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Groundfish Survey Trawls Used at the Northwest Atlantic Fisheries Centre, 1971-Present

by

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Introduction

Bottom survey trawls are used to collect information on the abundance and distribution of a variety of marine organisms and to provide scientific advice for the management of marine fisheries resources. Since the beginning of stratified random surveys in 1971 the Department of Fisheries and Oceans, Northwest Atlantic Fisheries Centre (NAFAC) in St. John's, Newfoundland has operated four different Fisheries Research Vessels (FRV) using a corresponding number of unique survey trawls to sample approximately 500,000 km² of ocean off Canada's northeast coast. Generally, a common commercial groundfish trawl in use at the time was selected to be the "standard" survey trawl and a small mesh liner was inserted in the codend to retain juvenile fish.

This paper presents a brief history and description of the bottom survey trawls and survey vessels used at the NAFAC from 1971 until present and outlines the program used to standardize all aspects of survey trawl construction, rigging and fishing protocols aimed at reducing measurement error associated with trawl efficiency.

Yankee 41.5 Otter Trawl (FRV *A. T. Cameron*)

When the 54 m side trawler *A. T. Cameron*, came into service in 1958, the Yankee 41.5 otter trawl was a popular commercial trawl at the time and it was adopted as the vessel's standard groundfish trawl. Prior to 1971 it was rigged with a 30.5 m steel bobbin footrope of 53 cm diameter bobbins in the bosom and 36 cm diameter bobbins in the bunt wings. The net was constructed of manila twine with mesh sizes of 130 mm in the wings tapering to 92 mm in the codend. After 1971, the trawl was constructed of polyethylene twine of similar mesh sizes and the footgear was changed to 53 cm rubber rollers and 46 cm rubber bunt bobbins (Fig 1; Table 1). The trawl used short upper and lower bridles (2.1 m) connected to a danlono leg and ball, 40 m sweep wires and rectangular wooden 4.5 m² Brompton trawl doors. The circumference of the fishing circle of this trawl was 43.2 m. The trawl was towed at 3.5 knots for a duration of 30 minutes by the *A. T. Cameron* in annual surveys of the Gulf of St. Lawrence, Grand Bank and St. Pierre Bank.

Engel 145 Hi-Lift Otter Trawl (FRV *Gadus Atlantica's* version)

In 1977, the 74 m stern trawler *Gadus Atlantica* was chartered by the Department of Fisheries and Oceans to conduct trawl surveys off Canada's east coast in particular the Labrador-Northeast Newfoundland Shelf, Flemish Cap and Gulf of St. Lawrence. The vessel came from Norway equipped with an Engel 164 Hi-Lift bottom trawl, a popular commercial trawl in use throughout the North Atlantic at the time. With the addition of a small mesh liner in the codend this undocumented version of the Engel 164 otter trawl became the *Gadus Atlantica's* de facto standard survey trawl. The 50 m long footrope of the Engel was not easily accommodated by the layout of the *Gadus Atlantica's* trawl deck creating delays in shooting and hauling and therefore beginning in 1979 surveys were conducted with the smaller Engel 145 Hi-Lift otter trawl (Fig. 2, 3 & 4). The Engel 145 is a two panel "balloon" design with a stretched mesh circumference of 60.5 m at the fishing circle. Short lower cut-away wings and a heavy steel bobbin footgear make it especially suited to rough bottom fishing. A middle bridle and middle bridle extension were used to transfer some of the towing strain from the headline to the riblines thus increasing vertical mouth opening. The large 5.6 m² polyvalent trawl doors were connected to the trawl net (made solely of nylon) by 17 m sweep wires and 50 m bridles. Trawl construction was of 4.0 mm diameter polyethylene

twine varying in mesh size from 180 mm in the upper and lower wings and square to 160 mm in the bellies and codend. The four seam codend was constructed of double 6.0 mm polyethylene and was fitted with a 30 mm stretched mesh liner, attached at a point 9.15 m deep from the after most end of the codend. One hundred 200 mm plastic floats were used on the headline for floatation (Table. 1). This trawl was towed at 3.5 knots for 30 minutes during groundfish surveys.

Engel 145 Hi-Lift Otter Trawl (FRV Wilfred Templeman's version)

In 1983, the newly commissioned stern trawler *Wilfred Templeman* replaced the retiring side trawler *A. T. Cameron* in conducting trawl surveys of the Grand Bank and St. Pierre Bank. To standardize survey trawls between the *Gadus Atlantica* and the *Wilfred Templeman*, an Engel 145 Hi-Lift otter trawl was chosen to replace the Yankee 41.5 otter trawl used on the *A. T. Cameron*, after appropriate conversion factors had been derived from comparative fishing experiments between the two vessels (Gavaris and Brodie 1984). Modifications were made to the Engel 145 by the fishing crew to adapt it to the smaller working deck of the *Wilfred Templeman*. These modifications consisted of a reduction in the size and weight of footgear components and because of the narrower stern of the *Wilfred Templeman* shorter door leg extensions were required which lead to a reduction in overall sweep length (Fig. 5, 6 & 7; Table 1). In contrast to the *Gadus Atlantica* the trawl body was constructed of polyethylene as opposed to nylon, a two seam nylon codend was adopted over a four seam codend; the headline floatation was changed to aluminum floats and mesh sizes ranged from 180 mm in the upper and lower wing and square to 150 mm in the 1st and 2nd bellies and 130 mm in the 3rd belly, extension and codend. Both the *Gadus Atlantica* and *Wilfred Templeman* used the same size and construction of codend liner. In early 1984 the fishing skipper was concerned that the larger 5.6 m² trawl doors were over sized for the trawl and changed to a smaller (3.8 m²), lighter polyvalent doors of the same design. This version of the Engel 145 became the standardized NW AFC groundfish survey trawl aboard the *Wilfred Templeman* in March, 1984. This trawl was towed at 3.5 knots for 30 minutes during annual groundfish surveys.

Yankee 41 Shrimp Trawl (FRV Wilfred Templeman)

Between 1980 and 1982, several fishing experiments were carried out to derive a new groundfish survey trawl to sample juvenile flatfish, particularly yellowtail flounder, *Pleuronectes ferruginea*, on the Grand Banks. Comparative fishing experiments were conducted to determine the trawling efficiency of a Yankee 36 bobbin rigged otter trawl, a Yankee 36 shrimp trawl rigged with a small disk footgear and a small mesh semi-balloon trawl with a leaded fishing line and chain footgear (Walsh 1984). A Yankee 36 shrimp trawl rigged with rubber roller disks in the bosom and half bunt bobbins in the quarters was found to be the most efficient trawl for juvenile groundfish. Because the horsepower of the offshore research vessels was too large for this trawl a switch was made to a larger version of the Yankee. With the introduction of the *Wilfred Templeman* in 1983, a modified version of the Yankee 41 shrimp trawl was selected. The footgear was modified to fish hard bottom by using 47 cm roller disks in the bosom and half bunt bobbins in the quarters (Fig. 8, 9 & 10). This two bridle trawl is a two panel trawl with a stretched mesh circumference of 38.8 m at the fishing circle and is constructed of 40 mm mesh size polyethylene throughout. A 12.7 mm nylon liner is used in the codend and the trawl is fished with 4.5 m² Brompton trawl doors. In 1985 it was adopted as the standard offshore juvenile groundfish survey trawl for the Grand Banks. The trawl was towed at 2.5 knots for 30 minutes during annual fall random stratified groundfish surveys of the Grand Bank.

Campelen 1800 Shrimp Trawl (FRV Wilfred Templeman & FRV Teleost)

In 1995, the *Gadus Atlantica* was released from charter and replaced by the 63 m stern trawler *Teleost*. The new multi-tasking nature of research vessel missions required a survey trawl that could catch a larger range of sizes and species of fish. In 1981, the Institute of Marine Research, Bergen, Norway selected a small mesh commercial shrimp trawl, Campelen 1800, as their standard bottom sampling trawl on the basis of its limited mesh selectivity (Engås, 1994). In 1992, comparative fishing experiments by the NW AFC were carried-out to evaluate the fishing efficiency of this shrimp trawl compared with the standard juvenile groundfish trawl, Yankee 41 shrimp trawl, using the alternate haul methodology (Walsh: unpublished data). Preliminary analysis showed that the selectivity of both trawls was similar. From 1992-1995, the Campelen 1800 was used to sample juvenile fish in the inshore environment because of its ability to fish rough bottoms more effectively than the Yankee 41 shrimp trawl. Based on the analysis of two sets of comparative fishing experiments; the Yankee 41 with the Campelen 1800 and the Campelen 1800 with the Engel 145, the Campelen 1800 was adopted as the new standard demersal survey trawl for the NW AFC in June 1995 (Cambridge Suites 1995: unpublished report). It replaced both versions of the Engel 145 otter trawl and the Yankee 41 shrimp trawl.

