New England Mesh Selectivity Studies

Experiment One

Inshore Groundfish

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Abstract

This is the preliminary report of results of the tests conducted from the fishing vessels FRANCES ELIZABETH and CHRISTOPHER ANDREW. The tests were conducted on December 12, 13, and 15, 1977, in inshore waters off Scituate, Massachusetts.

Personnel

FRANCES ELIZABETH

Dan Arnold	- Captain/Chief of Party
Tony Pinto	- Fisherman
David Arnold	- Fisherman
Jay Wennemer	- Fisherman/Biologist
Ronald Smolowitz	- Scientific Advisor (NMFS)
Jim Costakes	- Scientific Advisor (Mass. Div. Marine Fisheries)

CHRISTOPHER ANDREW

Frank Mirarchi	- Captain/Chief of Party
Louis Gifford	- Fisherman
Roland Bedard	- Fisherman
Tom Currier	- Scientific Advisor (Mass. Div. Marine Fisheries)
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Introduction

This experiment was the first in a series requested by the New England Regional Fisheries Management Council to provide a basis for evaluating the effect on present catches which could result from an increase in cod end mesh size.

The method chosen was to conduct a conventional selectivity experiment comparing a commonly used commercial cod end with a larger size, both under actual commercial fishing conditions. These trials were performed according to international standards to allow for comparison with past research. The goal was to determine the effects on catch composition of the two cod ends and obtain further selectivity data.

Selection Factor

When discussing mesh selectivity the key term used is "selection factor." The selection factor is equal to the 50% retention length (the length at which half the fish entering the net are retained) divided by the mesh size.

$$\text{Selection Factor} = \frac{\text{50\% retention length (mm)}}{\text{mesh size (mm)}}$$

This statistic is usually sufficient to represent the overall selection process for most purposes, such as deriving the 50% retention length for other mesh sizes. Selection factors vary with species, catch size, cod end material, and length of tow.

Average mesh selection factors (Table 1) for cod and haddock, obtained from previous experiments with double-braided polyamide (nylon) trawl nets,

were 3.6 and 3.4, respectively (Holden 1971, p. 40). For yellowtail flounder, the average selection factor for polyamide twine was 2.3--a factor determined from tests conducted by Lux (1968) aboard two New Bedford fishing boats in 1967.

Choosing Cod Ends

In 1975, mesh sizes used in the USA Subarea 5 cod and haddock fisheries ranged from 110-129 mm (4.3-5.1 inches), with the majority of cod ends examined (>85%) having mesh sizes from 115-124 mm (4.5-4.9 inches) (ICNAF 1976). Trawl cod end mesh sizes used in the 1975 yellowtail flounder fishery ranged from 110-139 mm (4.3-5.5 inches), with most cod end meshes between 115-129 mm (4.5-5.1 inches).

We chose our small mesh size by buying the largest nylon cod end webbing commercially available in New England. It is produced by Hope Mills of Rhode Island and is made of #102 double-braided nylon twine (runnage 73.76 m per kg). It is treated with hot water/steam and sold as 4.5-inch webbing. The actual average dry mesh measurement of our cod ends was 108 mm (4.25 inches). The average wet mesh measurement during the experiment was 106 mm.

The larger mesh size was chosen on the basis of increasing the minimum size of cod and haddock to 52 cm (20.5 inches). The 52-cm minimum size limit would increase age at first capture to 3 yr for cod and 3.5 yr for haddock; corresponding weights of each of the species would be 3.1 lb (1.4 kg) and 3.4 lb (1.5 kg), respectively. Increases in yield per recruit would result in both fisheries in the long term.

Using the selection factors stated above for cod and haddock and 52 cm as the mean selection length we get the following mesh sizes from the equation above:

cod: 144 mm (5.7 inches)

haddock: 153 mm (6.0 inches)

Table 1. Synopsis of Bottom Trawl Mesh Selectivity Data for Cod, Haddock, and Yellowtail Flounder[1]

Cod-end Net Material	Range of Mean Mesh Sizes Used	Range of 50% Selection Length	Range of Selection Factors
OD			
Double Manila	66-144 mm	173-580 mm	2.4 - 4.4
Double Polyamide, Type A	90-140 mm	357-488 mm	3.2 - 4.4
Double Polyamide, Type B	89-136 mm	(310)-539 mm	3.2 - 4.4
Double Polyester	106-122 mm	415-470 mm	3.9 - 4.0
Double Polyethylene	113-134 mm	369-452 mm	3.2 - 4.0
Double Polypropylene	105-146 mm	388-571 mm	2.8 - 4.4
Manila	73-168 mm	280-580 mm	3.1 - 3.8
Cotton	102-109 mm	370-445 mm	3.6
Polyamide	107-124 mm	410-475 mm	3.4 - 3.9
Sisal	126-127 mm	400-464 mm	3.2 - 3.7
HADDOCK			
Double Manila	66-178 mm	194-575 mm	2.3 - 3.8
Double Polyamide, Type A	89-140 mm	321-540 mm	3.4 - 4.0
Double Polyamide, Type B	104-133 mm	330-476 mm	3.1 - 3.6
Double Polyester	106-108 mm	350-372 mm	3.3 - 3.5
Double Polyethylene	121-144 mm	293-391 mm	2.0 - 3.2
Double Polypropylene	105-146 mm	345-497 mm	2.7 - 3.8
Manila	56-167 mm	190-547 mm	2.5 - 3.5
Cotton	57-144 mm	208-524 mm	2.8 - 4.4
Polyamide	62-146 mm	211-485 mm	3.1 - 4.4
Polyester	70-137 mm	234-398 mm	2.8 - 3.7
Polypropylene	70-132 mm	220-501 mm	2.9 - 4.0
Polyethylene	71- 87 mm	231-277 mm	2.9 - 3.3
Sisal	63- 73 mm	(195)-256 mm	(3.1)- 3.5
YELLOWTAIL FLOUNDER			
Polyamide	38-145 mm	266-360 mm	2.2 - 2.8

[1]Source: Holden, M. J., 1971. Report of the ICES/ICNAF working group on selectivity analysis. Coop. Res. Rept. ICES (A), No. 25: 144 p.

As no large webbing was available, handmade cod ends of 146 mm (5.75 inches) were constructed of the same #102 twine as were the smaller cod ends. During the length of the experiment these cod ends averaged 139 mm.

The mean selection lengths for the cod ends used in this experiment were predicted to be as follows:

	139 mm (5.5 inches)	106 mm (4.2 inches)
cod:	50.0 cm (19.7 inches)	38.1 cm (15.0 inches)
haddock:	47.2 cm (18.6 inches)	36.0 cm (14.2 inches)
yellowtail:	31.9 cm (12.6 inches)	24.4 cm (09.6 inches)

Methods

Study Areas

The study areas were jointly chosen by the captains of the participating fishing vessels. Areas selected were expected to contain adequate numbers of cod in the desired range, 12-32 inches (30-81 cm, or 1-6 years of age), together with haddock and flounder species. The area was also to have good bottom to avoid tear-ups. In this first experiment, we opted for the better bottom at the expense of larger cod catches.

Gear

The trawls and associated rigging for the experiment were chosen by the individual captains. Detailed information is presented in Tables 2 and 3 and in Figures 1 and 2. The only change in gear occurred on the third day of the experiment when the FRANCES ELIZABETH found that their sweep (footrope) was 2 ft too short and corrected it before Tow 9.

Two cod ends (106 mm and 139 mm) were provided for each boat as well as a 50-mm (2-inch) cover. The cover was 25% larger in circumference and about

1.5 m (5 ft) longer than the cod ends. The covers were attached to the cod ends by rings for quick connecting and disconnecting. Floats were attached to the top of the covers to minimize masking of the cod end (blocking of the cod end mesh by the cover) (Figure 2).

Procedures

The experiment consisted of three four-tow series. The four-tow series consisted of the following:

106-mm cod end

139-mm cod end

106-mm cod end covered

139-mm cod end covered

The order of the tows was chosen at random for each series. Both vessels towed in the same order, usually within a kilometer of each other. Vessel speed was maintained at 2.0-2.5 knots. The tows were conducted during daylight hours only.

Table 2. Vessel Specifications.

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Home Port	Scituate, Massachusetts	
Call sign	KXS 387	WYP 9523
Length	16.8 meters (55 feet)	18.9 meters (62 feet)
Gross tons	36 tons	54 tons
Draft	2 meters (6.5 feet)	2.7 meters (9 feet)
Speed	9 knots	9 knots
Engine and Drive	GM V671 Diesel 3:1 reduction	Detroit 8V71N Diesel 4.5:1 reduction
Horsepower	170 SHP	240 SHP @ 1800 rpm

Table 3. Gear Specifications.

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Trawl	133 mm average mesh size throughout. #54 braided nylon twine.	
Cod ends	Type 1 - 106 mm average mesh size; 80 meshes around by 50 deep; #102 braided nylon twine, machine made.	
	Type 2 - 139 mm average mesh size; 80 meshes around by 35 deep; #102 braided nylon twine, hand made.	
Cover (when used)	50 mm mesh size; #72 twisted nylon; 225 meshes around by 133 meshes deep, machine made.	
Headrope	15.8 meters total of 19 mm polypro	
Footrope (sweeps)	9.5 mm chain in wing section and 12.7 mm chain in bosom; strung with 10 cm diameter rubber "cookies" over 60% of its length.	11 mm chain strung with 10 cm diameter "cookies." About 30 per meter of length. Groundrope of 19 mm poly connected to sweep by 7.6 cm scallop rings and shackles about every 40 cm.
Floats	7-8" diameter aluminum spheres	9-8" diameter aluminum spheres; 2 along each wing and 5 along center
Chafing gear	Mat of polyethylene strands covering aft half (and underside only) of cod and and cover.	
Doors	Rectangular shaped of wood construction 2.13 meters long by 1.11 meters wide weighing 270 kg. Bracket triangular shaped in two parts of iron bar located 1/3 back from forward end.	Oval shaped steel 2.13 meters long by 1.11 meters wide weighing 382.5 kg. Solid bracket in two parts located 1/4 and 1/2 back from forward end.

Table 3 (cont.)

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Backstraps	Two 2.13 meter lengths of 9.5 mm chain	
Bridle wires (legs)	13.7 meters long 9.5 mm chain on bottom and 9.5 mm wire on top.	9.1 meters long 9.5 mm chain on bottom and 12.7 mm wire (6x19) on top.
Trawl wire	14.3 mm 6x19 wire	15.8 mm 6x19 wire
Ground cables	36.5 meters 15.8 mm 6x19 wire	55 meters of 15.8 mm 6x19 wire
Misc.	No quarter ropes, bull rope, lazy line or tickler chains used.	

