Comparative Analysis of Sea Scallop Escapement/Retention and Resulting Economic Impacts

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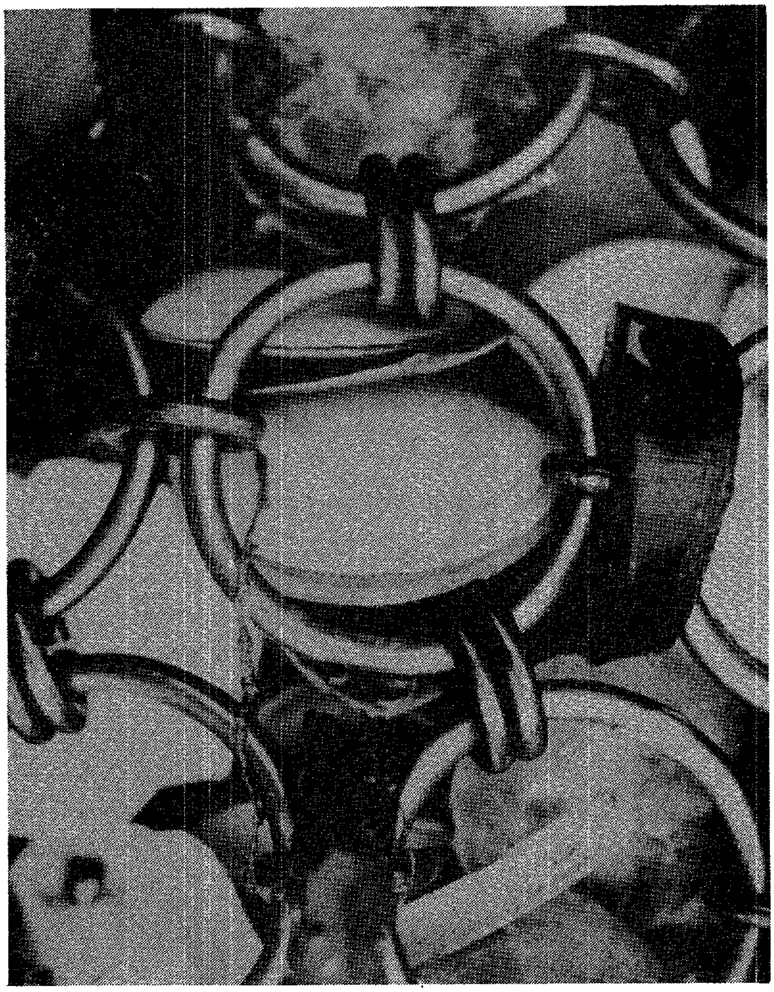

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Virginia Sea Grant Marine Advisory Program

Project funded under Saltonstall-Kennedy Act, Aware Number NA88EA-H-00011
and the New England Fishery Management Council.

COMPARATIVE ANALYSIS OF SEA SCALLOP ESCAPEMENT/RETENTION AND RESULTING ECONOMIC IMPACTS

BY

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ACKNOWLEDGEMENTS

As with most research, many individuals provided assistance and encouragement in completing this project. Kenneth Beal, Fred Serchuk, and Ron Smolowitz of the Northeast Regional Office, National Marine Fisheries Service provided constructive criticism of proposed research methods. The two captains--Gilbert Martinez and Juan Araiza--and the crews of the vessels which participated in the gear experiments provided considerable assistance and expertise. We are especially appreciative of the support provided by the vessels owner William Wells. We also thank the East Coast Fisheries Association for their assistance. Most important, however, we thank the vessel owners, operators, and crew members that not only tolerated our questions but also provided invaluable information. Last, we thank the Virginia Institute of Marine Science Computer Center for computer support.

TABLE OF CONTENTS

CHAPTER PAGE

APPENDIX

LIST OF TABLES

TABLE PAGE

TABLE PAGE

LIST OF FIGURES

I

EXECUTIVE SUMMARY

During the months of June and September 1988, gear experiments were conducted aboard the F/V Carolina Dawn and Carolina Capes. Funding for the research was provided by Saltonstall-Kennedy funds (Award Number NA88EA-H-00011), the Virginia Institute of Marine Science, College of William and Mary, and the New England Fishery Management Council. The primary objective of the experiments was to assess the technical efficiency and size selectivity of 3.5-inch ring dredges relative to the current commercially-used 3.0-inch ring dredges. Secondary objectives were to analyze the economic and regulatory ramifications of using 3.5-inch ring dredges to control the age-at-capture and enhance the yield-per-recruit.