The Campelen 1800 is a four panel design trawl with a stretched mesh circumference of 72 m at the fishing circle with large side panels extending from ahead of the footgear back to the end of the nd belly. The upper and lower bridles are 40 m long and a 24 m middle bridle is used to transfer strain from the upper and lower rib-lines to the headline (Fig. 11, 12 & 13). The footrope is of rockhopper construction consisting of 102 x 35 cm dia. tightly packed rubber disks and rubber spacers. Trawl construction is of 4.0, 3.0 and 2.0 mm diameter polyethylene twine varying in mesh size from 80 mm in the wings to 60 mm in the square and the first bellies and 40 mm in the remaining bellies and codend. A 12.7 mm mesh liner is used in the extension piece and codend, both of which are cover with a 140 mm codend cover constructed of 2.0 mm double polyethylene twine. The NWAFC version of the Campelen 1800 differs from that used by the Norwegians in that it is constructed entirely of polyethylene twine, as opposed to nylon, he 4.3 m² (1400 kg) polyvalent trawl doors have been substituted for the larger 6.0 m² (1500 kg) Waco doors and a 6.1 m long sweep wire has been added to facilitate shooting and hauling. This trawl is towed at a speed of 3.0 knots for 15 minutes during all annual groundfish surveys. SCANMAR acoustic trawl instrumentation is used to establish initial bottom contact and the start of tow.

Discussion

Prior to 1984 no attempt had been made to document and standardize survey trawl construction and rigging practices aboard either the *Gadus Atlantica* or *A. T. Cameron* and, consequently, unregulate changes in trawl specifications occurred up to 1992 (see Walsh and McCallum 1995). After a detailed examination of both Engel trawls, flume tank testing and crew member interviews, international standard trawl net plans of all survey trawls, with the exception of the Yankee 41.5 otter trawl, were developed during 1991-1992 for the first time in NWAFC history. Extreme care was taken to insure their accuracy and completeness. This was followed by training of the research vessel crew and scientific staff in trawl mensuration techniques and the development of a four page Survey Trawl Checklist to measure the trawl prior to and during each survey. A Quality Control program was put in place in 1993 to check that each trawl component supplied to the research vessel by manufactures/suppliers complied to the required specifications before delivery (see McCallum & Walsh 1995). During each fishing tow SCANMAR sensors record information on door spread, wing spread, trawl opening, depth and bottom contact. This data along with latitude and longitude from GPS, vessel towing speed and direction is recorded simultaneously on SEATRAWL, a NWAFC software package (McCallum & Walsh, 1995). Prior to introduction of the Campelen trawl, extensive flume tank testing of a scale model was conducted to analyze potential problems. The new standard survey trawl has been completely integrated into all quality control procedures. With the full implementation of these standardization procedures in 1993, the unregulated modification of bottom survey trawls at the NWAFC has ceased.

Beginning in the fall of 1995, the Campelen 1800 shrimp trawl has replaced both versions of the Engel 145 groundfish survey trawls and the Yankee 41 juvenile groundfish survey trawl. Comparative fishing experiments to derive conversion factors for both versions of the Engel (*Gadus Atlantica* and *Wilfred Templeman*) have shown that the Campelen catches a greater size range of most commercial species and a wider range of species selection than the Engel 145 otter trawl (Warren 1996). Similar comparative fishing experiments are planned for the Yankee 41 shrimp trawl in 1997. In addition to common demersal fishes the Campelen has been found to be an effective sampler of shrimp (*Pandalus sp.*) and other pelagic species such as caplin (*Mallotus villosus*), Arctic cod (*Boregadus saida*), etc. and a wide range of bottom invertebrates, including snow crab.

References

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Table 1. Comparison of survey trawls used at the NWAFC.

Parameter	Yankee 41.5 Otter trawl	Engel 145 Hi-Lift Otter trawl		Yankee 41 Shrimp trawl	Campelen 1800 Shrimp trawl
	A.T. Cameron	Gadus Atlantica	Wilfred Templeman	Wilfred Templeman	Wilfred Templeman
Doors	4.5m ² /590kg	5.6m ² /1400kg	3.8m ² /1250kg	4.5m ² /590kg	4.3m ² /1400kg
Sweeps (m)	40.2	17	15.2	99.4	6.1
Bridles (m)	2.1	50	50	18.3	40
Bouyancy (kg)	105	300	283.5	129.0	226.5
Headline (m)	24.1	29.2	29.2	24.4	29.5
Fishing Line (m)	unknown	31.2	31.2	31.8	19.5
<u>Footgear</u>					
Length (m)	30.5	44.2	44.2	31.7	35.6
Material	12 Rubber Rollers & 8 Rubber Bunts	27 Steel Bobbins	25 Steel Bobbins & 4 Rubber Rollers	6 Rubber Disks & 8 Rubber Bunts	102 Rubber Disks (Rockhopper)
Weight Air (kg)	unknown	3168.6	2349.7	470.3	501.3
Size (dia./cm)	53/46/36	61/53/46/36	53/46/36	30/11.5	35
<u>Mesh Size (mm)</u>					
Wings/Square	130	180	180	38	80/60
Bellies	130/92	160	150/130	38	60/44
Codend	92	160	130	38	44
Liner	30	30	30	12.7	12.7
Material	Polyethylene	Nylon	Polyethelyene Nylon Codend	Polyethylene	Polyethylene
Doorspread (m)	unknown	70-90	60-75	45-55	45-55
Wing Spread (m)	13*	18-25	17-22	10-15	15-17
Opening (m)	2.4-3.3*	3-6	4-6	2-3	4-5
Tow Speed (kts)	3.5	3.5	3.5	2.5	3.0

* Data taken from commercially used trawl (Carrothers, 1974).

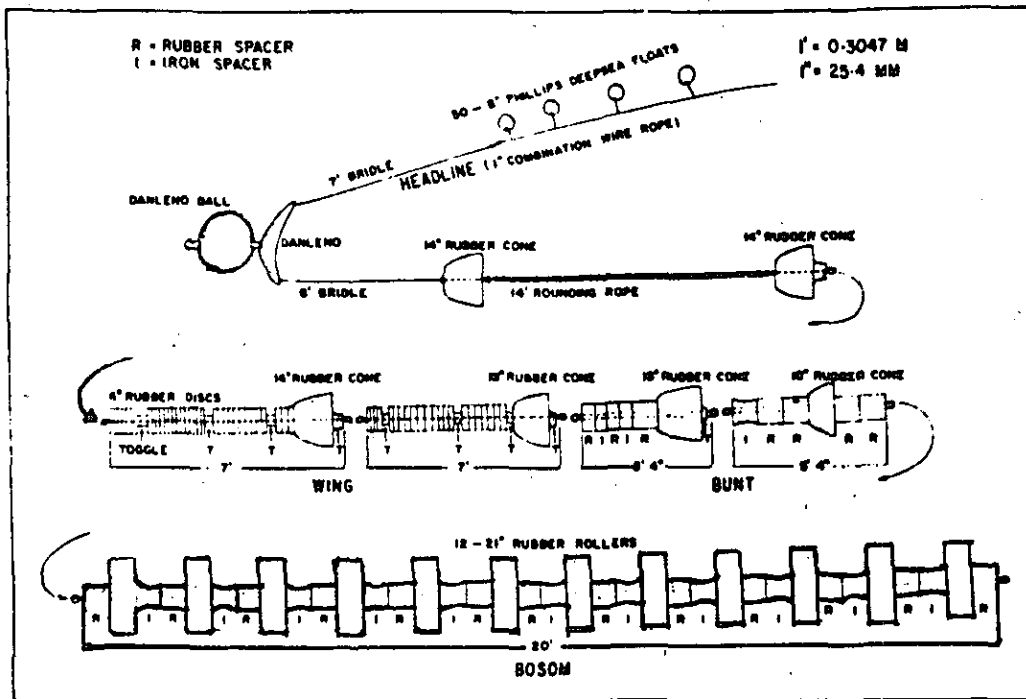
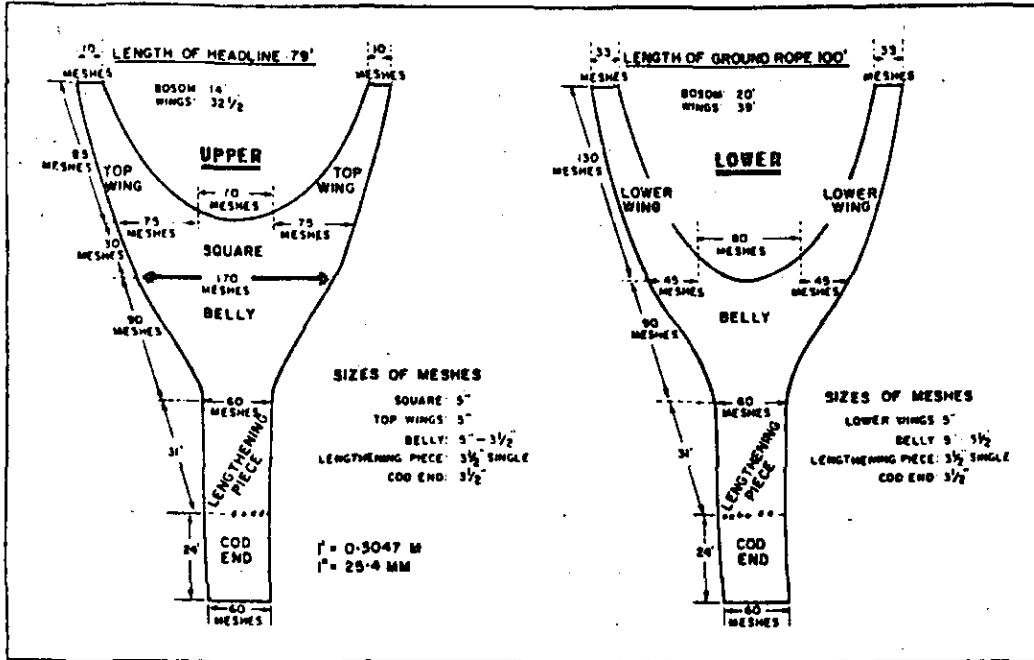
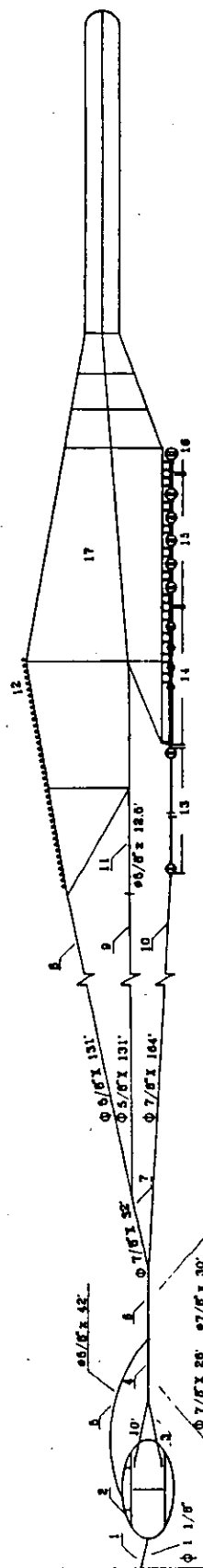



