

A Study of the Influence of Lastridge Ropes on Redfish Selectivity in a Bottom Trawler

W.M. Hickey, D.L. Boulos and G. Brothers

Industry Development Division
Fisheries Management Branch
Newfoundland Region
P.O. Box 5667
St. John's, Newfoundland A1C 5X1

November, 1995

**Canadian Technical Report
of Fisheries and Aquatic Sciences
No. 2076**



Fisheries
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Canadian Technical Report of Fisheries and Aquatic Sciences

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Newfoundland Region
P.O. Box 5667
St. John's, NF
A1C 5X1

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Cat. No. FS 97-6/ 2076E Issn. 0706-6457

Correct Citation for this Publication:

Hickey, W.M., D.L. Boulos and G. Brothers. 1995. A Study of the Influence of Lastridge Ropes on Redfish Selectivity in a Bottom Trawler. Can. Tech. Rep. Fish. Aquat. Sci. 2076:vii+25.

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ABSTRACT

W.M. Hickey, D.L. Boulos and G. Brothers, 1995. A Study of the Influence of Lastridge Ropes on Redfish Selectivity in a Bottom Trawler. Can. Tech. Rep. Fish. Aquat. Sci. 2076: vii + 25.

Between October and December of 1994, redfish (*Sebastes mentella*) selectivity was examined during two 10-day commercial fishing trips to NAFO sub-division 3Ps. The m/v "Atlantic Lindsey", a 44.5 meter FPI stern trawler, fished in water depths ranging from 335 to 516m. Set durations ranged from 2.3 to 4.3 hours and towing speeds from 2.8 to 3.0 knots. This vessel's standard model 96 bottom trawl converted to a trouser trawl with the addition of a 40mm mesh vertical divider panel and a divided extension to accommodate both an experimental and a 40mm control codend. The experimental codend contained a nominal mesh size of 115, 105 or 90mm and was rigged with and without shortened lastridge ropes hung at 88%. The objective of the selectivity experiment was to reduce, below 5%, the amount of small redfish (< 23cm) in the catch while maintaining a large percentage of the commercial-sized fish. Comparative results indicated that the codends with lastridge ropes produced sharper and less variable selection characteristics. These codends consistently lost more small fish and retained more commercial sized fish than the codends of similar mesh size with no lastridge ropes. Selection ranges obtained for the codends without lastridge ropes ranged from 4.6 to 6.6cm and from 3.3 to 3.8cm with lastridge ropes. The L50's assessed for the 115, 105 and 90mm mesh sizes were 31.5, 28.5 and 27.2cm when not using lastridge ropes and 32.3, 32.1 and 26.9cm with lastridge ropes, respectively. Of the codends evaluated, optimal selectivity was obtained using the 90mm nominal mesh size with lastridge ropes. The sets with this codend caught only 1.07% small redfish and possessed a narrow selection range of 3.3cm which maximized the retention of commercial-sized fish.

RÉSUMÉ

W.M. Hickey, D.L. Boulos and G. Brothers, 1995. A Study of the Influence of Lastridge Ropes on Redfish Selectivity in a Bottom Trawler. Can. Tech. Rep. Fish. Aquat. Sci. 2076: vii + 25.

Entre octobre et décembre 1994, on a étudié la sélectivité des chaluts employés pour pêcher le sébaste (*Sebastes mentella*) lors de deux sorties de pêche commerciale de dix jours chacune dans la subdivision 3Ps de l'OPANO. Le n/m Atlantic Lindsey, un chalutier à rampe arrière de 44,5 m appartenant à FPI, a pêché à des profondeurs de 329 m à 516 m. Il a effectué des traits de 2,3 à 4,3 h, à des vitesses de 2,8 et de 3,0 noeuds. Le chalut de fond de modèle 96 normalement utilisé sur ce navire a été modifié par l'addition d'une cloison verticale à petites mailles de façon à produire un chalut pantalon contenant à la fois un cul-de-chalut expérimental et un autre à petites mailles. Le cul-de-chalut expérimental était constitué de mailles de 115, 105 ou de 90 mm, avec ou sans ralingues à rapport d'armement de 88 %. Cette expérience de sélectivité avait pour objectif de réduire à moins de 5 % la quantité de petit sébaste (< 23 cm) capturé en retenant le plus fort pourcentage possible de poisson de taille commerciale. Une comparaison des résultats a révélé que les culs-de-chalut équipés de ralingues pratiquent une sélection plus précise et moins variable; de façon régulière, ces culs-de-chalut ont laissé partir plus de petits poissons et retenu plus de sébaste de taille commerciale que les culs-de-chalut sans ralingues. La gamme de sélection obtenue des culs-de-chalut sans ralingues s'est échelonnée de 4,6 à 6,6 cm; avec ralingues, elles n'a été que de 3,3 à 3,8 cm. Les chaluts de modèle L50 évalués avec des maillages de 115, 105 et 90 mm ont produit respectivement des résultats de 31,5, 28,5 et 27,2 cm sans ralingues et de 32,3, 32,1 et 26,9 cm avec ralingues. De tous les culs-de-chalut testés, c'est le filet aux mailles de 90 mm équipé de ralingues qui a démontré la meilleure sélectivité. On n'a relevé que 1,07 % de petits sébastes dans les filets équipés de ce type de cul-de-chalut, dont la gamme de sélection plus faible (3,3 cm) a permis d'optimiser la capture de poissons de taille commerciale.

INTRODUCTION

A widespread decline of redfish (*Sebastes mentella*) catches from all fishing areas has been reported by both inshore and offshore trawlers based in Atlantic Canada. This decline causes great concern as redfish is one of the few major fisheries still being pursued after the Atlantic wide shutdown of most groundfish fisheries. Moreover, as this species has such a slow growth rate (Scott and Scott, 1988), any severe reduction in stock size would require a lengthy period to replenish it (Kelly et al., 1972).

Fishery Products International (FPI) is presently the largest redfish quota holder in the Newfoundland region and it has diverted much of its remaining trawler fleet to fishing this species since the moratorium on most groundfish stocks (Pers. Comm.). As a response to its declining catches and as an attempt to reduce the catch of small redfish ($< 23\text{cm}$), the company had increased the codend mesh size in its otter trawls from 90mm to 105mm. However, the increase in landed fish size which resulted was still not satisfactory and new methods were investigated to improve size selectivity. One method selected for evaluation was the use of shortened lastridge ropes on codends.

A number of size selectivity experiments have been performed with shortened lastridge ropes and have indicated improved selectivity characteristics when compared to similar codends which did not use shortened lastridge ropes (Brothers and Boulos, 1994; Hickey et al., 1993; Jacobsen, 1991; Isaksen and Valdemarsen, 1990). Jacobsen (1991) has found a reduction in the number of small redfish caught off the Faroe Islands when a codend of 135mm mesh size was used with lastridge ropes hung at 85%, as opposed to the catch for a similar 135mm mesh

codend without shortened lastridge ropes. Experiments with cod (*Gadus morhua*) (Brothers and Boulos, 1994; Hickey et al., 1993) have indicated better selection characteristics as well as less variable results when shortened lastridge ropes were used. The results were characterized by catches with fewer fish whose length was below the codend's L50 and more fish of lengths above it when compared to codends which did not use shortened lastridge ropes.

Underwater video observations (Isaksen and Valdemarsen, 1990) and catch comparisons (Brothers and Boulos, 1994) with cod have indicated that shortened lastridge ropes allow meshes along the whole length of the codend to remain open since the weight of the catch is borne by the lastridge ropes and not the netting. Furthermore, the undulations in the slack netting may induce more fish to escape.

Following the approval of an FPI proposal that was submitted to DFO, two co-operative trips were arranged to evaluate redfish size selectivity in codends of various mesh sizes. These codends were assessed with lastridge ropes hung at 88% as well as without shortened lastridge ropes. The first trip was conducted from October to November of 1994 and evaluated codends containing a nominal mesh size of either 105mm or 115mm. A second trip, conducted in December of 1994, evaluated a nominal mesh size of 90mm. The main purpose of these trips was to reduce the catch of small redfish (below 23cm) to a level of 5% or less while still catching a large percentage of the commercial sized redfish. This report describes the results obtained from both these trips.

