	1st Belly Lower	PE Netting	1	2	CT24
10	2nd Belly Lower	PE Netting	1	2	CT25
11	3rd Belly Lower	PE Netting	1	2	CT26
12	Codend (1 Panel)	PE Netting	2	2	CT27
13	Side Panel No.1	PE Netting	2	2	CT28
14	Side Panel No.2	PE Netting	2	2	CT29
15	Side Panel No.3	PE Netting	2	2	CT30
16	Side Panel No.4	PE Netting	2	2	CT31
17	Codend Cover(1 Panel)	PE Netting	4	2	CT32
18	Headline	Comb. Rope	1	2	CT33
19	Upper Bolshline	PP Rope	1	2	CT34
20	Upper Wingline	Comb. Rope	2	2	CT35
21	Fishingline	Comb. Rope	1	2	CT36
22	Lower Bolshline	PP Rope	1	2	CT37
23	Lower Wingline	Comb. Rope	2	2	CT38
24	C/Wingend Bolshline	PP Rope	2	2	CT39
25	Breastline	Comb. Rope	4	2	CT40
26	Ribline (Forward)	PP Rope	4	2	CT41
27	Ribline (Middle)	PP Rope	4	2	CT42
28	Ribline (Aft)	PP Rope	2	2	CT43
29	Liner (1 panel)	Nylon	2	2	CT55

REMARKS

- TOP WING GUSSETS R4310TEX 80mm MESH SIZE
- 2 KNOTS FROM GUARD NETTING R5263TEX AND LOWER WING NETTING FORM SELVEDGE
- LOWER WING GUARD MESHES 141mm KC
- 2 KNOTS TO BE TAKEN UP ON ALL FRAMEROPES EXCEPT FOR THE 1748 TAPERS
- PANEL DEPTH DOES NOT INCLUDE JOINING ROUNDS
- PANEL WIDTHS INCLUDE SELVEDGE MESHES
- MESH SIZES ARE KNOT CENTER MEASUREMENTS

DOUBLE NETTING
JOINING ROUND
SINGLE NETTING
FRAMELINE & RIBLINE
UPPER PANEL
LOWER PANEL
DOUBLE MESH
DIAMETER
MS MESH SIZE
PE POLYETHYLENE
PP POLYPROPYLENE

