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Performance of a 4" Ring Scallop Dredge in the Context of an Area Management Strategy Research TAC Set-Aside Georges Bank Scallop Exemption Program, Closed Area Access

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Final Contract Report

"Performance of a 4" Ring Scallop Dredge in the Context of an Area Management Strategy"
Award No. NA06FM1002
Closed Area II

Research TAC Set-Aside
Georges Bank Scallop Exemption Program,
Closed Area Access

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VIMS Marine Resource Report No. 2002-05

May 2002

Final Report
"Performance of a 4" Ring Scallop Dredge
in the Context of an Area Management Strategy"
Award No. NA16FM1030

Preface

This research project award from the Research TAC Set-Aside Program was one of three separate awards to evaluate the performance of 4" ring scallop dredges. For all three awards, the research objectives, sampling protocols and data analyses were identical and are being treated as one experiment. Consequently, the final reports for each project may contain data from the other awards. However, each award budget and accounting of expenditures remained separate.

A peer reviewed paper is in preparation. In addition, the results of this research was presented at the 94th Annual Meeting of the National Shellfisheries Association being held in Mystic, Connecticut in April 2002. Of considerable importance, all the data obtained from the three research TAC set-aside awards has been presented to the Sea Scallop Plan Development Team and has been included in fishing mortality and yield per recruit models under development at the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts.

Summary

Under this award, three trips were conducted in the Georges Bank Closed Area II (CAII) aboard the F/V *Celtic*, a 94' western rigged scallop vessel operating out of port of New Bedford, Massachusetts. The first trip was conducted in July 2000, the second in September 2000 was prematurely terminated due to mechanical problems and the third, in June 2001. Paired catch data was obtained from 101 tows. The spread of trips between July 2000 to June 2001 allowed us to evaluate the 4" ring dredge performance over changing resource conditions in the same location. This data provided further insight relative to the size selectivity patterns of the dredge and clearly shows that scallops in the 70-95 mm size range are protected from harvest.

The results from this study are similar to those conducted in other closed areas. The 4" ring dredge was more efficient in harvesting scallops retained for shucking. Percentage increases in efficiency ranged from 0.5% to 14.4% by weight and from 0.5% to 22.9% by number of scallops retained. For the same quantity of scallops harvested, reductions in time of gear on the bottom ranged from 0.5% to 18.6%.

As in previous studies, the 4" ring dredge fished "cleaner" than the 3.5" ring dredge with significant reductions in "trash" ranging from 21.4% to 40.4%. Changes in finfish bycatch were evident for yellowtail flounder and grey sole < 35 cm, red hake, silver hake, sculpins and sea ravens.

The overall results for the data obtained in CAII, despite being obtained during and after the opening, are supportive of the use of a 4" ring scallop dredge in recently opened closed areas.

Materials and Methods

Under this award, three research trips were conducted in Georges Bank Closed Area II. Please refer to Figure A. Trips were conducted from July 11-19, 2000, September 7-11, 2000 and June 20-26, 2001. Catch data was obtained from 101 tows. The project employed a paired tow experimental design: two dredges, one with 3.5" (89 mm) rings and other with 4" (101 mm) rings towed simultaneously, side-by-side. The dredges were 15' (4.6 m) wide offshore New Bedford style dredges with bags, sweep chains, twinetops and chafing gear configured identically as possible (please refer to Figures B, C, D and E).

For each sampled tow, catch data was collected for each dredge. Catch data included sea scallop catch in volume (baskets), shell height in 5 mm intervals for sub-samples of total catch, scallops retained and scallops discarded, finfish bycatch species by number and size, and the volume of invertebrate trash and rubble. Bridge logs recorded date, time of tow, duration of tow, location of tow, water depth and weather conditions. Bridge logs and catch data were matched by corresponding tow number. Port and starboard dredges were switched mid-way through the trip mitigate for any side-to-side bias.

Results

The research results obtained under this award are grouped according to the project objectives stated in the original proposal.

Objective 1. To examine the relative size selectivity of a 4" ring scallop dredge versus a 3.5" ring dredge for scallops retained and discarded.

The catch data for the three trips to Closed Area II is presented in Tables 1, 2, 3, 4, 5 and 6; as well as Figures F, G, and H. Of particular interest is the large year class recruiting to the scallop gear with a modal SH at around 60 mm in July 2000. Surprisingly, there is little difference in selectivity between the two dredges. However, it is quite possible that 60 mm scallops pass with equal ease through either a 3.5" ring dredge of a 4" ring dredge.

Data from the September 2000 trip indicates that the above mentioned cohort grew to a model SH of 70-75 mm; at this size, the 3.5" ring dredge caught a significant greater number of scallops. From this data obtained in CA II and that obtained on trips in other closed areas, it is increasing apparent that the 4" ring dredge would be effective in protecting scallops form 70-95 mm or from ages 3-4+. Although the selection of this size is not absolute, it offers a significant protection to fast growing scallops. In some cases, the reductions are on the order 30-60%.

As in previous studies, the relative performance of the 3.5" ring dredge and the 4.0" ring dredge was about equal for scallops in the 110-115 mm size range (Figures F, G, and H). In addition, the 4.0" ring dredge was more efficient at harvesting scallops greater than 110 mm for tow of the three trips in CAII. On the third trip, most of the larger scallops had been harvested and the vessel focused on scallops in the 95-120 mm range which is on the cusp of the size range where both gears are equally efficient. Refer to Tables4 and 5 as well as Figure H.

Objective 2. *To determine the relative differences in bycatch and trash* retained by a 4" ring dredge versus a 3.5" ring dredge.

One of the primary assumptions about the performance characteristics of a 4" ring dredge was that it would probably reduce the amount of "trash" caught by the dredge. The term "trash" for this study includes all invertebrates and shell, but not cobble, rocks and sand. The inadvertent harvest of invertebrate and shell has importance where concerns about habitat and bycatch are voiced.

Data on "trash" is presented in Figures H and I. Significant differences in the reduction of trash collected by the 4" ring dredge was observed. Although this result was not totally unexpected, it is the first verification of the reduction of trash using larger rings.

The relative differences in finfish bycatch are presented in Tables 7 and 8. The results are interesting in that significant reductions of yellowtail flounder, American plaice and grey sole <35 cm were observed. The reductions in flatfish bycatch was not really expected but it is another important advantage of using a 4" ring dredge. The bycatch reductions in fusiform fishes such as red and silver hake, sculpins and sea ravens were significant.

Objective 3. *To determine the relative efficiency of 4" ring dredge versus a 3.5" ring dredge in the context of quantities of scallops landed (retained).*

A measure of relative efficiency is the amount of scallops captured, in this case retained by the crew, by each dredge for a given tow time or swept area. The quantity of scallops retained by the crew are presented in Tables 4, 5 and 9. Significant improvements in harvest efficiency were noted for the first two trips in CAII. Improvements ranged from 12.9 to 12.0% respectively when expressed as catch rate per minute of tow time for sampled tows only. When expressed as

"time on bottom" per basket of scallops harvested (sampled and non-sampled tows), reductions in bottom time was 18.6 and 9.5% respectively.

As stated previously, improvements in efficiency were not noted for the third trip when the vessel targeted smaller (95-115 mm) scallops.

Another expression of relative efficiency can be made when converting scallops retained to shucked meat weights. The results to not change the conclusions as increases in efficiency were 14.4 and 14.1% respectively.

Objective 4. To incorporate information on size selectivity and efficiency into models for area management strategies for sea scallops.

All harvest data for scallops and finfish bycatch under this award from CAII, along with the data from all three awards has been sent to the National Marine Fisheries Service (NMFS), Northeast Fisheries Science Center (NEFSC) in Woods Hole, Massachusetts for incorporation into the models for the scallop population on Georges Bank and Mid-Atlantic Closed Areas. Preliminary results have been presented to the SSPDT for review. These results will be available for inclusion into the Draft Supplement Environmental Impact Statement for Amendment 10 to the Sea Scallop Fisheries Management Plan which is now under development.

