

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

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Abstract

Since 1971 the Northwest Atlantic Fisheries Centre, Department of Fisheries and Oceans, St. John's, Newfoundland, has conducted stratified random surveys off Canada's northeast coast using four different fisheries research vessels; *A. T. Cameron*, *Gadus Atlantica*, *Wilfred Templeman* and *Teleost*. Each vessel used its own unique survey trawl. Left unregulated, these "standardized" survey trawls were found to have changed in construction and rigging over time. A technical description and the chronology of each survey trawl used by these research vessels is discussed along with procedures adopted to ensure the complete standardization of the survey trawl within a research vessel and across the fleet.

Keywords: Canadian surveys, groundfish, standardization, survey trawls, trawl description

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 (NWAFC) 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 (Table 1) used at the NWAFC from 1971 until present, and outlines a new program used to standardize all aspects of survey trawl construction, rigging and fishing protocols aimed at reducing measurement error associated with trawl efficiency.

Materials

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 footrope of 53 cm diameter steel bobbins in the bosum and

36 cm diameter bobbins in the bunt wings. The net was constructed of manila twine with stretched mesh sizes of 127 mm in the wings, square and the upper and lower bellies tapering to 89 mm mesh in the lengthening piece and codend. The double mesh codend was fitted with a 28.6 mm nylon liner. After 1971, the trawl was constructed of couylene twine of similar mesh sizes and the footgear was changed to 53 cm diameter rubber rollers in the bosum with 46 cm and 36 cm diameter rubber bunt bobbins in the wings (Fig 1; Table 2). The trawl used short upper and lower bridles (2.1 m) connected to a danleno 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 37 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* defacto standard survey trawl. The 50 m long footrope of the Engel was not easily

TABLE 1. Comparison of research vessel specifications.

Specification	Research Vessel			
	<i>A. T. Cameron</i>	<i>Gadus Atlantica</i>	<i>Wilfred Templeman</i>	<i>Teleost</i>
Vessel Type	Side Trawler	Stern Trawler	Stern Trawler	Stern Trawler
Length Overall (m)	54	80.3	50.3	63
Beam (m)	9.75	13.3	11	14.2
Gross Tonnage	753	2 350	1 079	2 405
Draft (m)	4.88	5.75	4.3	7.2
Main Engine				
Power (bhp)	1 000	4 260	2 000	4 000
Speed (rpm)	310	750	850	700/850
Propellor				
Type	C.P.P*	C.P.P*	C.P.P*	C.P.P*
Diameter (m)	n/a	3.1	2.2	3.8
Speed (rpm)	290	250	300	110/132
Cruising Speed (knots)	12.5	14	10	12

* C.P.P. = Controllable Pitch Propellor

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 was a two panel "balloon" design with a stretched mesh circumference of 57.8 m at the fishing circle. Short lower cut-away wings and a heavy steel bobbin footgear made 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, 1 500 kg polyvalent trawl doors were connected to the trawl net by 17 m sweep wires and 50 m bridles. Trawl construction was of 4.0 mm diameter nylon 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 nylon and was fitted with a 28.5 mm stretched mesh liner, attached at a point 9.15 m deep from the after most end of the codend. One hundred 203 mm plastic floats were used on the headline for floatation (Table. 2). 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 (see Gavaris and Brodie, MS 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 led to a reduction in overall sweep length (Fig. 5, 6 and 7; Table 1). In contrast to the *Gadus Atlantica* the trawl body was constructed entirely of polyethylene rather than 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 officer 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 door of the same design. This version of the Engel 145 became the standardized NWAFC 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.

