



Final Contract Report

**“Performance of a 4” Ring Scallop Dredge
in the Context of an Area Management Strategy”
Award No. NA16FM1030
Closed Area I and Nantucket Lightship Closed Area**

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

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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 will be 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, two research trips were conducted in Closed Area I (CAI) and one was conducted in the Nantucket Lightship Closed Area (NLCA) aboard the F/V *Celtic*, a 94' western rigged scallop vessel operating out of port of New Bedford, Massachusetts. Catch data was obtained from a total of 39 tows. Data from CAI indicates that the 4" ring dredge was up to 17% more efficient than the 3.5" ring dredge when the scallop population was dominated by scallops greater than 115 mm in size. For the same quantity of scallops harvested, this resulted in a reduction ranging from 3.5% to 8.9% for the time that the gear was on the bottom. The 4" ring dredge fished “cleaner” than the 3.5" ring dredge with reductions of trash (invertebrates and debris) ranging from 13.9% to 18.2%. Similar results were obtained in the NLCA with improvements in harvest efficiency averaging 21.4%. Reductions in bycatch was minimal and non-significant.

The results of the data obtained from the two trips in CAI and the one trip in the NLCA are supportive for the use of 4" ring scallop dredges in recently opened closed areas where the predominant size of the scallops are greater than 110 mm.

The use of 4" rings on a scallop dredge did not entail additional repair or replacement relative to the use of 3.5" rings. Overall, the performance of the 4" ring was superior in that the dredge was more efficient on scallops greater than 110 mm, reduced the amount of scallop discards and trash and demonstrated a marginal improvement in reducing finfish bycatch.

Materials and Methods

Under this award, three research trips were conducted aboard the scallop vessel, F/V *Celtic* in the Georges Bank Closed Areas; two in CAI and one in NLCA. Please refer to Figure A. The trips to CAI were on 10/02/2000 to 10/05/2000 and 10/12/2000 to 10/16/2000 respectively. The trip to the NLCA was conducted on 08/21/2001 to 08/23/2001. The goal was to evaluate the performance of the experimental gear (4" ring scallop dredge) in a variety of resource conditions and bottom types found in the Georges Bank Closed Areas. The project employed a paired tow experimental design: two dredges, one with 3.5" (89 mm) rings and other with 4.0" (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, twinotops 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 two research trips into CAI and a single trip into the NLCA are presented in Figures F, G and H; Tables 1, 2 and 3. The length frequency distribution of the scallop population shows a distinct peak between 125-140 mm. These large scallops are above the selectivity point of each dredge. As observed in previous studies (Bourne, 1965; DuPaul and Kirkley, 1995), larger ring scallop dredges catch a greater percentage of larger scallops. The same phenomena was observed for the scallops in the NLCA where the majority of scallops were in the 125-155 mm size range. The catch rate of scallops retained by the crew in the NLCA was

21.4% greater for the 4" ring dredge when compared to the 3.5" ring dredge (Table 4). There were no significant reductions in the discard rate for either dredge in the NLCA and CAI. This was due to the predominance of large (>100 mm) scallops in these resource areas and very few scallops in recruiting year classes. Improvements in the catch rates of scallops retained by the crew in CAI ranged from 3.3% to 16.9% (Table 5). The lower value was observed for the second trip into CAI after the scallop fleet had harvested the largest of the scallops during the first tow weeks of the opening.

Scallop discards during the two Closed Area openings were unusually high relative to the low towing time of 174 and 194 minutes (time of gear on bottom) to harvest 10,000 lbs. of scallops (Table 6). Most scallops were relatively large (>100 mm) but crew members culled at 120 mm in an attempt to obtain <10 MPP scallops. Even so, the 4" ring dredge performed better than the 3.5" ring as determined by the reduction in bottom time to harvest a given amount of scallops. For both trips, the reductions in bottom time was 8.9% and 3.5% respectively (Table 6). Discard rate reductions were on the order of 2.8% and 2.1% (Table 7).

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 the amount of trash collected by the two dredges is presented in Table 8 and Figure I. Significant differences in the reduction of trash collected by the 4" ring dredge was observed. This result was not totally unexpected. However, it is the first verification of the reduction of trash using larger rings.

The differences in finfish bycatch in CAI was minimal and no significant reductions was noted (Table 9). However, strong trends in bycatch reduction was noted for sculpins, four-spot flounder, silver hake and sea ravens. In general, there was very little finfish bycatch in CAI as compared to other areas.

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. The quantity of scallops retained per minute, tow time is presented in Table 6. For both trips in CAI improvements in harvest rates for the 4" ring dredge were 9.9% and 3.4% respectively. This results can also be expressed as a reduction in the time the gear is on the bottom. Any reduction in time on bottom is an important habitat consideration. Reductions in time on bottom range from 3.5% to 8.9%.

Total catch information for both trips in CAI and the NLCA is presented in the catch data is expressed in terms of swept area (sq. km.). This type of catch is also useful in evaluating relative efficiency. In all cases, the 4" ring dredge was more efficient at capturing large scallops (>100 mm). Please refer to Tables 10, 11 and 12. Although there appears to be variable results in this respect, tow to tow variability was high and the assumptions on efficiency can only be made using the shell heights of scallops when more than 1,000 individuals were captured. This data can also be expressed as the relative fraction of the total catch caught by the 4" ring dredge. Please refer to Figures J, K and L.

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

All of the data obtained under this award from CAI and the NLCA, 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.

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

Permit # 410146
Registration # 591971

Literature Cited

Bourne, N. 1965. A comparison of catches by 3- and 4-inch rings on offshore scallop drags.
J. Fish. Res. Can. 22(2): 313-333.

DuPaul, W. D. and J. E. Kirkley. 1995. Evaluation of sea scallop dredge ring size. Contract report submitted to NOAA, National Marine Fisheries Service. Grant #NA36FD0131.

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Figure A. Closed areas under the Multispecies Fishery Management Plan and the Sea Scallop Fishery Management Plan.