List of Entities

All of the work on 4" rings was conducted on the F/V *Celtic*, a 96' steel-hulled scallop vessel operating from the port of New Bedford, Massachusetts. The F/V *Celtic* is owned and operated by Capt. Charles Quinn.[1]

Fishing operations, gear storage and logistical support was provided by Eastern Fisheries, New Bedford, Massachusetts.

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[1]F/V *Celtic*
Quinn Fisheries
14 Hervey Tichon Avenue
New Bedford, MA 02740

Permit # 410146
Registration # 591971

List of Figures

Figure A. **Closed areas under the Multi-species Fishery Management Plan and the Sea Scallop Fishery Management Plan.**

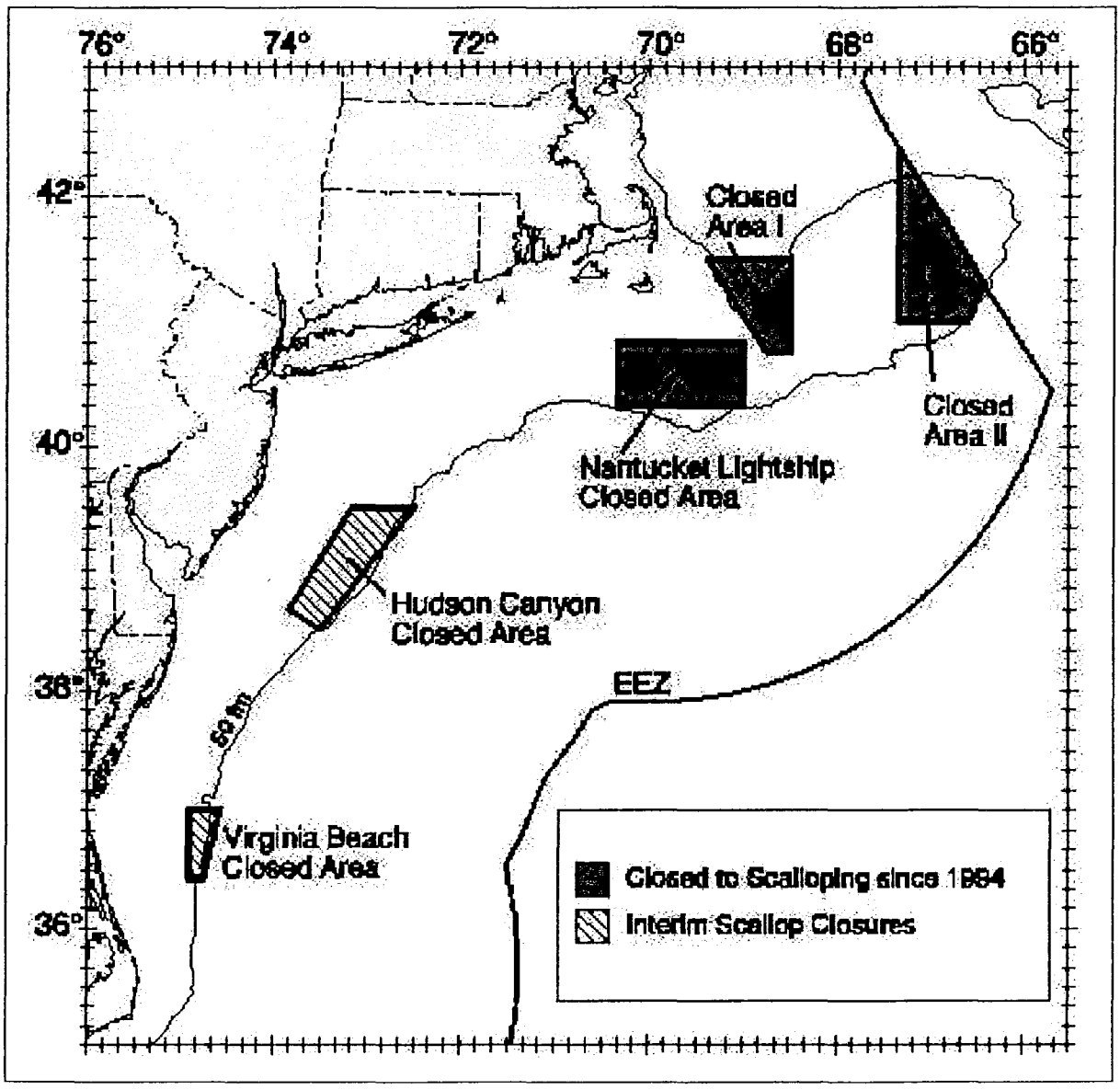


Figure B. The underside of a New Bedford scallop dredge. Chafing gear absent.

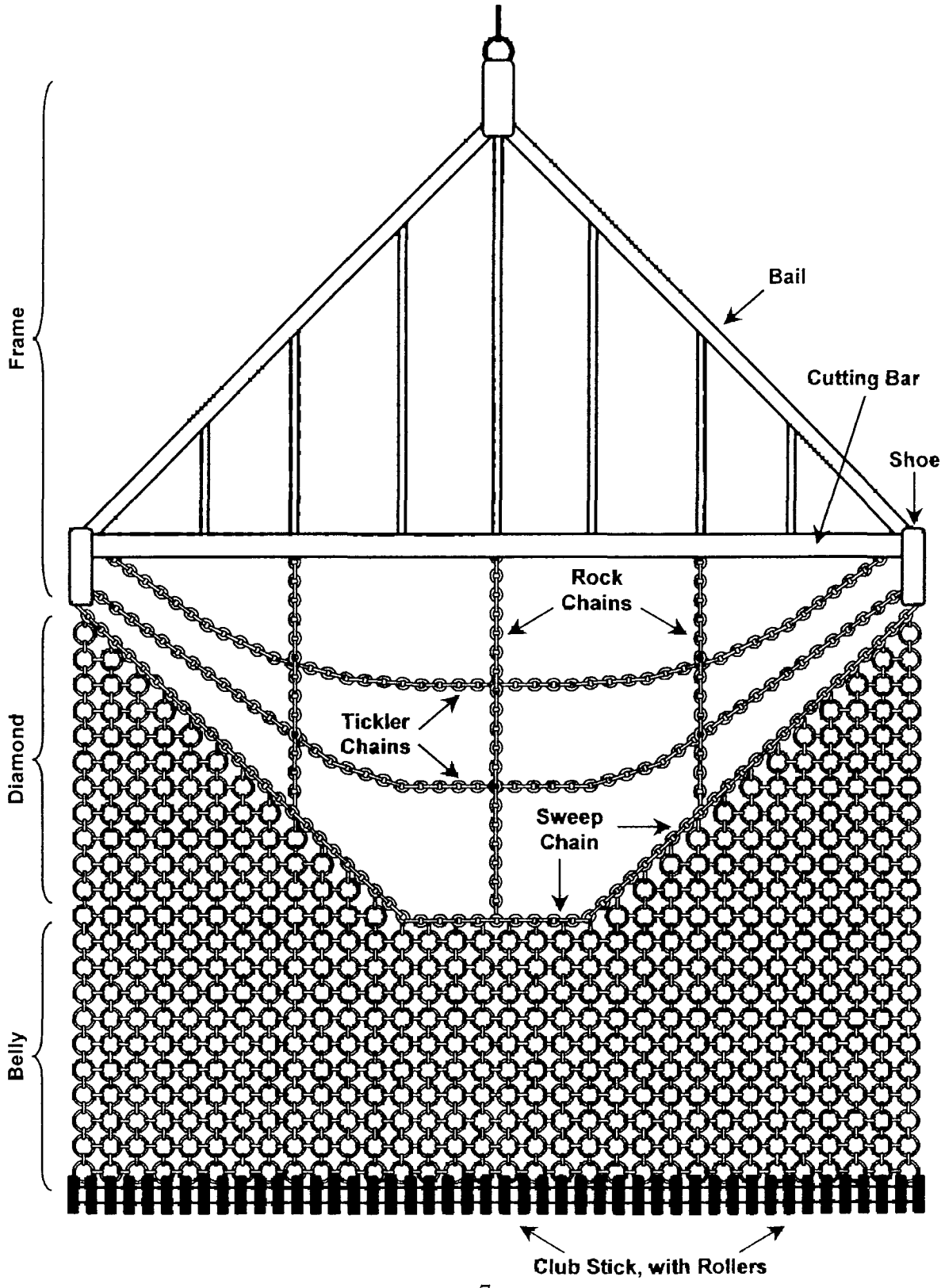


Figure C. The topside of a New Bedford scallop dredge.