Figure 1. Trawl plan and footgear diagram of the FRV A. T. Cameron's Yankee 41.5 Otter trawl (reprinted from Pinhorn, 1971).



#	COMPONENT	MATERIALS	QTY	PAGE	PART NO.
1	Nerp	Wire 6 x 19	2	1	EAO1
2	3.6 m Door	1500 lb Dural	8	1	EAO2
3	Door Leg Chain	5/8" Chain	4	1	EAO3
4	Door Leg End	Wire 6 x 19	2	1	EAO4
5	Penant Wire	Wire 6 x 19	2	1	EAO5
6	Ground Nerp	Wire 6 x 19	2	1	EAO6
7	U/M Bridle ext	Wire 6 x 19	2	1	EAO7
8	Upper Bridle	Wire 6 x 19	2	1	EAO8
9	Middle Bridle	Wire 6 x 19	2	1	EAO9
10	Lower Bridle	Wire 6 x 19	2	1	EAO10
11	M. Bridle ext	Wire 6 x 19	2	1	EAO11
12	Flights B' Pl. (2 x 39) x 22	100	1	1	EAO12
13	F/Gear Sect A	Chain 5/8" Φ	2	8	EAL3
14	F/Gear Sect B	Chain 5/8" Φ	2	8	EAL4
15	F/Gear Sect C	Chain 5/8" Φ	2	8	EAL5
16	F/Gear Sect D	Chain 5/8" Φ	1	8	EAL6
17	Trawl Body	Nylon Netting	1	2	EAL7


FISHERIES AND OCEANS
PEUERE
et Océans

ENGEL 145 SURVEY TRAWL
RIGGING PROFILE
GADUS ATLANTICA

DRAWN BY: []
 DATE: 28/03/91
 DRAWN BY: ENG-0410 PG 1 OF 16 PG 16/01/91
 UNIT: EST. 8
 UNIT: FISHERIES TECHNOLOGY UNIT
 UNIT: ST. JOHN'S NEWFOUNDLAND

Figure 2. Rigging diagram of the FRV Gadus Atlantica's Engle 145 Hi-Lift Otter trawl.

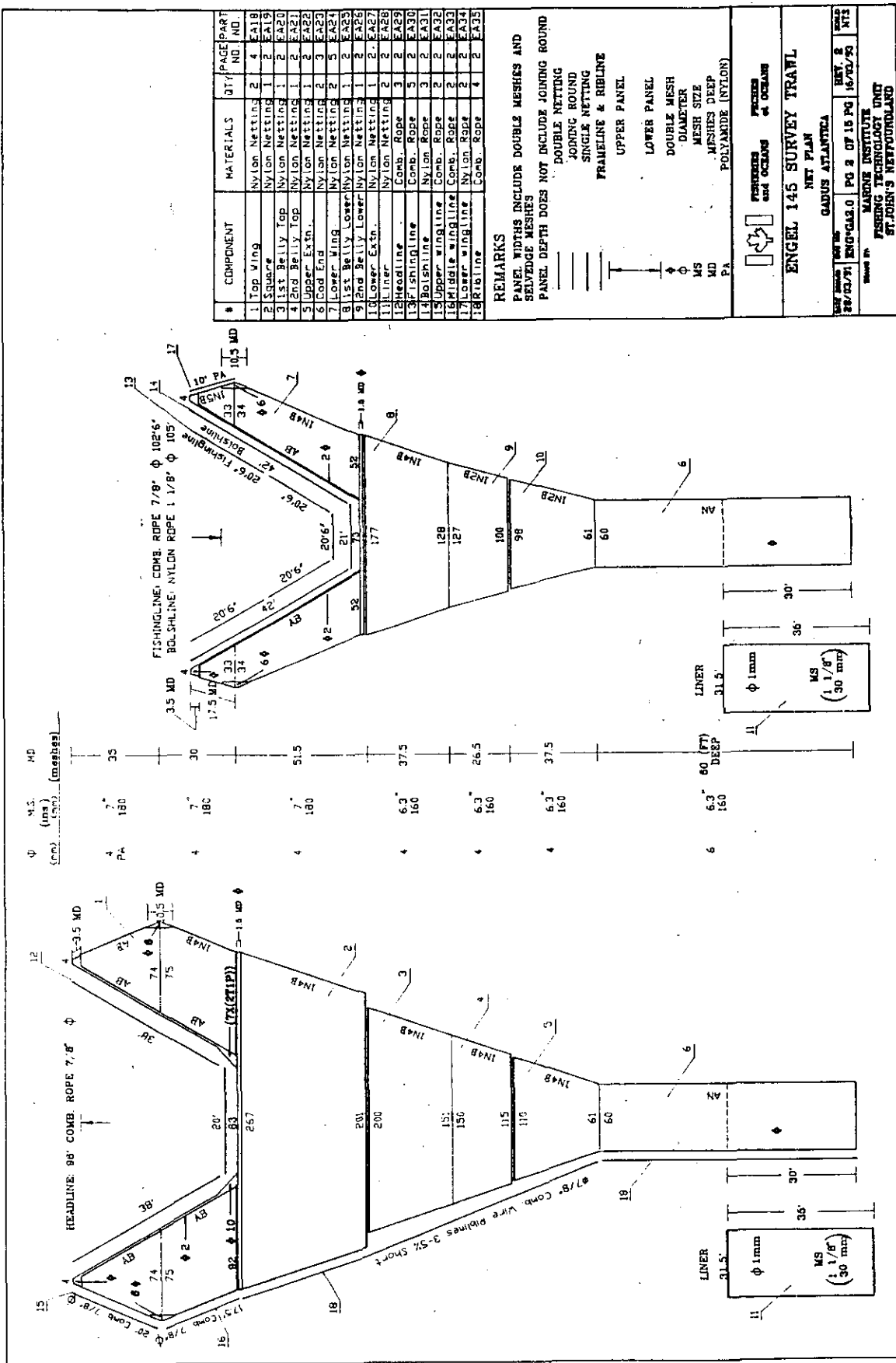


Figure 3. Trawl plan of the FRV Gadus Atlantica's Engel 145 Hi-Lift Otter trawl.