Results of the experiments indicated that the 3.5-inch ring dredge was approximately 50% as efficient as the 3.0-inch ring dredge with respect to harvesting both baskets of scallops and pounds of meats when the vessel was exempted from all regulations. In terms of meat yields and the current 30 meat per pound (MPP) restriction, the 3.5-inch ring dredge was approximately 70% as efficient as the 3.0-inch ring dredge. Corresponding analyses of the experiments indicated that the 3.5-inch ring dredges do not offer a singular effective replacement to the current meat-count

restrictions. Simply, the 3.5-inch ring dredge allowed more escapement of small scallops than allowed by the 3.0-inch ring dredge, but the 3.5-inch ring dredge did not eliminate the capture of all small scallops.

In terms of size selectivity, the 3.5-inch ring dredge harvested fewer small scallops and more large scallops than caught by the 3.0-inch ring dredge. Full selection or 100% retention appeared to occur for scallops 95-110 mm. shell height. The 3.5-inch ring dredge relative to the 3.0-inch ring dredge increased the average shell size of scallops harvested from 88.2 to 98.5 mm. shell height. The corresponding average meat counts for the 3.0 and 3.5-inch ring dredges were 35.1 and 25.1 MPP. Although the count for the larger ring dredge was, on average, legal, it should be realized that higher counts would occur for scallops harvested in areas with large concentrations of small scallops.

Results of the experiments, however, were inconsistent or contradictory. Different results and conclusions were obtained from the various experiments. These differences were believed to have been associated with varying resource, environmental, and weather conditions. Nevertheless, extreme variation in resource and weather conditions characterize commercial fishing operations. Unfortunately, the inconsistencies obfuscated making broad general conclusions about regulating the fishery by 3.5-inch ring dredges.

A short-run economic analysis of using 3.5-inch ring dredges rather than 3.0-inch ring dredges indicated that revenues would decline by approximately 22%. This would occur despite an estimated 8% increase in ex-vessel price which would result from a 30% reduction--estimated loss associated with using 3.5-inch ring dredges rather than 3.0-inch ring dredges--in supply. More important, however, was the likelihood that vessel-to-vessel effects of using 3.5-inch ring dredges would vary depending on vessel configuration and the abilities of the captain and crew.

In general, the 3.5-inch ring dredge does not appear to be a viable replacement to the current meat-count restriction. Analyses presented in this report suggest that other regulations are necessary to prevent biological overfishing. However, the 3.5-inch ring dredge should be considered as part of a more comprehensive regulatory strategy. Additional research, though, is necessary to more precisely determine the effects of regulating the fishery with 3.5-inch ring dredges.

II

INTRODUCTION

Recent studies on sea scallops, Placopecten magellanicus (Gmelin) indicate that the management standard and regulations are fundamentally flawed (Naidu 1984, 1987; Serchuk 1987; Shumway and Schick 1987; Kirkley and DuPaul 1989). Current meat count regulations restrict landed meats to no more than an average 30 MPP between February and September and 33 MPP between October and January; enforcement policy allows a 10% tolerance for the purpose of prosecuting violations. Vessels which shell stock or land scallops in the shell are subject to a minimum shell height restriction of 3.5-inches; enforcement permits a 10% tolerance.

The regulations, however, have not prevented the exploitation of young scallops or sufficiently enhanced yield-per-recruit. More recently, the combination of diminished availability of large scallops and increased availability of small scallops has resulted in industry altering the product via several methods (e.g., mixing sizes and soaking) in order to satisfy the meat count restriction; this has resulted in a deterioration of the quality of landed scallops. The regulations have also generated equitability issues between shuckers and shell stockers. The regulations have posed compliance problems because of the difficulty of determining meat counts at sea. Last, enforcement is believed by industry to be inadequate.

Industry has recently suggested that different regulations are necessary to manage the fishery. They have suggested that the size of rings used on dredges be increased from 3 to 3.5-inches to allow escapement of smaller scallops. It is well recognized that restricting ring size must be accompanied by additional regulations to effectively control total mortality and provide maximum long-term benefits. However, increasing the ring size on dredges appears to be supported by industry and likely offers the potential for increasing yield-per-recruit. Determination of technical efficiency, size selectivity, and escapement is thus required to ascertain the feasibility of implementing restrictions on the size of rings used on dredges.

This study provides an analysis of technical efficiency, size selectivity, and escapement associated with increasing the ring size to 3.5-inches and supplementary gear restrictions. Data for this study were obtained from at-sea experiments in June and September 1988 funded under S-K Award Number NA88EA-H-0011. The data obtained were used to assess the technical efficiency, escapement, and size selectivity for different gear configurations and resource areas. It is stressed, however, that all results presented in this study are conditional on prevailing resource and environmental conditions. Alternative resource and environmental conditions could result in different conclusions.

III

PURPOSE

Problems and Impediments

Major objectives of sea scallop resource management have been to reduce the capture of undersized scallops and to delay the age of entry into the fishery. One approach to these objectives has been an attempt to evaluate the effectiveness of increasing the ring size on the standard New Bedford dredge. The evaluation of various ring sizes and inter-ring spaces on the retention/escapement of sea scallops was initiated in the early 1950's and continues at present.