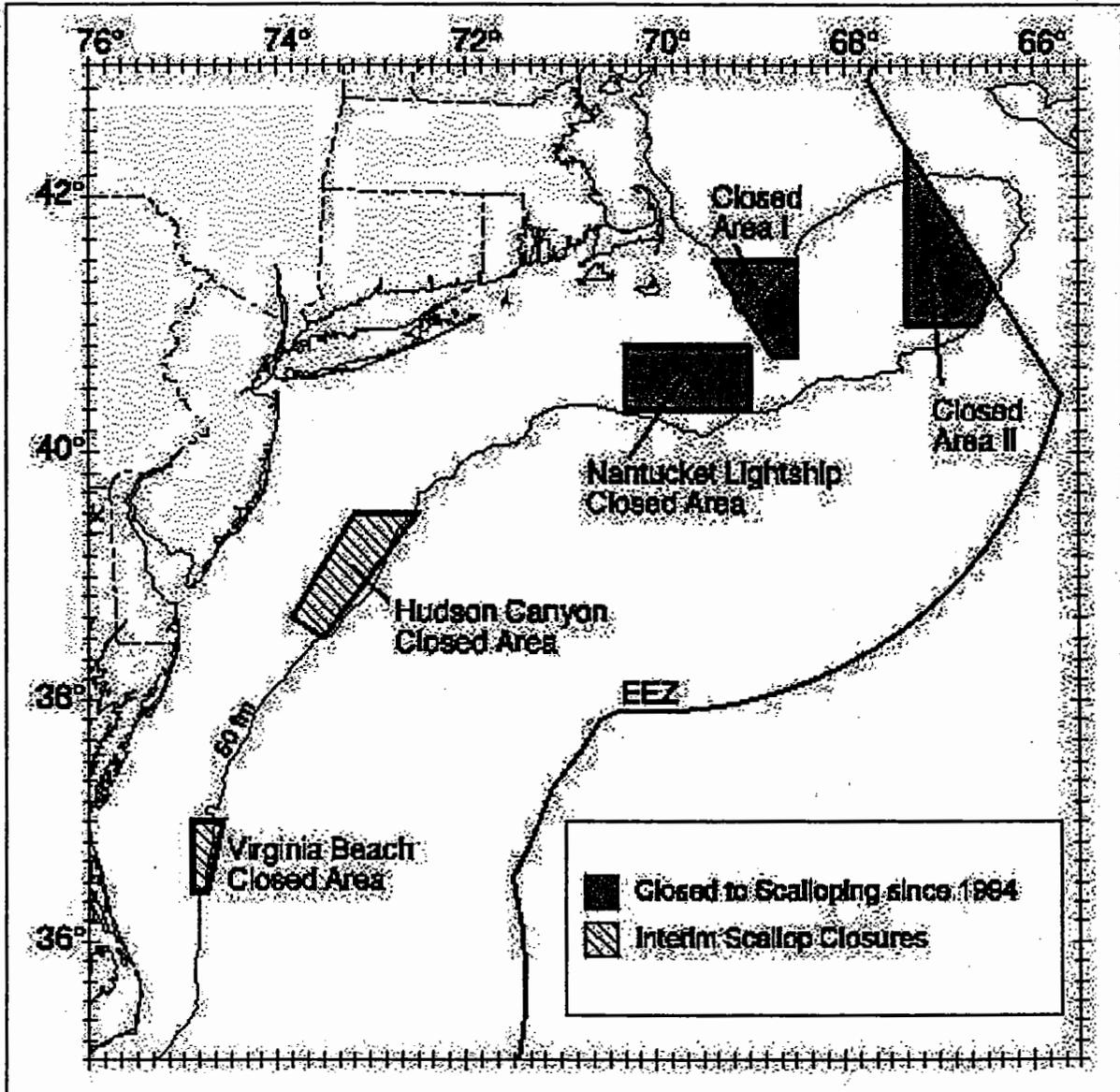


Figure B. The underside of a New Bedford scallop dredge. Chafing gear absent.

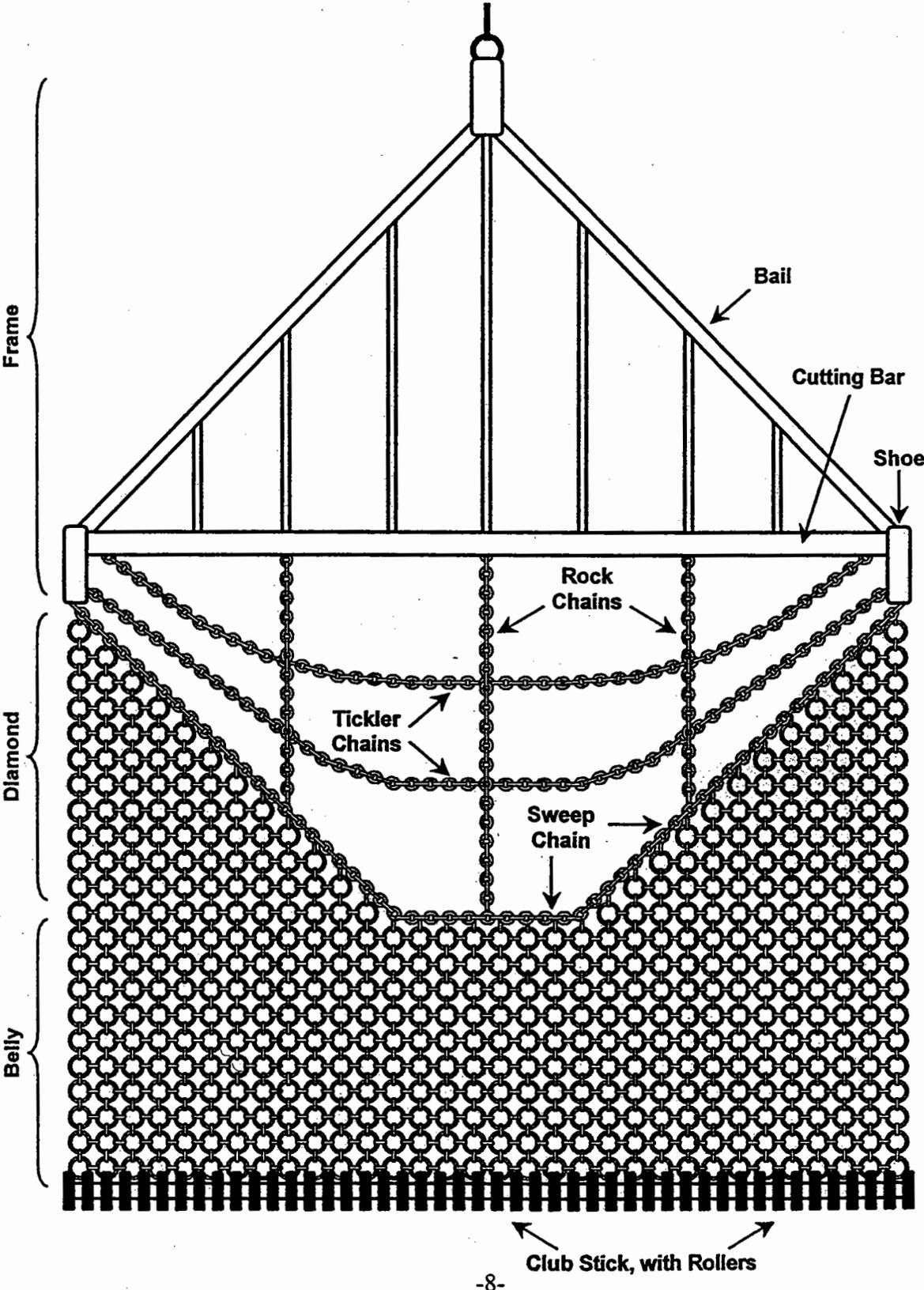


Figure C. The topside of a New Bedford scallop dredge.