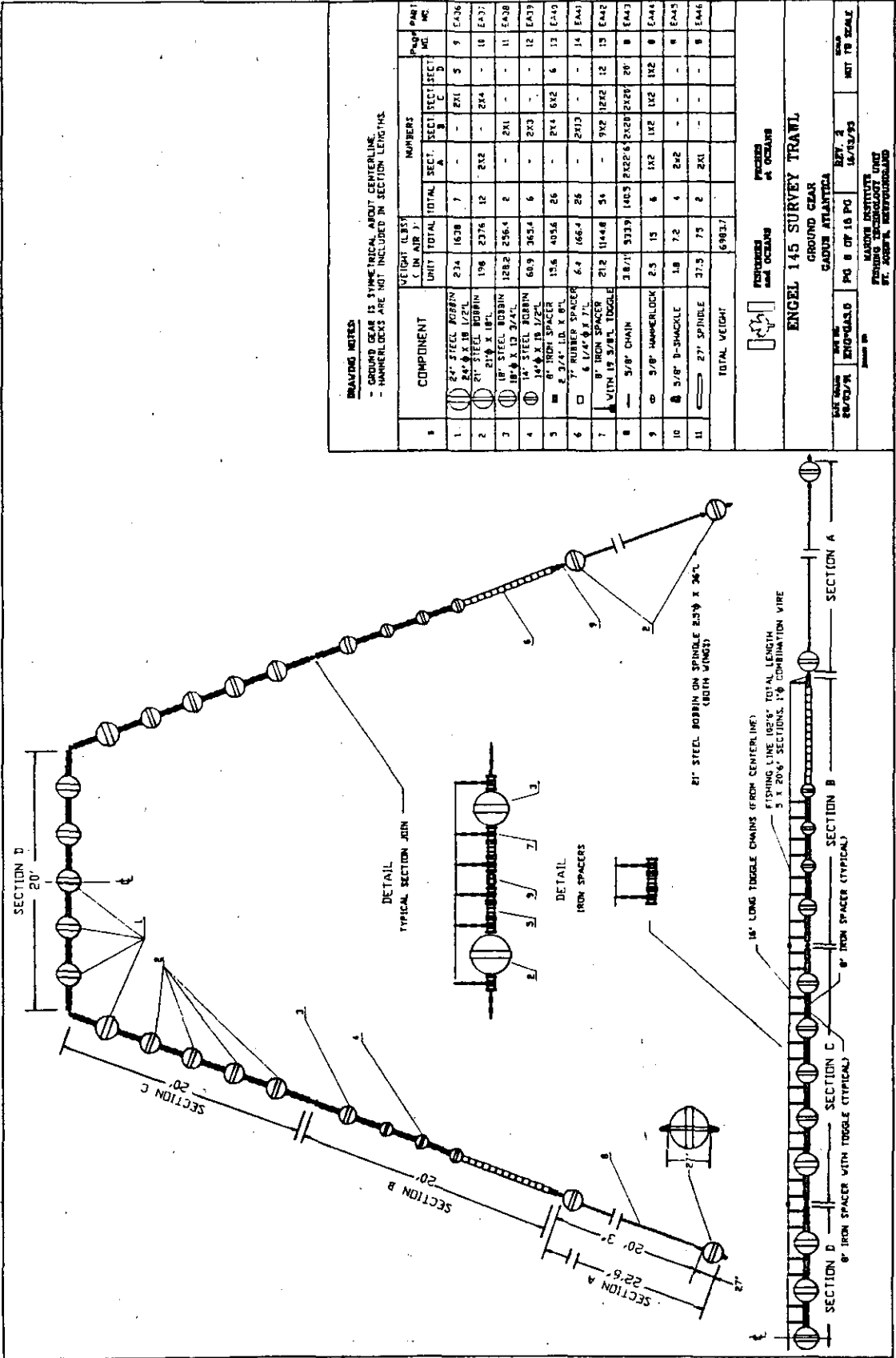


Figure 4. Footgear diagram of the FRV Gadus Atlantica's 145 Hi-Lift Otter trawl.

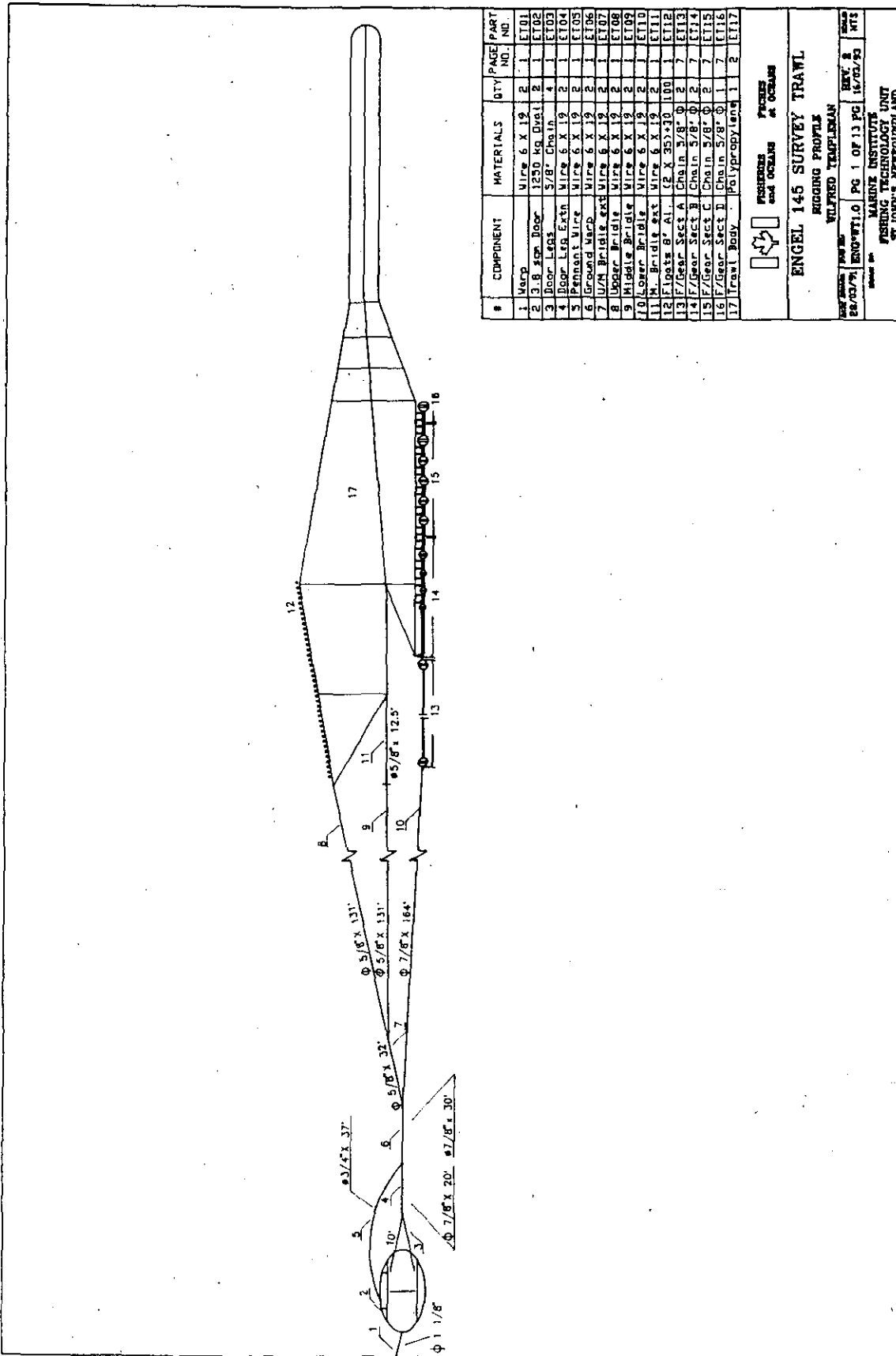


Figure 5. Rigging diagram of the FRV Wilfred Templeman's Engle 145 Hi-Lift Otter trawl.