Figure 1

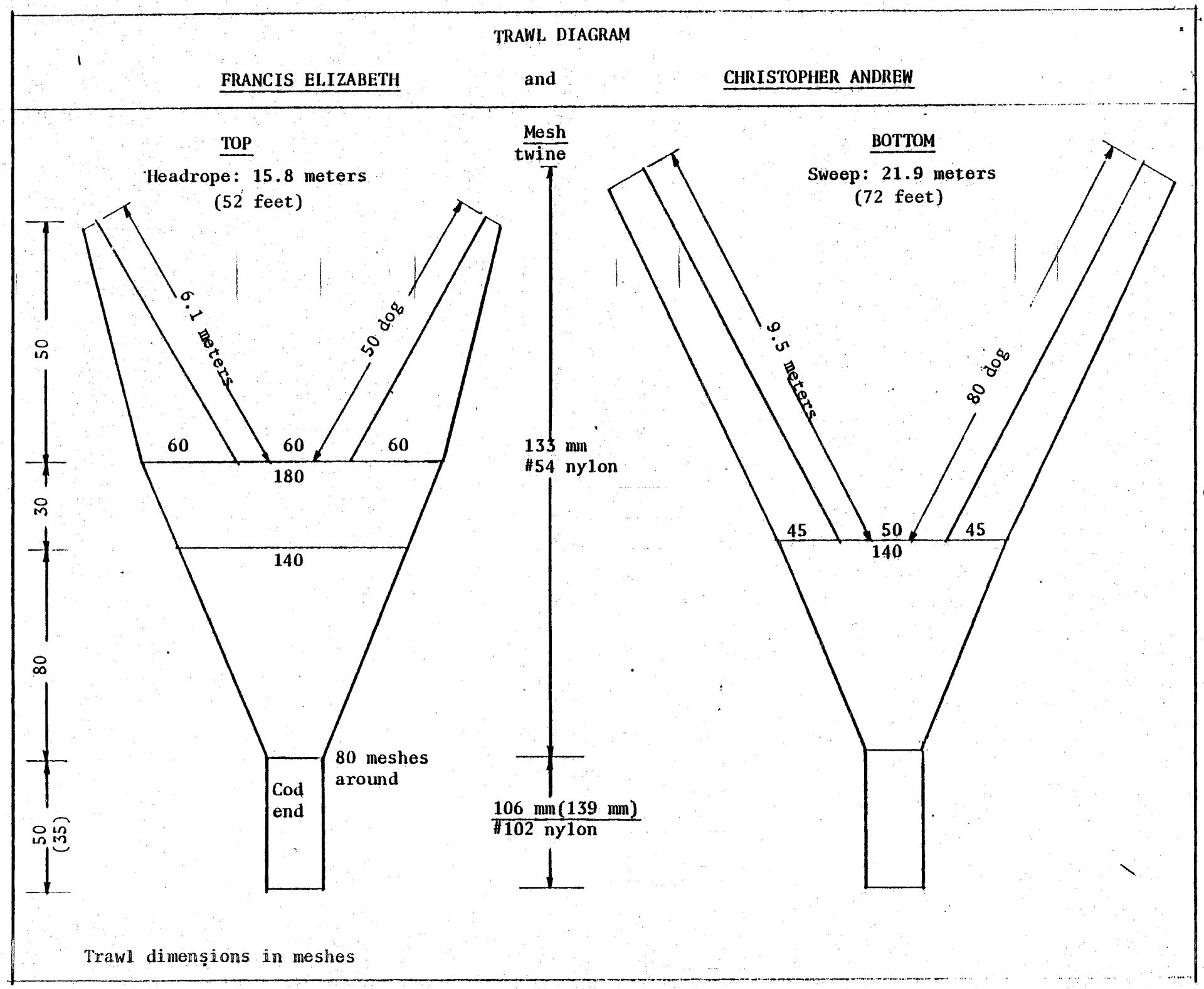
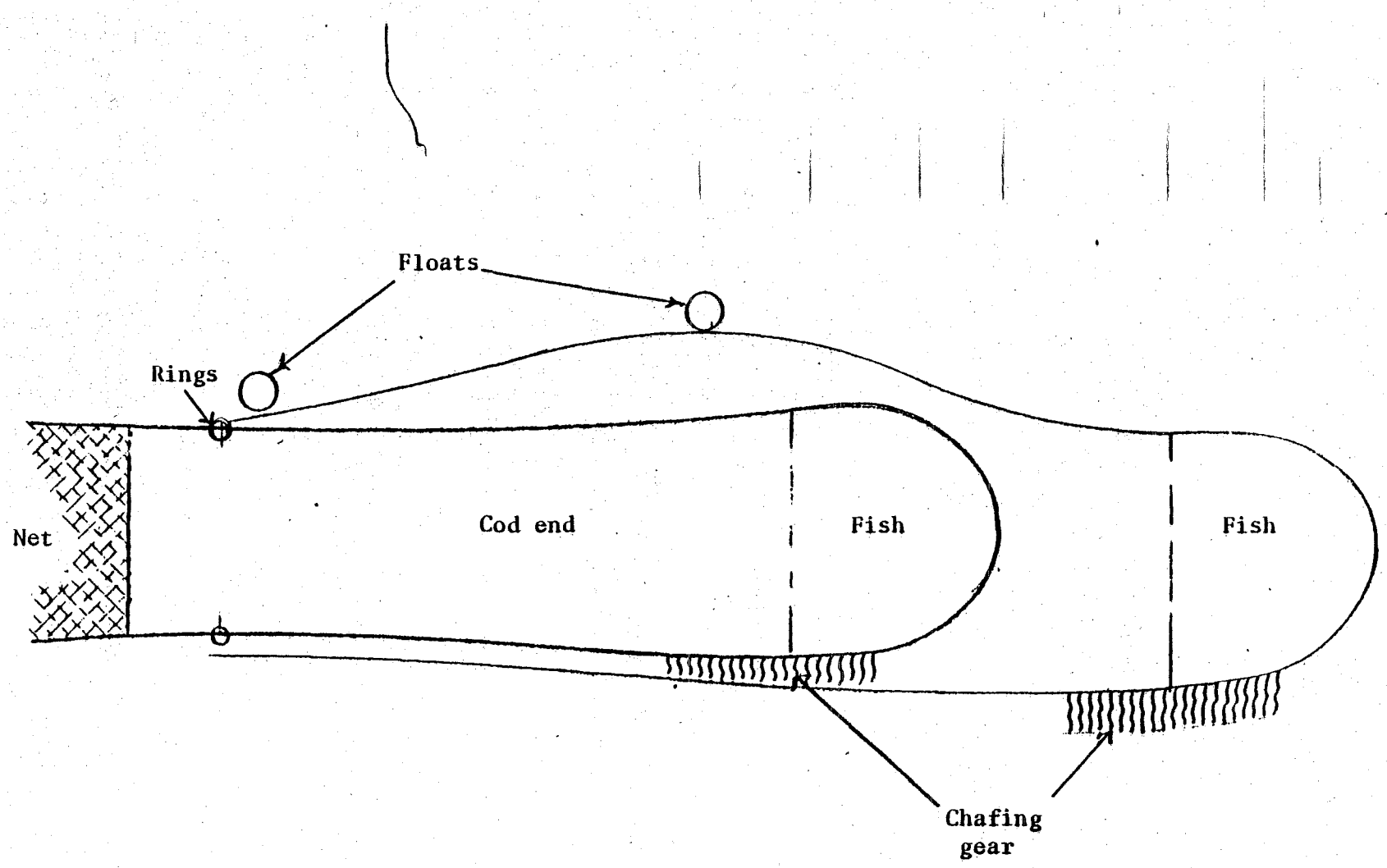

TRAWL DIAGRAM
FRANCIS ELIZABETH
and
CHRISTOPHER ANDREW
TOP
Headrope: 15.8 meters
(52 feet)
6.1 meters
50 dog
60
60
60
180
140
80 meshes
around
Cod
end
50
30
80
50
(35)
Mesh
twine
133 mm
#54 nylon
106 mm(139 mm)
#102 nylon
BOTTOM
Sweep: 21.9 meters
(72 feet)
9.5 meters
80 dog
45
50
45
140
Trawl dimensions in meshes

Figure 2

COVER RIGGING



At the conclusion of each tow, the respective catches (if a cover was used) were kept segregated. The gear was meticulously checked and if there was major damage in the cod end, the tow was rejected. Notes were taken on anything unusual that may have affected the validity of the tow such as rocks in the cod end or fouled gear. Cod-end and cover knots were tied tight and a piece of old webbing was placed in the end to prevent leakage of catch (FRANCES ELIZABETH only).

After each tow, 30 cod-end meshes were measured along the top of the cod end; 10 each from the forward, mid, and aft sections. They were measured using the ICES gauge set at 4 kg pressure.

The segregated catch (cod end and cover when used) was worked up separately. Any fish found forward of the cod end were excluded. The fish were sorted by species into 1- and 2-bushel baskets and weighed. Lengths were then taken by species. Subsamples were used if the catch was large.

Several times during the experiment, subsamples were measured for girths.

All data were recorded on standardized groundfish survey trawl logs.

Results

Mesh Measurements

All cod ends were measured dry before starting the experiment. The small cod ends of machine-made webbing initially averaged 108 mm in size but by the second and third day of the experiment averaged 106 mm.

The twine used for the hand-made larger cod ends apparently was not heat treated. The dry measurements averaged 154 mm and during the experiment the mesh averaged 139 mm; a 10% shrinkage rate.

No stretching of the twine was observed during the experiment. There was no consistent variation between meshes of the forward and aft parts of the cod end as would be logically expected with larger catches.

There was a problem measuring the meshes, especially the first day, when the twine started freezing and produced false readings as the twine would not stretch fully. For this reason we rejected the first day's data.

In the small mesh there was a maximum range of 16 mm (0.6 inches) between mesh sizes. In the large mesh the maximum range was 23 mm (0.9 inches). A series of standard error calculations (Table 4) shows that the 95% confidence limits are within one millimeter of the sample mean.

We were concerned that our small "4.5-inch" commercial cod end was measuring out smaller than what the enforcement statistics were showing for the fishing fleet--ours being 4.2 inches vs the fleet's 4.75 inches. We knew something was wrong because most of the fleet was using the same cod end. Assuming this was a measuring problem we ran a mesh-measuring comparison test. A NMFS enforcement agent, using a wedge gauge, measured ten meshes on one of our large cod ends. The same meshes were then measured using the wedge gauge with a 5-kg weight and the ICES gauge set at 4-kg tension. The results (Table 5) show that the wedge gauge read almost 0.5 inches higher than the ICES gauge.

Random measurements were then taken on our commercial-sized cod end. The ICES gauge indicated a little over 4 inches. The wedge gauge readings were about 4.5 inches; however, the gauge could be wedged in further to read 4.75 inches or greater (the NMFS enforcement agent said that this is the routine procedure in the field).

Table 4. Mesh Measurement Statistics.

Vessel: Christopher Andrew
Mesh: 106 mm cod end

Trawl Station - 5

$N = 30$
$\overline{X} = 104$
$Sx = 3.2$

Trawl Station - 6

$N = 30$
$\overline{X} = 107.5$
$Sx = 3.28$

Trawl Station - 9

$N = 30$
$\overline{X} = 103.92$
$Sx = 2.55$

Trawl Station - 12

$N = 30$
$\overline{X} = 104.33$
$Sx = 2.97$

Total Number (ΣN) = 120

$\overline{Sx} = 2.98 \quad \overline{X} = 104.9$

$$SE = \frac{2.98}{\sqrt{120}} = \boxed{.272}$$

95% limits: 104.4 to 105.4 mm

Vessel: Francis Elizabeth
Mesh: 106 mm cod end

Trawl station - 5

$N = 30$
$\overline{X} = 109.23$
$Sx = 3.99$

Trawl Station - 6

$N = 30$
$\overline{X} = 106.37$
$Sx = 4.07$

Trawl Station - 9

$N = 30$
$\overline{X} = 106.53$
$Sx = 2.64$

Trawl Station - 12

$N = 30$
$\overline{X} = 104.97$
$Sx = 4.47$

Total N (ΣN) = 120

$\overline{Sx} = 3.79 \quad \overline{X} = 106.8$ mm

$$SE = \frac{3.79}{\sqrt{120}} = \boxed{.346}$$

95% limits: 106.1 to 107.5 mm

N equals the number of meshes measured.