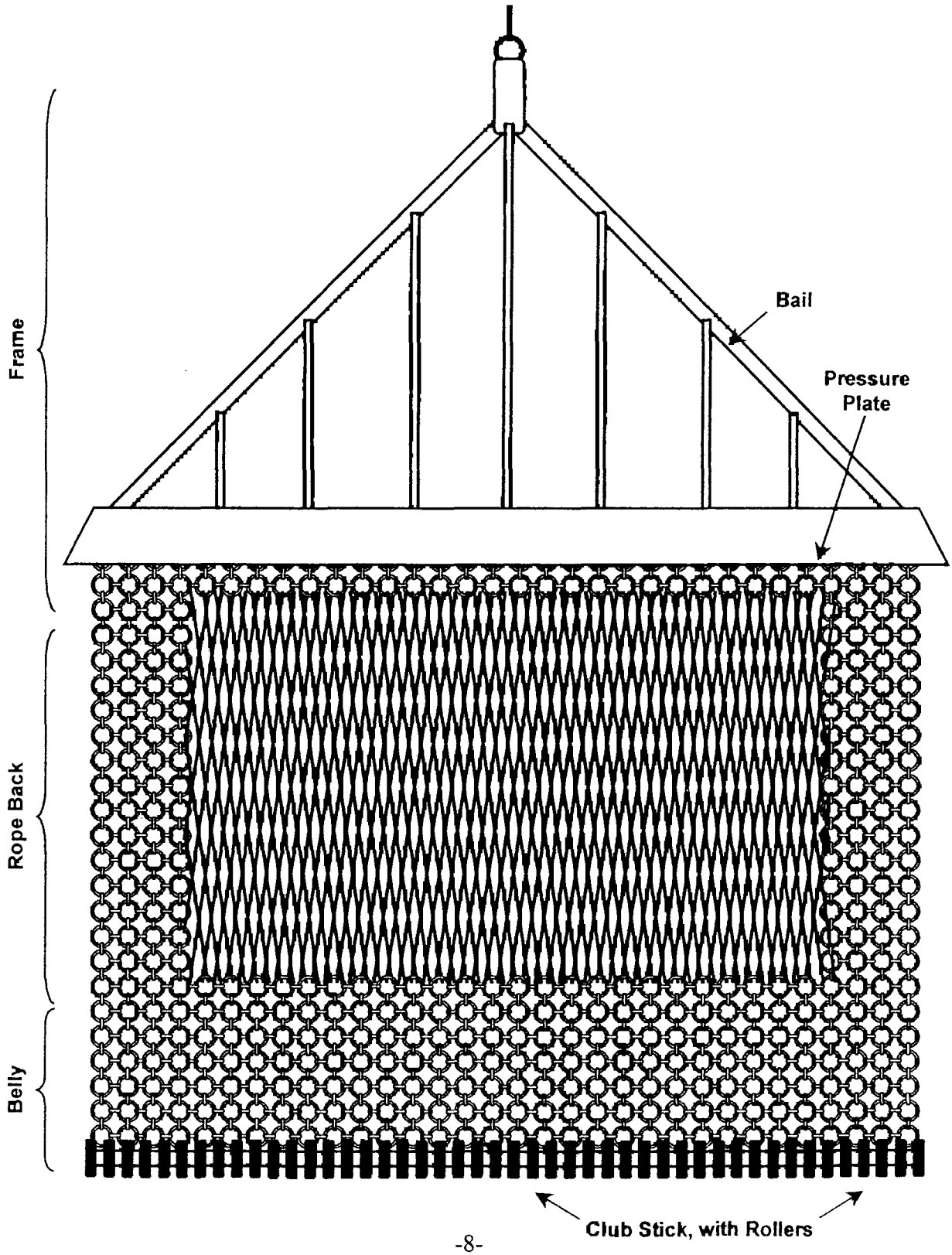


Figure D. **Four inch rings with split links. When lying flat, the inter-ring space is approximately 4.5" (115 mm). Note, however, that by twisting and pulling the rings, one can cause the inter-ring space to gape as wide as 6.75" (170 mm). During towing, therefore, the inter-ring space probably fluctuates as the rings and links shift about. The corresponding dimensions for 3.5" rings are an inter-ring space of about 4" flat (100 mm), with a maximum forced gape of 5" (130 mm). Note also that the number of split links between the rings will vary, and this, too, affects the gape of the inter-ring space.**

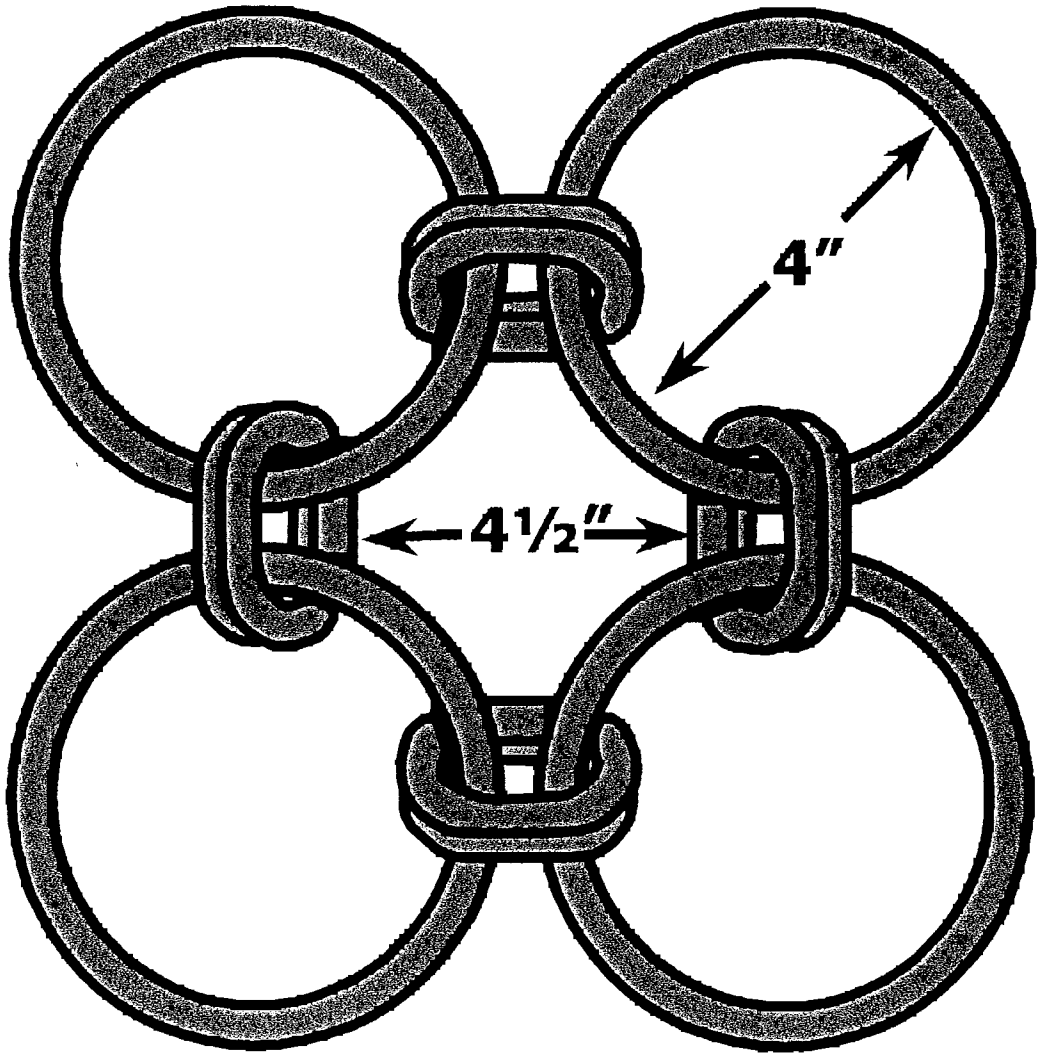
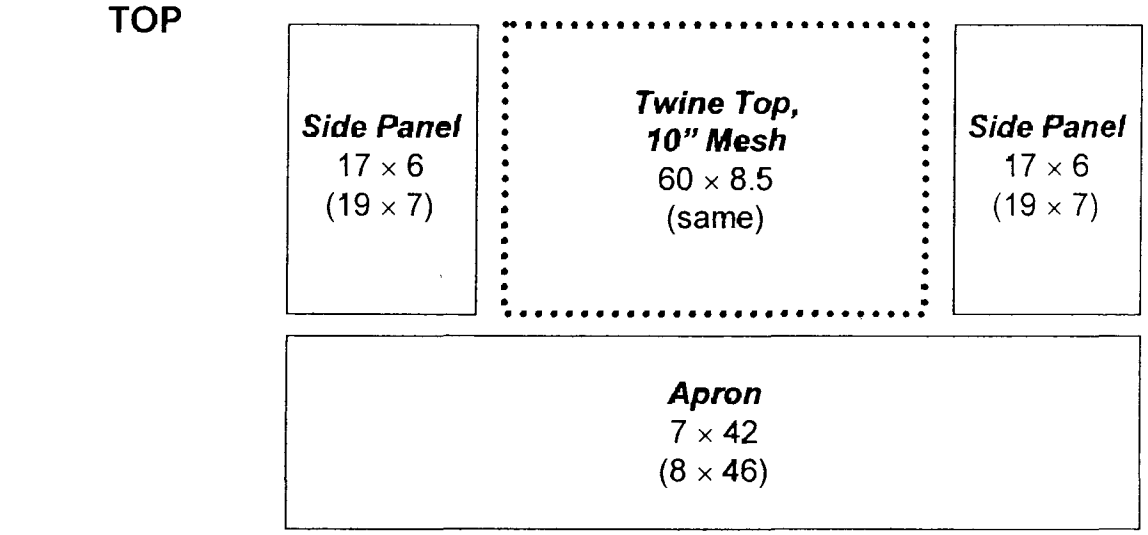