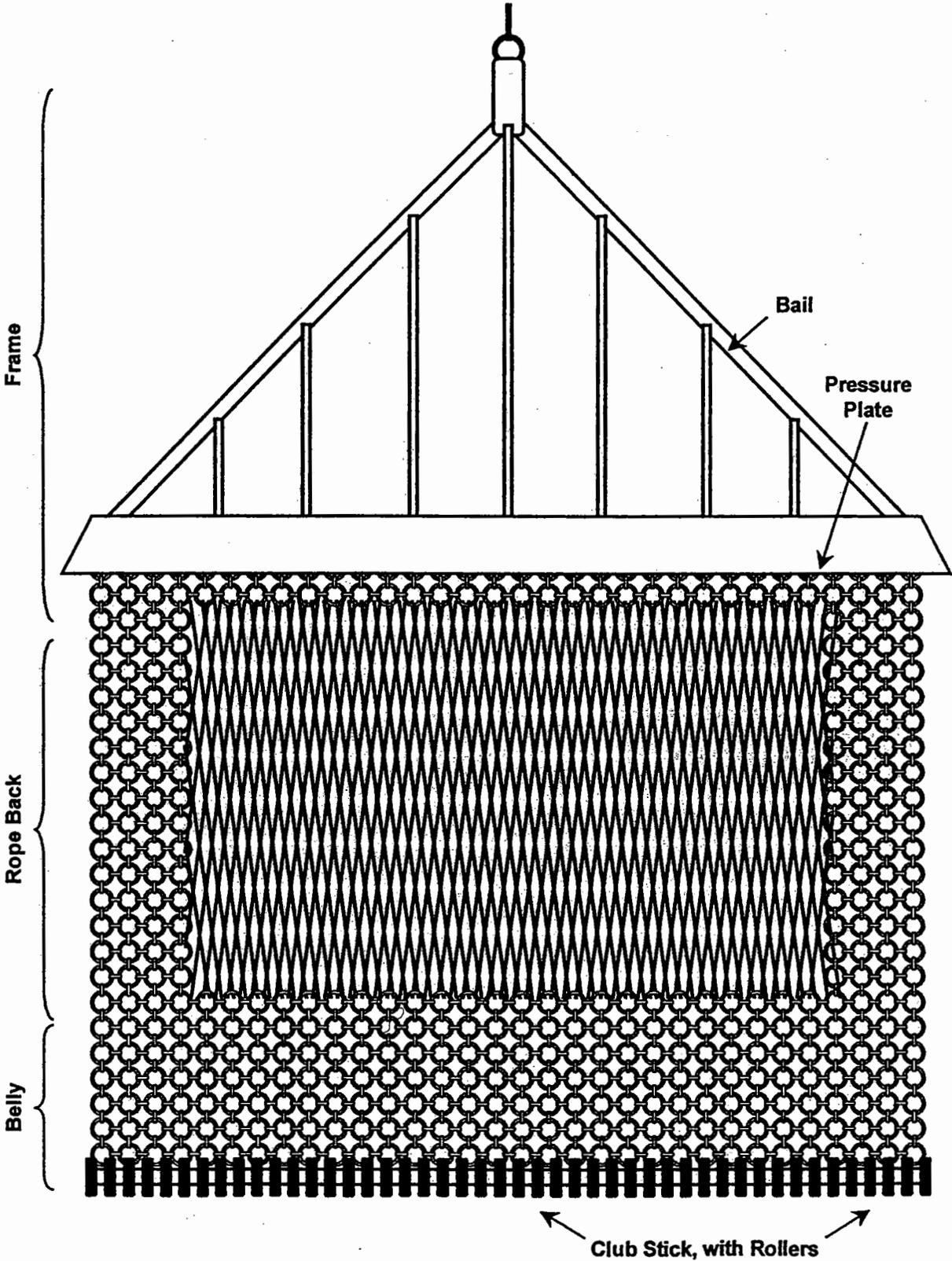


Figure D. Four inch rings with split links. When lying flat, the inter-ring space is approximately 4.5" (115 mm). Note, however, that by twisting and pulling the rings, one can cause the inter-ring space to gape as wide as 6.75" (170 mm). During towing, therefore, the inter-ring space probably fluctuates 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.

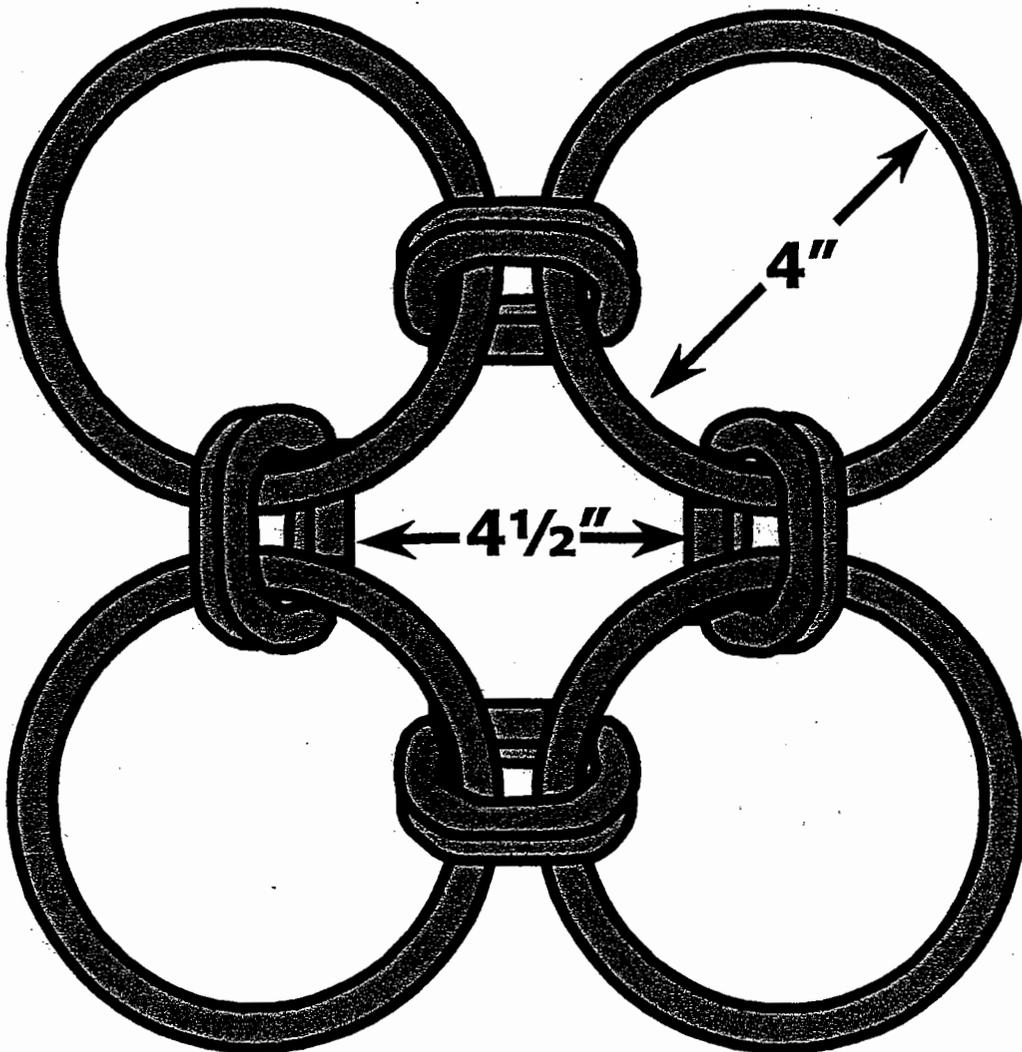
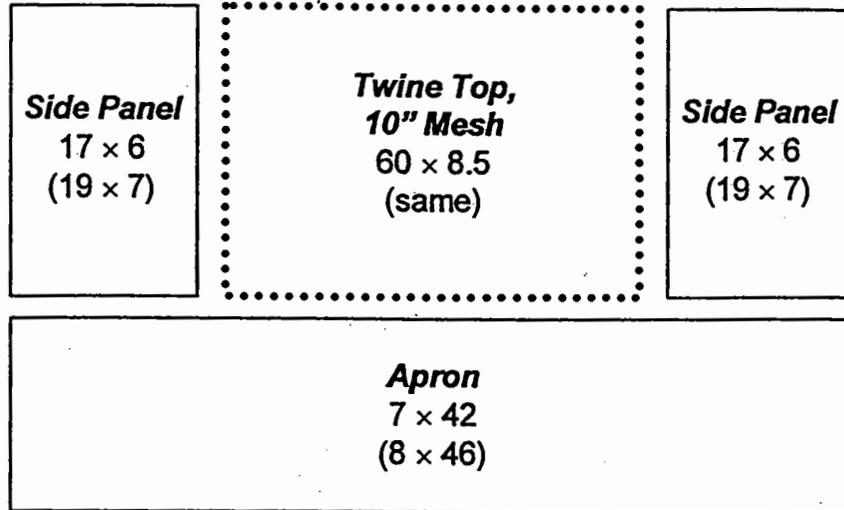