$\overline{X}$ is the average (mean) size of the meshes (mm).

Sx is the standard deviation which gives an indication of the variation in mesh sizes. Two times Sx, added to and subtracted from $\overline{X}$, gives the size limits where 95% of the meshes fall between.

SE is the standard error which is a measure of the preciseness of the mean. Two times SE, added to and subtracted from $\overline{X}$, gives the 95% confidence limits of $\overline{X}$ which is shown in this table.

Table 4 (cont.)

Vessel: Christopher Andrew
Mesh: 139 mm cod end

Trawl Station - 7

$N = 30$
$\overline{X} = 140$
$Sx = 4.23$

Trawl Station - 8

$N = 30$
$\overline{X} = 143.4$
$Sx = 4.45$

Trawl Station - 10

$N = 30$
$\overline{X} = 140$
$Sx = 4.14$

Trawl Station - 11

$N = 30$
$\overline{X} = 138$
$Sx = 3.61$

Total N (ΣN) = 120

$\overline{Sx} = 4.11$ $\overline{X} = 140.35$

$$Se = \frac{4.11}{\sqrt{120}} = \boxed{.375}$$

95% limits: 139.6 to 141.1 mm

Vessel: Frances Elizabeth
Mesh: 139 mm cod end

Trawl Station - 7

$N = 30$
$\overline{X} = 141$
$Sx = 3.7$

Trawl Station - 8

$N = 30$
$\overline{X} = 138.23$
$Sx = 4.66$

Trawl Station - 10

$N = 30$
$\overline{X} = 133.83$
$Sx = 3.9$

Trawl Station - 11

$N = 30$
$\overline{X} = 134.33$
$Sx = 5.2$

Total Number (ΣN) = 120

$\overline{Sx} = 4.37$ $\overline{X} = 136.8$

$$Se = \frac{4.37}{\sqrt{120}} = \boxed{.398}$$

95% limits: 136.0 to 137.6 mm

Table 5. Comparison of Mesh Measuring Techniques.

Wedge Gauge	Wedge Gauge w/5 kg weight	ICES Gauge
144 mm	142 mm	136 mm
142	140	135
144	138	130
150	146	134
144	144	135
142	142	131
146	145	135
142	141	131
144	141	131
150	151	142
mean 144.8 mm (5.7 inches)	143.0 mm (5.63 inches)	135.0 mm (5.3 inches)

The measurements were made on the same meshes (measured dry) on a #102 braided-nylon cod end. The wedge gauge measurements were made by an NMFS enforcement officer.

Tow Summary

The tows were conducted as described in the Methods section. On the first day we ran into a number of problems. The twine started to freeze before mesh measurements could be taken. During Tow 2 a cover float flooded on the CHRISTOPHER ANDREW, causing a marked masking effect. During Tow 3 the FRANCES ELIZABETH caught a large object that caused a door (otter board) to capsize. Tow 4 was scrubbed because of darkness and the resulting change in fish population available to the gear. For these reasons we did not use the first day's data in the overall analysis. All data presented in the Results section, unless otherwise indicated, are for only the second and third days of the experiment. Table 6 presents the basic tow information.

Table 7 is a listing of the catch by weight per tow. The "flounders" category consisted mostly of winter flounder, though some American dabs were included. The "other" category consisted mainly of skates, sculpin, goosefish,

Table 6

Tow Data - all tows one hour from set to haul back.

Date: 12 December 1977

Area: 10 kilometers east of Scituate, Massachusetts.

Bottom type: Sand and Mud

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Tow 1		
Cod end:	139 mm uncovered	
Wire out:	128 meters	137 meters
Course:	170°	155°
Start time:	1110	1056
Avg. depth:	45 meters	45 meters
Weather:	Overcast; wind NNW at 15 knots; seas 1-2 meters; temp. -6°C.	
Tow 2		
Cod end:	139 mm covered	
Wire out:	128 meters	137 meters
Course:	170°	165°
Start time:	1305	1255
Avg. depth:	45 meters	45 meters
Weather:	Overcast; wind NW at 10 knots; seas 1-1.5 meters; temp. -6°C.	
Tow 3		
Cod end:	106 covered	
Wire out:	128 meters	137 meters
Course:	170°	170°
Start time:	1510	1434
Avg. depth:	41 meters	41 meters
Weather:	Overcast - same as tow 2.	
Tow 4		
Cod end:	----------	106 mm uncovered
Wire out:	----------	137 meters
Course:	----------	330°
Start time:	----------	1615
Avg. depth:	----------	41 meters
Weather:	----------	Same as tow 2.

Table 6 (cont.)

Date: 13 December 1977
Area: 11 kilometers ENE of Scituate, Massachusetts
Bottom type: Mud.

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Tow 5		
Cod end:	106 mm Uncovered	
Wire out:	137 meters	137 meters
Course:	000°	350°
Start time:	0805	0750
Avg. depth:	50 meters	47 meters
Weather:	Overcast; wind north at 10 knots; seas 1 meter; temp. -6°C.	
Tow 6		
Cod end:	106 mm Covered	
Wire out:	137 meters	137 meters
Course:	160°	125°
Start time:	0955	0929
Avg. depth:	50 meters	50 meters
Weather:	Overcast; wind NNE at 15 knots; seas 1 meter; temp. -3°C.	
Tow 7		
Cod end:	139 mm Uncovered	
Wire out:	137 meters	137 meters
Course:	350°	350°
Start time:	1140	1130
Avg. depth:	51 meters	51 meters
Weather:	Overcast; wind NE at 15 knots; seas 1 meter; temp. 0°C.	
Tow 8		
Cod end:	139 mm Covered	
Wire out:	137 meters	137 meters
Course:	170°	170°
Start time:	1320	1307
Avg. depth:	51 meters	51 meters
Weather:	Same as tow 7.	

Table 6 (cont.)

Date: 15 December 1977
Area: 6 kilometers east of Brant Rock, Massachusetts
Bottom type: Mud and Sand.

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Tow 9		
Cod end:	106 mm Uncovered	
Wire out:	91 meters	91 meters
Course:	190°	208°
Start time:	0800	0750
Avg. depth:	27 meters	27 meters
Weather:	Overcast, fog; wind NW at 10 knots; sea 1 meter SW swell; temp. 4°C.	
Tow 10		
Cod end:	139 mm Covered	
Wire out:	91 meters	91 meters
Course:	000°	025°
Start time:	0940	0929
Avg. depth:	27 meters	27 meters
Weather:	Same as tow 9.	
Tow 11		
Cod end:	139 mm Uncovered	
Wire out:	91 meters	91 meters
Course:	180°	200°
Start time:	1110	1100
Avg. depth:	27 meters	27 meters
Weather:	Same as tow 10 but no fog.	
Tow 12		
Cod end:	106 mm Covered	
Wire out:	91 meters	91 meters
Course:	000°	025°
Start time:	1245	1233
Avg. depth:	27 meters	27 meters
Weather:	Partly cloudy; wind NW at 15 knots; seas 1 meter; temp. 4°C.	

Table 7

Catch Weight Data (in kilograms)

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Tow 1 139 Cod end	Yellowtail - 45.8 Flounders - 13.4 Cod (1) - 11.0 Whiting - 5.0 Ocean pout - 15.4 Other - 18.4 Total 109.0	Yellowtail - 157.0 Flounders - 14.0 Cod - 27.0 Ocean pout - 33.4 Other - 19.0 Total 250.4
Tow 2 139 Cod end	Yellowtail - 101.0 Flounders - 15.4 Cod(2) - 6.0 Whiting - 8.4 Ocean pout - 73.5 Other - 25.5 Total 229.8	Yellowtail - 121.0 Flounders - 26.0 Cod - 9.5 Ocean pout - 107.0 Other - 24.0 Total 287.5
Tow 2 Cover	Loose knot no weights taken	Yellowtail - 53.5 Flounders - 11.0 Cod - 11.0 Ocean pout - 183.0 Other - 20.0 Total 278.5
Tow 3 106 Cod end	No good (net caught something heavy; caused door to capsize)	Yellowtail - 39.0 Flounders - 24.6 Cod - 16.0 Ocean pout - 126.5 Other - 57.0 Total 263.0
Tow 3 Cover	No good	Yellowtail - 6.0 Ocean pout - 32.5 Other - 11.0 Total 49.5

Catch Weight Data (cont'd)-2

	FRANCES ELIZABETH	CHRISTOPHER ANDREW
Tow 4 106 Cod end	Did not tow (Darkness)	Yellowtail - 83.5 Flounders - 36.5 Cod - 62.5 Ocean pout - 68.5 Other - 37.5 Total 288.5
Tow 5 106 Cod end	Yellowtail - 47.0 Flounders - 16.0 Cod - 34.0 Whiting - 5.5 Ocean pout - 11.0 Haddock - 4.5 Other - 50.0 Total 168.0	Yellowtail - 126.5 Flounders - 30.5 Cod - 27.5 Whiting - 9.5 Ocean pout - 29.0 Haddock - 3.0 Pollock(1) - 7.0 Other - 27.0 Total 260.0
Tow 6 106 Cod end	Yellowtail - 14.5 Flounders - 15.0 Cod - 39.0 Ocean pout - 13.5 Other - 36.0 Total 118.0	Yellowtail - 74.5 Flounders - 37.5 Cod - 46.0 Whiting - 18.0 Ocean pout - 39.0 Other - 42.5 Total 257.5
Tow 6 Cover	Flounders - 8.5 Cod - 5.5 Whiting - 4.5 Ocean pout - 18.5 Total 37.0	Yellowtail - 2.5 Flounders - 19.0 Cod, haddock, and pollock- 4.5 Whiting - 22.0 Ocean pout - 49.0 Other - 44.0 Total 141.0
Tow 7 139 Cod end	Yellowtail - 33.5 Flounders - 15.0 Cod - 55.0 Other - 49.0 Total 152.5	Yellowtail - 64.0 Flounders - 32.0 Cod - 47.0 Whiting - 7.5 Pollock(1) - 11.5 Other - 18.5 Total 180.5