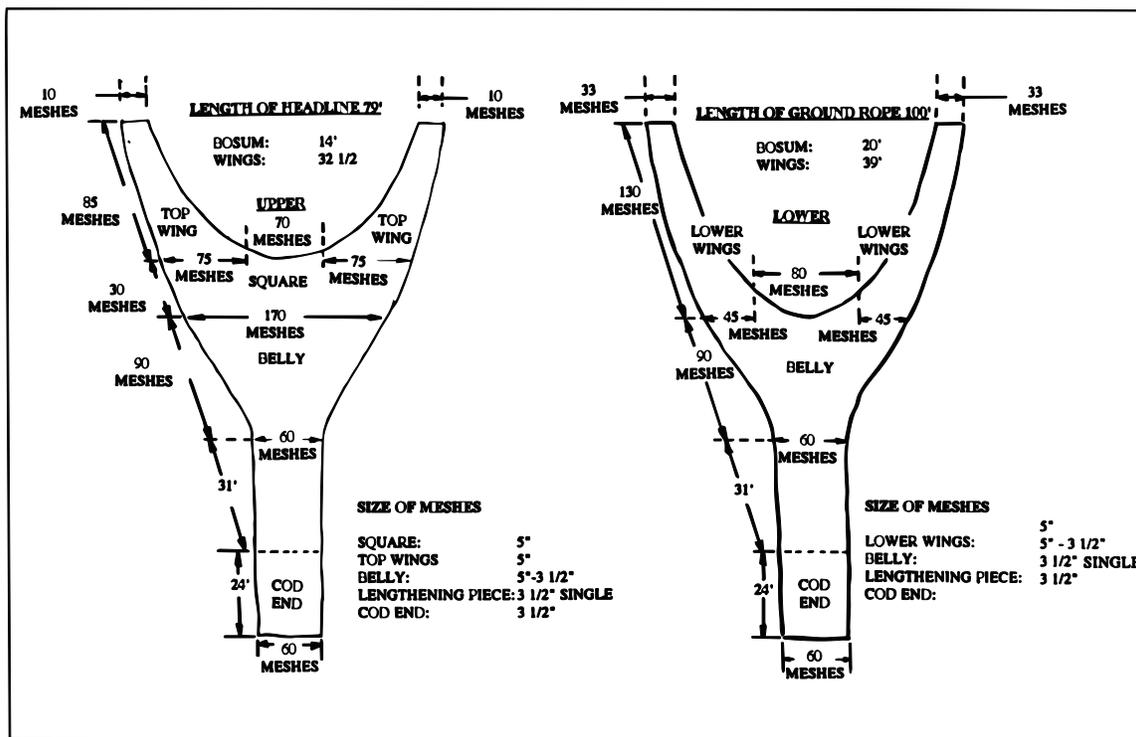
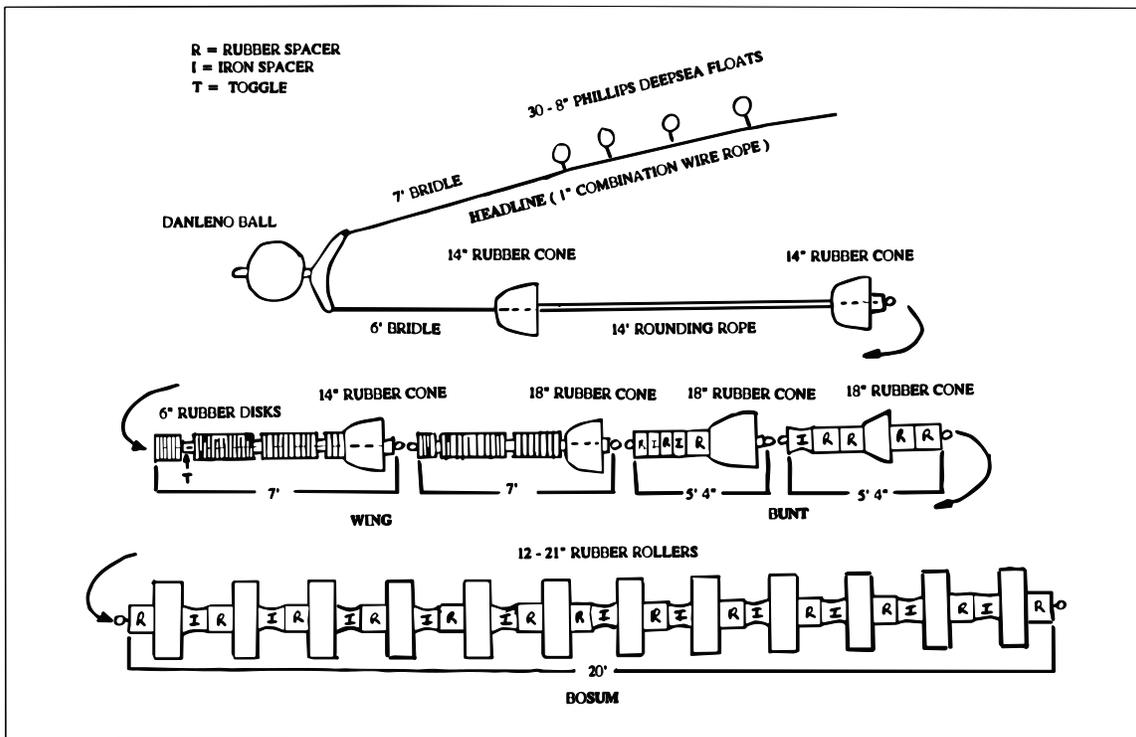


Fig. 1. Trawl plan and footgear diagram of the FRV A.T. Cameron's Yankee 41.5 Otter trawl (reprinted from Pinhorn, 1971).