Figure E. Schematic diagram of bag with four inch rings. Dimensions are given in ring counts (fore-to-aft length X width across), with corresponding counts for 3.5" bag in parentheses. Although the ring counts differ between the two dredges, the actual lengths and widths are approximately identical.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

TOP



BOTTOM

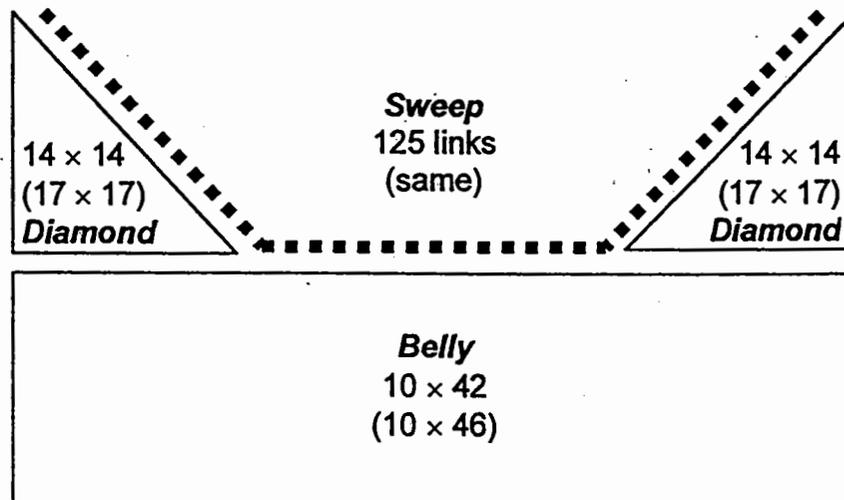


Figure F.

Catch of sea scallops by 3.5" and 4.0" ring dredges

F/V Celtic
Closed Area I
October 2000
n=16 tows

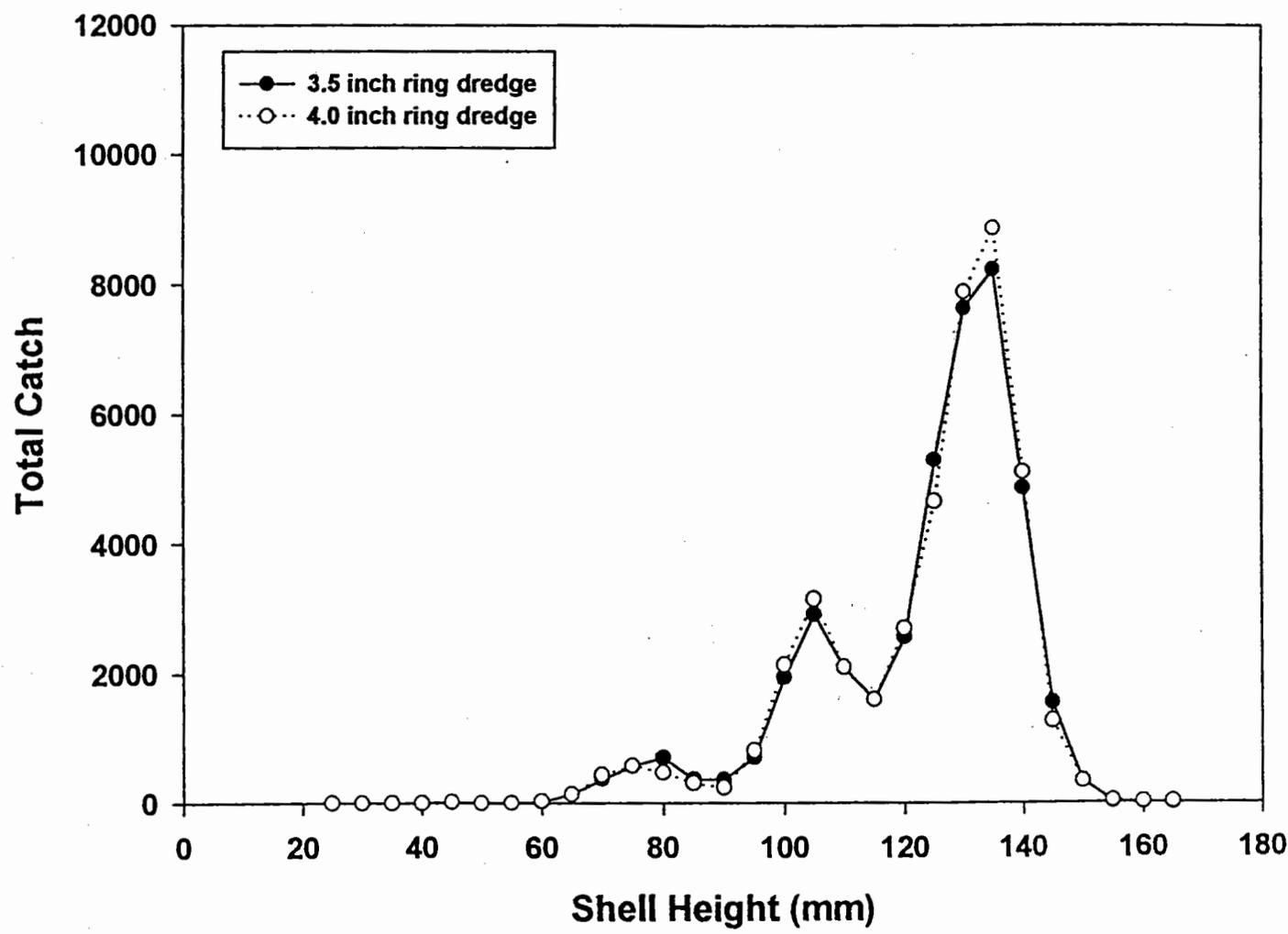


Figure G.