Catch Weight Data (cont'd)-3

	FRANCES ELIZABETH		CHRISTOPHER ANDREW	
Tow 8	Yellowtail -	14.5	Yellowtail -	33.0
139 Cod end	Flounders -	12.0	Flounders -	17.0
	Cod -	18.5	Cod -	24.5
	Other -	12.5	Pollock(1) -	3.5
			Whiting -	4.5
	Total	57.5	Ocean pout -	14.0
			Other -	14.5
			Total	111.0
Tow 8	Yellowtail -	4.5	Yellowtail -	12.0
Cover	Flounders -	13.0	Flounders -	10.0
	Cod -	6.5	Cod -	14.5
	Whiting -	25.5	Whiting -	19.5
	Hakes -	51.0	Hakes -	33.0
	Haddock -	18.5	Haddock -	3.0
	Ocean pout -	18.5	Ocean pout -	30.0
	Total	137.5	Total	122.0
Tow 9	Yellowtail -	72.5	Yellowtail -	138.0
106 Cod end	Flounders -	26.5	Flounders -	16.0
	Cod -	37.0	Cod -	46.5
	Ocean pout -	87.5	Ocean pout -	128.5
	Other -	45.0	Other -	16.5
	Total	268.5	Total	345.5
Tow 10	Yellowtail -	47.0	Yellowtail -	59.5
139 Cod end	Flounders -	27.5	Flounders -	22.5
	Cod -	26.5	Cod -	14.0
	Ocean pout -	30.5	Ocean pout -	32.0
	Other -	32.0	Other -	23.5
	Total	163.5	Total	151.5
Tow 10	Yellowtail -	28.5	Yellowtail -	54.0
Cover	Flounders -	12.5	Flounders -	17.0
	Cod -	28.5	Cod -	25.5
	Ocean pout -	42.0	Whiting -	2.5
	Other -	13.5	Ocean pout -	36.5
			Other -	10.0
	Total	125.0		
			Total	145.5

Catch Weight Data (cont'd)-4

	FRANCES ELIZABETH		CHRISTOPHER ANDREW	
Tow 11 139 Cod end	Yellowtail -	35.5	Yellowtail -	32.0
	Flounders -	23.5	Flounders -	18.0
	Cod -	22.5	Cod -	33.0
	Ocean pout -	63.0	Ocean pout -	98.5
	Other -	21.5	Other -	22.5
	Total	166.0	Total	204.5
Tow 12 106 Cod end	Yellowtail -	55.5	Yellowtail -	36.0
	Flounders -	15.5	Flounders -	7.5
	Cod -	53.0	Cod	38.0
	Ocean pout -	54.0	Ocean pout -	20.5
	Other -	42.0	Other	18.0
	Total	220.0	Total	120.0
Cover	Yellowtail -	19.5	Yellowtail -	26.0
	Flounders -	1.0	Flounders -	3.5
	Cod -	6.5	Cod -	7.0
	Ocean pout -	18.5	Ocean pout -	14.0
	Other -	5.5	Other -	7.5
	Total	51.0	Total	58.0

Data Analysis

Yellowtail. This analysis is made using the catch data from the 16 tows made on the second and third day of the experiment; a total catch of 3,581 fish.

To determine if we could compare one size mesh with the other or if we could combine the data from both vessels, we need to know if both size nets and both vessels sampled the same basic size distribution of fish. To do this we calculated the length frequency distributions of the covered tows (cod ends and covers combined). A visual inspection of Table 8 shows that the distributions

are basically the same. Figure 3, a plot of the vessel distributions, demonstrates the same point. This figure also shows two year classes of yellowtail--one heavily fished and one about to enter the fishery.

Selection data for the 106-mm covered cod end tows are given in Table 9 and the corresponding selection curve, drawn by eye, is shown in Figure 4. The 50% retention length of approximately 22 cm (8.7 inches) gives a selection factor of 2.07. The 25-75% selection range is approximately 3 cm (1.2 inches).

Selection data for the 139-mm covered cod end tows are given in Table 10, and the corresponding selection curve is shown in Figure 4. The 50% retention length of approximately 30 cm (11.8 inches) gives a selection factor of 2.16. The 25-75% selection range is approximately 4 cm (1.6 inches).

Selection data for the 106-mm and 139-mm uncovered tows are given in Table 11. We normalized the distributions by assuming equal retention by both size cod ends above the 100% retention point (a rough assumption, as the fishing power of the large mesh may be greater). From this method, a 50% retention length of 33 cm (13.0 inches) is obtained which gives a selection factor of 2.37.

Comparing the 139-mm selection curves in Figure 4, we note the uncovered tow curve gives a higher selection than the covered tow. This may be due to a masking effect caused by the cover, an increased efficiency of the larger mesh on the larger size fish, or even random error.

It should be noted that a comparison of the two 139-mm selection curves to each other is not strictly valid. This is due to the fact that the uncovered selection curve was derived by comparing the 139-mm uncovered cod ends with the 106-mm uncovered cod ends and the covered selection curve was derived by comparing the 139-mm covered cod ends with the 50-mm covers. In the first case the retention percentages will be affected by the selectivity

Table 8. Length Frequency Distributions (%)--Yellowtail Flounders

	Cod Ends and Covers					Cod Ends Only			
Length 3 cm Intervals	Overall average	106 mm	139 mm	FRANCES ELIZABETH	CHRISTOPHER ANDREW	106 mm covered	139 mm covered	106 mm uncovered	139 mm uncovered
10-12	0.1	0.2	0.0	0.2	0.0	0	0	0	0
13-15	2.6	3.5	1.9	2.7	2.5	0	0.3	0	0.3
16-18	17.4	18.4	16.7	20.3	15.4	2.3	3.4	0.8	1.0
19-21	28.6	27.7	29.4	29.9	27.8	10.0	4.2	6.5	0.3
22-24	15.4	14.8	16.0	15.4	15.5	18.4	4.0	17.9	1.4
25-27	4.0	4.2	3.9	3.4	4.5	8.1	2.8	9.0	1.0
28-30	5.7	5.2	6.1	4.6	6.4	10.4	6.2	14.9	5.8
31-33	7.8	6.4	8.9	8.2	7.5	12.5	23.7	16.0	15.7
34-36	8.2	7.2	9.1	7.4	8.8	14.0	28.2	14.7	24.2
37-39	4.1	4.2	4.0	4.4	3.9	8.3	13.6	8.0	21.1
40-42	3.3	4.4	2.4	2.2	4.0	8.7	8.2	6.8	14.7
43-45	1.6	2.2	1.1	.8	2.1	4.4	3.7	3.1	10.9
46-48	0.6	1.1	.3	.4	0.8	2.1	1.1	0.9	2.0
49-51	0.1	.1	.2	.0	0.2	0.2	0.6	0.9	1.4
52-54	0	.1	0	0	0.1	0.2	0	0.2	0
55-57	0	.2	0	0	0.1	0.4	0	0.2	0
TOTAL	2147	946	1201	890	1257	472	354	1141	293

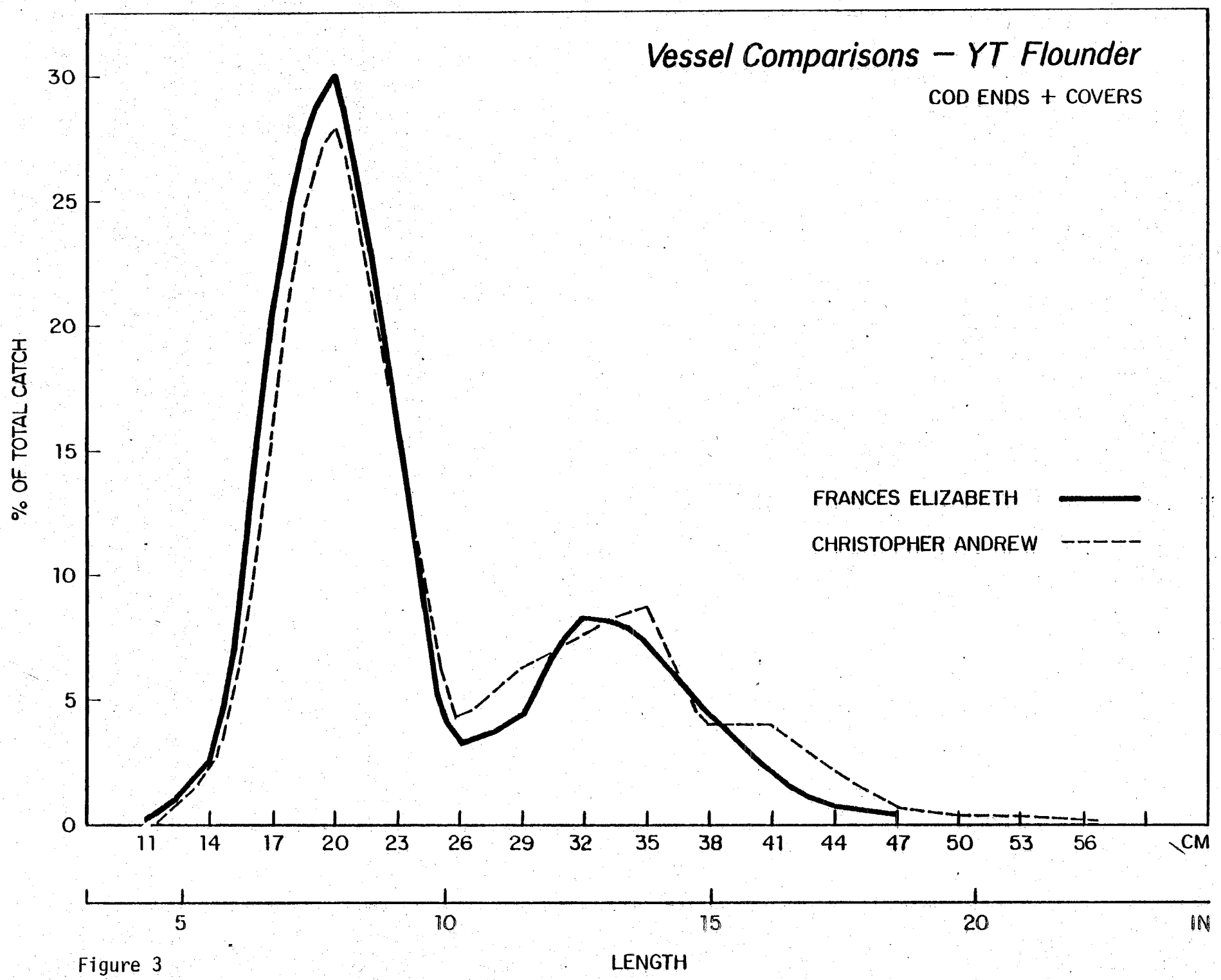

Vessel Comparisons — YT Flounder
COD ENDS + COVERS
FRANCES ELIZABETH
CHRISTOPHER ANDREW
% OF TOTAL CATCH
30
25
20
15
10
5
0
11
14
17
20
23
26
29
32
35
38
41
44
47
50
53
56
CM
5
10
15
20
IN
LENGTH

Figure 3

Table 9. Yellowtail length frequency distributions and percent retained for 106-mm cod end covered tows; both vessels.