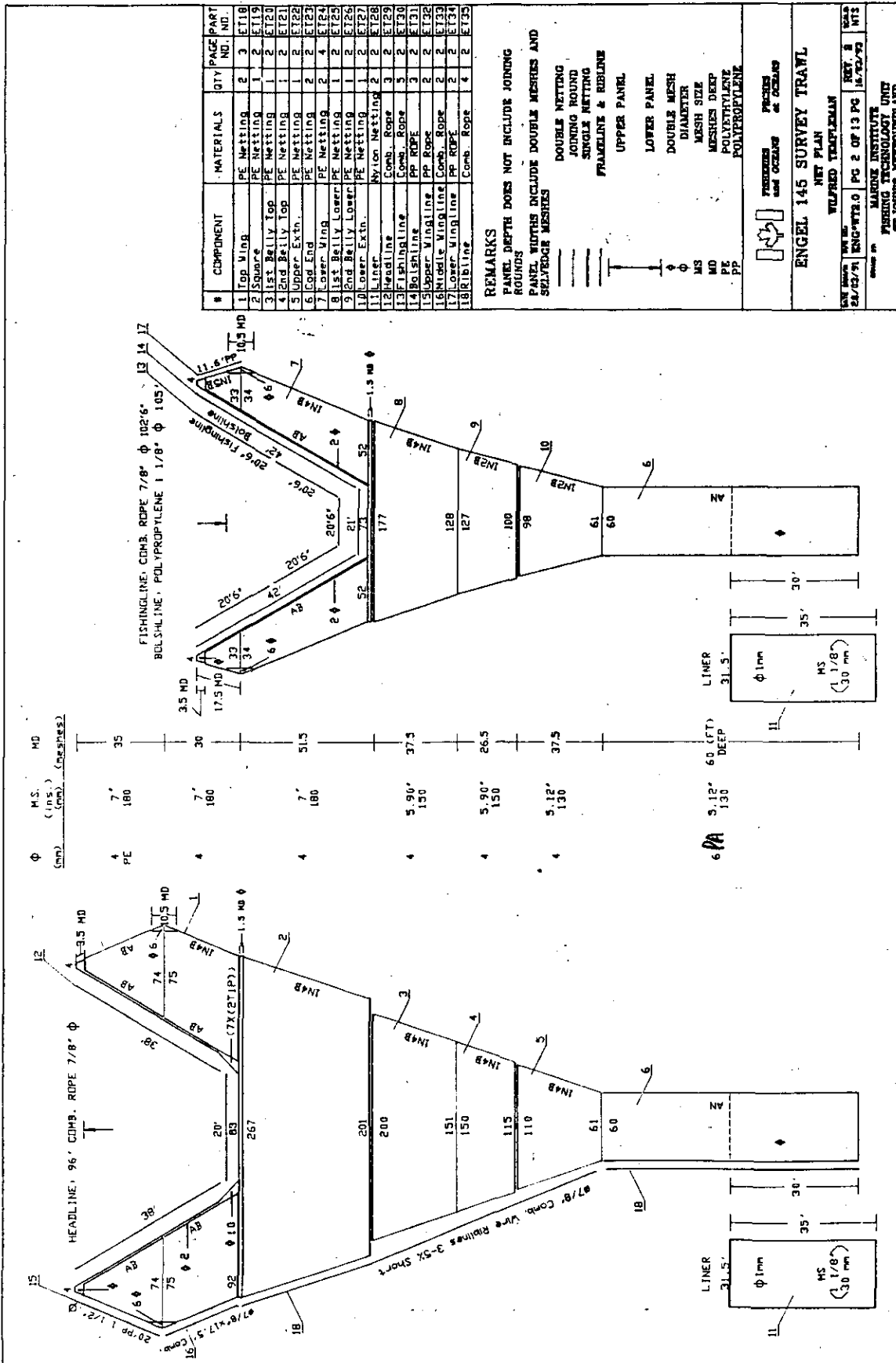


Figure 6. Trawl plan of the FRV Wilfred Templeman's 145 Hi-Lift Otter trawl.

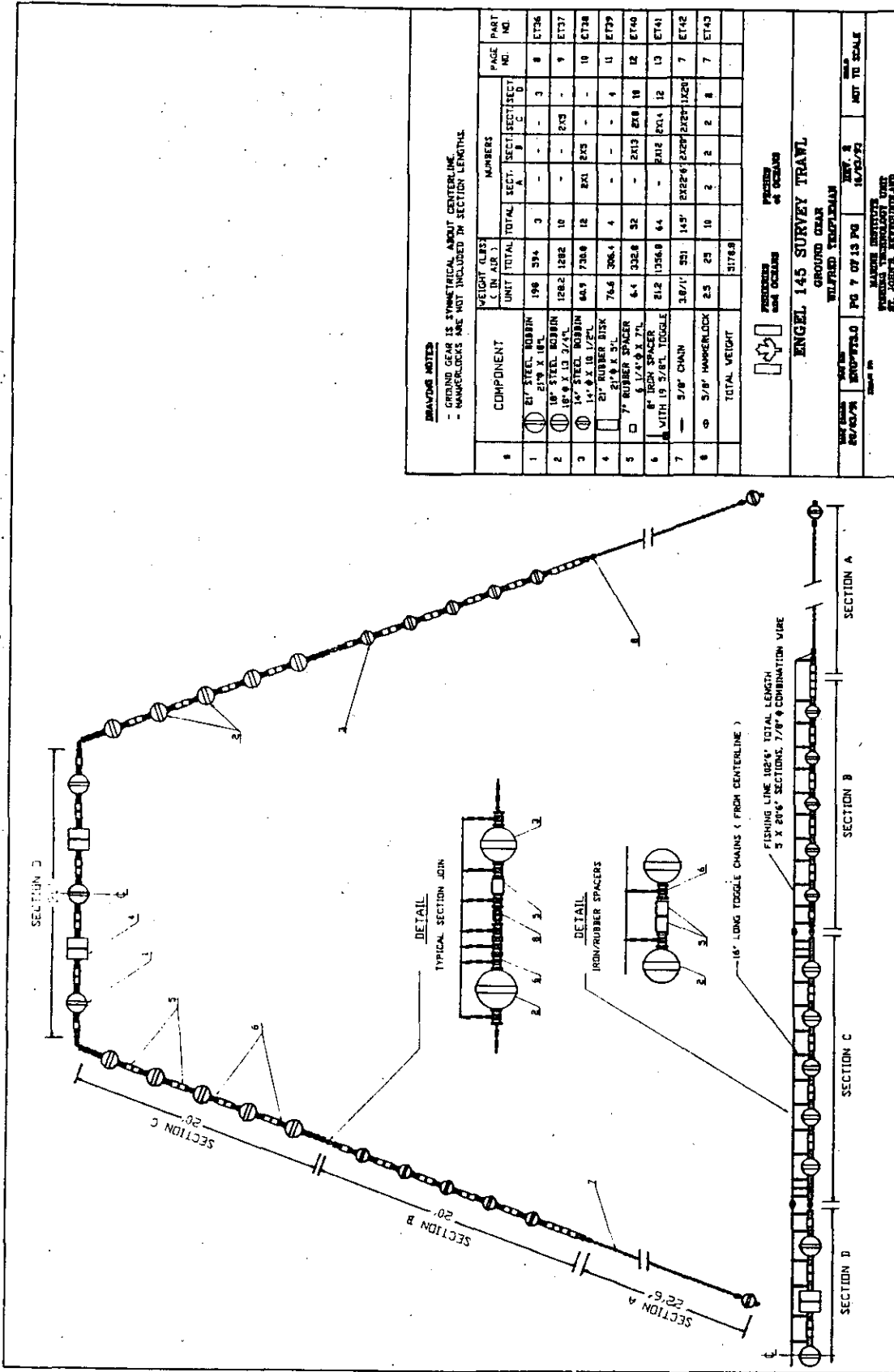


Figure 7. Footgear diagram of the FRV Wilfred Templeman's 145 Hi-Lift Otter trawl.