Figure E. **Schematic diagram of bag with four inch rings. Dimensions are given in ring counts (fore-to-aft length X width across), with corresponding counts for 3.5" bag in parentheses. Although the ring counts differ between the two dredges, the actual lengths and widths are approximately identical. Twine top counts are in the number of meshes, each 10" X 10". Sweep counts are in the number of chain links.**



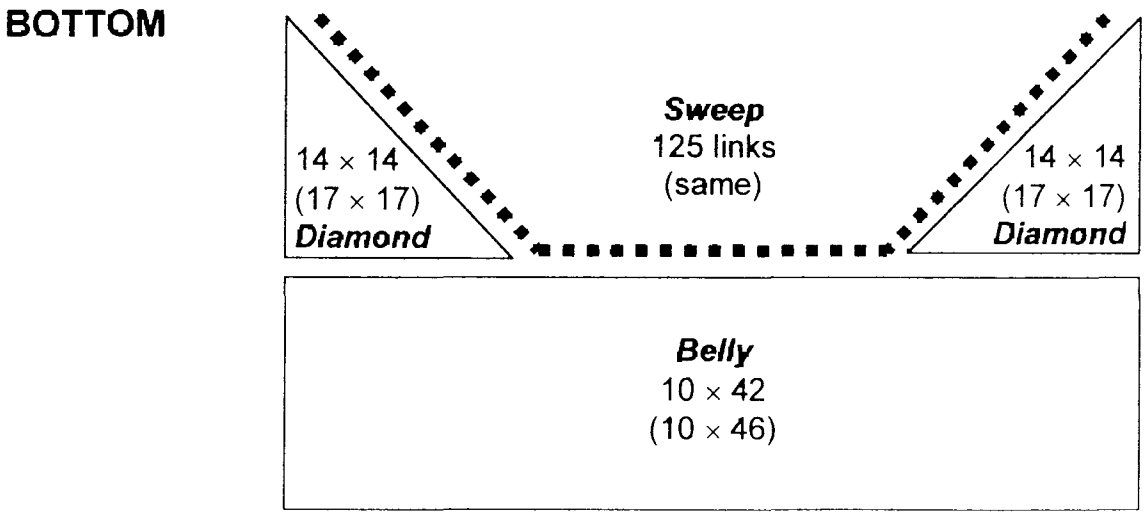


Figure F.

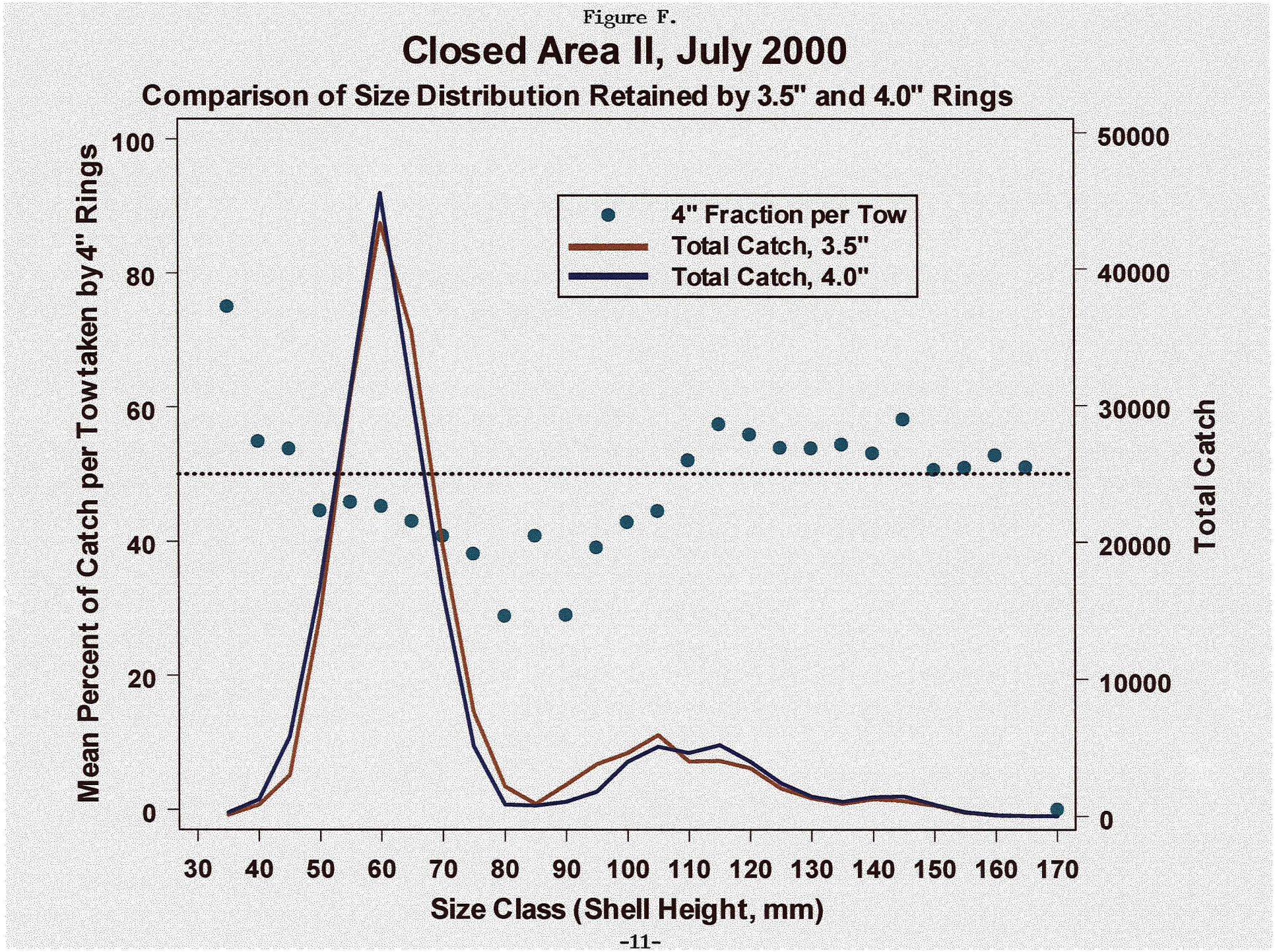

Closed Area II, July 2000
Comparison of Size Distribution Retained by 3.5" and 4.0" Rings
Mean Percent of Catch per Towtaken by4" Rings
Total Catch
4" Fraction per Tow
Total Catch, 3.5"
Total Catch, 4.0"
100
80
60
40
20
0
50000
40000
30000
20000
10000
0
30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Size Class (Shell Height, mm)

Figure G.