Length Interval (cm)	Numbers Caught #1 106 mm	106 mm plus covers	% retained
10-12	0	2	0
13-15	0	33	0
16-18	11	174	6.3
19-21	47	262	17.9
22-24	87	140	62.1
25-27	38	40	95.0
28-30	49	49	100.0
31-33	59	61	96.7
34-36	66	68	97.0
37-39	39	40	97.5
40-42	41	42	97.6
43-45	21	21	100.0
46-48	10	10	100.0
49-51	1	1	100.0
52-54	1	1	100.0
55-57	2	2	100.0
TOTALS	472	946	

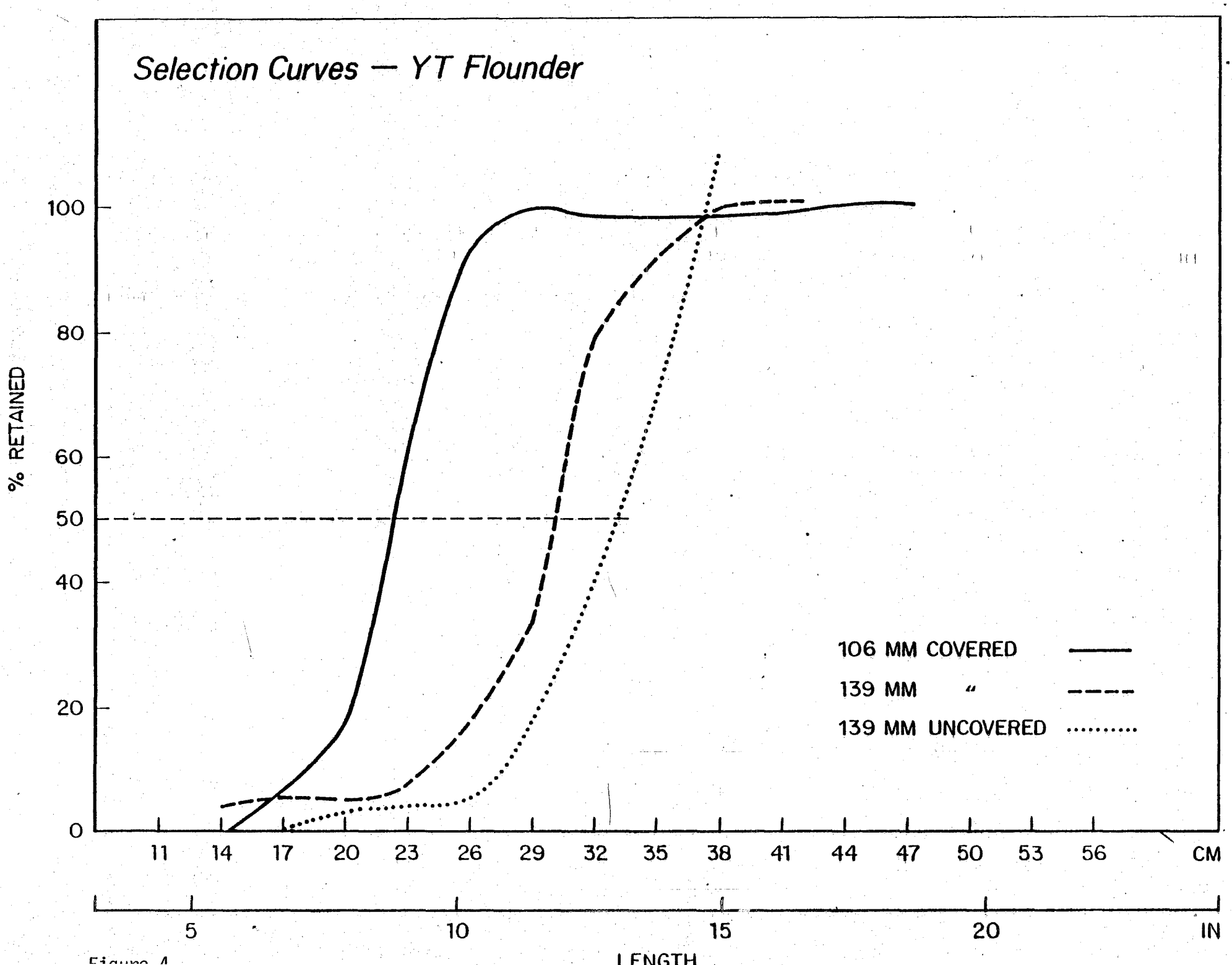

Selection Curves — YT Flounder
% RETAINED
100
80
60
50
40
20
0
11
14
17
20
23
26
29
32
35
38
41
44
47
50
53
56
CM
5
10
15
20
IN
LENGTH
106 MM COVERED
139 MM "
139 MM UNCOVERED

Figure 4

Table 10. Yellowtail length frequency distributions and percent retained for 139-mm cod end covered tows; both vessels.

Length Interval (cm)	Numbers Caught #2 139 mm	139 mm plus covers	% retained
10-12	0	0	0
13-15	1	23	4.3
16-18	12	201	5.9
19-21	15	353	4.2
22-24	14	192	7.3
25-27	10	47	21.2
28-30	22	73	30.1
31-33	84	107	78.5
34-36	100	109	91.7
37-39	48	48	100.0
40-42	29	29	100.0
43-45	13	13	100.0
46-48	4	4	100.0
49-51	2	2	100.0
52-54	0	0	-
55-57	0	0	-
TOTALS	354	1201	

Table 11. Yellowtail length frequency distributions and percent retained for the 139-mm uncovered cod end compared with the 106 mm uncovered cod end; both vessels

Length Interval (cm)	Numbers Caught #3 (A) 106 mm	Numbers Caught #4 (B) 139 mm	$\frac{B}{.63A} \times 100 =$ % retained by 139 mm
10-12	0	0	0
13-15	0	1	-
16-18	9	3	-
19-21	74	1	2.1
22-24	204	4	3.1
25-27	103	3	4.6
28-30	170	17	15.9
31-33	183	46	39.9
34-36	168	71	67.1
37-39	91	62	108.1
40-42	78	43	87.5
43-45	36	32	141.1
46-48	10	6	95.2
49-51	11	4	57.7
52-54	2	0	0
55-57	2	0	0

$$\sum_{37}^{57} A = 230 \qquad \sum_{37}^{57} B = 147 \qquad 147/230 = .63$$

of the 106-mm mesh; this occurring where the selection process overlaps (about 17 to 27 cm). The degree of inaccuracy introduced was checked by adjusting the 139-mm uncovered retention percentages with the 106-mm covered retention percentages and was found to be small.

Continuing in the same vein, if all four types of tows (106 and 139 covered and uncovered) were compared to the same base (covered cod ends plus covers) and adjusted on a numbers-per-tow basis, a comparison could be made between the two size meshes that might indicate some degree of relative efficiency. A larger number of tows than performed during this experiment is required to do this with any degree of confidence.

Table 12 summarizes the selection data from this experiment and from the experiment conducted by Lux (1968) in September 1967.

Figure 5 demonstrates the portion of the available population, represented by the cod ends plus covers curve, that each cod end selects. As the fish grow the available population curve will shift to the right and thus more of these small fish will be within the selection range of the gear. There will be an increase in the catch of fish by the small cod end that under existing market conditions are discarded (<30 cm). (By the time that year class reaches market size it will be decimated by the small mesh cod ends.) The figure shows that the large mesh will hardly select this year class until it reached market size.

Table 13 is a further demonstration of this point. From observations made on the two vessels we noted that the majority of fish under 30 cm (11.8 inches) were discarded. (New Bedford landings data show very few fish being landed under 30 cm.) This is a lower cull point than in the past. Hennemuth and Lux (1970) reported a cull midpoint for yellowtail by the commercial fleet of 34 cm (13.5 inches).

Table 12. Retention lengths for yellowtail flounder for mesh sizes tested in New England.

% Retained	Mesh size 106	129*	139	145*
100	29>	34>	38>	39>
75	24	30	32	36
50	22	29	31	34
25	21	25	28	28
Selection Factor	2.07	2.28	2.27**	2.34
Selection Range	3 cm	5 cm	4 cm	8 cm

*From Lux, F.E. 1968. ICNAF Redbook, Part III.
**Average from covered and alternate tow methods.

Table 13. Weights of yellowtail by 3-cm groups.

Lengths 3 cm intervals	kg/fish	106 uncovered	106 covered	139 uncovered	139 covered	
DISCARD 10-12	0	0	0	0	0	
13-15	.0225	0	0	.02	.02	
16-18	.045	.405	.49	.13	.54	
19-21	.0675	4.995	3.17	.07	1.01	
22-24	.09	18.36	7.83	.36	1.26	
25-27	.135	13.905	5.13	.41	1.35	
28-30	.225	38.25	11.03	3.83	4.95	
31-33	.315	57.646	18.58	14.49	26.46	
34-36	.405	68.04	26.73	28.75	40.50	
37-39	.585	53.235	22.81	36.27	28.08	
40-42	.675	52.65	27.67	29.03	19.57	
43-45	.855	30.78	17.95	27.36	11.11	
46-48	1.035	10.35	10.35	6.21	4.14	
49-51	1.17	12.87	1.17	4.68	2.34	
52-54	1.44	2.88	1.44	0	0	
55-57	1.665	3.33	3.33	0	0	
Theo. Total Weight		367.67	157.68	151.61	141.33	
Actual Total Weight		382.3	180.50	165.00	154.00	
Error		3.7%	13%	8%	8%	Avg 8%
Theo. Discard Weight		75.90	27.65	4.82	9.13	
Landings		291.77	130.03	146.79	132.20	
% Discards		20.6	17.5	3.1	6.4	
Mean		19.1%		4.8%		