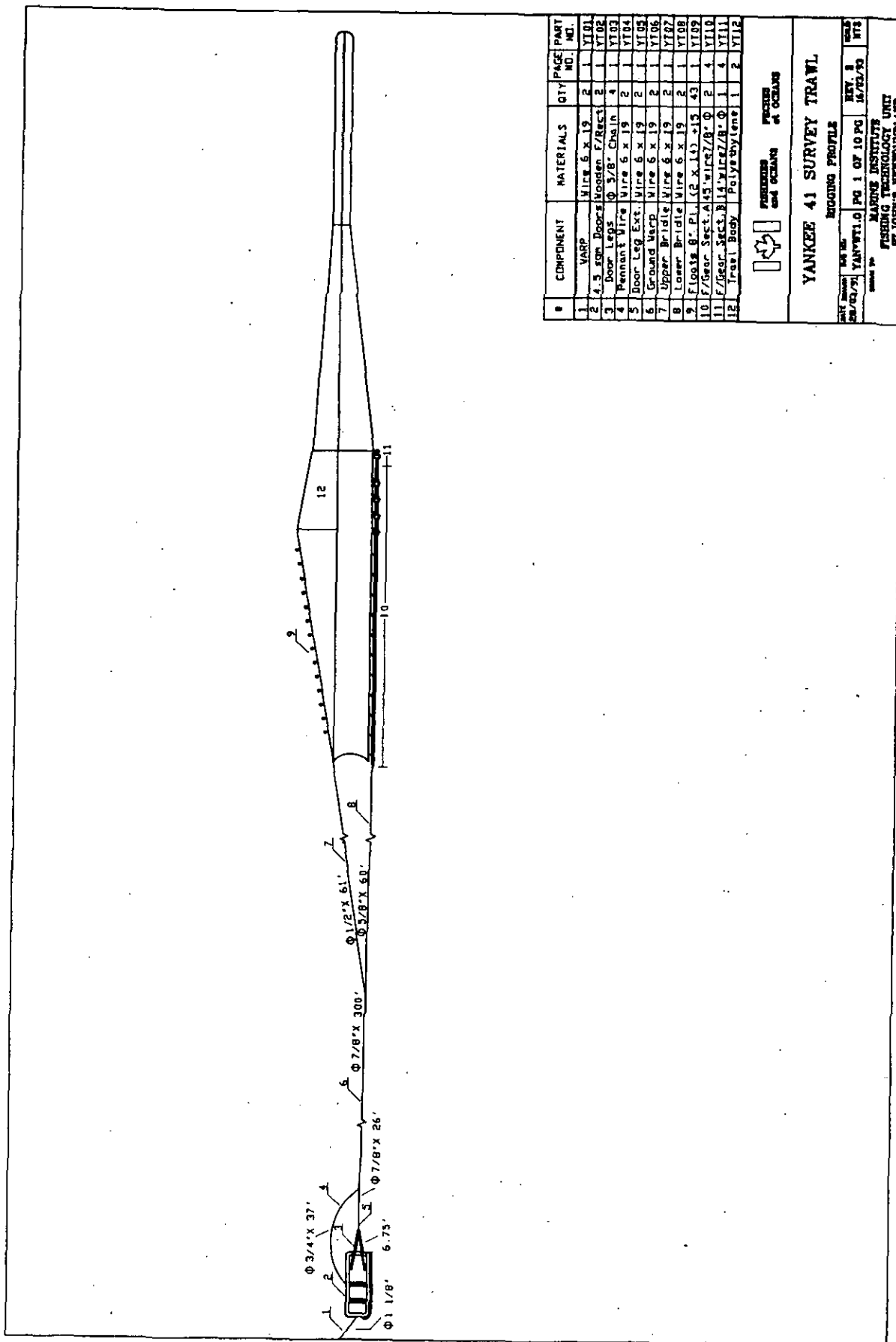
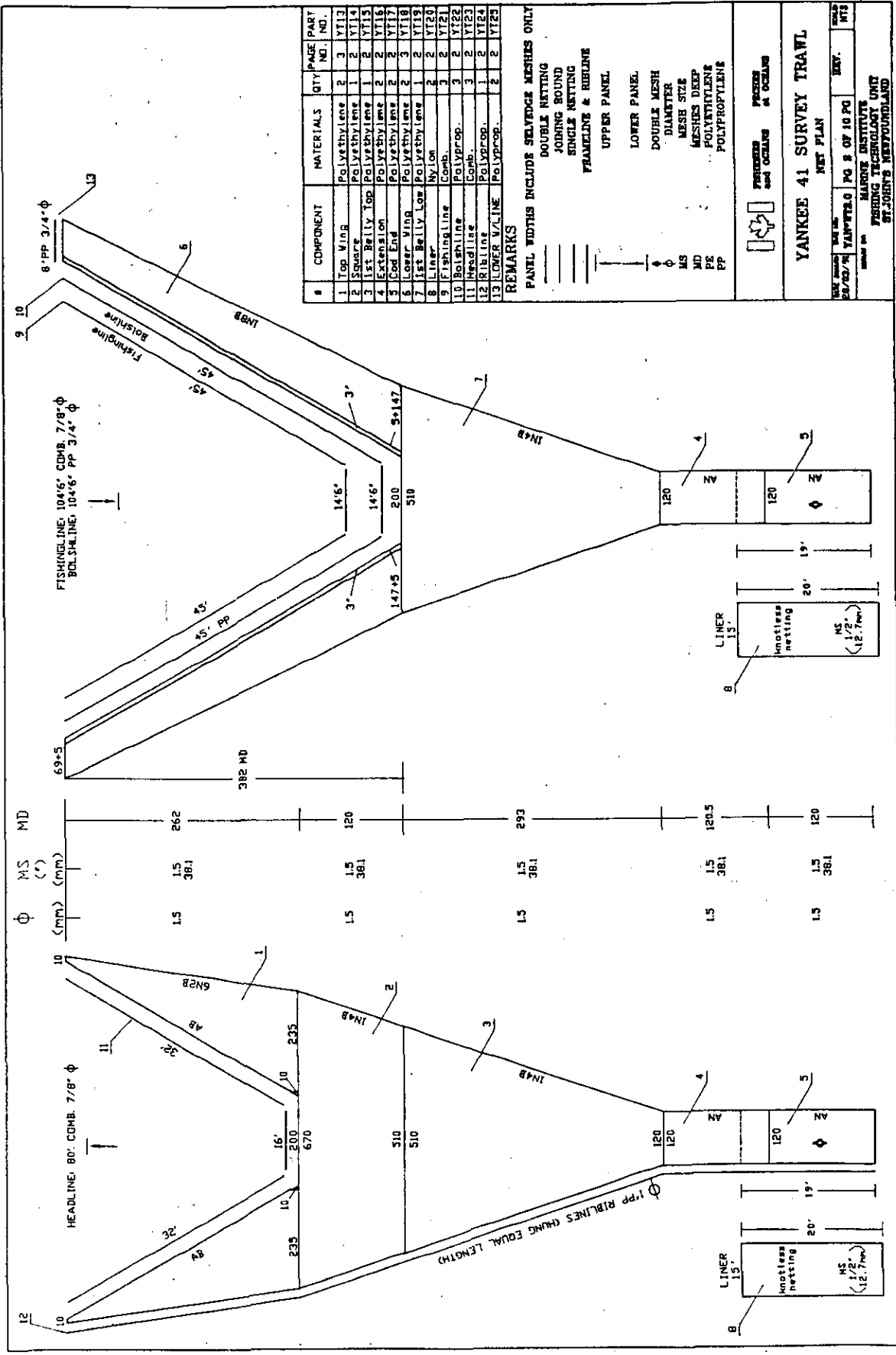


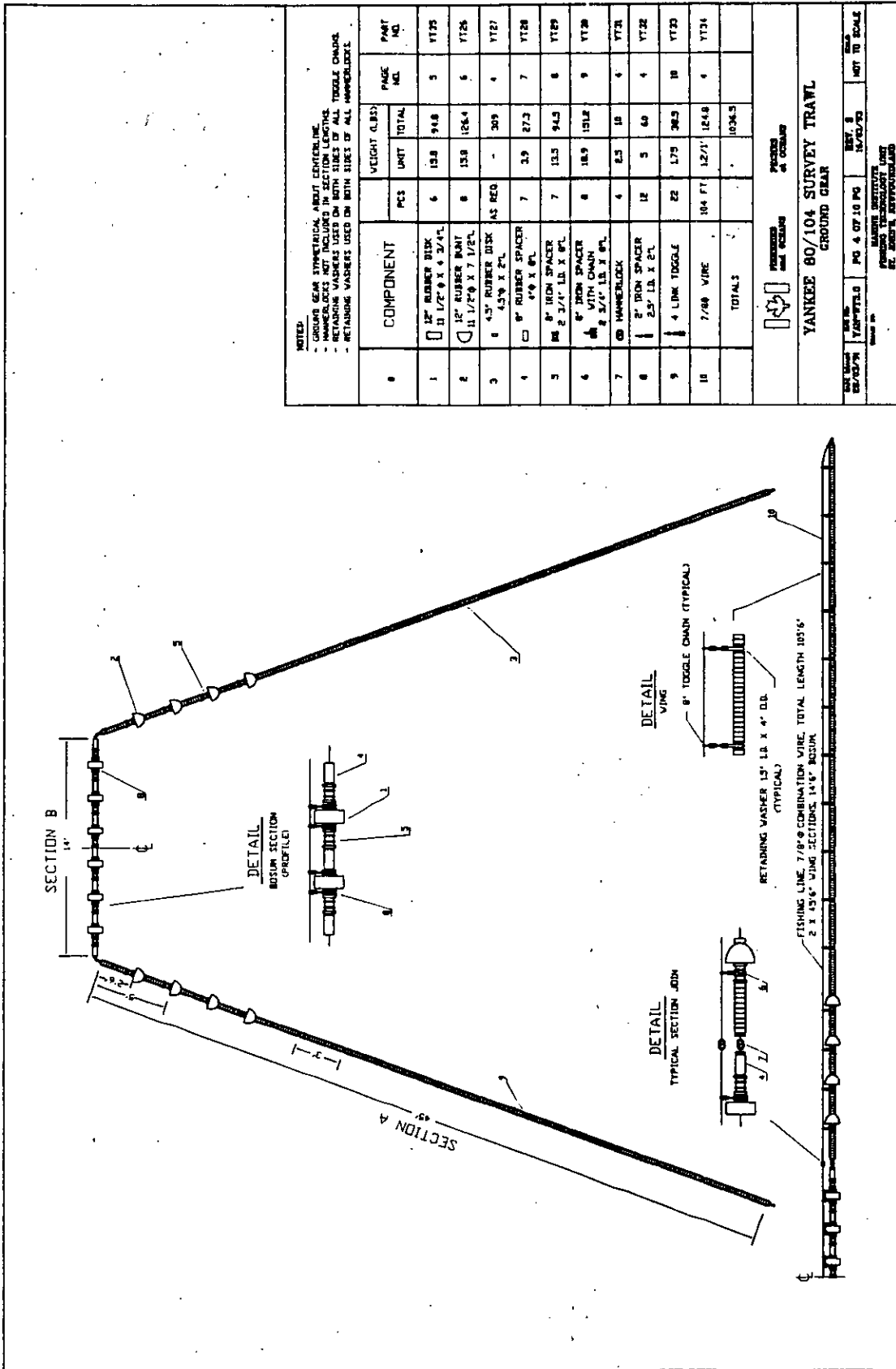
Figure 8. Rigging diagram of the FRV Wilfred Templemans's Yankee 41 Shrimp trawl.