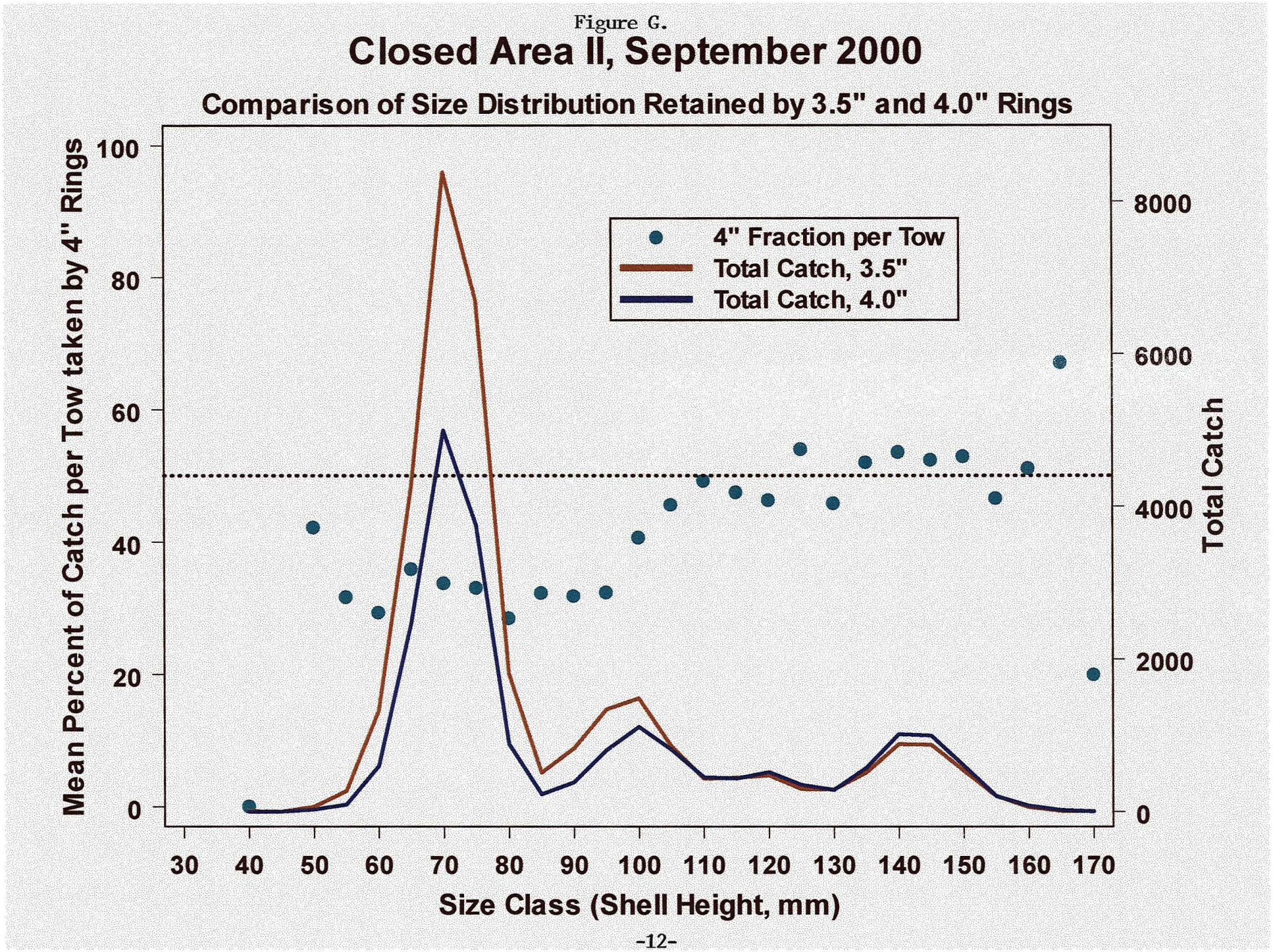

Closed Area II, September 2000
Comparison of Size Distribution Retained by 3.5" and 4.0" Rings
Mean Percent of Catch per Tow taken by 4" Rings
Total Catch
4" Fraction per Tow
Total Catch, 3.5"
Total Catch, 4.0"
0
20
40
60
80
100
0
2000
4000
6000
8000
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Size Class (Shell Height, mm)

Figure H.