$\frac{4.8}{19.1}$ = 75% Reduction in discards with larger mesh

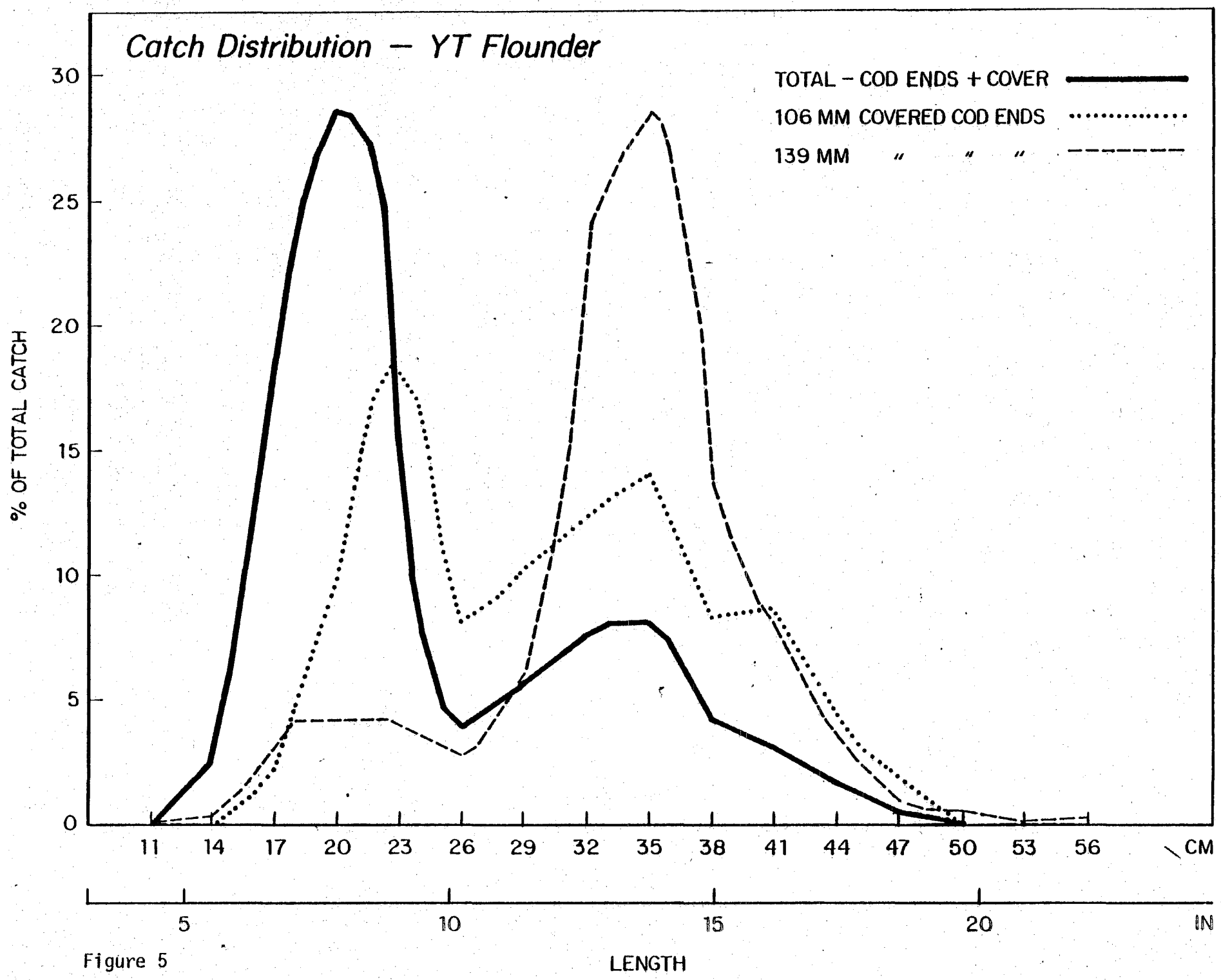

Catch Distribution — YT Flounder
TOTAL - COD ENDS + COVER
106 MM COVERED COD ENDS
139 MM " " "
% OF TOTAL CATCH
30
25
20
15
10
5
0
11 14 17 20 23 26 29 32 35 38 41 44 47 50 53 56 CM
5 10 15 20 IN
LENGTH

Figure 5

Using length-weight curves developed by the Northeast Fisheries Center, we determined the total weight of the catch by cod-end types. The difference between this theoretical weight and the actual weight may be caused by averaging the weight by 3-cm intervals, thus biasing the data toward the smaller fish as weight increases exponentially. It may also be due in part to the choice of weight curves.

Table 13 also shows the 106-mm uncovered cod ends outfishing the other three categories. This is due to the fact that in our random design the 106-mm uncovered cod ends were towed first on the second and third day. The first tow of the day in the small areas we repeatedly towed over may tend to catch more fish. This effect has been observed previously by the captains of both vessels.

Taking the above into account, we can still observe from the table that the large-mesh cod end decreases the discards by approximately 75%. If we compare the 106-mm covered cod ends against the 139-mm cod ends, we note that the landings of the big mesh do not decrease and may even increase. This effect has been observed in previously documented selectivity experiments and is thought to be an increase in fishing power of the larger mesh.

Cod. This analysis was made on the same 16 tows as used for yellowtail. A total of 492 cod were caught. The amount of data is insufficient to determine any solid selectivity information, but trends are visible.

Table 14 contains the length frequency distributions of the covered tows (cod ends plus covers), and by visual inspection we see that we sampled the same basic population. The catch curves in Figure 6 show that both vessels were probably sampling cod mostly from one year class.

Tables 15, 16, and 17 present the length frequency distributions of cod in the same manner as the previous tables in the yellowtail section. A visual

Table 14. Length Frequency Distributions (%) - Cod

Length 3 cm ntervals	Cod Ends and Covers					Cod Ends Only			
	overall	106 mm	139 mm	ELIZABETH	CHRISTOPHER ANDREW	106 mm covered	139 mm covered	106 mm uncovered	139 mm uncovered
19-21	4.1	3.2	4.9	4.8	3.2				
22-24	1.5	0.6	2.4	1.2	1.9				
25-27	0.9	0.6	1.2	0.0	1.9				
28-30	3.1	3.2	3.1	3.0	3.2	0.8			
31-33	5.6	3.8	7.4	6.0	5.2	0.8		0.8	
34-36	7.5	7.7	7.4	9.7	6.5	5.8	2.2	2.4	
37-39	16.3	17.3	15.3	16.4	16.2	14.0	11.1	9.0	2.0
40-42	15.4	10.2	20.2	15.8	14.9	12.4	8.9	21.3	
43-45	13.2	14.1	12.2	16.4	9.7	18.2	8.9	20.5	5.9
46-48	8.5	10.2	6.7	6.7	10.4	11.6	13.3	10.6	5.9
49-51	4.1	3.2	4.9	3.0	4.5	4.1	11.1	9.8	3.9
52-54	5.6	8.3	3.1	5.5	5.8	9.9	6.7	8.2	9.8
55-57	2.5	2.6	2.4	1.8	3.2	3.3	6.7	3.3	11.8
58-60	3.8	3.8	3.7	4.2	3.2	5.0	13.3	4.1	11.8
61-63	2.2	2.6	1.8	1.8	2.6	3.3	6.7	4.9	7.8
64-66	1.5	3.2		0.6	2.6	4.1		2.4	11.8
67-69	.9	1.3	0.6	0.6	1.3	1.7	2.2	0.8	3.9
70-72	1.5	2.6	0.6	0.6	2.6	3.3	2.2		2.0
73-75								0.8	7.8
76-78	0.3		0.6	0.6			2.2	0.8	3.9
79-81									5.9
82-84	0.3		0.6				2.2		2.0
85-87									
88-90	0.6	0.6	0.6	0.6		0.8	2.2		
91-93	0.3	0.6		0.6	0.6	0.8			
94-96									2.0
97-99									
100-102									
103-105									
105-108									2.0
Totals	319	156	163	165	154	121	45	122	51

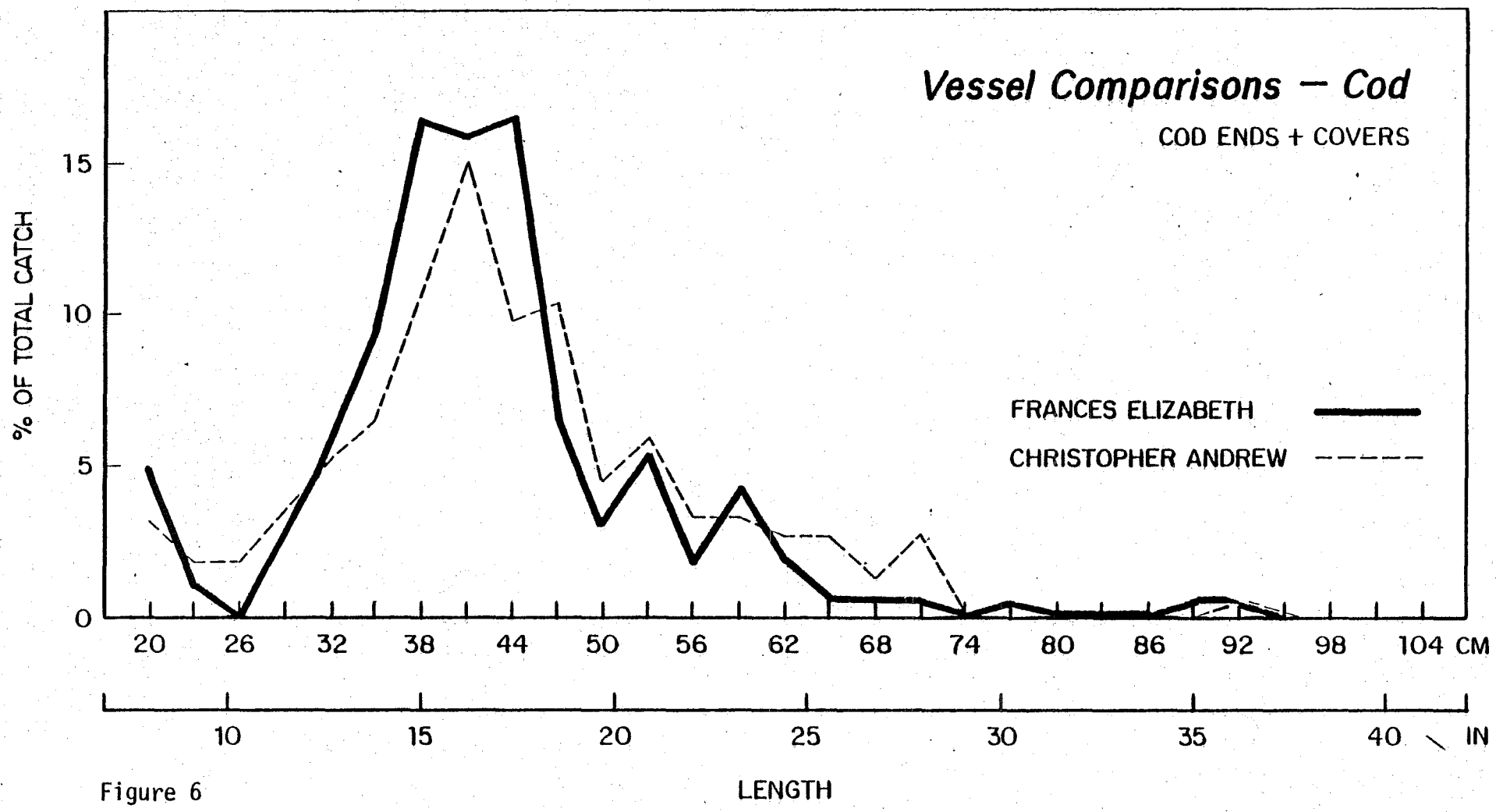

Vessel Comparisons — Cod
COD ENDS + COVERS
FRANCES ELIZABETH
CHRISTOPHER ANDREW
% OF TOTAL CATCH
0
5
10
15
20 26 32 38 44 50 56 62 68 74 80 86 92 98 104 CM
10 15 20 25 30 35 40 IN
LENGTH

Figure 6

inspection of the variations in the percent-retained category indicates that there is an insufficient amount of data to determine the 50% retention points and selection factors accurately. This problem may be accentuated by the fact that the population consists mostly of one year class first entering the selection range.

A plot of the catch distribution, Figure 7, again shows the one year class and that the small-mesh cod end is fishing on it. The calculated 50% retention point for the 139-mm cod end of 50 cm (19.7 inches) just happens to be where there is a small amount of fish. As that year class grows, the catch composition of the large-mesh cod end will change.

The weight distribution, Table 18, was derived in the same manner as the one on yellowtail. In this table we chose two discard points. The first was set at 40 cm (15.7 inches), corresponding with the cull point for small scrod cod and the second at 52 cm (20.5 inches), corresponding to a suggested legal minimum size. These data are insufficient to draw any firm conclusions from, though a trend in percentage of discard and landings may be seen.

Cod Girths. The diagram plotting the data taken on cod girths (Figure 8) is a random sampling of the total catch. The girths, for the most part, have very little variance from the published means for girth-length ratios.