MATERIALS AND METHODS

The “Atlantic Lindsey”, a 50m stern trawler that is owned and operated by FPI, was used for two 10 day experimental fishing trips to NAFO sub-division 3Ps. This vessel normally directs for redfish and utilized a 96 model bottom trawl that was modified with the addition of a vertical separator panel extending from the center of the headline and footrope to the twin extensions (Figure 1). This trouser trawl rigging was developed and tested with the aid of the flume tank at Memorial University’s Marine Institute. The trawl was fitted with a combination rockhopper/rubber roller footrope with rockhopper sections in the wings and rollers in the bosum section. The roller section was added to improve bottom contact. Morgere super v trawl doors, each measuring 5.5m^2 and weighing 1600kg, were used during the first trip. These doors were found to over spread the trawl which resulted in a lower headline height with slack netting in the vertical panel. Number 7 Bergen doors (BMV), weighing 1400kg each, replaced the Morgere doors prior to the second trip.

The headrope was 29.3m in length and it contained 55 plastic floats that were 20.0cm in diameter. Footrope length was 30.5m and it used rubber discs with a 40.6cm diameter in the wings and rollers with a 53.3cm diameter in the bosum section. The bridle and ground warp lengths were 45.7m and 128.0m, respectively. Mesh sizes were 162mm in the wings, 143mm in the body (i.e. square and belly) and 125mm in the lengthening piece. One leg of the trouser trawl, the experimental codend, contained one of the mesh sizes tested while the other leg, the control codend, and the separator panel were both made from a 40mm mesh size. The nominal mesh sizes tested within the experimental codend were 115 or 105mm on the first trip and 90mm

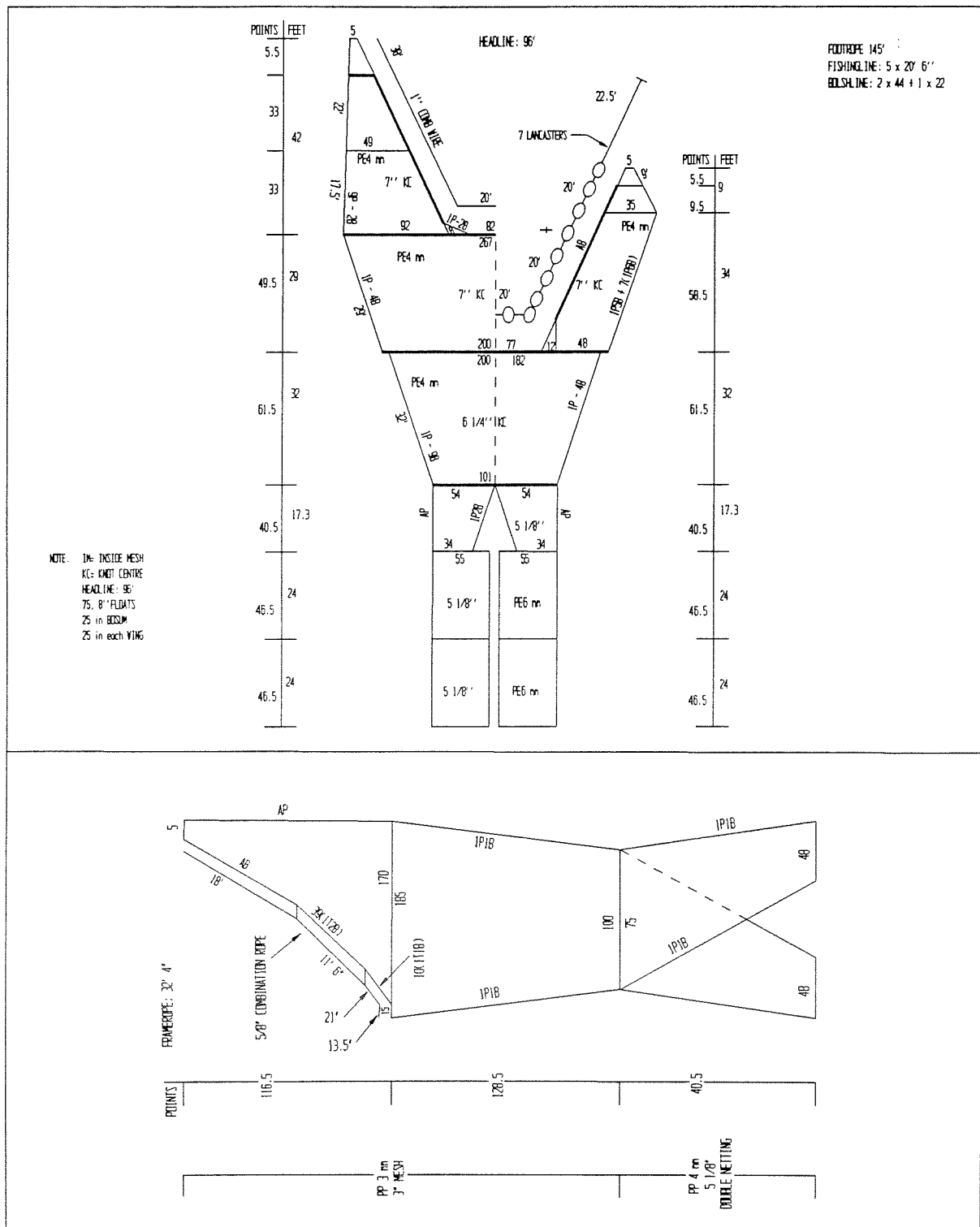


Figure 1: A Schematic Diagram of the Trawl used During this Study.

on the second. These mesh sizes were evaluated in codends with and without shortened lastridge ropes. The measured individual mesh sizes were found to vary somewhat but the mean sizes were close to the reported nominal sizes. The nominal 115mm mesh size was determined to have a mean value of 114mm in the codend with shortened lastridge ropes and 115mm in the codend without shortened lastridge ropes. For the codends with a nominal 105mm mesh size, the mean measured value was 107mm in the codend which used lastridge ropes hung at 88% and 108mm in the codend which did not use shortened lastridge ropes. Similarly, the nominal 90mm mesh size was determined to be 86mm when shortened lastridge ropes were used and 91mm when they were not.

All tests were performed while the vessel was commercial fishing and this was conducted on a 24-hour schedule. The gear's operation was monitored on both trips using a scanmar catch control system and this was performed for all sets except those that required battery charging. Fish behaviour and gear performance were recorded intermittently throughout the first cruise with an underwater video camera system. This system consisted of an osprey colour camera, an osprey I-S.I.T. camera and a self-contained recording unit with power pack.

One observer and one DFO representative collected data and monitored fishing operations on a 24 hour basis. After each set was taken onboard, fork length measurements were made on a random sample of redfish that was taken from each codend. Total redfish catch weights and sample weights were recorded for each codend while total weights only were taken for all other species.

Selectivity parameters were obtained for the individual sets of each experimental codend using the Select methodology of Millar and Walsh (1992). Using a significance level of 0.05, the deviance goodness of fit test (Myers, 1990) was used to determine whether the retention of redfish followed a logistic relationship for the individual sets, where sets not passing this test were not included for comparison. The methodology of Boulos et al. (1993) was used with sets passing the goodness of fit test to determine the selectivity characteristics for the combined sets of each experimental codend.

RESULTS

TRIP #1

A total of 29 successful sets were completed in NAFO sub-division 3Ps. Each set was conducted in water depths ranging from 335 to 516m with set durations of 2.3 to 4.3 hours. Towing speeds were 2.8 to 3.0 knots. The total catch of redfish in all codends was 61,373kg. The total by-catch of all other species included 271kg of cod, 1,789kg of witch (*Glyptocephalus cynoglossus*), 1,720kg of white hake (*Urophycis tenuis*), 330kg of monkfish (*Lophius americanus*), 479kg of pollock (*Pollachius virens*), 374kg of skate (*Raja radiata*, mainly) and 269kg of Atlantic halibut (*Hippoglossus hippoglossus*). Small amounts of argenteries (*Argentina silus*), turbot (*Reinhardtius hippoglossoides*), squid (*Illex illecebrosus*), grenadier (*Coryphaenoides rupestris*), american plaice (*Hippoglossoides platessoides*), spiny crab (*Neolithodes grimaldii*), silver hake (*Merluccius bilinearis*), wolfish (*Anarhichas lupus*), dogfish (*Squalus acanthias*) and snow crab (*Chionoecetes opilio*) were occasionally taken.

The underwater camera was positioned to view different areas of the trawl throughout the trip. These viewing positions included the center of the headline, above the aft end of the square, in the codend looking aft and on top of the codend looking aft. This footage confirmed that the trawl was performing correctly with the exception of excessive door spread which reduced the headline height and induced slack netting in the vertical panel. Attachment of the lastridge ropes using metal "bandits" was satisfactory for the duration of this experiment but minor slippage did occur and suggests that a more permanent solution is necessary.