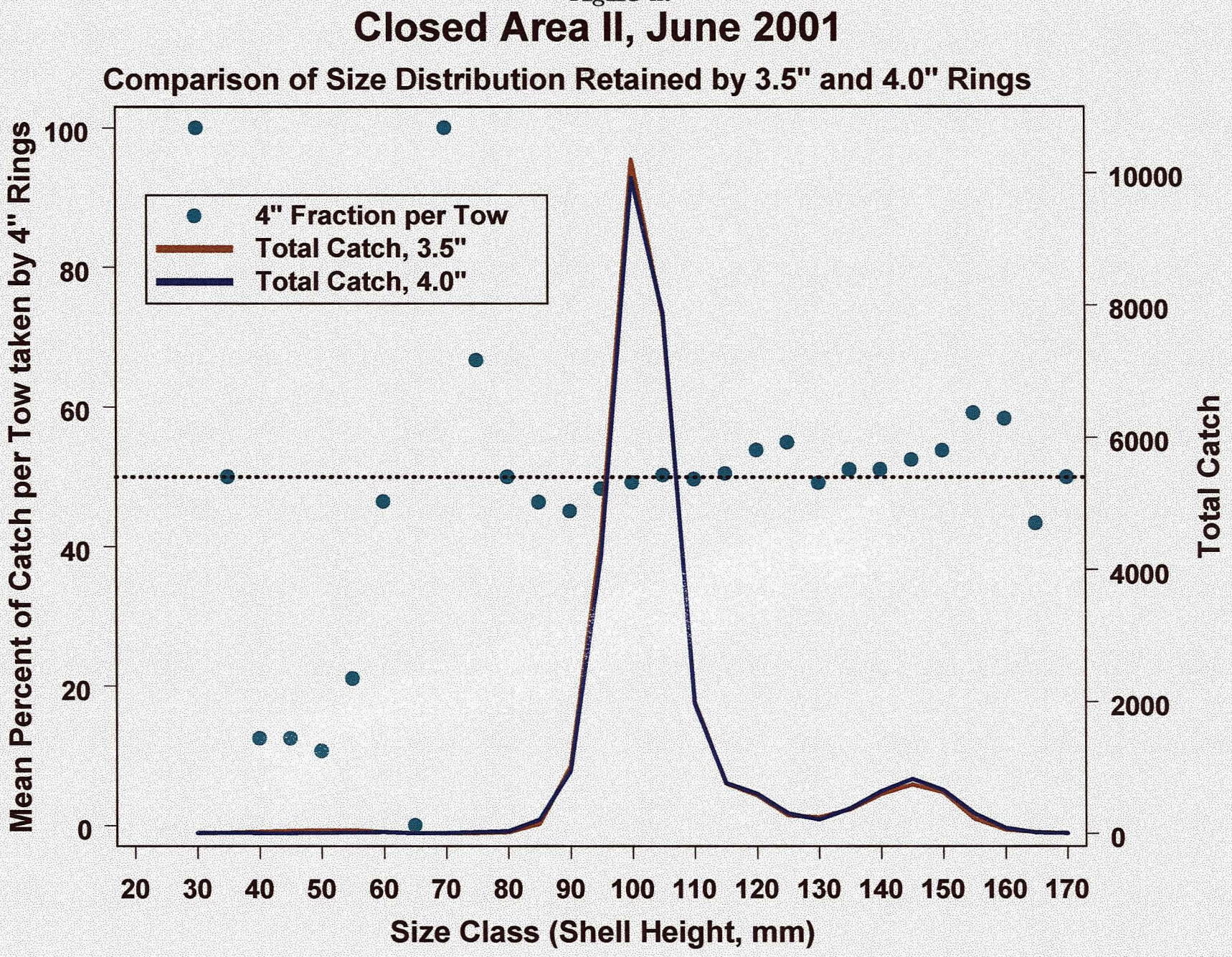
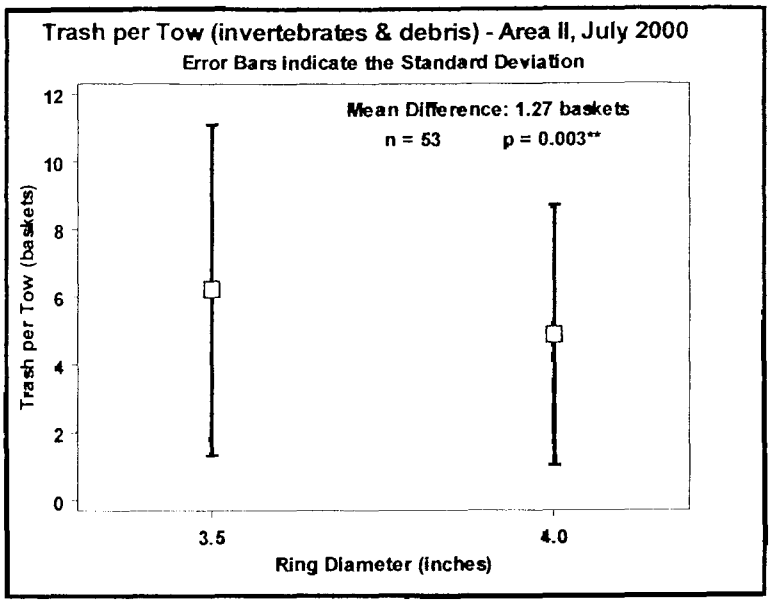
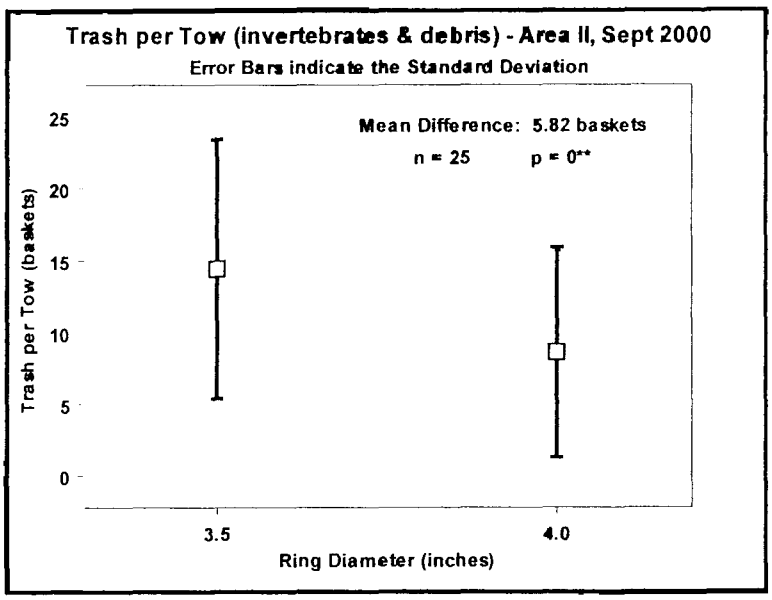

Closed Area II, June 2001
Comparison of Size Distribution Retained by 3.5" and 4.0" Rings
Mean Percent of Catch per Tow taken by 4" Rings
Total Catch
4" Fraction per Tow
Total Catch, 3.5"
Total Catch, 4.0"
0
20
40
60
80
100
0
2000
4000
6000
8000
10000
20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170
Size Class (Shell Height, mm)

Figure I.
Baskets of invertebrate trash per tow for the Closed Area II trips. Error bars indicate the standard deviation.





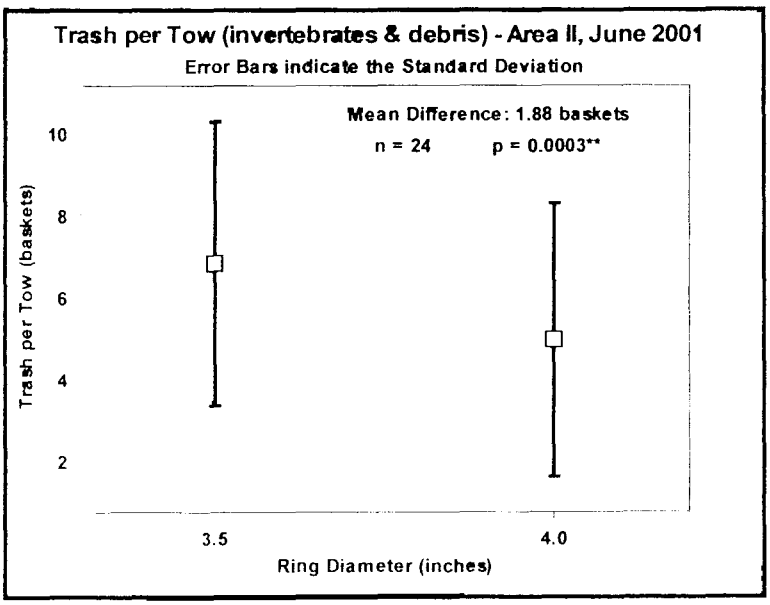


Figure J.
Comparison of volume of trash retained by 4" and 3.5" rings.

Trash (Invertebrates and Debris)

Trip	Mean Trash per Tow Retained by 3.5" Rings (baskets)	Mean Trash per Tow Retained by 4.0" Rings (baskets)	Mean Difference per Tow	p – value (paired t test)	Mean Percent Reduction in Trash
Area II, July 2000	**5.94**	**4.67**	**1.27**	**0.003****	***21.4%***
Area II, Sept 2000	**14.42**	**8.60**	**5.82**	**0****	***40.4%***
Area II, June 2001	**6.79**	**4.92**	**1.88**	**0.0003****	***27.7%***
Area I, Oct 2000a	**4.10**	**3.54**	**0.57**	**0.04***	***13.9%***
Area I, Oct 2000b	**5.73**	**4.69**	**1.04**	**0.0087****	***18.2%***
Hudson Canyon, June 2001	**8.63**	**6.67**	**1.96**	**0.0063****	***22.7%***

List of Tables

Table 1.

Closed Area II, July 2000 (54 sampled tows)

Shell Ht	Catch, 3.5	Catch, 4.0	Swept Area Per Dredge (Sq Km)	Catch Per Sq Km, 3.5	Catch Per Sq Km, 4.0	Total Catch Per Sq Km	Relative Catch per Swept Area
35	96	256	2.255486	42.6	113.5	156.1	**0.73**
40	832	1200	2.255486	368.9	532.0	900.9	**0.59**
45	2989	5784	2.255486	1325.2	2564.4	3889.6	**0.66**
50	14700	16790	2.255486	6517.4	7444.1	13961.5	**0.53**
55	30584	30927	2.255486	13559.8	13711.9	27271.7	**0.50**
60	43381	45584	2.255486	19233.5	20210.3	39443.8	**0.51**
65	35466	30887	2.255486	15724.3	13694.2	29418.5	**0.47**
70	19811	16417	2.255486	8783.5	7278.7	16062.2	**0.45**
75	7594	5095	2.255486	3366.9	2258.9	5625.8	**0.40**
80	2148	857	2.255486	952.3	380.0	1332.3	**0.29**
85	900	761	2.255486	399.0	337.4	736.4	**0.46**
90	2299	1059	2.255486	1019.3	469.5	1488.8	**0.32**
95	3799	1784	2.255486	1684.3	791.0	2475.3	**0.32**
100	4605	3956	2.255486	2041.7	1753.9	3795.6	**0.46**
105	5913	5057	2.255486	2621.6	2242.1	4863.7	**0.46**
110	3979	4599	2.255486	1764.1	2039.0	3803.2	**0.54**
115	4038	5183	2.255486	1790.3	2298.0	4088.3	**0.56**
120	3489	3954	2.255486	1546.9	1753.1	3300.0	**0.53**
125	2025	2399	2.255486	897.8	1063.6	1961.4	**0.54**
130	1322	1421	2.255486	586.1	630.0	1216.1	**0.52**
135	903	1045	2.255486	400.4	463.3	863.7	**0.54**
140	1248	1377	2.255486	553.3	610.5	1163.8	**0.52**
145	1117	1435	2.255486	495.2	636.2	1131.5	**0.56**
150	758	843	2.255486	336.1	373.8	709.8	**0.53**
155	256	293	2.255486	113.5	129.9	243.4	**0.53**
160	60	66	2.255486	26.6	29.3	55.9	**0.52**
165	17	14	2.255486	7.5	6.2	13.7	**0.45**
170	1	0	2.255486	0.4	0.0	0.4	**0.00**

Table 2.