RTEX	DIAMETER (mm)
2200	2.00
3650	3.00
4310	3.50
5263	4.00

CAMPELEN 1800 SURVEY TRAWL
NET PLAN

02/08/99	CAM-2.0	PG 2 OF 4 PG	REV.
			NTS

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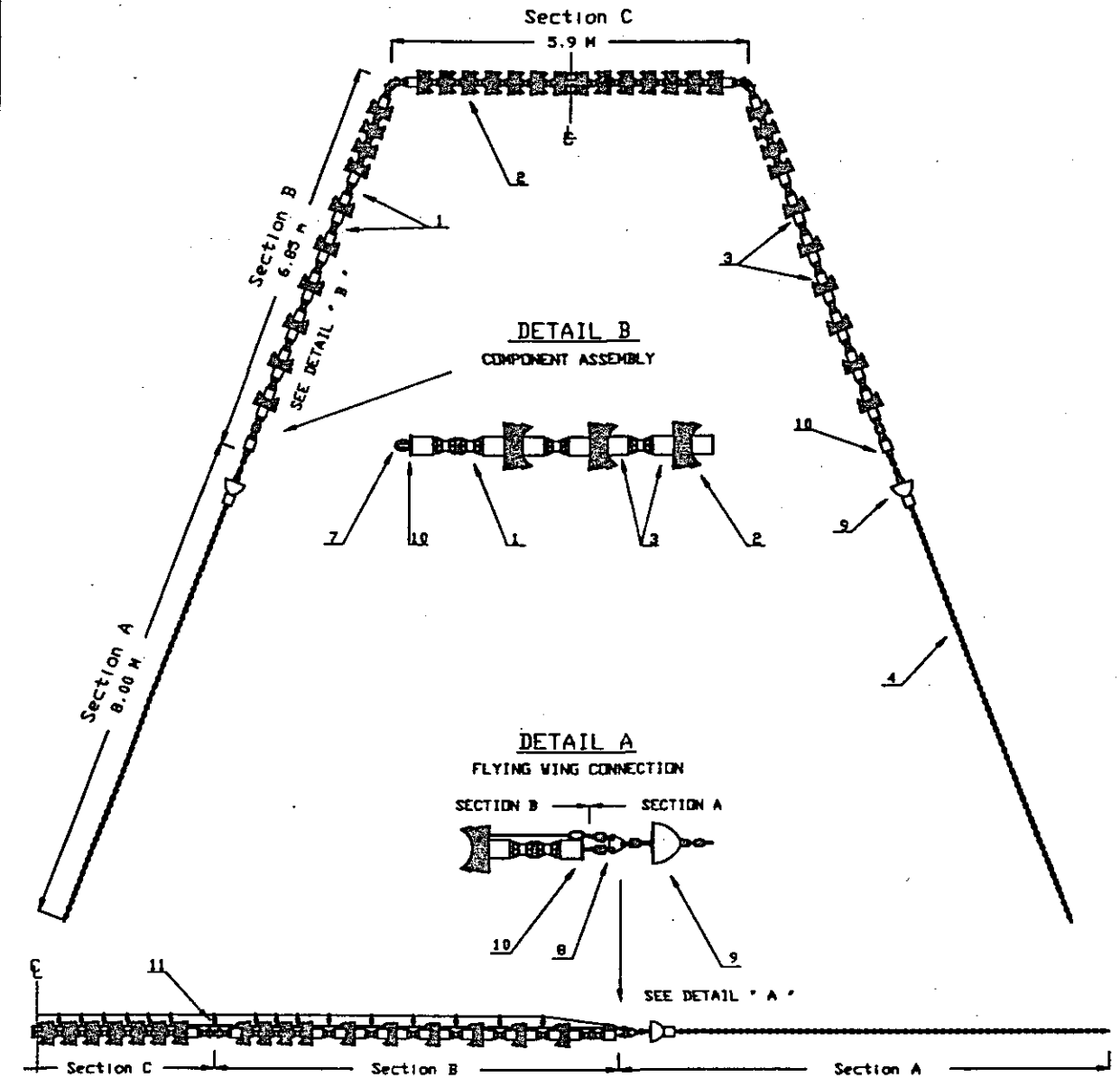
Fig. 5 Trawl plan of the Campelen 1800 shrimp trawl

Fig 6 Rigging of the footgear of the Campelen 1800 shrimp 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	WEIGHT (KGS) (IN SEAWATER) TOTAL	NUMBERS TOTAL	NUMBERS SECT. A	NUMBERS SECT. B	NUMBERS SECT. C	Page NO.	PART NO.
1	8" (200mm) Iron Spacer	5.29	206.31	39	8	2x12	1x15	8	CT44
2	14" Rockhopper Sets of 3 Disk	0.55	56.1	34X3	8	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	1	2x10	1x13	14	CT52
	TOTAL WEIGHT		501.03						