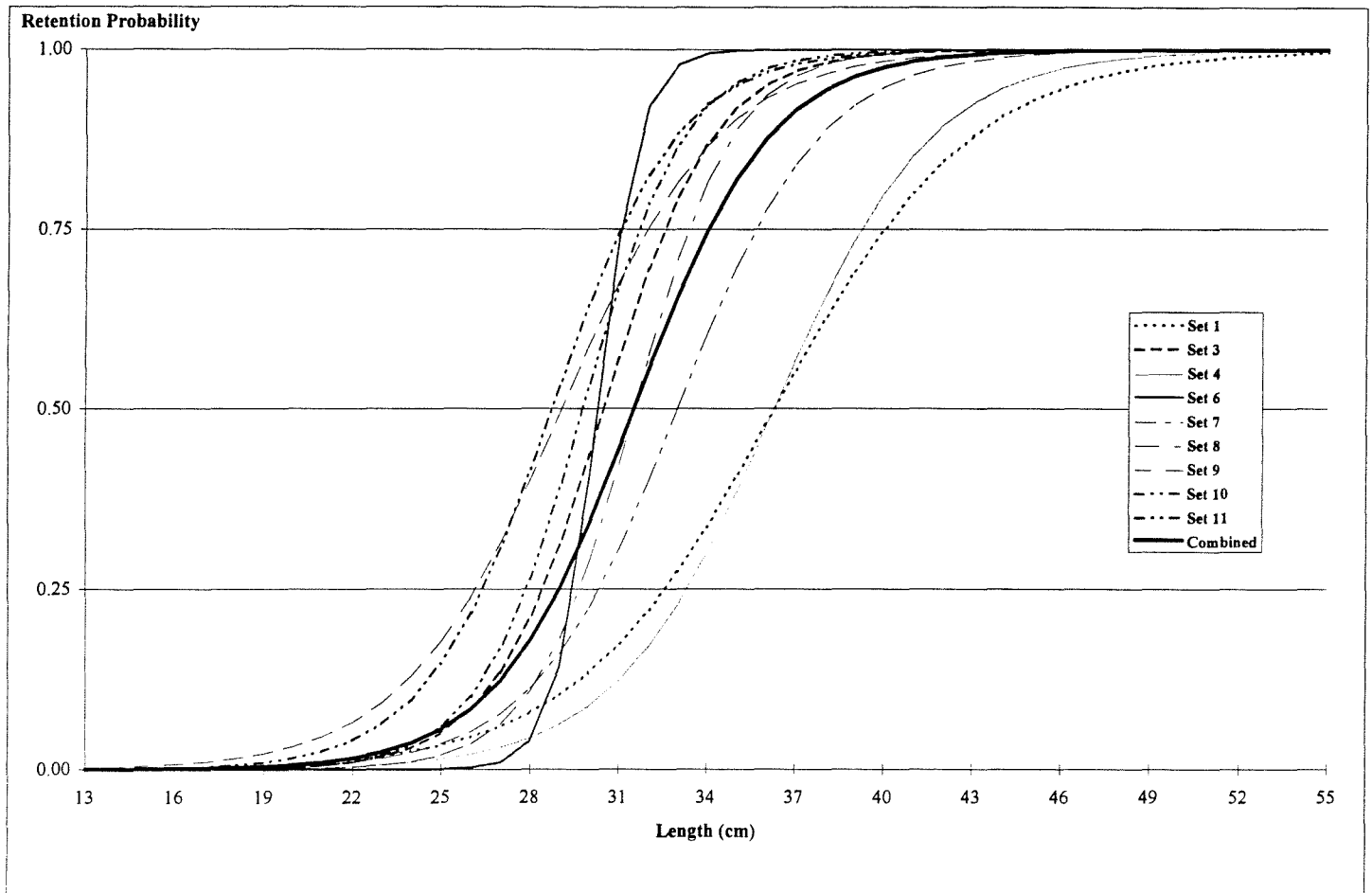
Nominal 115mm Diamond Mesh With and Without Shortened Lastridge Ropes

Redfish catches of 1,287 to 4,993kg were taken in both the experimental and control codends of the nine successful sets performed with the 115mm mesh codend. Within the experimental codend, catches ranged from 115 to 1,924kg. These combine to give a total catch of 24,901kg that possessed a mean length of 31.20cm with 1.83% of redfish below 23cm (Table 1). The percentage below 23cm was somewhat variable, ranging from 0 to 6.02% for the 115mm mesh codend. However, this does indicate that a large number of small redfish were released since 26.60% of the population encountered were below 23cm.

TABLE 1: A Summary of the Catch Results Obtained when using the Nominal 115mm Mesh With and Without Shortened Lastridge Ropes.

Mesh Size	Lastridge	Sets	Sampled Catch					Catch (kg)
			Number Sampled	Length Range (cm)	Mean Length (cm)	Mean Fish Weight (kg)	% Below 23cm	
115	No	9	3,170	17 - 49	31.20	0.48	1.83	24,901
40	-	9	3,681	16 - 48	25.97	0.26	26.60	44,302
114	88%	11	3,091	18 - 48	33.52	0.52	0.46	17,888
40	-	11	4,509	13 - 46	25.77	0.27	37.54	32,106

The selectivity characteristics determined for these sets was quite variable. Sets which used a 115mm mesh codend without shortened lastridge ropes were determined to have an L50 of 31.5cm and a selection range of 5.0cm when combined (Figure 2). These parameters indicate that while most small redfish are released with this mesh size, many fish above 23cm are also



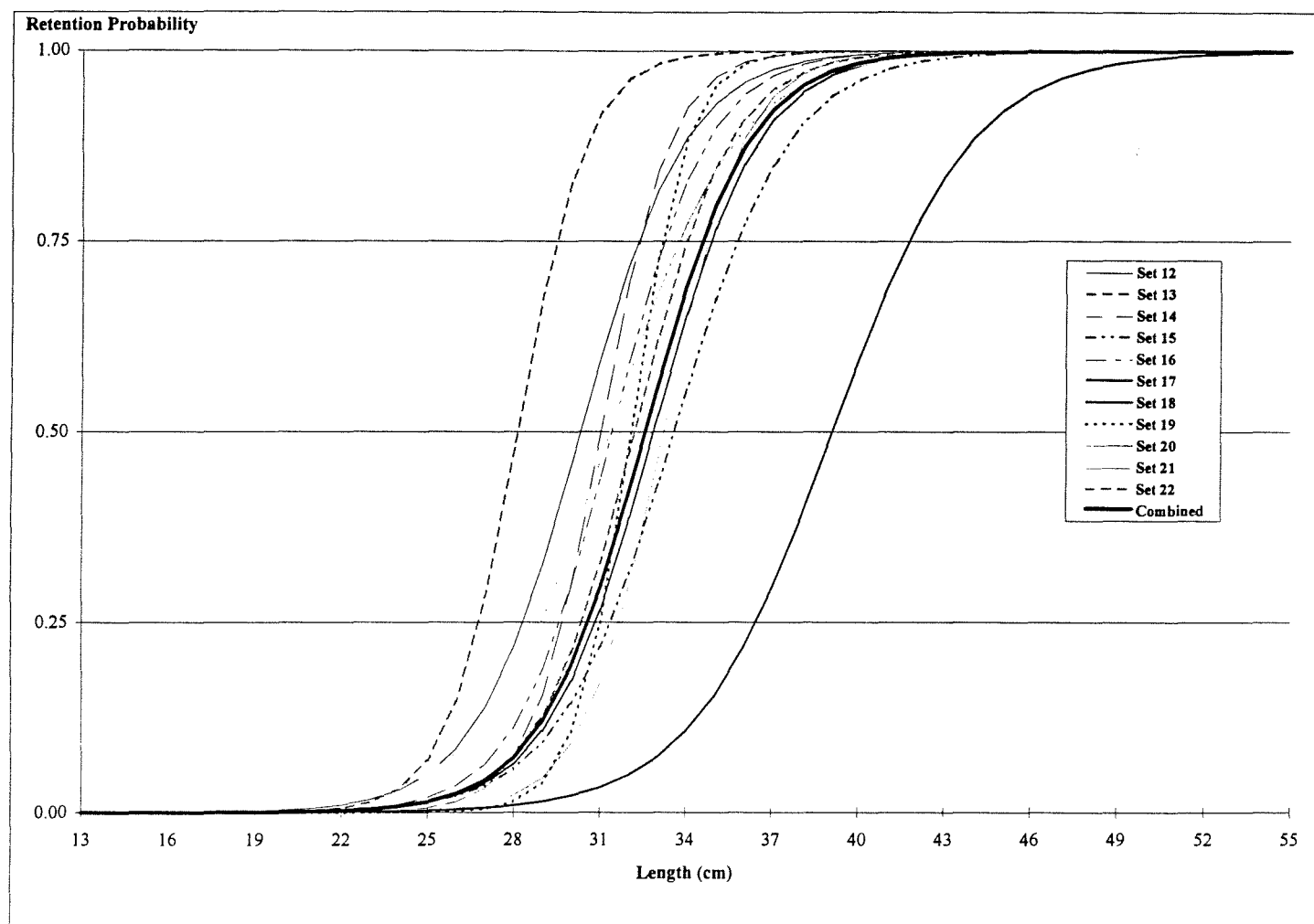
	Set 1	Set 3	Set 4	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Combined
a	-10.76	-16.37	-13.54	-42.86	-13.69	-18.93	-10.98	-17.33	-13.59	-13.73
b	0.30	0.54	0.37	1.42	0.42	0.60	0.38	0.58	0.47	0.44
L25 (cm)	32.6 (4.88)	28.4 (0.87)	33.3 (4.35)	29.5 (0.31)	30.3 (1.03)	29.7 (1.08)	26.1 (1.11)	27.9 (0.74)	26.4 (0.85)	29.0 (0.30)
L50 (cm)	36.3 (5.27)	30.5 (1.06)	36.3 (4.56)	30.3 (0.42)	33.0 (1.32)	31.5 (1.22)	29.0 (1.49)	29.8 (0.91)	28.7 (1.17)	31.5 (0.41)
L75 (cm)	40.0 (5.68)	32.5 (1.27)	39.2 (4.77)	31.0 (0.59)	35.6 (1.63)	33.3 (1.38)	32.0 (1.91)	31.7 (1.09)	31.0 (1.63)	34.0 (0.54)
S.R. (cm)	7.4 (0.96)	4.1 (0.48)	5.9 (0.56)	1.5 (0.45)	5.3 (0.72)	3.6 (0.37)	5.9 (0.96)	3.8 (0.44)	4.6 (1.14)	5.0 (0.31)
S.F.	3.2	2.7	3.2	2.6	2.9	2.7	2.5	2.6	2.5	2.7