Catch of sea scallops by 3.5" and 4.0" ring dredges

F/V Celtic
Closed Area I
October 2000

n=17 tows

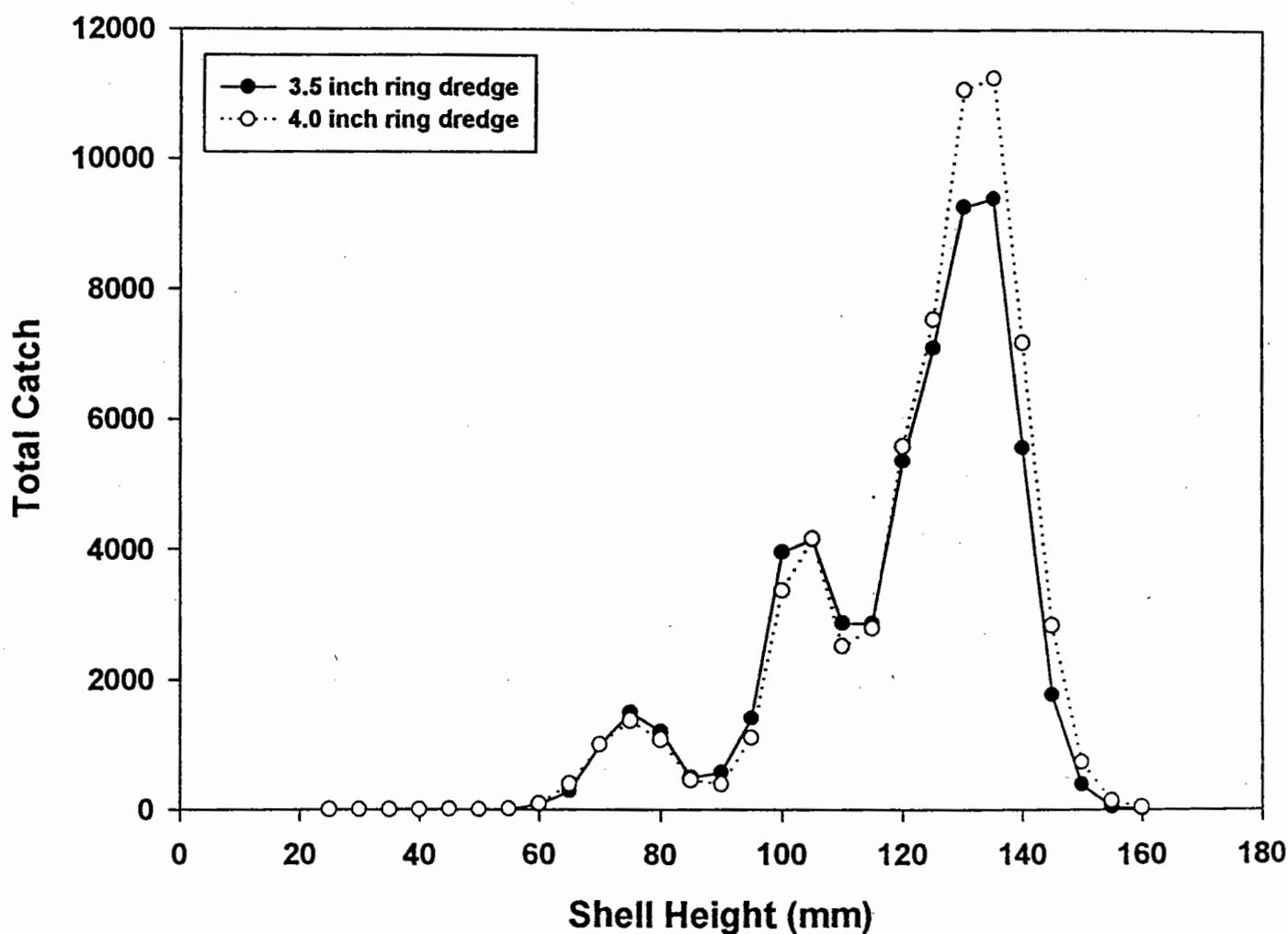


Figure H.

Catch of sea scallops by 3.5" and 4.0" ring dredges

F/V Celtic

Nantucket Lightship Closed Area

August 2001

n=6 tows

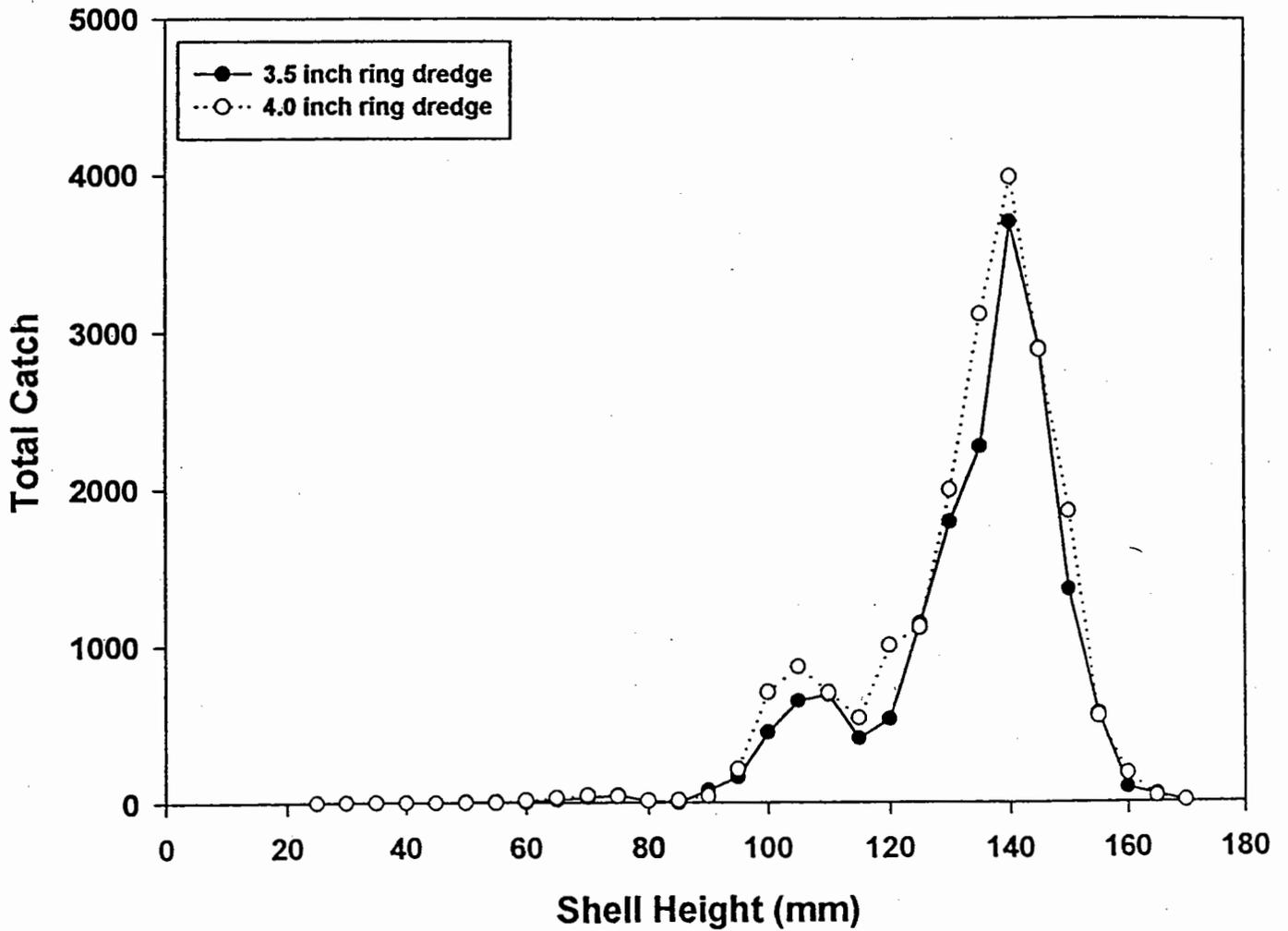


Figure I. Baskets of invertebrate trash per tow for the Closed Area I and Hudson Canyon trips. Error bars indicate the standard deviation.