Closed Area II, Sept 2000 (24 sampled tows)

Shell Ht	Catch, 3.5	Catch, 4.0	Swept Area Per Dredge (Sq Km)	Catch Per Sq Km, 3.5	Catch Per Sq Km, 4.0	Total Catch Per Sq Km	Relative Catch per Swept Area
40	4	0	0.896	4.5	0.0	4.5	**0.00**
45	0	0	0.896	0.0	0.0	0.0	**#DIV/0!**
50	60	24	0.896	67.0	26.8	93.8	**0.29**
55	268	92	0.896	299.1	102.7	401.8	**0.26**
60	1320	597	0.896	1473.2	666.3	2139.5	**0.31**
65	4245	2470	0.896	4737.7	2756.7	7494.4	**0.37**
70	8389	4997	0.896	9362.7	5577.0	14939.7	**0.37**
75	6696	3757	0.896	7473.2	4193.1	11666.3	**0.36**
80	1807	884	0.896	2016.7	986.6	3003.3	**0.33**
85	505	227	0.896	563.6	253.3	817.0	**0.31**
90	829	380	0.896	925.2	424.1	1349.3	**0.31**
95	1338	800	0.896	1493.3	892.9	2386.2	**0.37**
100	1482	1107	0.896	1654.0	1235.5	2889.5	**0.43**
105	851	811	0.896	949.8	905.1	1854.9	**0.49**
110	431	445	0.896	481.0	496.7	977.7	**0.51**
115	442	435	0.896	493.3	485.5	978.8	**0.50**
120	472	516	0.896	526.8	575.9	1102.7	**0.52**
125	293	347	0.896	327.0	387.3	714.3	**0.54**
130	289	281	0.896	322.5	313.6	636.2	**0.49**
135	512	571	0.896	571.4	637.3	1208.7	**0.53**
140	882	1011	0.896	984.4	1128.3	2112.7	**0.53**
145	873	996	0.896	974.3	1111.6	2085.9	**0.53**
150	535	602	0.896	597.1	671.9	1269.0	**0.53**
155	199	199	0.896	222.1	222.1	444.2	**0.50**
160	58	73	0.896	64.7	81.5	146.2	**0.56**
165	9	19	0.896	10.0	21.2	31.3	**0.68**
170	6	2	0.896	6.7	2.2	8.9	**0.25**

Table 3.

Closed Area II, June 2001 (23 sampled tows, commercial only)

Shell Ht	Catch, 3.5	Catch, 4.0	Swept Area Per Dredge (Sq Km)	Catch Per Sq Km, 3.5	Catch Per Sq Km, 4.0	Total Catch Per Sq Km	Relative Catch per Swept Area
35	8	5	0.897068	8.9	5.6	14.5	0.38
40	23	4	0.897068	25.6	4.5	30.1	0.15
45	35	4	0.897068	39.0	4.5	43.5	0.10
50	43	5	0.897068	47.9	5.6	53.5	0.10
55	42	9	0.897068	46.8	10.0	56.9	0.18
60	17	15	0.897068	19.0	16.7	35.7	0.47
65	1	0	0.897068	1.1	0.0	1.1	0.00
70	0	4	0.897068	0.0	4.5	4.5	1.00
75	4	16	0.897068	4.5	17.8	22.3	0.80
80	20	32	0.897068	22.3	35.7	58.0	0.62
85	143	204	0.897068	159.4	227.4	386.8	0.59
90	1014	944	0.897068	1130.3	1052.3	2182.7	0.48
95	4459	4204	0.897068	4970.6	4686.4	9657.0	0.49
100	10200	9930	0.897068	11370.4	11069.4	22439.8	0.49
105	7819	7871	0.897068	8716.2	8774.1	17490.3	0.50
110	1990	1968	0.897068	2218.3	2193.8	4412.2	0.50
115	752	761	0.897068	838.3	848.3	1686.6	0.50
120	574	593	0.897068	639.9	661.0	1300.9	0.51
125	271	301	0.897068	302.1	335.5	637.6	0.53
130	240	207	0.897068	267.5	230.8	498.3	0.46
135	358	377	0.897068	399.1	420.3	819.3	0.51
140	592	638	0.897068	659.9	711.2	1371.1	0.52
145	737	823	0.897068	821.6	917.4	1739.0	0.53
150	620	653	0.897068	691.1	727.9	1419.1	0.51
155	222	300	0.897068	247.5	334.4	581.9	0.57
160	60	79	0.897068	66.9	88.1	154.9	0.57
165	18	11	0.897068	20.1	12.3	32.3	0.38
170	1	1	0.897068	1.1	1.1	2.2	0.50

Table 4.

Catch and Catch Rates for Scallops Retained by the Crew (Sampled Tows Only)

	Towing Time	Number of Retained Scallops, 3.5"	Number of Retained Scallops, 4.0"	Percent Retained by 4.0" Bag	Catch Rate per Minute, 3.5"	Catch Rate per Minute, 4.0"	Catch Rate Improvement
Area II, July 2000	**3,107 minutes**	**23,344**	**26,353**	***53.0%***	**7.5**	**8.5**	***12.9%***
Area II, Sept 2000	**1,269 minutes**	**5,158**	**5,776**	***52.8%***	**4.1**	**4.6**	***12.0%***
Area II, June 2001	**1,367 minutes**	**28,161**	**26,933**	***48.9%***	**20.6**	**19.7**	***- 4.4%***
Area I, Oct 2000a	**119 minutes**	**37,900**	**44,287**	***53.9%***	**318.5**	**372.2**	***16.9%***
Area 1, Oct 2000b	**114 minutes**	**26,739**	**27,621**	***50.8%***	**234.6**	**242.3**	***3.3%***
H. Canyon, June 2001	**1,578 minutes**	**41,884**	**44,782**	***51.7%***	**26.5**	**28.4**	***7.2%***

Table 5.

Harvest Rates and Time on Bottom, by the Basket (All Paired Tows, Sampled & Unsampled)

	Towing Time	Baskets, 3.5"	Baskets, 4.0"	Baskets per Minute, 3.5"	Baskets per Minute, 4.0"	Harvest Rate Improvement	Time on Bottom per Basket, 3.5"	Time on Bottom per Basket, 4.0"	Reduction in Time on Bottom
Area II, July 2000	**9,548 minutes**	**627.9**	**771.7**	**0.066**	**0.081**	***22.9%***	**15.2 min**	**12.4 min**	***18.6%***
Area II, Sept 2000	**3,892 minutes**	**207.9**	**230.5**	**0.053**	**0.059**	***10.9%***	**18.7 min**	**16.9 min**	***9.6%***
Area II, June 2001	**5,273 minutes**	**769.4**	**773.4**	**0.146**	**0.147**	***0.5%***	**6.85 min**	**6.82 min**	***0.5%***
Area I, Oct 2000a	**174 minutes**	**737.9**	**810.5**	**4.23**	**4.65**	***9.9%***	**0.236 min**	**0.215 min**	***8.9%***
Area 1, Oct 2000b	**187 minutes**	**654.7**	**676.3**	**3.50**	**3.62**	***3.4%***	**0.286 min**	**0.276 min**	***3.5%***
H. Canyon, June 2001	**3,930 minutes**	**729.5**	**796.0**	**0.186**	**0.203**	***9.1%***	**5.39 min**	**4.94 min**	***8.4%***

Table 6.