TABLE 2. 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
	<i>A. T. Cameron</i>	<i>Gadus Atlantica</i>	<i>Wilfred Templeman</i>	<i>Wilfred Templeman</i>	<i>Wilfred Templeman</i>
Doors	4.5m ² /590 kg	5.6m ² /1 500 kg	3.8m ² /1 250 kg	4.5m ² /590 kg	4.3m ² /1 400 kg
Sweeps (m)	40	17	15.2	99.4	6.1
Bridles (m)	2.1	50	50	18.3	40
Buoyancy (kg)	105	299	283.6	129.0	229
Headline (m)	24.1	29.3	29.3	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	3 168.6	2 349.7	470.3	501.3
Size (dia./cm)	53/46/36	61/53/46/36	53/46/36	30.5/11.5	35.6
<u>Mesh Size (mm)</u>					
Wings/Square	127	180	180	38	80/60
Bellies	127/89	160	150/130	38	60/44
Codend	89	160	130	38	44
Liner	30	28.5	28.5	12.7	12.7
Material	Courlene	Nylon	Polyethylene 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, MS 1974).

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 Bank. 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 Marinovitch semi-balloon trawl with a leaded fishing line and chain footgear (for details see Walsh, 1984). A Yankee 36 shrimp trawl rigged with rubber roller disks in the bosum 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 30.5 cm roller disks in the bosum and half bunt bobbins in the quarters (Fig. 8, 9 and 10). This two bridle trawl is a two panel trawl with a stretched mesh circumference of 38.2 m at the fishing circle and was constructed of 38 mm mesh size polyethylene throughout. A 12.7 mm nylon liner was used in the codend and the trawl was fished with 4.5 m² Brompton trawl doors. In 1985 it was adopted as the standard offshore juvenile groundfish survey trawl for the Grand Bank. The trawl was towed at 2.5 knots for 30 minutes during annual autumn random stratified groundfish surveys of the Grand Bank.

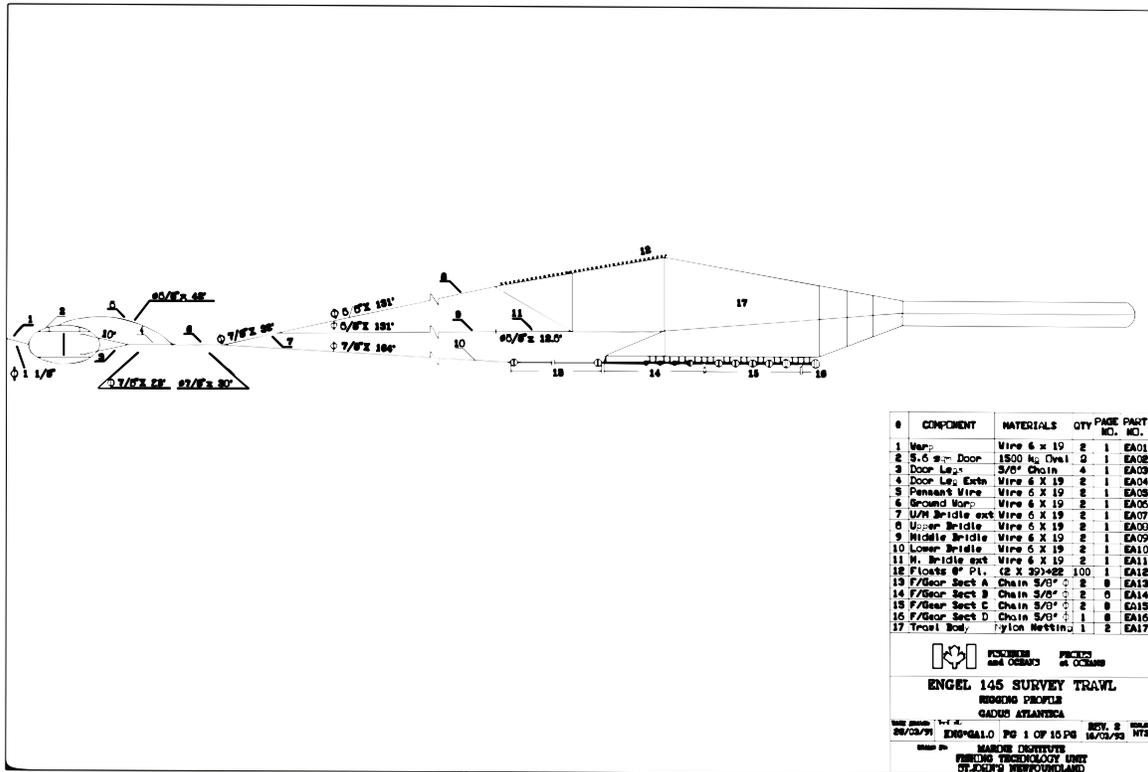


Fig. 2. Rigging diagram of the FRV *Gadus Atlantica's* Engel 145 Hi-Lift Otter trawl.