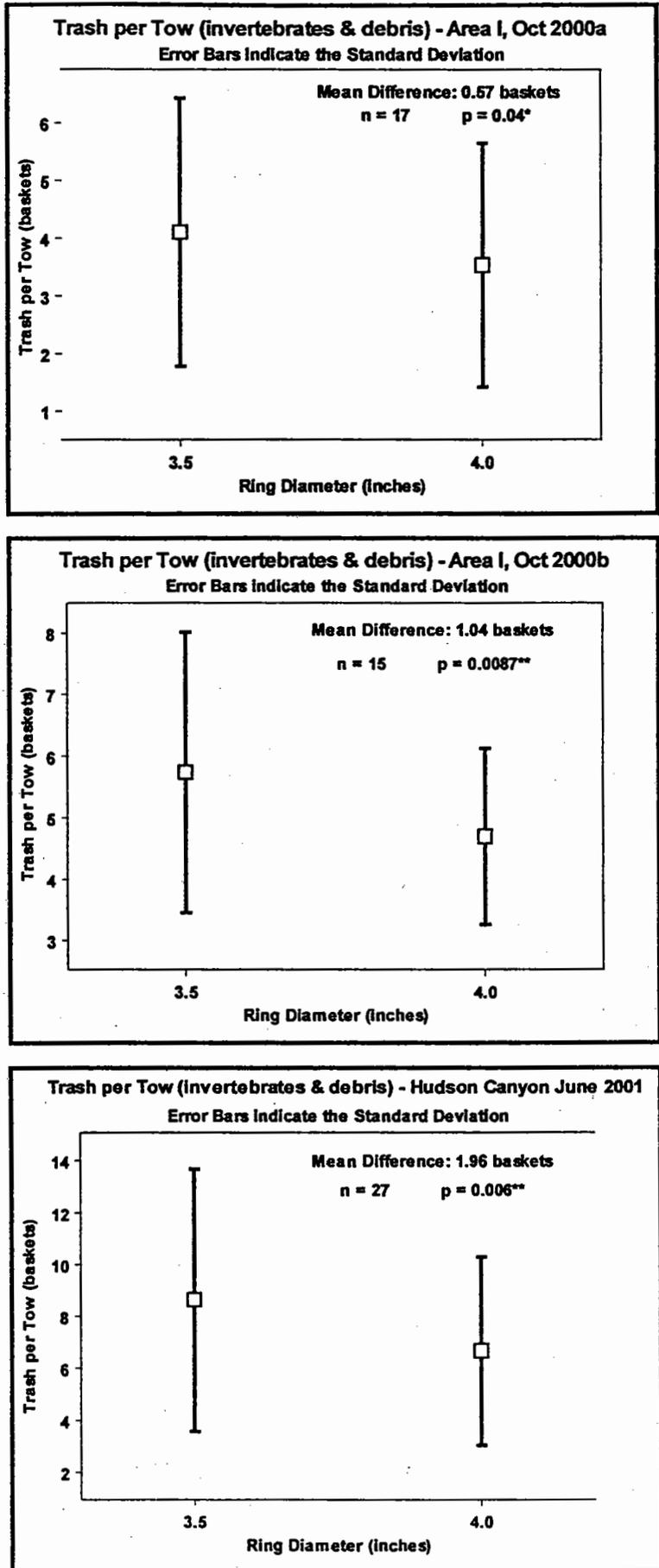


Figure J.

Closed Area I, October 2000, Trip #1

Comparison of Size Distribution Retained by 3.5" and 4.0" Rings

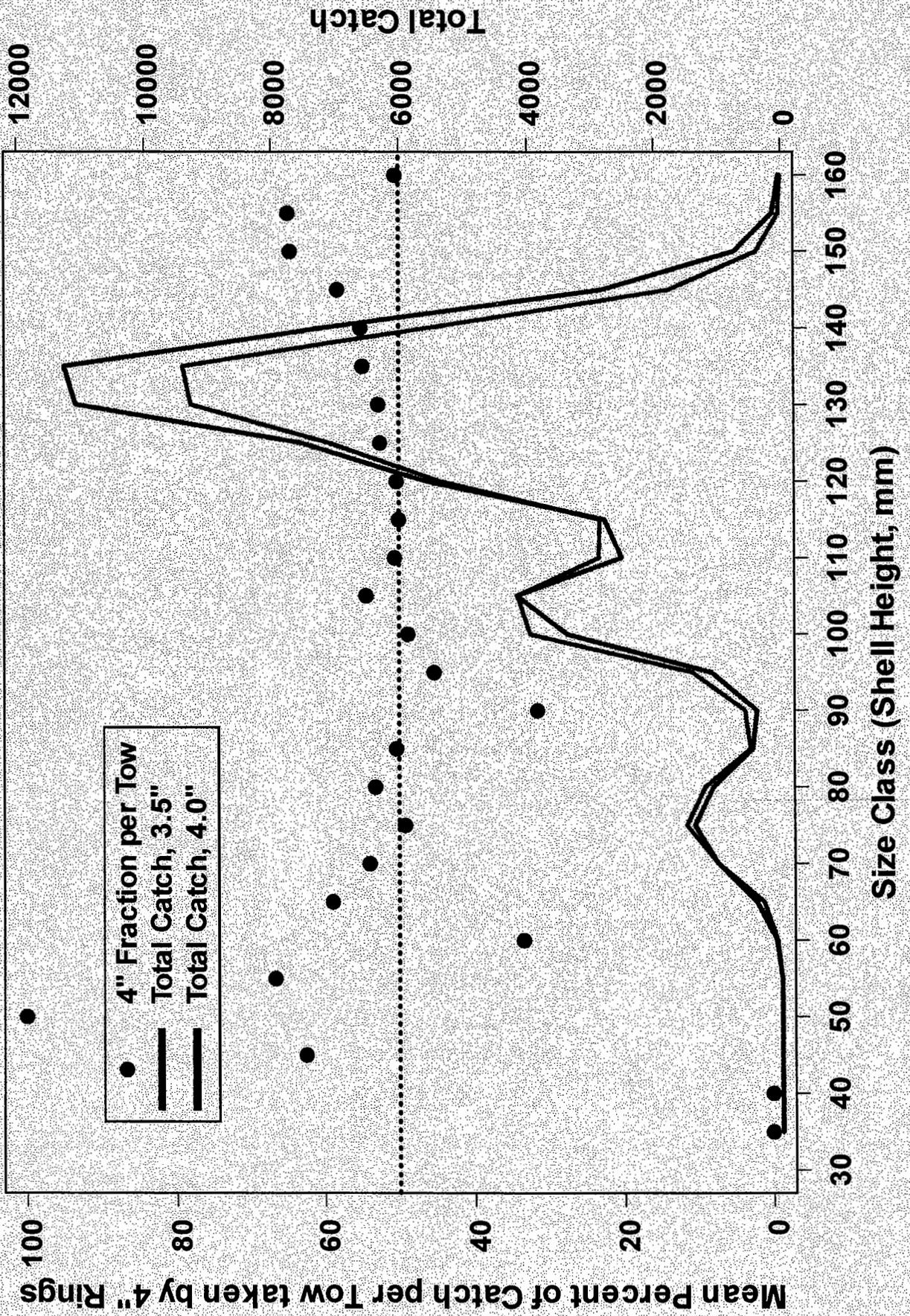


Figure K.