FISHERIES and OCEANS

CAMPELEN 1800 SURVEY TRAWL
GROUND GEAR

DATE	DRG NO.	PG 7 OF 14 PG	REV.	SCALE
02/08/93	CAM-3.0			NTS

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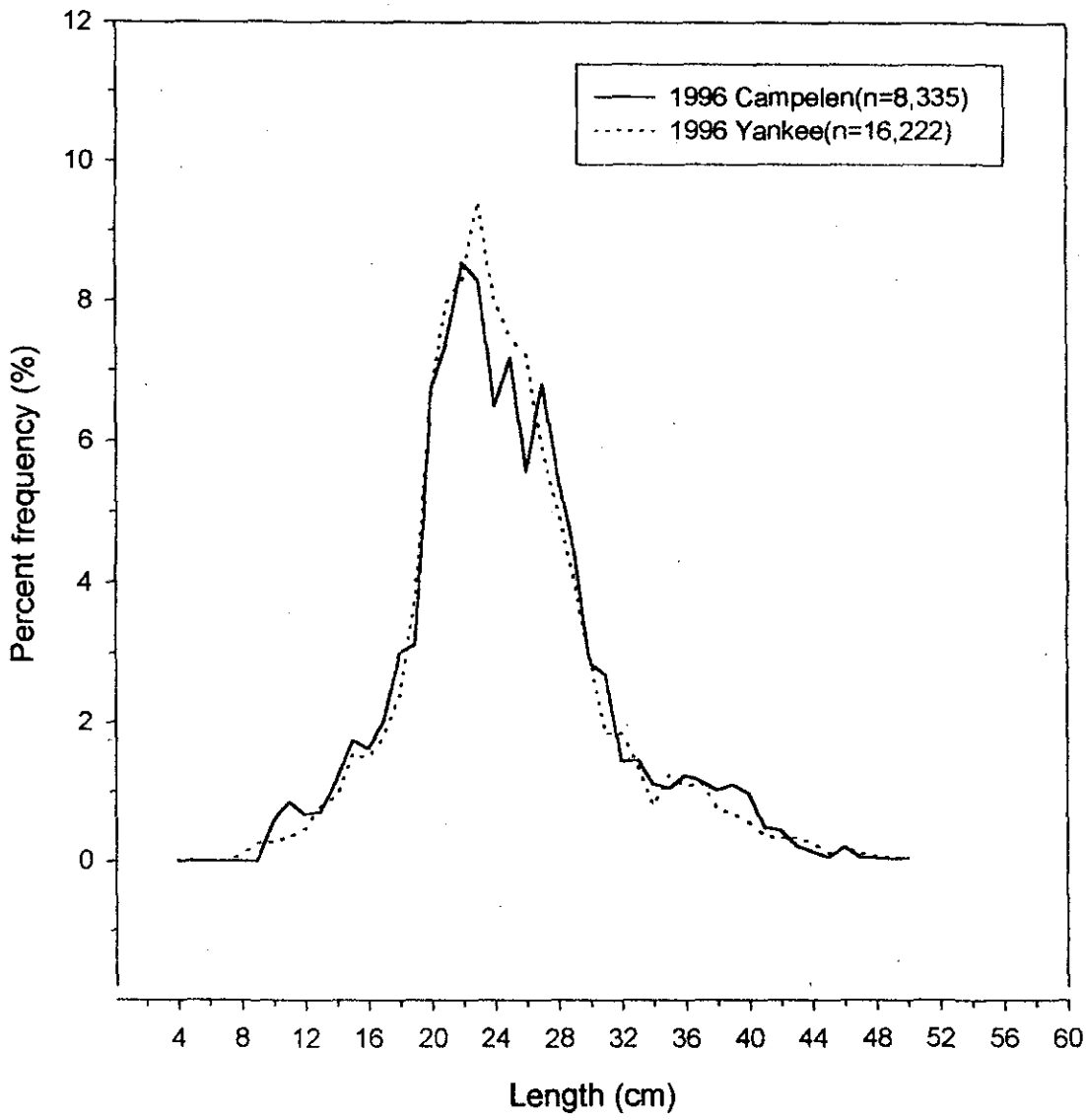

Fig. 7 Comparison of the length frequency of yellowtail flounder caught in the 1996 comparative fishing trials (14 paired tows) between Campelen 1800 shrimp trawl and a Yankee 41 shrimp trawl.