#	COMPONENT	MATERIALS	QTY	PAGE NO.	PART NO.
1	Top Wing	Polyethylene	2	3	Y113
2	Square	Polyethylene	1	2	Y114
3	1st Belly Top	Polyethylene	1	2	Y115
4	Extension	Polyethylene	2	2	Y116
5	Cod End	Polyethylene	2	2	Y117
6	Lower Wing	Polyethylene	2	3	Y118
7	1st Belly Low	Polyethylene	1	2	Y119
8	Liner	Nylon	2	2	Y120
9	Fishingline	Comb.	3	2	Y121
10	Bolshline	Polyprop.	3	2	Y122
11	Bolshline	Comb.	3	2	Y123
12	Ribline	Polyprop.	2	2	Y124
13	LOWER V/LINE	Polyprop.	2	2	Y125

REMARKS
 PANEL WIDTHS INCLUDE SELVAGE MESHES ONLY
 DOUBLE NETTING
 JOINING ROUND
 SINGLE NETTING
 FRAMELINE & RIBLINE
 UPPER PANEL
 LOWER PANEL
 DOUBLE MESH
 DIAMETER
 MESH SIZE
 MESHES DEEP
 POLYETHYLENE
 POLYPROPYLENE

Figure 9. Trawl plan of the FRV Wilfred Templeman's Yankee 41 Shrimp trawl.



NOTES:

- GROUND GEAR SYMMETRICAL ABOUT CENTERLINE
- RETAINING WASHERS USED ON BOTH SIDES OF ALL TOGGLE CHAINS
- RETAINING WASHERS USED ON BOTH SIDES OF ALL HANDBLOCKS

#	COMPONENT	WEIGHT (LBS)		PART NO.
		PCS	TOTAL	
1	12" RUBBER DISK 11 1/2" X 4 3/4"	6	19.8	Y175
2	12" RUBBER MOUNT 11 1/2" X 7 1/2"	6	13.8	Y126
3	4.5" RUBBER DISK AS REQ	-	309	Y127
4	8" RUBBER SPACER 4" X 8"	7	2.9	Y128
5	8" IRON SPACER 3 1/4" LB. X 8"	7	13.5	Y129
6	8" IRON SPACER WITH CHAIN 2 3/4" LB. X 8"	8	18.9	Y129
7	8" HANDBLOCK	4	8.5	Y129
8	8" IRON SPACER 2 3/4" LB. X 2"	12	5	Y122
9	4 LINK TOGGLE	22	1.75	Y123
10	7/8" WIRE 104 FT	1271	124.8	Y124
TOTALS			1036.5	

**YANKEE 80/104 SURVEY TRAWL
GROUND GEAR**

PERIODS AND SEASONS **PERIODS OF OBSERVATION**

DATE **TIME** **PC** **GT** **PC** **BT** **BT**

NO. OF **NO. OF** **NO. OF** **NO. OF** **NO. OF** **NO. OF** **NO. OF**

SHRIMP **SHRIMP** **SHRIMP** **SHRIMP** **SHRIMP** **SHRIMP** **SHRIMP**

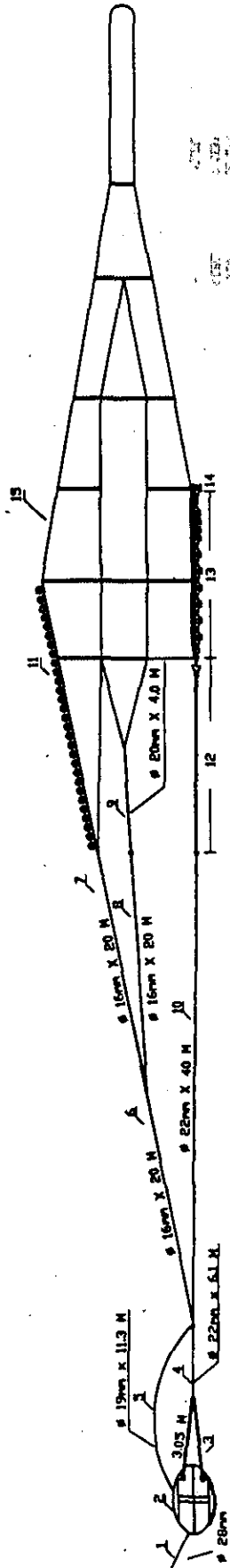
PERCENTAGE **PERCENTAGE** **PERCENTAGE** **PERCENTAGE** **PERCENTAGE** **PERCENTAGE** **PERCENTAGE**

BY **BY** **BY** **BY** **BY** **BY** **BY**

FRV WILFRED TEMPLEMAN

NO. 41

Figure 10. Footgear diagram of the FRV Wilfred Templeman's Yankee 41 Shrimp trawl.



#	COMPONENT	MATERIALS	QTY	PAGE NO.	PART NO.
1	Warp	Wire 6 x 19	2	1	CT01
2	4.3 sqm Door	1400 kg Oval	2	1	CT02
3	Door Legs	18mm Chain	4	1	CT03
4	Door Leg Ears	Wire 6 x 19	2	1	CT04
5	Warpnet Wire	Wire 6 x 19	2	1	CT05
6	U/M Bridle Ears	Wire 6 x 19	2	1	CT06
7	Upper Bridle	Wire 6 x 19	2	1	CT07
8	Middle Bridle	Wire 6 x 19	2	1	CT08
9	Lower Bridle	Wire 6 x 19	2	1	CT09
10	Lower Bridle Ears	Wire 6 x 19	2	1	CT10
11	Floats (203mm)	PL (2 x 39)+10	86	1	CT11
12	F/Gear Sect. A	Chain 16mm #	2	1	CT12
13	F/Gear Sect. B	Chain 16mm #	2	1	CT13
14	F/Gear Sect. C	Chain 16mm #	1	1	CT14
15	Trawl Body	PE Netting	1	2	CT15


FISHERIES and OCEANS
POISSONS et Océans

CAMPELEN 1800 SURVEY TRAWL

DRAWING NO. **Cam-1.0** PG 1 OF 14 PG
 DRAWN BY **MARINE INSTITUTE**
 CHECKED BY **FISHING TECHNOLOGY UNIT**
ST. JOHN'S NEWFOUNDLAND

Figure 11. Rigging diagram of the Campelen 1800 Shrimp trawl as used on the FRV's Wilfred Templeman and Teleost.