Closed Area I, October 2000, Trip #2

Comparison of Size Distribution Retained by 3.5" and 4.0" Rings

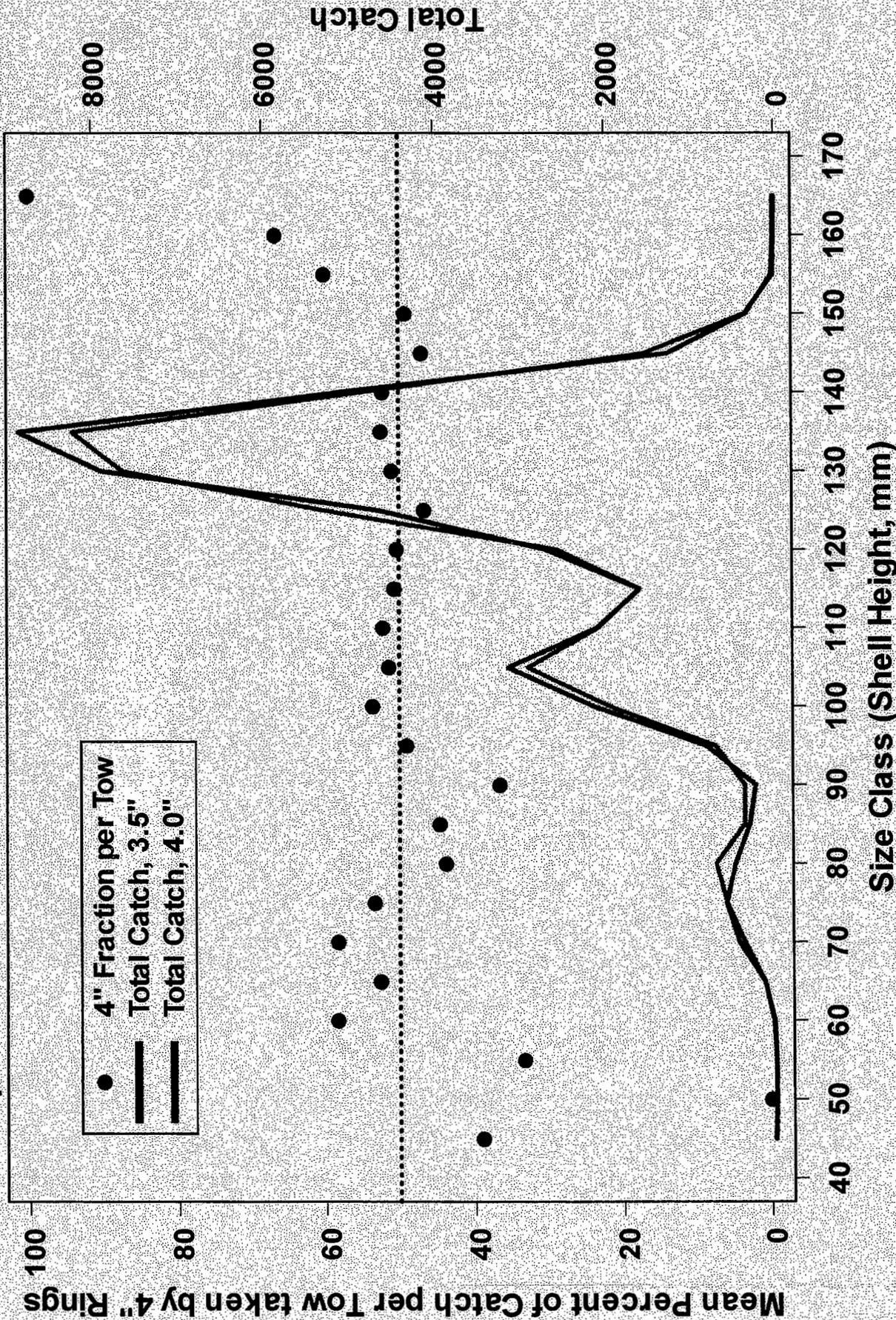
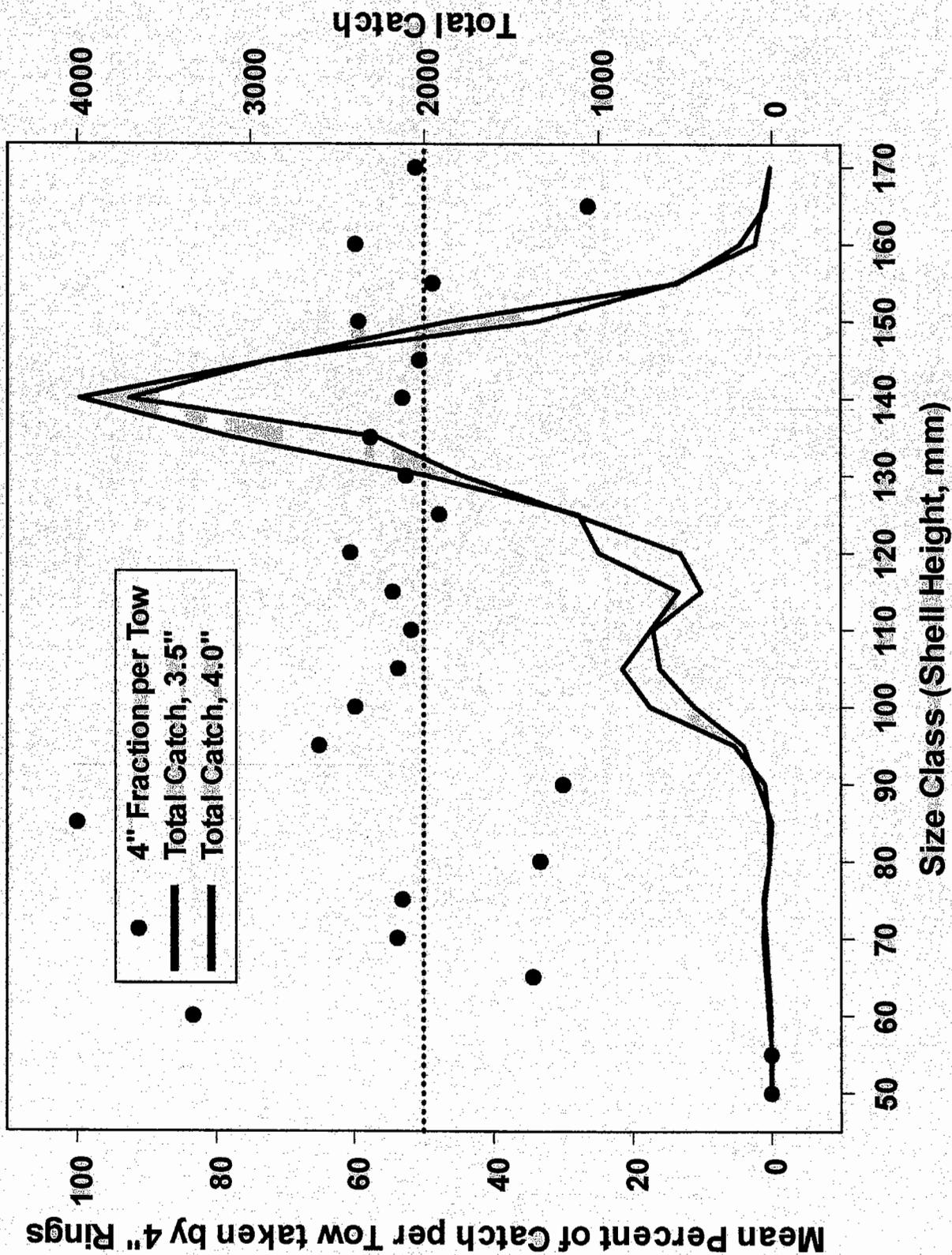


Figure L.

Nantucket Lightship Closed Area, August 2001

Comparison of Size Distribution Retained by 3.5" and 4.0" Rings



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12. Catch rates. NLCA; August 2001.

Table 1.
 Total catches of sea scallops using the standard 3.5 inch ring dredge versus an experimental 4.0 inch ring dredge. Data represents the results from 16 comparative tows aboard the F/V *Celtic* during October of 2000 in Closed Area I.

Shell Ht (mm)	Catch 3.5"	Catch 4.0"
45	20	20
50	8	0
55	8	8
60	24	32
65	136	136
70	368	436
75	576	580
80	704	472
85	364	304
90	364	236
95	704	812
100	1942	2132
105	2908	3142
110	2086	2095
115	1598	1593
120	2561	2695
125	5293	4649
130	7640	7890
135	8232	8864
140	4853	5099
145	1541	1260
150	343	332
155	17	32
160	5	14
165	0	12

Table 2.

Total catches of sea scallops using the standard 3.5 inch ring dredge versus an experimental 4.0 inch ring dredge. Data represents the results from 17 comparative tows aboard the F/V *Celtic* during October of 2000 in Closed Area I.