Figure 2: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined Sets which used the 115mm Diamond Mesh Codends with no Shortening of Lastridge Ropes.

lost. The selection range reflects the separating qualities of the mesh and indicates that the separation between small and large redfish was not very sharp. The large variability for the selectivity of this codend, typical of diamond mesh codends, indicates that the performance of this mesh size was not very consistent.

Eleven sets were obtained using a codend that contained a 114mm mesh size which was fitted with shortened lastridge ropes. Catches of redfish varied from 487 to 4,205kg within both the experimental and control codends. The 114mm mesh codend contained catches of 23 to 1,220kg that totalled 17,888kg over all sets. This catch consisted of redfish possessing a mean length of 33.52cm and only 0.46% below 23cm (Table 1). The percentage of redfish below 23cm was fairly consistent, ranging from 0 to 1.7%, and represents a large reduction from the 37.54% present in the fish that were encountered.

The selectivity characteristics assessed for the sets using a 114mm mesh codend with shortened lastridge ropes was a little more consistent than the regular 115mm mesh codend. For the combined sets, the selection range was slightly lower at 3.9cm and the L50 was slightly higher at 34.1cm (Figure 3). These results indicate that this codend with shortened lastridge ropes does allow most of the small redfish to escape but the high mean length, mean fish weight and L50 all indicate that too many fish above 23cm were escaping.



	Set 12	Set 13	Set 14	Set 15	Set 16	Set 17	Set 18	Set 19	Set 20	Set 21
a	-16.81	-23.55	-26.26	-16.83	-19.18	-16.27	-18.11	-33.38	-14.44	-24.09
b	0.55	0.84	0.85	0.50	0.61	0.42	0.55	1.04	0.46	0.73
L25 (cm)	28.3 (0.87)	26.8 (0.90)	29.7 (1.00)	31.4 (0.83)	29.6 (0.87)	36.5 (5.55)	30.8 (0.77)	31.0 (0.37)	28.9 (0.75)	31.7 (0.52)
L50 (cm)	30.3 (1.16)	28.1 (1.06)	31.0 (1.16)	33.6 (1.03)	31.4 (1.01)	39.1 (5.72)	32.8 (0.98)	32.1 (0.50)	31.3 (0.97)	33.2 (0.70)
L75 (cm)	32.3 (1.48)	29.4 (1.24)	32.3 (1.34)	35.7 (1.24)	33.2 (1.17)	41.7 (5.90)	34.8 (1.22)	33.1 (0.69)	33.7 (1.30)	34.7 (0.92)
S.R.(cm)	4.0 (0.75)	2.6 (0.45)	2.6 (0.43)	4.3 (0.52)	3.6 (0.37)	5.2 (0.51)	4.0 (0.59)	2.1 (0.45)	4.8 (0.88)	3.0 (0.50)
S.F.	2.7	2.5	2.7	2.9	2.8	3.4	2.9	2.8	2.7	2.9

	Set 22	Combined
a	-19.58	-18.20
b	0.61	0.56
L25 (cm)	30.4 (0.59)	30.6 (0.22)
L50 (cm)	32.2 (0.76)	32.6 (0.28)
L75 (cm)	34.0 (0.98)	34.5 (0.35)
S.R.(cm)	3.6 (0.54)	3.9 (0.17)
S.F.	2.8	2.9

Figure 3: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined sets which used the 114mm Diamond Mesh Codends with Shortened Lastridge Ropes Hung at 88%.

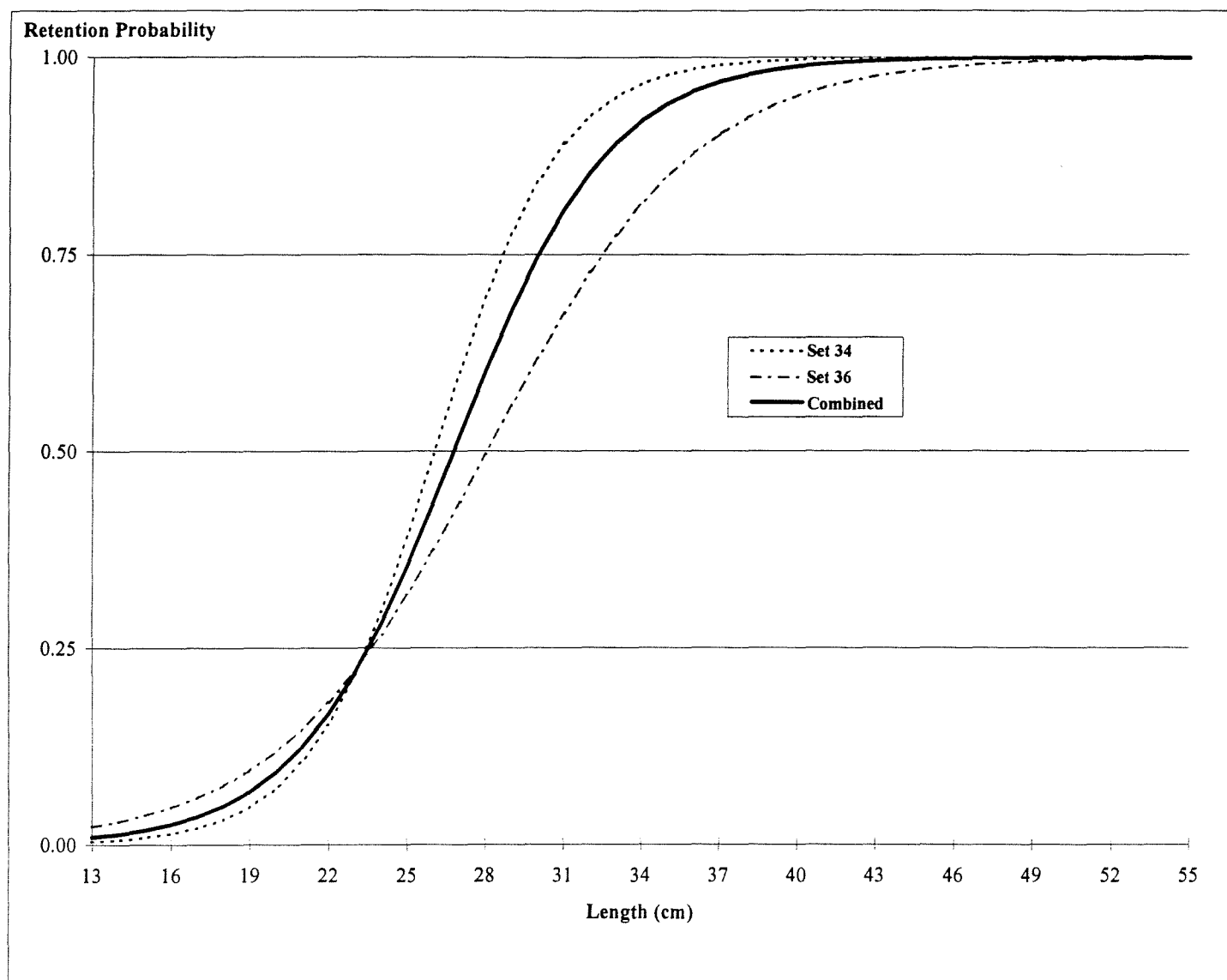
Nominal 105mm Diamond Mesh With and Without Shortened Lastridge Ropes

Only two successful sets were obtained using a 108mm mesh codend and the redfish catches from these were 1,788 and 1,947kg within both the experimental and control codends. The experimental codend contained catches of 190 and 393kg, totalling 583kg. This catch of redfish in the 108mm mesh codend contained a mean length of 26.08cm with 12.72% that were below 23cm (Table 2). This percentage was 11.92% and 13.55% for the individual sets and represents a moderate reduction from the 38.73% in the population that was encountered.