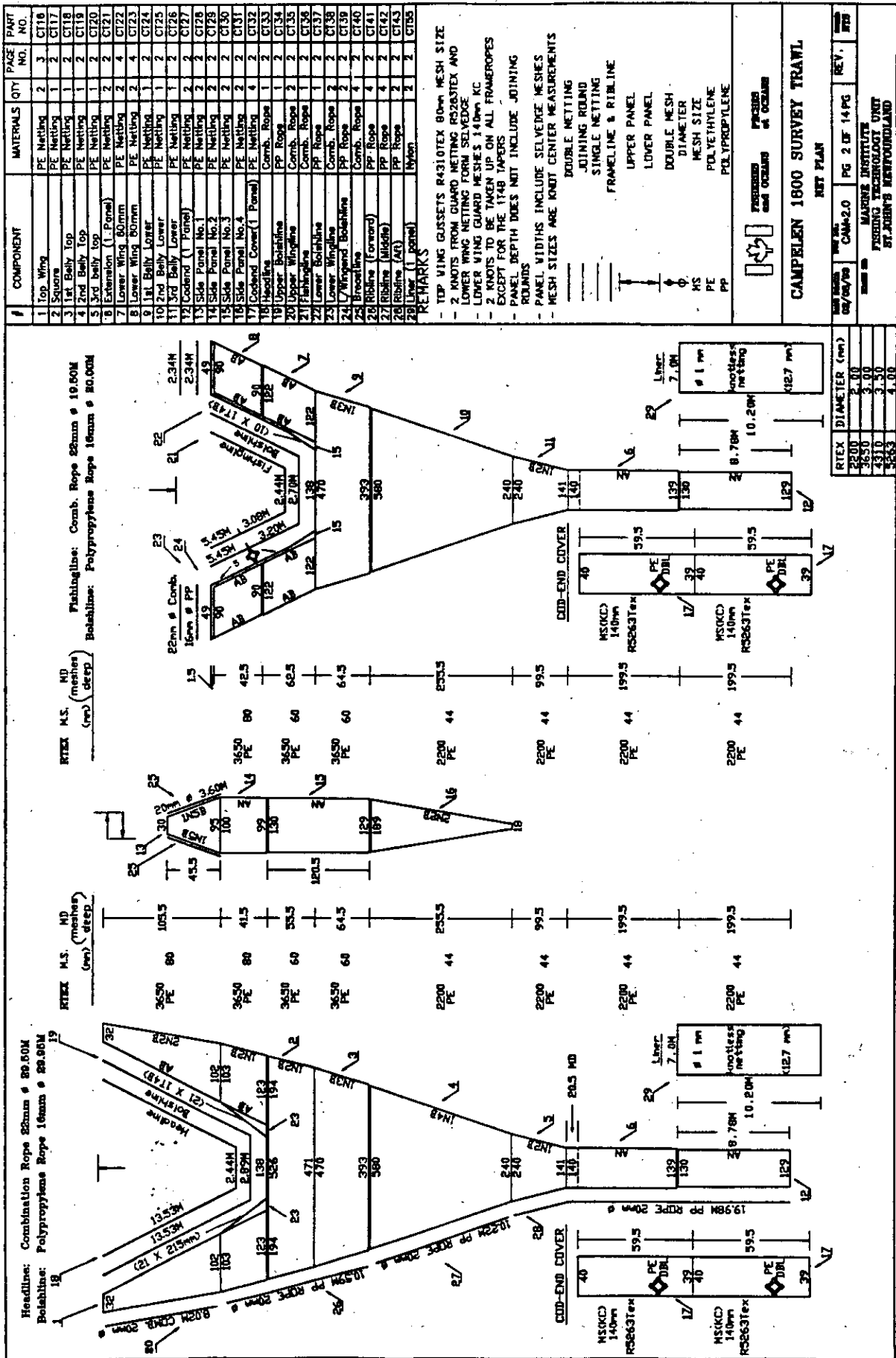
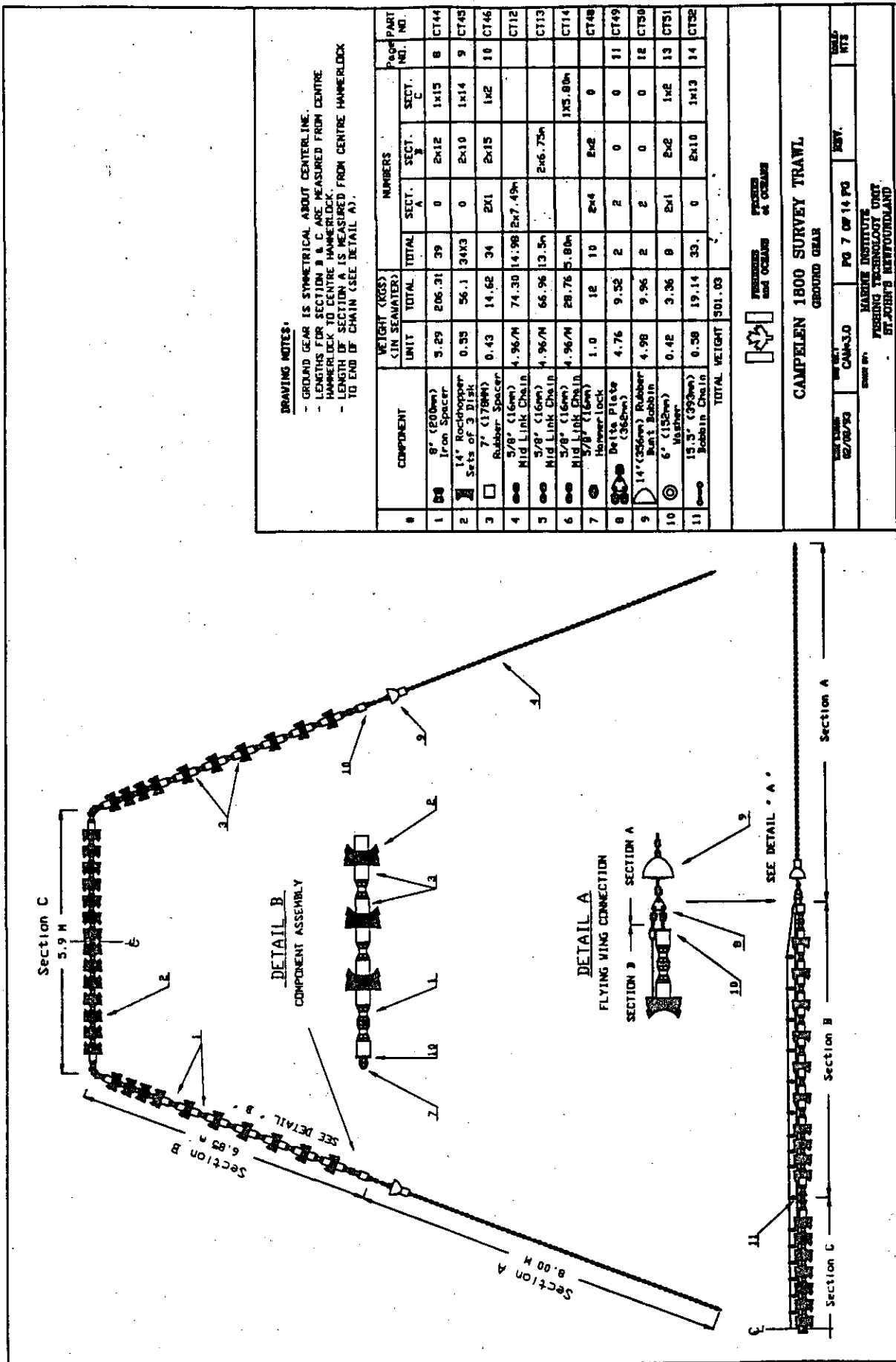


Figure 12. Trawl plan of the Campelen 1800 Shrimp trawl as used on the FRV's Wilfred Templeman and Teleost.



DRAWING NOTES:

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

#	COMPONENT	WEIGHT (KGS)		NUMBERS			Page/Part No. / No.			
		UNIT	TOTAL	SECT. A	SECT. B	SECT. C				
1	9° (200mm) Iron Spacer	3.29	206.31	39	0	2x12	1x15	8	CT44	
2	14° Rockstoppers Sets of 3 2/12R	0.33	56.1	34X3	0	2x10	1x14	9	CT45	
3	7° 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	2x7.49h				CT12	
5	5/8" (16mm) Mid Link Chain	4.96/M	66.96	13.5h		2x6.75h			CT13	
6	5/8" (16mm) Mid Link Chain	4.96/M	28.76	5.80h			1X5.80h		CT14	
7	5/8" (16mm) Hammer Lock	1.0	12	10	2x4	2x2	0		CT48	
8	14" (356mm) Ply (382mm)	4.76	9.52	2	2	0	0	11	CT49	
9	14" (356mm) Rubber Bunt Bobbin Washer	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	15.3" (393mm) Rubber Chain	0.58	19.14	33	0	2x10	1x13	14	CT52	
TOTAL WEIGHT			501.03							



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CAMPELEN 1800 SURVEY TRAWL
GROUND GEAR

DESIGN NO.	DATE	REV.
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Figure 13. Footgear diagram of the Campelen 1800 Shrimp trawl as used on the FRV's Wilfred Templeman and Telecost.