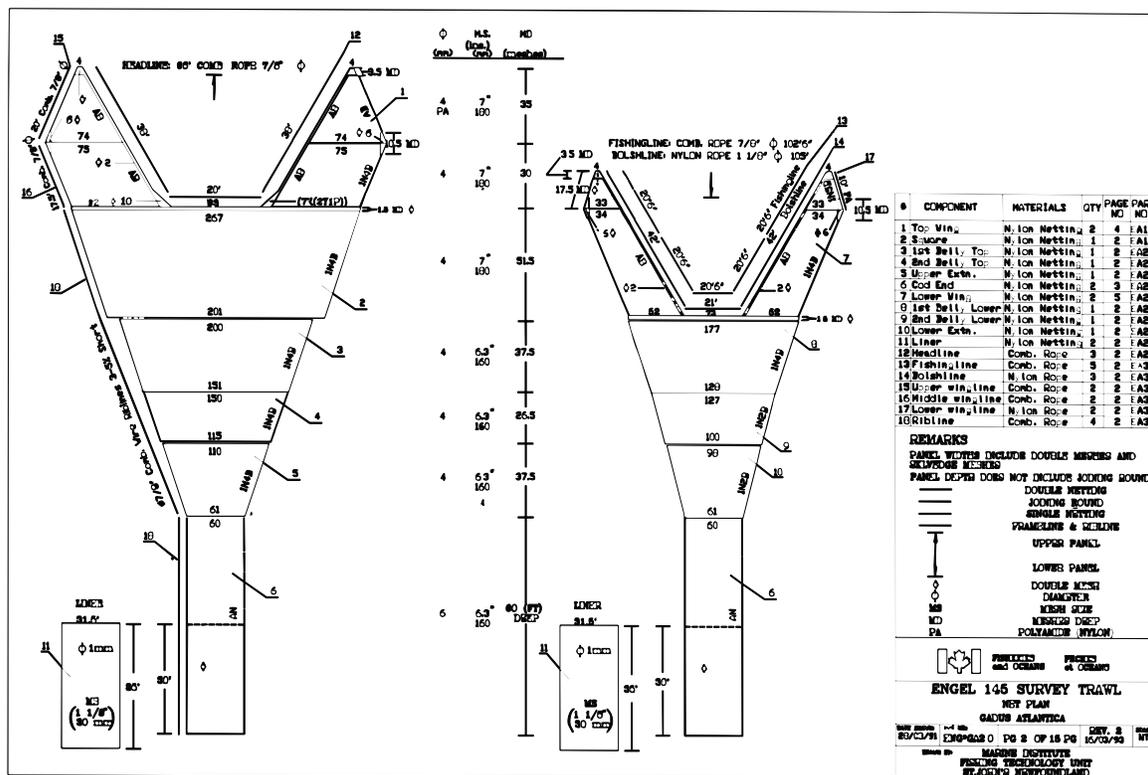


Fig. 3. Trawl plan of the FRV *Gadus Atlantica's* Engel 145 Hi-Lift Otter trawl.