TABLE 2: A Summary of the Catch Results Obtained when using the Nominal 105mm Mesh With and Without Shortened Lastridge Ropes.

Mesh Size (mm)	Lastridge	Sets	Sampled Catch					Catch (kg)
			Number Sampled	Length Range (cm)	Mean Length (cm)	Mean Fish Weight (kg)	% Below 23cm	
108	No	2	676	17 - 39	26.08	0.24	12.72	583
40	-	2	932	16 - 39	23.35	0.18	38.73	3,152
107	88%	7	2,609	18 - 49	33.86	0.55	0.44	3,383
40	-	7	2,997	13 - 47	24.81	0.22	33.50	11,466

The selectivity characteristics determined for this codend with a 108mm mesh size tended to reflect the catch composition. For the two combined sets, an L50 of 26.8cm and a fairly large selection range of 6.5cm (Figure 4) were obtained. This further indicated that this mesh size was not performing very selectively. Many small redfish were retained while the high selection range indicated that the expected retention probability did not change very quickly with increases in



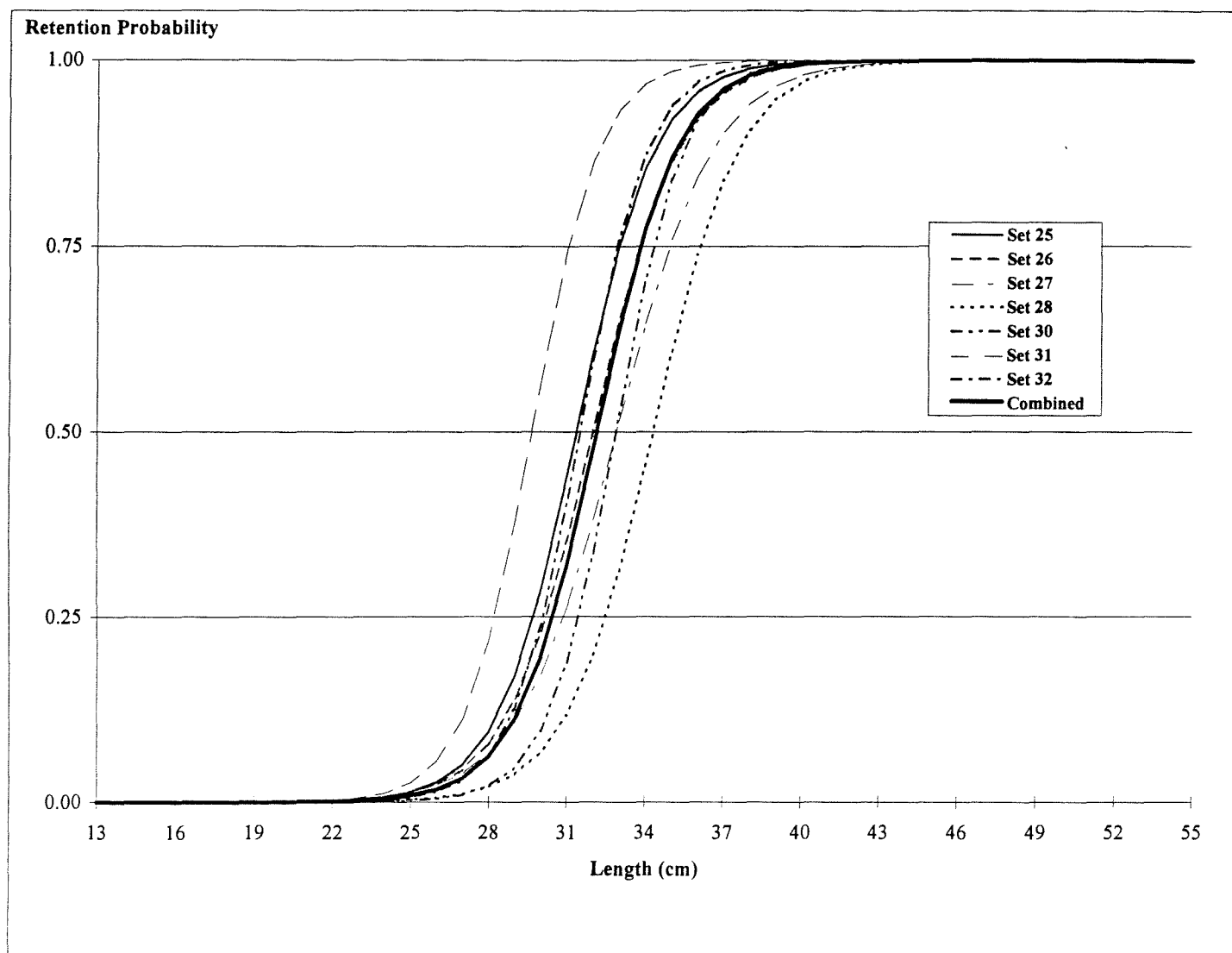
	Set 34	Set 36	Combined
a	-11.07	-7.00	-9.06
b	0.42	0.25	0.34
<i>L</i> 25 (cm)	23.4 (1.06)	23.7 (2.68)	23.5 (1.06)
<i>L</i> 50 (cm)	26.0 (1.37)	28.1 (3.68)	26.8 (1.41)
<i>L</i> 75 (cm)	28.6 (1.72)	32.4 (4.75)	30.0 (1.79)
<i>S.R.</i> (cm)	5.2 (0.80)	8.8 (2.31)	6.5 (0.85)
<i>S.F.</i>	2.4	2.6	2.5

Figure 4: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined Sets which used the 108mm Diamond Mesh Codends with no Shortening of Lastridge Ropes.

fish length. This latter point suggests that while the retention of small fish was moderate, the retention of medium-sized redfish was not much different from the small fish and thus indicates a fair loss of larger redfish. These selectivity results were somewhat unexpected. The selection curve was shifted more to the left than would be expected from results obtained for the other mesh sizes tested. This may be a result of the fairly large number of small redfish in the population encountered (38.73%), however, it is more likely that two sets were insufficient to obtain an accurate representation of the selectivity characteristics for this mesh size.

Seven successful sets resulted in redfish catches of 1,298 to 3,782kg from both the experimental and control codends when evaluating a 107mm mesh with shortened lastridge ropes. Within the experimental codend, catches ranged from 177 to 1,382kg which combine to give a total of 3383kg. The catch contained a mean fish length of 33.86cm and only 0.44% of redfish were below 23cm (Table 2). This percentage varied from 0 to 0.8% and represents a reduction from the 33.50% that were in the population encountered.

The selectivity characteristics determined for the 107mm mesh codend which used shortened lastridge ropes were more in line with the results obtained for the other mesh sizes evaluated. An L50 of 32.1cm and a selection range of 3.3cm were determined for redfish from the combined sets which used this codend (Figure 5). These results were relatively consistent over the individual sets tested. The narrow selection range and low percentage of redfish below 23cm obtained with the use of this codend indicates that the sharp cut-off between fish lengths escaping and those retained leads to few small fish being caught. However, this cut-off length appears to be too high as it produced an unacceptable loss of redfish that were larger than 23cm.