This ratio, taken from the published data of A. R. Margetts (1954 and 1957) and later confirmed by the experimentation of J. Messtorff (1957-1958), is tabulated by the following equations:

$$\text{length} = \text{natural girth} \times 1.95$$

and

$$\text{length} = (\text{constricted girth} \times 2.03) + 0.7$$

Most of the sampled girths that were plotted fall fairly well within this ratio range bracket. Some girth measurements were possibly affected by the

Table 15. Cod length frequency distributions and percent retained for 106 mm cod end covered tows; both vessels.

Length Interval (cm)	Numbers Caught: 106 mm	Numbers Caught: 106 mm plus covers	% retained
19-21		5	0
22-24		1	0
25-27		1	0
28-30	1	5	20.0
31-33	1	6	16.6
34-36	7	12	58.3
37-39	17	27	62.9
40-42	15	16	93.7
43-45	22	22	100.0
46-48	14	16	87.5
49-51	5	5	100.0
52-54	12	13	92.3
55-57	4	4	100.0
58-60	6	6	100.0
61-63	4	4	100.0
64-66	5	5	100.0
67-69	2	2	100.0
70-72	4	4	100.0
88-90	1	1	100.0
91-93	1	1	100.0
Totals	121	156	

Table 16. Cod length frequency distributions and percent retained for 139 mm cod end covered tows; both vessels.

	Numbers Caught		
Length Interval (cm)	139 mm	139 mm plus covers	% retained
19-21		8	0
22-24		4	0
25-27		2	0
28-30		5	0
31-33		12	0
34-36	1	12	8.3
37-39	5	25	20.0
40-42	4	33	12.1
43-45	4	20	20.0
46-48	6	11	54.5
49-51	5	8	62.5
52-54	3	5	60.0
55-57	3	4	75.0
58-60	6	6	100.0
61-63	3	3	100.0
64-66	0	0	
67-69	1	1	100.0
70-7:	1	1	100.0
73-75	0	0	
76-78	1	1	100.0
79-81	0	0	
82-84	1	1	100.0
85-87	0	0	
88-90	1	1	
Totals	45	163	

Table 17. Cod length frequency distributions and percent retained for the 139 mm uncovered cod end compared with the 106 mm uncovered cod end; both vessels.

Length Interval (cm)	Numbers Caught (A) 106 mm	(B) 139 mm	$\frac{B}{A} \times 100 =$ % retained by 139 mm
31-33	1		0
34-36	3		0
37-39	11	1	5.1
40-42	26		0
43-45	25	3	6.8
46-48	13	3	13.1
49-51	12	2	9.5
52-54	10	5	28.4
55-57	4	6	85.2
58-60	5	6	68.2
61-63	6	4	37.8
64-66	3	6	113.6
67-69	1	2	200.0
70-72	1	1	100.0
73-75	1	4	400.0
76-78		2	
79-81		3	
82-84		1	
94-96		1	
106-108		1	
Totals	122	51	

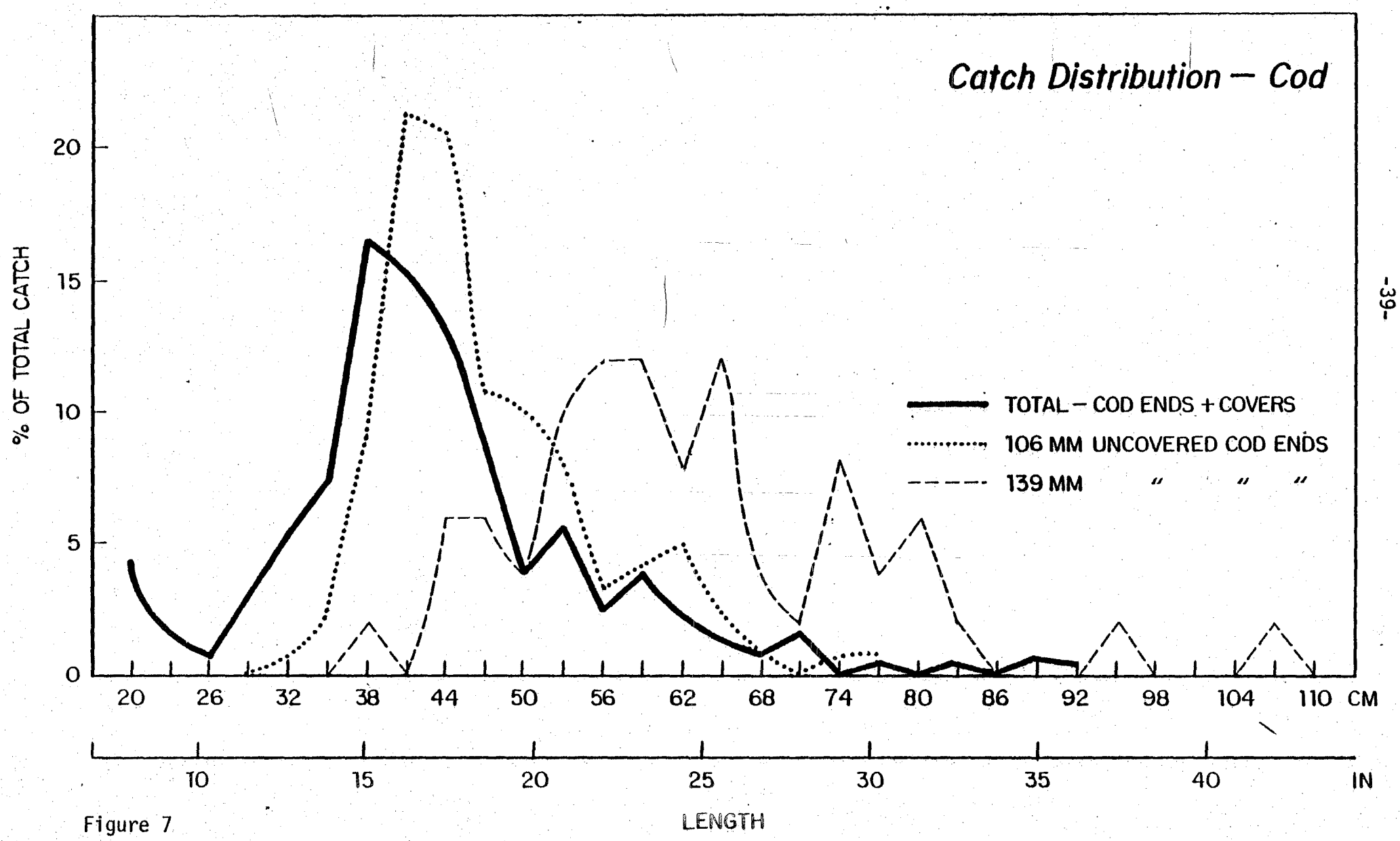

Catch Distribution — Cod
% OF TOTAL CATCH
0
5
10
15
20
TOTAL — COD ENDS + COVERS
106 MM UNCOVERED COD ENDS
139 MM " " "
20 26 32 38 44 50 56 62 68 74 80 86 92 98 104 110 CM
10 15 20 25 30 35 40 IN
LENGTH

Figure 7

Table 18. Weights of Cod by 3-cm Groups

Lengths 3 cm Intervals	kg/fish	106 uncovered	106 covered	139 uncovered	139 covered
19-21	.04				
22-24	.09				
25-27	.13				
28-30	.22		.22		
31-33	.34	.34	.34		
34-36	.45	1.35	3.15		.45
37-39	.58	6.38	9.86	.58	2.90
40-42	.67	17.42	10.05	.00	2.68
43-45	.85	21.25	18.70	2.55	3.40
46-48	1.03	13.39	14.42	3.09	6.18
49-51	1.21	14.52	6.05	2.42	6.05
52-54	1.44	14.40	17.28	7.20	4.32
55-57	1.71	6.84	6.84	10.26	5.13
58-60	2.07	10.35	12.42	12.42	12.42
61-63	2.30	13.80	9.20	9.20	6.90
64-66	2.66	7.98	13.30	15.96	.00
67-69	3.02	3.02	6.04	6.04	3.02
70-72	3.38		13.52	3.38	3.38
73-75	4.10	4.10		16.40	
76-78	4.50	4.50		9.00	4.50
79-81	5.40		16.20		
82-84	5.90			5.90	5.90
85-87	6.30				
88-90	7.20		7.20		7.20
91-93	7.70		7.70		
94-96	8.60			8.60	
97-99	9.90				
100-102	10.80				
103-105	11.70				
106-108	12.60			12.60	
Theo. Total Weight		139.64	156.29	141.80	74.43
Actual Total Weight		145.00	176.00	157.80	83.50
Error		3.7%	11.2%	10.0%	10.8%
					Avg. 8.9
Theo. Discard Weight (<40 cm)		8.07	13.57	.58	3.35
Landings		131.57	142.72	141.22	71.08
% Discards		5.8%	8.7%	0.4%	4.5%
Theo. Discard Weight (<52 cm)		74.65	62.79	8.64	21.66
Landings		64.99	93.50	133.16	52.77
% Discards		53.4%	40.2%	6.1%	29.1%