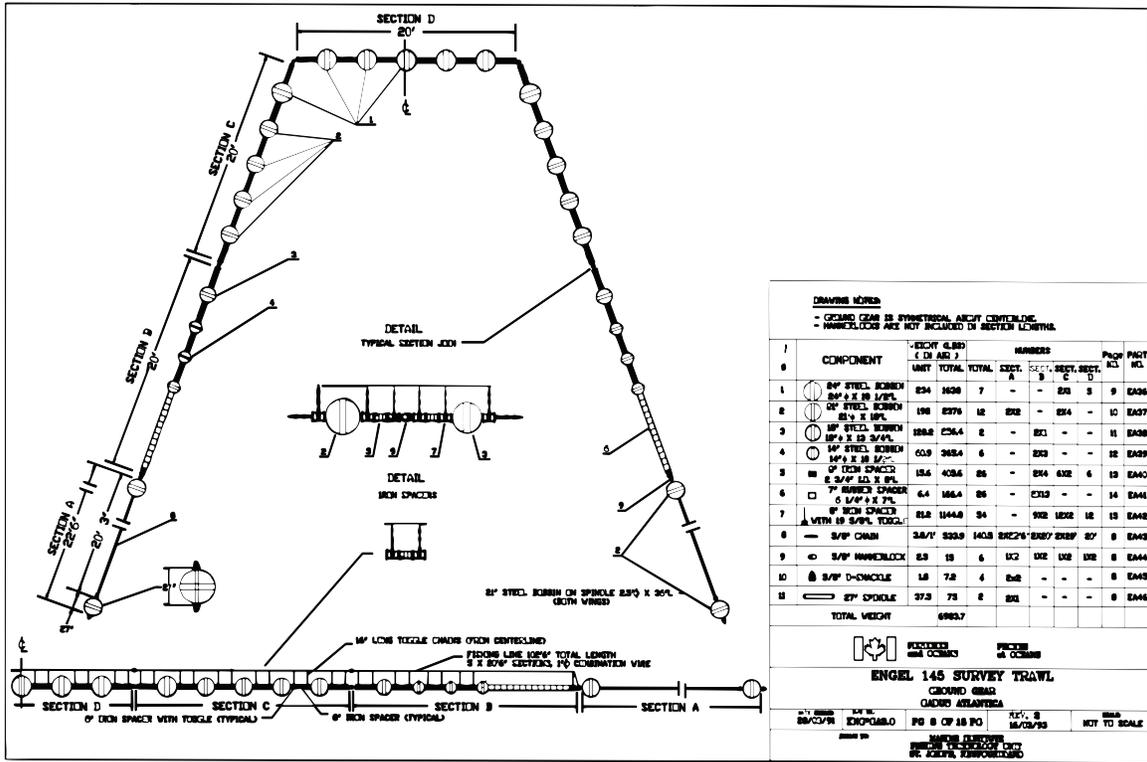


Fig. 4. Footgear diagram of the FRV *Gadus Atlantica's* 145 Hi-Lift Otter trawl.

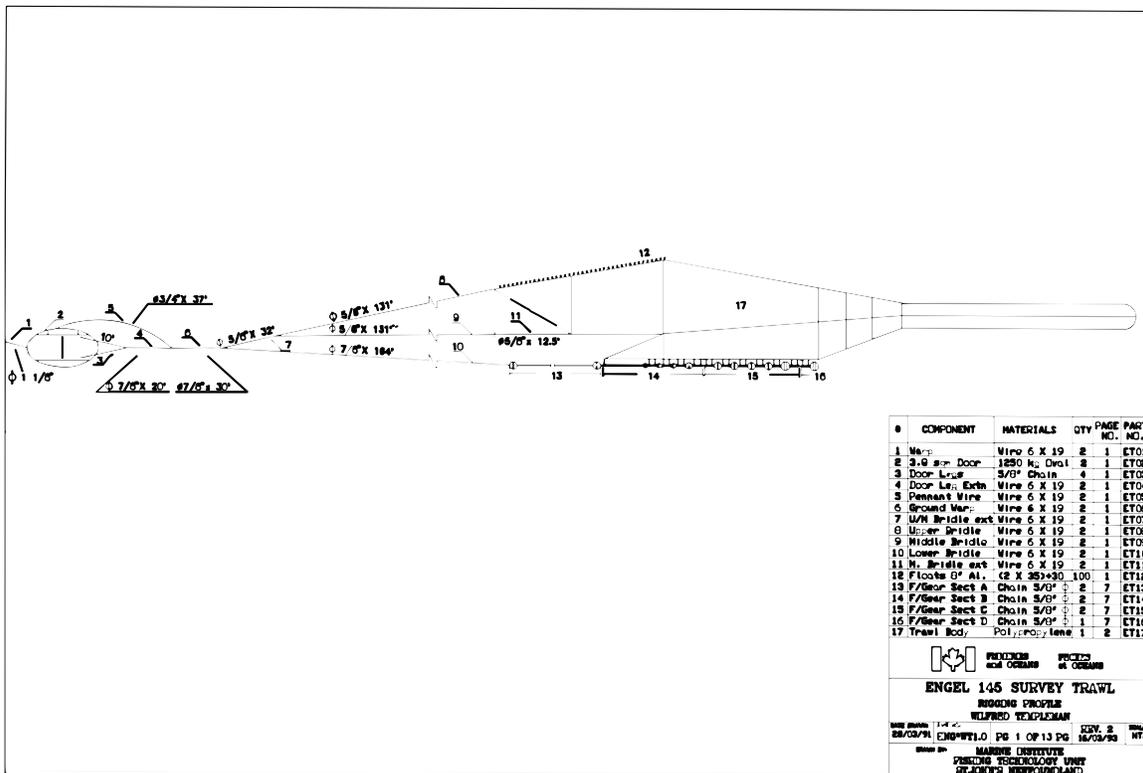


Fig. 5. Rigging diagram of the FRV *Wilfred Templeman's* Engel 145 Hi-Lift Otter trawl.