	Set 25	Set 26	Set 27	Set 28	Set 30	Set 31	Set 32	Combined
a	-21.12	-19.72	-17.89	-21.05	-25.70	-23.23	-24.52	-21.27
b	0.67	0.62	0.54	0.61	0.78	0.78	0.78	0.66
<i>L</i> 25 (cm)	29.7 (0.79)	30.2 (0.64)	30.9 (0.69)	32.5 (1.46)	31.5 (0.79)	28.2 (0.55)	30.1 (0.55)	30.5 (0.18)
<i>L</i> 50 (cm)	31.4 (0.90)	32.0 (0.81)	32.9 (0.85)	34.3 (1.56)	32.9 (0.89)	29.6 (0.67)	31.5 (0.68)	32.1 (0.22)
<i>L</i> 75 (cm)	33.0 (1.02)	33.8 (1.03)	34.9 (1.05)	36.1 (1.67)	34.3 (1.00)	31.0 (0.81)	32.9 (0.83)	33.8 (0.28)
<i>S.R.</i> (cm)	3.3 (0.30)	3.6 (0.55)	4.0 (0.46)	3.6 (0.29)	2.8 (0.29)	2.8 (0.32)	2.8 (0.36)	3.3 (0.15)
<i>S.F.</i>	2.9	3.0	3.1	3.2	3.1	2.8	2.9	3.0

Figure 5: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined Sets which used the 107mm Diamond Mesh Codends with Shortened Lastridge Ropes Hung at 88%.

TRIP #2

A total of 15 sets were made in NAFO sub-division 3Ps in depths ranging from 380 to 465m. The duration of each set varied from 2.4 to 4.3 hours. The total catch of redfish in all codends was 47,646kg. The total by-catch of all other species included 1,293kg of cod, 981kg of witch, 1065kg of white hake, 69kg of monkfish, 53kg of pollock, 208kg of skate, 90kg of american plaice and 61kg of Atlantic halibut. In addition, small amounts of argentines, turbot, squid, grenadier, spiny crab, silver hake, wolfish, dogfish and snow crab were also occasionally taken. Some lastridge rope slippage was recorded during this trip and suggests that re-attachment may be a periodic necessity during commercial fishing operations.

Nominal 90mm Diamond Mesh With and Without Shortened Lastridge Ropes

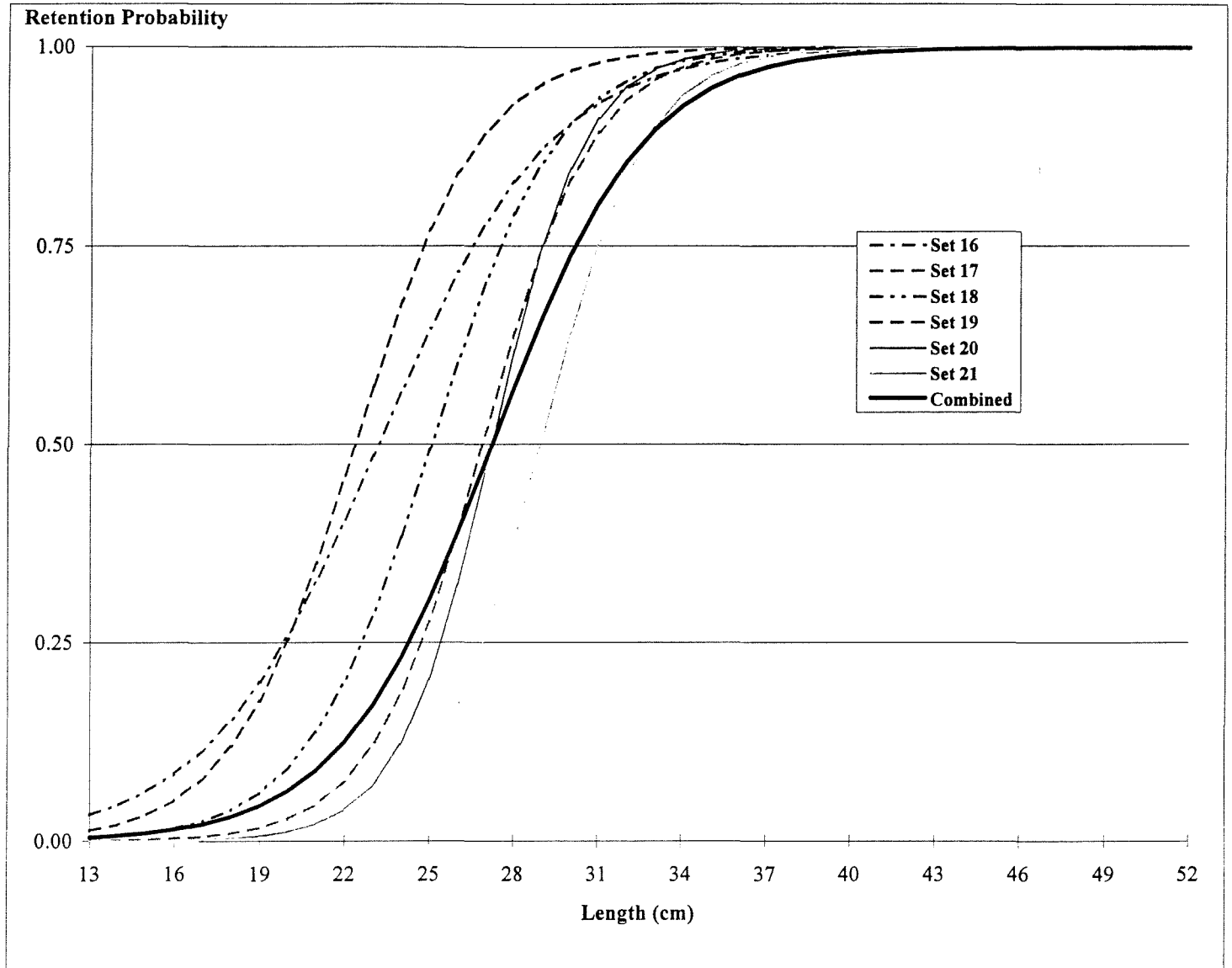
Six sets were performed with a codend made from a 91mm mesh size. These produced redfish catches of 925 to 4,711kg in both experimental and control codends. Within the experimental codend, catches ranged from 260 to 1,532kg which combine to give a total of 4,508kg. This catch in the 91mm mesh codend contained a mean fish length of 30.34cm and 13.30% of redfish were below 23cm. The percentage below 23cm varied from 6.34 to 31.32% and represents a reduction from the 55.09% that were present in the population encountered.

TABLE 3: A Summary of the Catch Results Obtained when using the Nominal 90mm Mesh With and Without Shortened Lastridge Ropes.

Mesh Size (mm)	Lastridge	Sets	Sampled Catch					Catch (kg)
			Number Sampled	Length Range (cm)	Mean Length (cm)	Mean Fish Weight (kg)	% Below 23cm	
91	No	6	2305	17 - 49	30.34	0.43	13.30	4508
40	-	6	2454	14 - 45	24.89	0.26	55.09	10028
86	88%	9	3611	18 - 49	32.30	0.49	1.07	13426
40	-	9	3708	16 - 47	27.29	0.33	30.06	19684

The selectivity determined for this 91mm mesh generally reflected the catch composition within the codend. For the combined sets, the redfish catches from this codend produced an L50 of 27.2cm and a selection range of 5.9cm (Figure 6). This L50 in conjunction with a relatively wide selection range indicates that many small redfish (below 23cm) are retained while a moderate amount of small, but commercially sized redfish, escape. The selection characteristics were not very consistent, as evidenced by the high variability over the individual sets, the L50 ranged from 22.4 to 29.0cm (Figure 6).