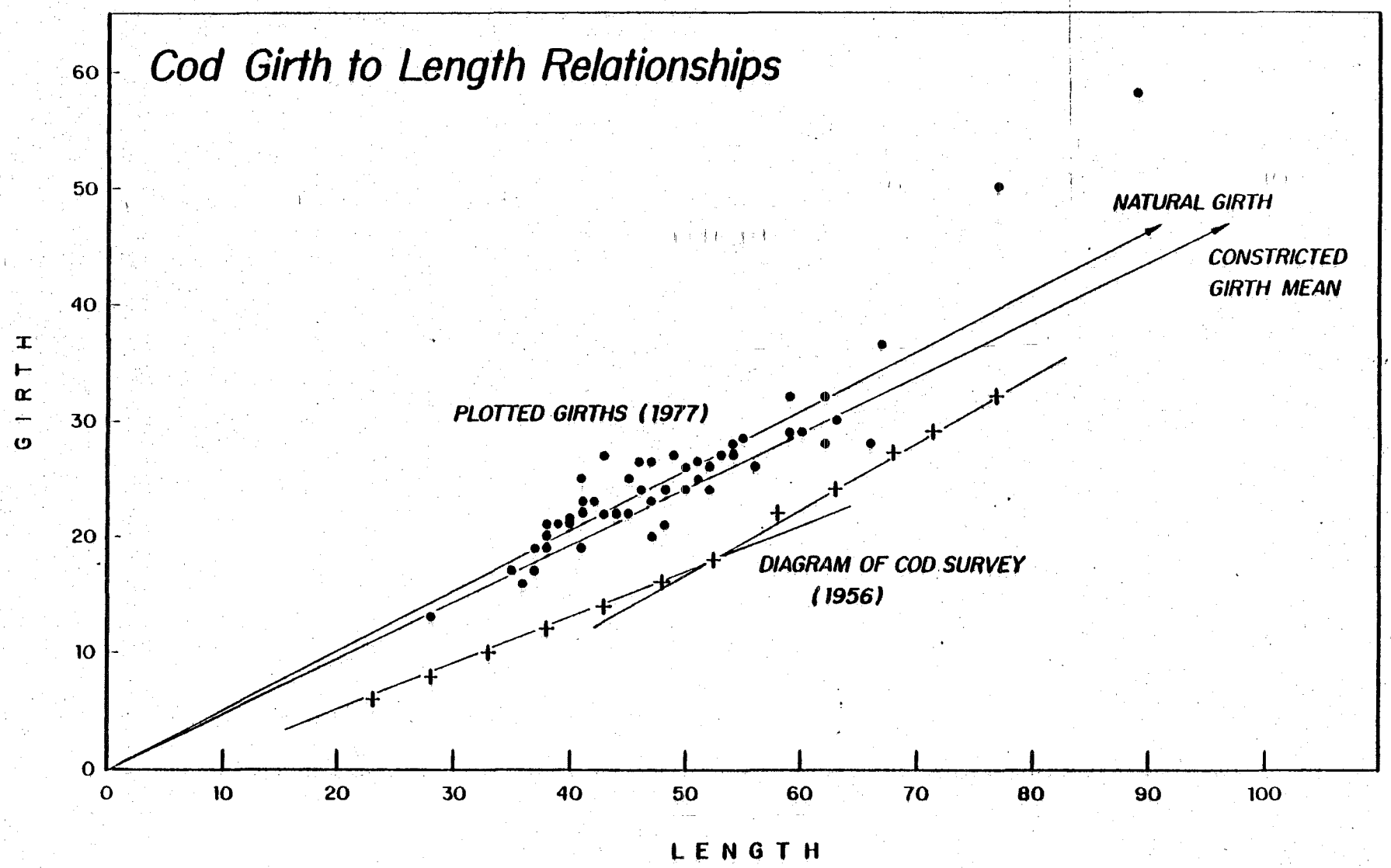

Cod Girth to Length Relationships
NATURAL GIRTH
CONSTRICTED GIRTH MEAN
PLOTTED GIRTHS (1977)
DIAGRAM OF COD SURVEY (1956)
GIRTH
LENGTH
0
10
20
30
40
50
60
70
80
90
100

Figure 8

expansion of the air bladders due to the activity exerted by the fish swimming through the meshes (Margetts 1957). This factor would thus slightly affect the measurements, hence explaining a few of the points that deviated moderately from the norm.

Remarks

In reviewing this experiment we must keep in mind that this is not an unstudied subject. In the report of the ICES/ICNAF Working Groups on Selectivity Analysis (Holden 1971) there is a table summarizing past selectivity experiments in ICES and ICNAF areas. For cod there were 104 experiments conducted, consisting of 685 tows. For haddock there were 305 experiments conducted, consisting of 2,112 tows. In addition there is a bibliography consisting of 239 references on selectivity.

For practical purposes there is no need to refine the selectivity factors any further for management decisions. For instance, the difference caused by using a selection factor of 2.1 instead of 2.3 for yellowtail with a 106-mm (4.2-inch) cod end is a shift of the 50% retention length by 2 cm (0.78 inches). Certain questions can be answered without concerning ourselves with such detail.

Some of the management questions that need to be addressed are:

1. What should be accomplished by using mesh sizes, e.g., spawning-stock protection, market stabilization, elimination of discards, etc.?
2. Should minimum size limits be used in conjunction with mesh-size regulations? Where would this size limit be set in relation to the 50% retention point?
3. How would the regulation be enforced? What tolerances would be allowed, and what measuring instruments would be used?
4. In deriving mesh sizes, should different growth rates by area be taken into account, e.g., Gulf of Maine vs southern New England?

Hopefully the information provided from this and future experiments in this series will make everyone involved feel a little more comfortable with the decisions that have to be made.

Respectfully submitted,

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Literature Cited

Hennemuth, R. C., and F. E. Lux. 1970. The effects of large meshes in the yellowtail flounder fishery. Int. Comm. Northw. Atlant. Fish. Redbook, Part III, 111-115.

Holden, M. J. 1971. Report of the ICES/ICNAF Working Groups on Selectivity Analysis. Coop. Res. Rep. ICES (A), No. 25, 144 p.

ICNAF. 1976. Summary of trawl materials and mesh size sampling. 1975. Ann. Meet., Int. Comm. Northw. Atlant. Fish. Summ. Doc. 76/VI/45, 6 p.

Lux, F. E. 1968. Cod end mesh selection studies of yellowtail flounder, Limanda ferruginea (Storer). Int. Comm. Northw. Atlant. Fish. Redbook, 1968, Part III, Selected Papers:101-109.

Margetts, A. R. 1957. The Length-Girth Relationships in Whiting and Cod and Their Application to Mesh Selection. J. Cons. Perm. Int. Explor. Mer, 23:64-71.

Messtorff, J. 1958. Length-Girth Measurements of Cod and Their Relationship to Mesh Selection. ICES, CM 1958, Comp. Fishing Comm., Doc. 23.

Extract from the Federal Register

Vol. 42, No. 112 (June 10, 1977)

Title 50 - Wildlife and Fisheries

Chapter VI - Fishery Conservation and Management, NOAA

Part 651 - Haddock, Cod, Yellowtail Flounder--Final Regulations

651.6 Gear restrictions.

(a) For directed fisheries for cod and yellowtail flounder, a mesh size restriction for trawl nets is applicable. It shall be unlawful to take these species in nets having, in any part of the net other than the cod end, meshes of dimensions less than 4½ inches (114 mm), and having, in the cod end of the nets, meshes of dimensions less than 5 $^{1}/_{8}$ inches (130 mm). These mesh sizes relate to netting when measured wet after use.

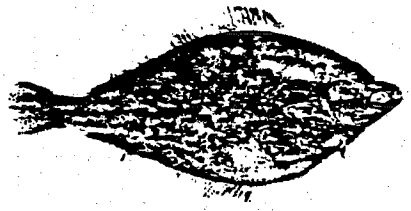
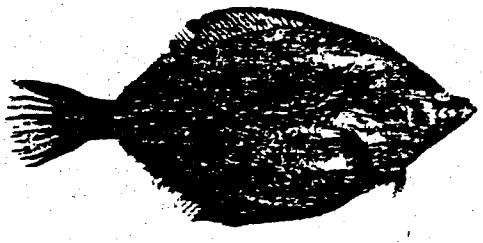
(b) Mesh sizes are measured by a flat wedge-shaped gauge having a taper of 2 centimeters in 8 centimeters and a thickness of 2.3 millimeters, inserted into the meshes under a pressure or pull of 5 kilograms. The mesh size of a net shall be taken to be the average of the measurements of any series of twenty consecutive meshes, at least ten meshes from the landings, and when measured in the cod end of the net beginning at the after end and running parallel to the long axis.

(c) This mesh size regulation will not apply to vessels taking haddock, cod, or yellowtail flounder as by-catch so long as such vessels do not have on board (either at sea or at the time of offloading) cod, haddock, or yellowtail flounder in amounts in excess of 5,510 pounds (2.5 metric tons) for each species or 10 percent by weight of all fish on board such vessel for each species, whichever is greater.

(d) It shall be unlawful for any person to attach any device or use any method that would diminish the effect of the mesh sizes authorized in paragraph (a) of this section.

Growth of Yellowtail Flounders for Southern New England

GROWTH

YEAR		IN	CM	LB	KG
ONE		5	12.7	1/20	.02
TWO		10 3/4	27.3	3/8	.17
THREE		13 1/2	34.3	7/8	.39
FOUR		15	38.1	1 3/8	.62
FIVE		16 1/4	41.3	1 3/4	.79
SIX		17 1/4	43.8	2	.90
SEVEN		18	45.7	2 1/4	1.01

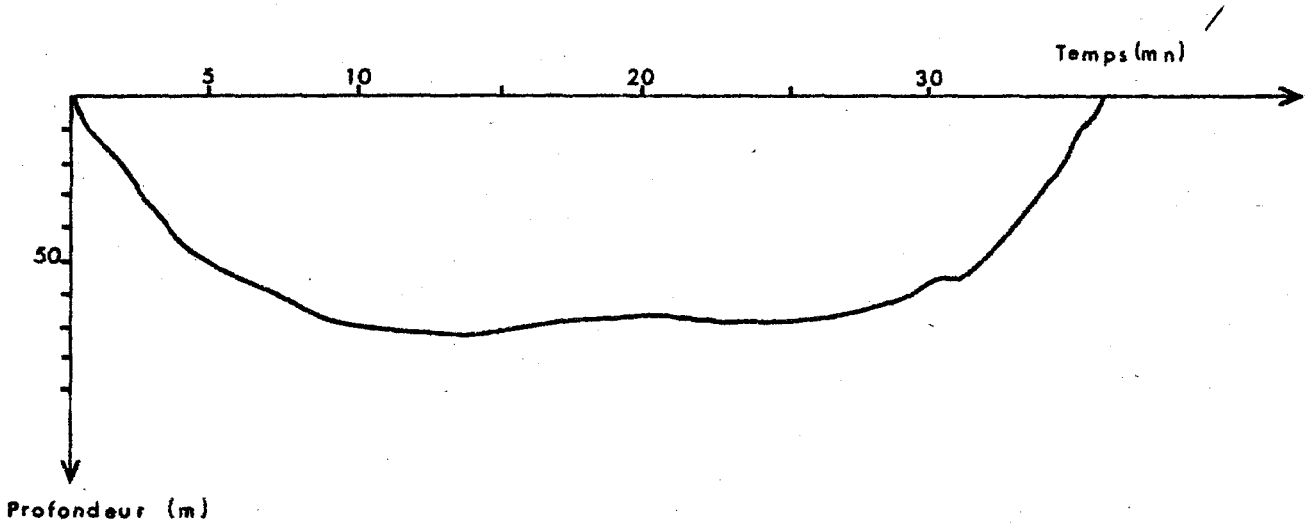


Figure (1) : Exemple d'enregistrement obtenu a l'aide d'un bathykymographe

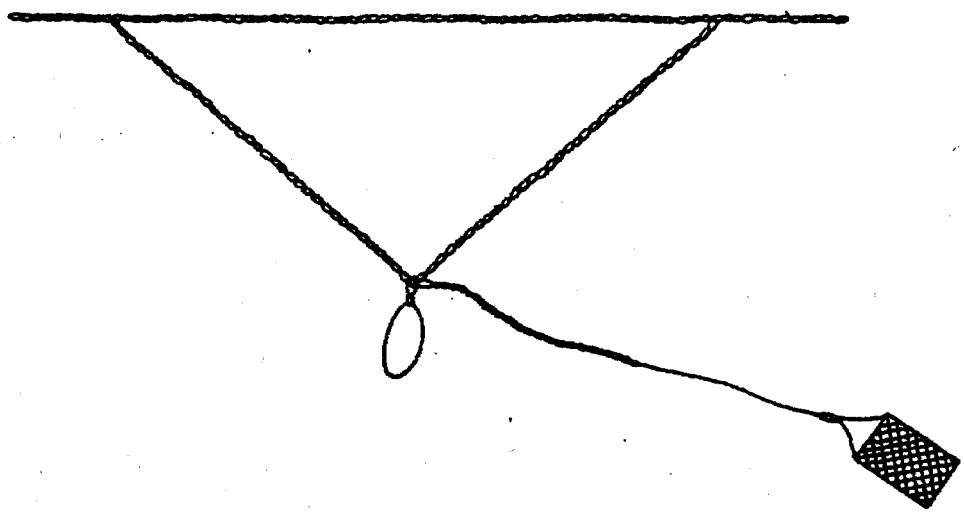


Figure (2) : Amarrage du bathykymographe