Shell Ht (mm)	Catch 3.5"	Catch 4.0"
35	8	0
40	8	0
45	12	8
50	0	4
55	8	12
60	80	96
65	288	400
70	1004	1004
75	1496	1368
80	1204	1076
85	496	456
90	576	392
95	1408	1108
100	3961	3371
105	4157	4169
110	2873	2515
115	2864	2785
120	5362	5587
125	7104	7542
130	9273	11077
135	9403	11255
140	5566	7183
145	1765	2826
150	393	733
155	44	140
160	16	39

Table 3.

Total catches of sea scallops using the standard 3.5 inch ring dredge versus an experimental 4.0 inch ring dredge. Data represents the results from six comparative tows aboard the F/V *Celtic* during August of 2001 in Nantucket Lightship Closed Area.

Shell Ht (mm)	Catch 3.5"	Catch 4.0"
50	4	0
55	4	0
60	4	16
65	20	32
70	32	48
75	48	40
80	12	12
85	0	16
90	80	40
95	164	216
100	448	704
105	648	864
110	687	700
115	409	538
120	531	1000
125	1140	1114
130	1786	1991
135	2268	3114
140	3701	3984
145	2894	2886
150	1353	1852
155	565	547
160	96	185
165	51	37
170	7	7

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
Lightship, Aug 2001	13.2 minutes	12,696	15,411	54.8%	962	1,168	21.4%
H. Canyon, Sept 2001	2,330 minutes	44,806	40,470	47.5%	19.2	17.4	-9.4%

**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
Lightship, Aug 2001	13.2 minutes	4,256	4,532	51.6%	322.4	343.3	-6.5%
H. Canyon, Sept 2001	2,330 minutes	18,660	10,614	36.3%	8.0	4.6	42.5%

Table 5.

**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 6.

**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 7.

**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 8. Comparison of volume of trash.

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%

Table 9.

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 10.

Closed Area I, October 12, 2000 (16 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
45	20	20	0.0794	251.9	251.9	503.8	0.50
50	8	0	0.0794	100.8	0.0	100.8	0.00
55	8	8	0.0794	100.8	100.8	201.5	0.50
60	24	32	0.0794	302.3	403.0	705.3	0.57
65	136	136	0.0794	1712.8	1712.8	3425.7	0.50
70	368	436	0.0794	4634.8	5491.2	10125.9	0.54
75	576	580	0.0794	7254.4	7304.8	14559.2	0.50
80	704	472	0.0794	8866.5	5944.6	14811.1	0.40
85	364	304	0.0794	4584.4	3828.7	8413.1	0.46
90	364	236	0.0794	4584.4	2972.3	7556.7	0.39
95	704	812	0.0794	8866.5	10226.7	19093.2	0.54
100	1942	2132	0.0794	24458.4	26851.4	51309.8	0.52
105	2908	3142	0.0794	36624.7	39571.8	76196.5	0.52
110	2086	2095	0.0794	26272.0	26385.4	52657.4	0.50
115	1598	1593	0.0794	20125.9	20063.0	40188.9	0.50
120	2561	2695	0.0794	32254.4	33942.1	66196.5	0.51
125	5293	4649	0.0794	66662.5	58551.6	125214.1	0.47
130	7640	7890	0.0794	96221.7	99370.3	195591.9	0.51
135	8232	8864	0.0794	103677.6	111637.3	215314.9	0.52
140	4853	5099	0.0794	61120.9	64219.1	125340.1	0.51
145	1541	1260	0.0794	19408.1	15869.0	35277.1	0.45
150	343	332	0.0794	4319.9	4181.4	8501.3	0.49
155	17	32	0.0794	214.1	403.0	617.1	0.65
160	5	14	0.0794	63.0	176.3	239.3	0.74
165	0	12	0.0794	0.0	151.1	151.1	1.00

Table 11.

Closed Area I, October 2, 2000 (17 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	8	0	0.0806	99.3	0.0	99.3	0.00
40	8	0	0.0806	99.3	0.0	99.3	0.00
45	12	8	0.0806	148.9	99.3	248.1	0.40
50	0	4	0.0806	0.0	49.6	49.6	1.00
55	8	12	0.0806	99.3	148.9	248.1	0.60
60	80	96	0.0806	992.6	1191.1	2183.6	0.55
65	288	400	0.0806	3573.2	4962.8	8536.0	0.58
70	1004	1004	0.0806	12456.6	12456.6	24913.2	0.50
75	1496	1368	0.0806	18560.8	16972.7	35533.5	0.48
80	1204	1076	0.0806	14938.0	13349.9	28287.8	0.47
85	496	456	0.0806	6153.8	5657.6	11811.4	0.48
90	576	392	0.0806	7146.4	4863.5	12009.9	0.40
95	1408	1108	0.0806	17469.0	13746.9	31215.9	0.44
100	3961	3371	0.0806	49143.9	41823.8	90967.7	0.46
105	4157	4169	0.0806	51575.7	51724.6	103300.2	0.50
110	2873	2515	0.0806	35645.2	31203.5	66848.6	0.47
115	2864	2785	0.0806	35533.5	34553.3	70086.8	0.49
120	5362	5587	0.0806	66526.1	69317.6	135843.7	0.51
125	7104	7542	0.0806	88139.0	93573.2	181712.2	0.51
130	9273	11077	0.0806	115049.6	137431.8	252481.4	0.54
135	9403	11255	0.0806	116662.5	139640.2	256302.7	0.54
140	5566	7183	0.0806	69057.1	89119.1	158176.2	0.56
145	1765	2826	0.0806	21898.3	35062.0	56960.3	0.62
150	393	733	0.0806	4875.9	9094.3	13970.2	0.65
155	44	140	0.0806	545.9	1737.0	2282.9	0.76
160	16	39	0.0806	198.5	483.9	682.4	0.71

Table 12.

Lightship, August 2001 (6 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
50	4	0	0.00868	460.8	0.0	460.8	0.00
55	4	0	0.00868	460.8	0.0	460.8	0.00
60	4	16	0.00868	460.8	1843.3	2304.1	0.80
65	20	32	0.00868	2304.1	3686.6	5990.8	0.62
70	32	48	0.00868	3686.6	5530.0	9216.6	0.60
75	48	40	0.00868	5530.0	4608.3	10138.2	0.45
80	12	12	0.00868	1382.5	1382.5	2765.0	0.50
85	0	16	0.00868	0.0	1843.3	1843.3	1.00
90	80	40	0.00868	9216.6	4608.3	13824.9	0.33
95	164	216	0.00868	18894.0	24884.8	43778.8	0.57
100	448	704	0.00868	51612.9	81106.0	132718.9	0.61
105	648	864	0.00868	74654.4	99539.2	174193.5	0.57
110	687	700	0.00868	79147.5	80645.2	159792.6	0.50
115	409	538	0.00868	47119.8	61981.6	109101.4	0.57
120	531	1000	0.00868	61175.1	115207.4	176382.5	0.65
125	1140	1114	0.00868	131336.4	128341.0	259677.4	0.49
130	1786	1991	0.00868	205760.4	229377.9	435138.2	0.53
135	2268	3114	0.00868	261290.3	358755.8	620046.1	0.58
140	3701	3984	0.00868	426382.5	458986.2	885368.7	0.52
145	2894	2886	0.00868	333410.1	332488.5	665898.6	0.50
150	1353	1852	0.00868	155875.6	213364.1	369239.6	0.58
155	565	547	0.00868	65092.2	63018.4	128110.6	0.49
160	96	185	0.00868	11059.9	21313.4	32373.3	0.66
165	51	37	0.00868	5875.6	4262.7	10138.2	0.42
170	7	7	0.00868	806.5	806.5	1612.9	0.50