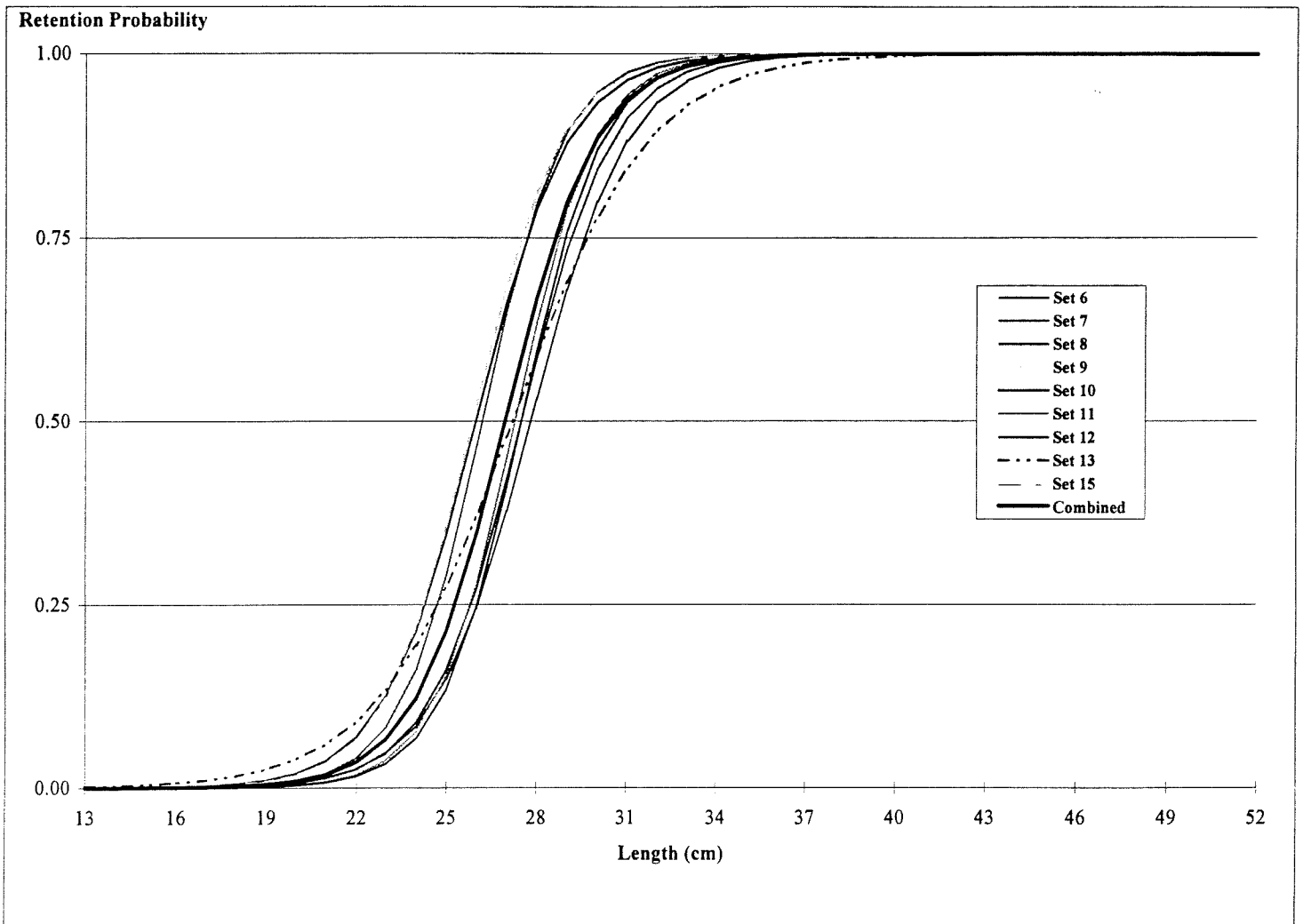
Nine sets were performed using an 86mm mesh codend fitted with shortened lastridge ropes. Redfish catches of 1,457 to 7,752kg were obtained in both the experimental and control mesh codends of the sets performed. Within the experimental codend, catches ranged from 272 to 3,819kg which combine to produce a total of 13,426kg. This catch for the 86mm mesh codend contained a mean fish length of 32.30cm and 1.07% of redfish were below 23cm. The percentage below 23cm varied from 0 to 2.20% and represents a reduction from the 30.06% below 23cm that were present in the population encountered.



	Set 16	Set 17	Set 18	Set 19	Set 20	Set 21	Combined
a	-7.67	-13.84	-11.33	-10.25	-16.72	-15.67	-10.16
b	0.33	0.51	0.45	0.46	0.61	0.54	0.37
<i>L</i> 25 (cm)	19.9 (0.83)	24.7 (0.61)	22.6 (0.63)	20.0 (0.77)	25.4 (0.46)	26.9 (0.60)	24.3 (0.32)
<i>L</i> 50 (cm)	23.2 (1.26)	26.9 (0.79)	25.1 (0.87)	22.4 (1.18)	27.2 (0.65)	29.0 (0.84)	27.2 (0.47)
<i>L</i> 75 (cm)	26.5 (2.06)	29.0 (0.99)	27.5 (1.15)	24.8 (1.67)	29.0 (0.88)	31.0 (1.12)	30.2 (0.65)
<i>S.R.</i> (cm)	6.6 (1.88)	4.3 (0.48)	4.9 (0.64)	4.8 (1.08)	3.6 (0.55)	4.0 (0.64)	5.9 (0.42)
<i>S.F.</i>	2.6	3.0	2.8	2.5	3.0	3.2	3.0

Figure 6: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined Sets which used the 91mm Diamond Mesh Codends with no Shortening of Lastridge Ropes.

The selection characteristics of this 86mm mesh codend with shortened lastridge ropes were also quite good. Catches over the combined sets resulted in an L50 of 26.9cm and a selection range of 3.3cm (Figure 7). These results indicate that very few small (below 23cm) redfish would be caught with a codend of this mesh size when it is fitted with shortened lastridge ropes. In addition, the relatively narrow selection range indicates that redfish escapement increases dramatically as fish size decreases from 26.9cm and decreases dramatically as fish size increases from 26.9cm. This type of redfish selection leads to very few small fish being retained and low losses of larger redfish. Moreover, the very low variability in selection characteristics between sets suggests that these results would be expected to remain relatively consistent among repetitive sets.



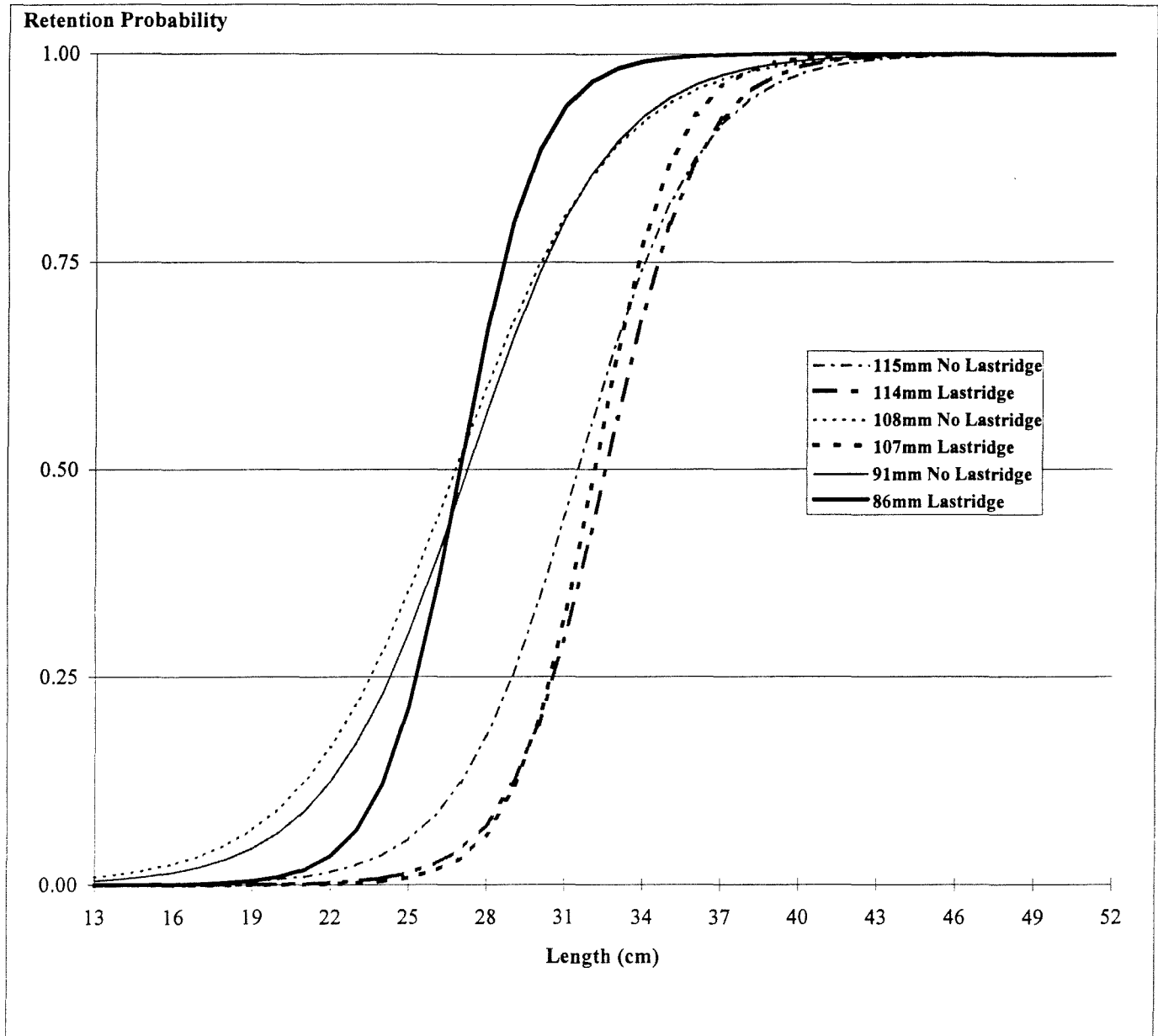
	Set 6	Set 7	Set 8	Set 9	Set 10	Set 11	Set 12	Set 13	Set 15	Combined
a	-18.33	-19.83	-17.03	-17.78	-17.42	-20.70	-20.70	-12.11	-18.24	-18.07
b	0.67	0.76	0.66	0.69	0.63	0.76	0.75	0.45	0.68	0.67
<i>L25 (cm)</i>	25.8 (0.43)	24.7 (0.39)	24.3 (0.54)	24.3 (0.45)	26.1 (0.48)	25.8 (0.66)	26.0 (0.41)	24.7 (0.66)	25.3 (0.42)	25.3 (0.14)
<i>L50 (cm)</i>	27.5 (0.59)	26.2 (0.51)	26.0 (0.80)	25.9 (0.62)	27.8 (0.68)	27.3 (0.96)	27.5 (0.54)	27.2 (1.00)	26.9 (0.57)	26.9 (0.19)
<i>L75 (cm)</i>	29.1 (0.78)	27.6 (0.65)	27.6 (1.19)	27.5 (0.84)	29.6 (0.90)	28.7 (1.34)	28.9 (0.70)	29.7 (1.50)	28.5 (0.76)	28.6 (0.26)
<i>S.R. (cm)</i>	3.3 (0.44)	2.9 (0.33)	3.4 (0.92)	3.2 (0.54)	3.5 (0.52)	2.9 (0.90)	2.9 (0.38)	4.9 (1.17)	3.2 (0.45)	3.3 (0.15)
<i>S.F.</i>	3.1	2.9	2.9	2.9	3.1	3.0	3.1	3.0	3.0	3.1