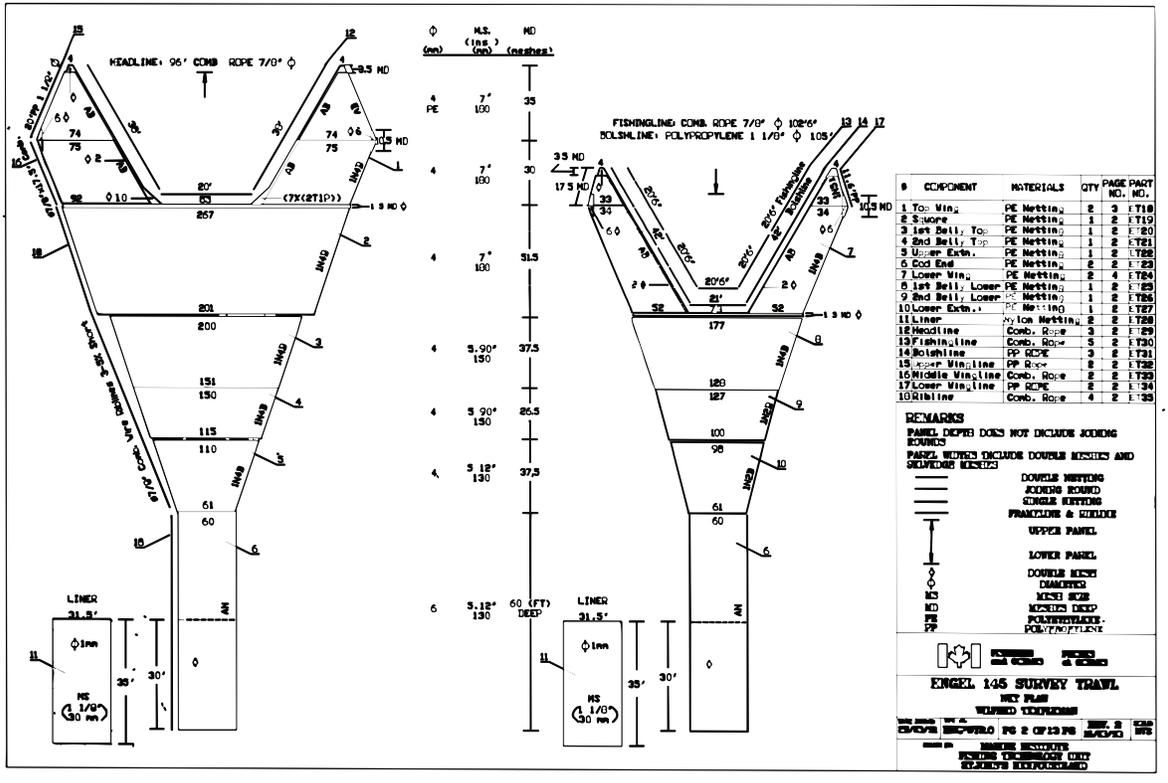


Fig. 6. Trawl plan of the FRV *Wilfred Templeman's* 145 Hi-Lift Otter trawl.