Catch and Catch Rates for Scallops Discarded by the Crew (Sampled Tows Only)

	Towing Time	Number of Discards, 3.5"	Number of Discards, 4.0"	Percent Retained by 4.0" Bag	Discards per Minute, 3.5"	Discards Rate per Minute, 4.0"	Discard Rate Reduction
Area II, July 2000	**3,107 minutes**	**170,985**	**162,690**	***48.8%***	**52.4**	**55.0**	***4.9%***
Area II, Sept 2000	**1,269 minutes**	**27,634**	**15,866**	***36.5%***	**21.8**	**12.5**	***42.5%***
Area II, June 2001	**1,367 minutes**	**2,922**	**2,306**	***44.1%***	**2.14**	**1.69**	***21.1%***
Area I, Oct 2000a	**119 minutes**	**21,468**	**20,860**	***49.3%***	**180.4**	**175.3**	***2.8%***
Area 1, Oct 2000b	**114 minutes**	**15,556**	**15,236**	***49.5%***	**136.5**	**133.7**	***2.1%***
H. Canyon, June 2001	**1,578 minutes**	**23,928**	**18,804**	***44.0%***	**15.2**	**11.9**	***21.4%***

Table 7. Finfish bycatch totals for each trip.

Finfish Bycatch Totals

Species	Closed Area II July 2000		Closed Area II Sept 2000		Closed Area II June 2000		Closed Area I Oct 2000 a & b		Hudson Canyon June 2001		Totals	
	3.5"	4.0"	3.5"	4.0"	3.5"	4.0"	3.5"	4.0"	3.5"	4.0"	3.5"	4.0"
Yellowtail Flounder	1069	998	1118	1131	788	830	39	43	0	0	***3014***	***3002***
Yellowtail <30 cm	54	22	194	76	66	41	2	3	0	0	***316***	***142***
Witch Flounder (Grey Sole)	41	46	2	1	107	104	0	0	1	0	***151***	***151***
Witch <35 cm	4	1	2	0	11	6	0	0	1	0	***18***	***7***
American Plaice	21	18	6	4	46	52	0	0	7	7	***80***	***81***
Plaice <35 cm	13	5	4	0	14	18	0	0	5	3	***36***	***26***
Winter Flounder (Blackback)	4	3	12	9	1	0	47	52	0	0	***64***	***64***
Monkfish (Goosefish)	87	132	157	159	147	138	40	34	111	148	***542***	***611***
Red Hake	112	64	75	33	75	81	11	9	18	22	***291***	***209***
Silver Hake	321	241	129	81	494	422	18	8	0	0	***962***	***752***
Windowpane	50	53	55	70	56	61	62	68	0	0	***223***	***252***
Fourspot Flounder	193	139	397	277	197	211	60	47	47	31	***894***	***705***
Sculpin	141	74	323	189	200	121	79	69	0	0	***743***	***453***
Sea Raven	12	11	12	4	37	28	20	14	0	0	***81***	***57***
Skates	740	744	4103	4083	1711	1672	607	584	1086	1103	***8247***	***8186***

Table 8.

Finfish Bycatch (All Trips Combined)

	Catch by 3.5" Rings	Catch by 4.0" Rings	Relative Catch
Yellowtail Flounder	**3014**	**3002**	**-0.4%**
Yellowtail <30 cm	**316**	**142**	**-55.1%**
Witch Flounder (Gray Sole)	**151**	**151**	**0.0%**
Witch <35 cm	**18**	**7**	**-61.1%**
American Plaice	**80**	**81**	**+1.3%**
Plaice <35 cm	**36**	**26**	**-27.8%**
Winter Flounder (Blackback)	**64**	**64**	**0.0%**
Monkfish (Goosefish)	**542**	**611**	**+12.7%**
Red Hake	**291**	**209**	**-28.2%**
Silver Hake	**962**	**752**	**-21.8%**
Windowpane	**223**	**252**	**+13.0%**
Fourspot Flounder	**894**	**705**	**-21.1%**
Sculpin	**743**	**453**	**-39.0%**
Sea Raven	**81**	**57**	**-29.6%**
Skates	**8247**	**8186**	**-0.7%**

Harvest Rates and Time on Bottom, by the Basket
(All Paired Tows, Sampled and Unsampled)

	Towing Time	Baskets, 3.5"	Baskets, 4.0"	Baskets per Minute, 3.5"	Baskets per Minute, 4.0"	Harvest Rate Improvement	Time on Bottom per Basket, 3.5"	Time on Bottom per Basket, 4.0"	Reduction in Time on Bottom
Area II, July 2000	**9,548 minutes**	**627.9**	**771.7**	**0.066**	**0.081**	***22.9%***	**15.2 min**	**12.4 min**	***18.6%***
Area II, Sept 2000	**3,892 minutes**	**207.9**	**230.5**	**0.053**	**0.059**	***10.9%***	**18.7 min**	**16.9 min**	***9.6%***
Area II, June 2001	**5,273 minutes**	**769.4**	**773.4**	**0.146**	**0.147**	***0.5%***	**6.85 min**	**6.82 min**	***0.5%***
Area I, Oct 2000a	**174 minutes**	**737.9**	**810.5**	**4.23**	**4.65**	***9.9%***	**0.236 min**	**0.215 min**	***8.9%***
Area 1, Oct 2000b	**187 minutes**	**654.7**	**676.3**	**3.50**	**3.62**	***3.4%***	**0.286 min**	**0.276 min**	***3.5%***
H. Canyon, June 2001	**3,930 minutes**	**729.5**	**796.0**	**0.186**	**0.203**	***9.1%***	**5.39 min**	**4.94 min**	***8.4%***

Table 9.

Table 10.

Harvest Weights (Sampled Tows Only)

	Harvest Weight, 3.5" Rings Pounds (Kilograms)	Harvest Weight, 4.0" Rings Pounds (Kilograms)	Percent Increase with 4.0" Rings
Area II, July 2000	**1399 (636)**	**1600 (727)**	**14.4%**
Area II, Sept 2000	**419 (191)**	**478 (217)**	**14.1%**
Area II, June 2001	**1194 (543)**	**1200 (454)**	**0.5%**
H. Canyon, June 2001	**2078 (945)**	**2246 (1021)**	**8.1%**
H. Canyon, Sept 2001	**2096 (953)**	**1948 (885)**	**-7.1%**
Area I, Oct 2000a	**2563 (1165)**	**3073 (1397)**	**19.9%**
Area 1, Oct 2000b	**1887 (858)**	**1951 (887)**	**3.4%**
Lightship, Aug 2001	**1203 (547)**	**1441 (655)**	**19.8%**

Table 11.

Meat Weights in Kilograms (Trip Totals, Sampled Tows Only)

	Discards, 4"	Discards, 3.5"	Retained, 4"	Retained, 3.5"
CA II, July 2000	622.9	725.1	727.4	636.0
CA II, Sept 2000	111.4	188.6	217.1	190.6
CA II, June 2001	33.4	41.4	545.3	542.9
HC, June 2001	215.4	265.1	1021.0	944.6
HC, Sept 2001	121.8	206.7	885.4	952.7
CA I, Oct 2000a	338.7	338.0	1397.0	1165.2
CA I, Oct 2000b	273.0	284.1	887.0	857.7
NL, Aug 2001	101.3	106.5	655.2	546.7

Meat Weights in Pounds (Trip Totals, Sampled Tows Only)

	Discards, 4"	Discards, 3.5"	Retained, 4"	Retained, 3.5"
CA II, July 2000	1370.4	1595.2	1600.3	1399.2
CA II, Sept 2000	245.1	414.9	477.6	419.3
CA II, June 2001	73.5	91.1	1199.7	1194.4
HC, June 2001	473.9	583.2	2246.2	2078.1
HC, Sept 2001	268.0	454.7	1947.9	2095.9
CA I, Oct 2000a	745.1	743.6	3073.4	2563.4
CA I, Oct 2000b	600.6	625.0	1951.4	1886.9
NL, Aug 2001	222.9	234.3	1441.4	1202.7