Figure 7: Redfish Selectivity Curves and Parameter Estimates (standard errors in brackets) for the Individual and Combined Sets which used the 86mm Diamond Mesh Codends with Shortened Lastridge Ropes Hung at 88%.

DISCUSSION

Our results have shown that the use of shortened lastridge ropes can significantly improve the redfish selectivity characteristics of codends. Fewer small and more large redfish appear to be retained in codends that use shortened lastridge ropes, as compared to similar codends with regular lastridge ropes. In all the codends evaluated, the use of shortened lastridge ropes also produced more consistent results over consecutive sets. These redfish selectivity characteristics for shortened lastridge rope codends were similar to the improvements obtained for redfish when 135mm mesh codends were fitted with shortened lastridge ropes in experiments off the Faroe Islands (Jacobsen, 1991) and for cod selectivity in shortened lastridge rope experiments off Newfoundland's west coast (Brothers and Boulos, 1994).

The measured mesh sizes varied somewhat for each of the codends evaluated. However, of the codend mesh sizes tested, it appears that the objective of this study was most fully met by the use of a 90mm nominal mesh size that was fitted with shortened lastridge ropes. The results from this codend produced one of the lowest L50's with the narrowest selection range (Figure 8) which characterizes an expected catch performance where very few small redfish (<23cm) are retained and very few larger redfish (>23cm) are lost. The importance of the narrow selection range becomes apparent when comparing the 91mm, 108mm and 86mm mesh codends. Of these three mesh sizes tested, only the 86mm mesh codend was fitted with shortened lastridge ropes. Catches from these 3 codends produced similar L50's but differing selection ranges (Figure 8). The percentage of small redfish in the catches of the 108 and 91mm



	115mm No Lastridge	114mm Lastridge	108mm No Lastridge	107mm Lastridge	91mm No Lastridge	86mm Lastridge
a	-13.73	-18.20	-9.06	-21.27	-10.16	-18.07
b	0.44	0.56	0.34	0.66	0.37	0.67
<i>L25 (cm)</i>	29.0	30.6	23.5	30.5	24.3	25.3
<i>L50 (cm)</i>	31.5	32.6	26.8	32.1	27.2	26.9
<i>L75 (cm)</i>	34.0	34.5	30.0	33.8	30.2	28.6
<i>S.R. (cm)</i>	5.0	3.9	6.5	3.3	5.9	3.3
<i>S.F.</i>	2.7	2.9	2.5	3.0	3.0	3.1

Figure 8: Redfish Selectivity Curves and Parameter Estimates for the Combined Sets using Various Diamond Mesh Codends With and Without Shortened Lastridge Ropes of 88%.

mesh codends, both of which resulted in fairly wide selection ranges, was substantially larger than what was present in the 86mm mesh codend, which possessed a much narrower selection range (Figure 9). This 86mm mesh codend not only reduced its catch of small redfish to well below the targeted 5%, it also optimized the catch of larger commercial sized redfish. The selectivity of this codend was also found to be even more consistent than the other shortened lastridge rope codends evaluated.

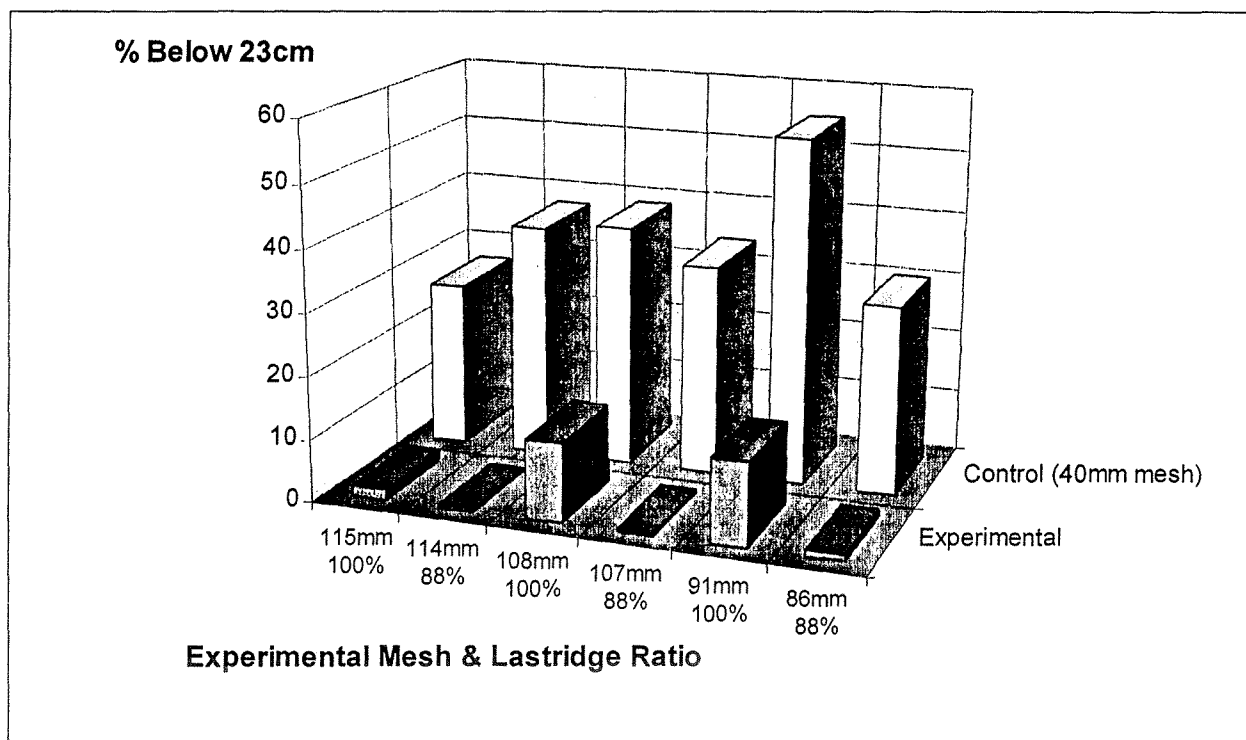


Figure 9: A Comparison of the Redfish that were Below 23cm in the Catches of the Various Codends used during this Study. Codends with shortened lastridge ropes can be seen to have fewer small fish than their counterpart without shortened lastridge ropes.

The catches from all the sets performed were relatively small and as such, it is unknown how the various codends would perform when large catches are encountered. Lower redfish escapement has been attributed to larger catches (McKone, 1981) and large catches may cause more slippage of the bandit attachments of the lastridge ropes, especially since some minor slippage was noted during this study. However in the latter case, a more permanent or reinforced attachment of the lastridge rope would easily correct this slippage. While no attempt was made to separately identify the selectivity of males and females, it has been found (Templeman, 1963) that there may be some differences in their codend selectivity.

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