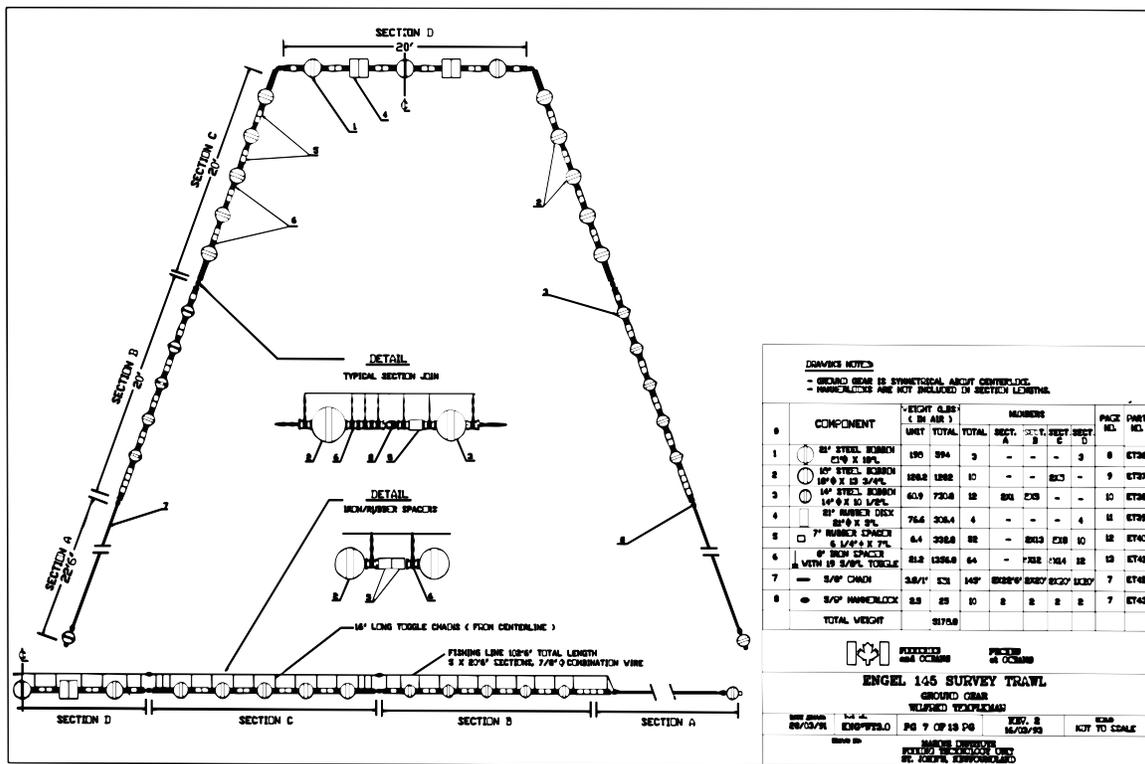


Fig. 7. Footgear diagram of the FRV *Wilfred Templeman's* 145 Hi-Lift Otter trawl.

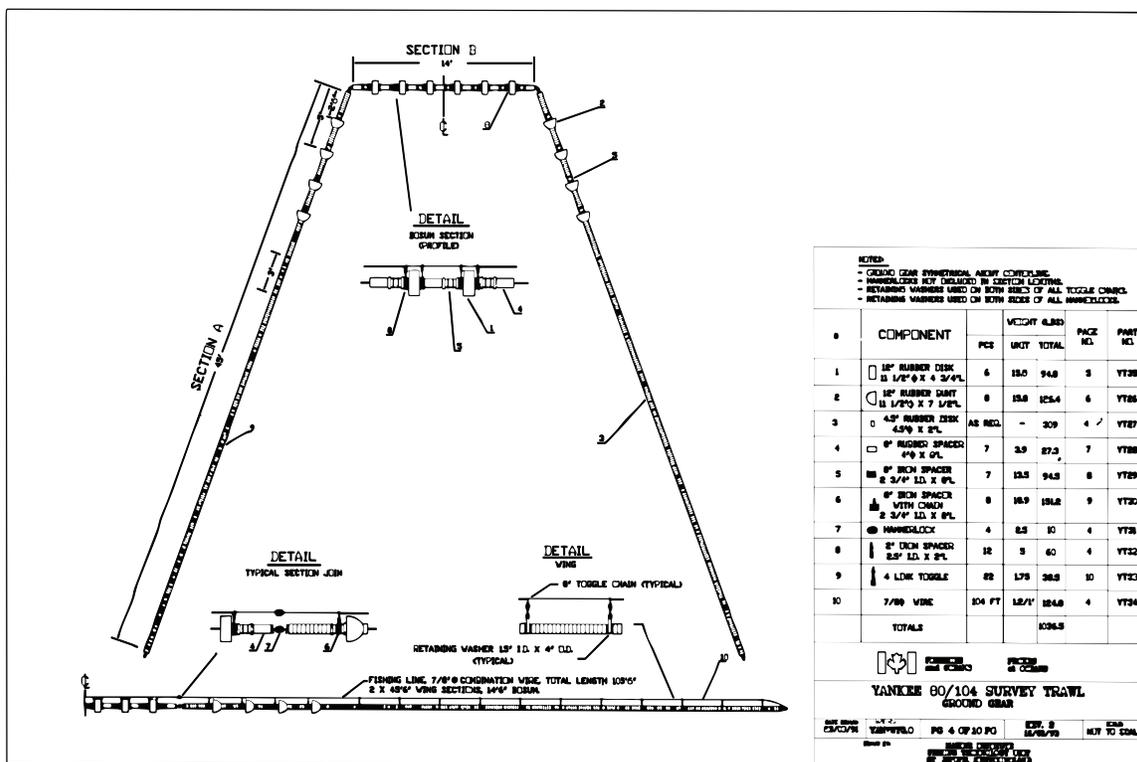


Fig. 10. Footgear diagram of the FRV *Wilfred Templeman's* Yankee 41 Shrimp trawl.