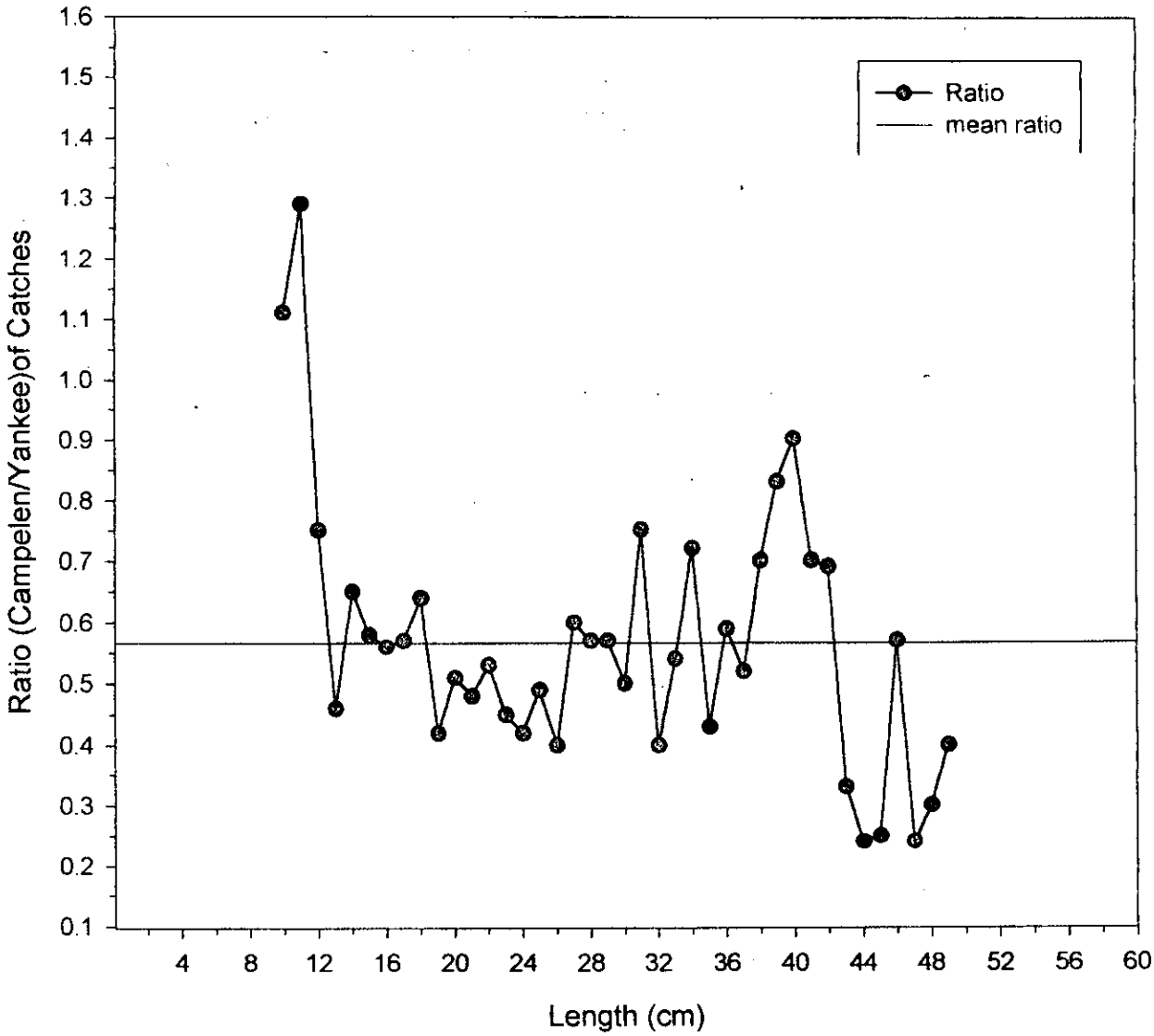

Fig. 8 Ratios of catches per length group of yellowtail flounder from 1996 14 paired tows between the Campelen and the Yankee shrimp trawls.

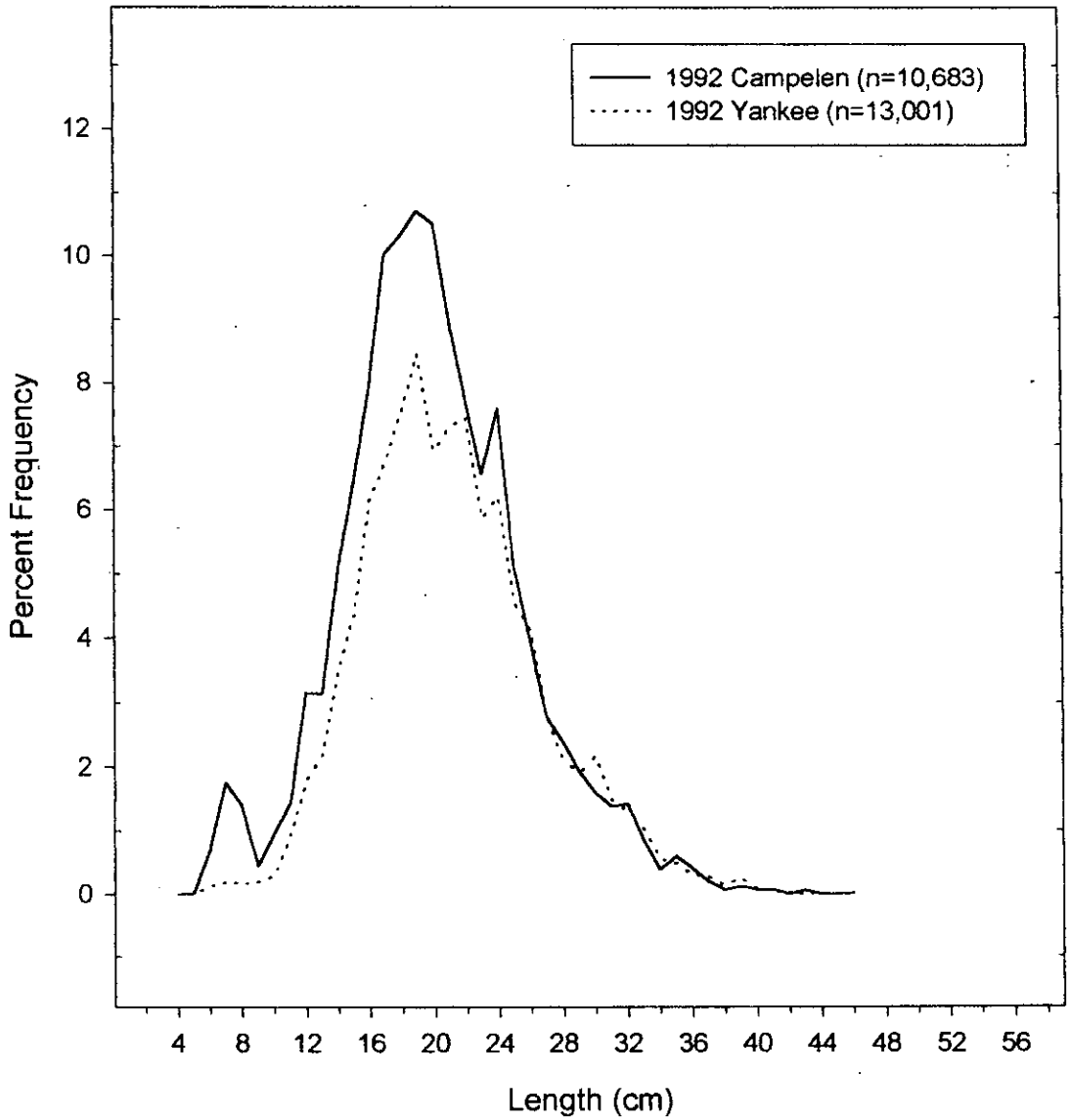

Fig.9 Comparison of the length frequency of yellowtail flounder caught in the 1992 comparative fishing trials (14 alternate paired tows) between Campelen 1800 shrimp trawl and a Yankee 41 shrimp trawl.