Campelen 1800 Shrimp Trawl (FRV *Wilfred Templeman* and 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, the 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 NWAFC 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: NWAFC, unpublished data). Preliminary analysis showed that the selectivity of both trawls was similar. From 1992 to 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 using 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 NWAFC in June 1995

(unpublished report). It replaced both versions of the Engel 145 otter trawl and the Yankee 41 shrimp trawl.

The Campelen 1800 shrimp trawl is a four panel 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 2nd 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 riblines to the headline (Fig.11, 12 and 13). The footrope is of rockhopper construction consisting of 102 x 35.6 cm diameter 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 44 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 covered 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, uses 4.3 m² (1 400 kg) polyvalent trawl doors instead of the larger 6.0 m² (1 500 kg) Waco doors and a 6.1 m long sweep wire has been

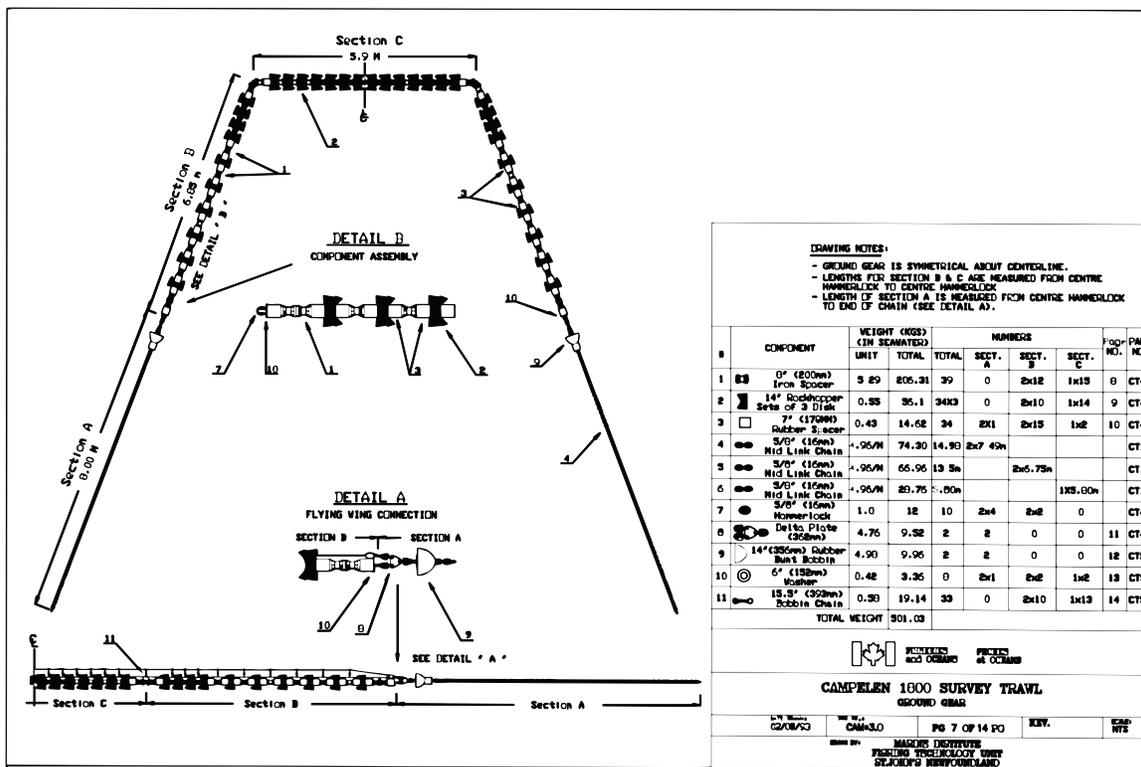


Fig. 13. Footgear diagram of the Campelen 1800 Shrimp trawl as used on the FRVs *Wilfred Templeman* and *Teleost*.

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, unregulated changes in trawl specifications occurred up to 1992 (see Walsh and McCallum, MS 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 were developed during 1991–92 for the first time in NWAFC history. Extreme care was taken to ensure 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 with the required specifications before delivery (for details see McCallum and Walsh, MS 1995). During each fishing tow SCANMAR acoustic trawl sensors record information on door spread, wing spread, trawl opening, depth and bottom contact. These data along with latitude and longitude from GPS, vessel towing speed and direction, are recorded simultaneously on SEATRAWL, a NWAFC software package (McCallum and Walsh, MS 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 autumn 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, 1997). Similar comparative fishing experiments are planned for the Yankee 41 shrimp trawl in 1996. In addition to common demersal fishes, the Campelen has been found to be an effective sampler of shrimp (*Pandalus* sp.), capelin (*Mallotus villosus*), Arctic cod (*Boregadus saida*) and a wide range of bottom invertebrates, including snow crab (*Chionoecetes opilio*).

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