The U.S. sea scallop fishery is currently regulated by restrictions on the number of meats per pound for landed fresh product and a minimum shell size for landed shellstock. Regulations restricting harvest levels and effort have been considered but strong reactions from various sectors of the industry (both for and against) have likely precluded their implementation.

Industry has modified harvesting strategies and on-board handling practices in order to comply with existing meat count regulations. The mixing of large and small scallops, harvested during different portions of the trip, to obtain a legal average meat count has not decreased the harvest of small scallops and has had an adverse impact on the quality of landed product. In addition, since the weight and thus the meat count of shuck product can be manipulated by a variety of washing and soaking procedures, the intent of a meat count regulation and the issue of product quality has been subject to compromise.

The potential for gear modifications and restrictions (ring size, dredge size) has intermittently surfaced as part of an alternative management strategy. If gear restrictions are to be successfully implemented as a management tool, precise data on gear size selectivity, catch and effort economic impacts, and attempts to circumvent the intent of the gear must be quantified. The present research project addresses these issues by examining the relative performance of a 3.0 versus 3.5-inch ring dredge under commercial fishing operations.

Previous studies to evaluate the performance of a 3.0 versus 3.5-inch ring dredge have not fully examined the effects of chafing gear. In the present study, both dredges, towed simultaneously had the same configuration of chafing gear. In addition to quantifying the relative reduction in the capture of undersized scallops by the dredges, little work has been directed to determine catch per unit effort and resulting changes in revenue under current commercial fishing practices and responses. The present study attempts to quantify such parameters at various scallop cull sizes in two different resource areas; one characterized by a moderate abundance of well mixed sizes, the other by a high abundance of uniformly small scallops.

Objectives

The objectives of the study were designed to address the problems and impediments previously described:

1. To determine the technical efficiency and relative size selectivity of a 3 versus 3.5-inch ring dredge.

2. To assess the economic ramifications associated with the use of a 3.5-inch ring dredge.

3. To evaluate the potential ramifications on the management of sea scallops and industry response associated with the use of a 3.5-inch dredge.

IV

APPROACH

To determine the relative performance of a 3 versus 3.5-inch ring dredge, the two dredges were towed simultaneously by a commercial sea scallop vessel. Tows were conducted similar to commercial fishing operations and varied from 15 to 75 minutes. All tows were made in resource areas commonly fished by other vessels. Data for each tow were recorded on a Tow Data Log maintained by the captain/mate; information included date, tow number, time, Loran bearings, latitude, longitude, vessel speed, depth, and gross catch of scallops and trash. The Deck Log, maintained by the chief scientist recorded catch of scallops, trash and by-catch, length frequency of scallops sampled, tow number, date, time, weather and sea conditions, depth and Loran bearings.

After each tow, scallops from each dredge were separated from trash and by-catch. Scallops and trash from each dredge were measured in terms of baskets (1 basket = 1.5 bushels) per tow. Depending upon the volume of catch, up to two baskets of scallops/dredge were set aside to be counted and measured. Scallops were measured at 5 mm. intervals using NMFS scallop counting boards. If the harvest of scallops from each dredge was significantly greater than two baskets, a sub sample of two baskets was measured and counted.

If the harvest was approximately two baskets or less per dredge, the total catch was measured and counted.

Both scallop dredges were fished with basic configurations of chafing gear. For the first series of tows, both dredges were fished without chafing gear. Subsequent series of tows were made with dredges configured with chafing gear. This approach of sequentially "stepping up" dredges with chafing gear was designed to evaluate the effects of chafing on selectivity and efficiency of the dredges.

Tows were conducted in a commercially fished resource area in depths from 22 - 36 F. Tow patterns were variable depending upon bottom contour, tide, and sea conditions. Given the number of variable that can potentially affect the performance of a dredge, effort was directed to maximize the number of observations (tows) from which usable data could be obtained.

Experimental Framework

The data to evaluate the performance of the two dredges was obtained from two trips conducted in June-July and September-October 1988. Both trips were divided into two sections or "legs" each providing different types of data. The framework for experimental conditions, data collected, and gear configurations is presented in Tables 4.1 and 4.2.

Trip 1

During the first trip aboard the F/V Carolina

Table 4.1

F/V Carolina Dawn, June through July 1988

Date	Tows	Area Fished	Gear Configuration	Date Collected
6/14-6/15	1-10	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring no chafing gear	scallops trash size frequency
6/15-6/16	11-34	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring chafing gear no donut spacers	scallops trash size frequency
6/16-6/20	35-121	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash size frequency
6/23-6/24	1-7	NJ-NY	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash size frequency
6/24-7/2	8-154	NJ-NY	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers 1" twine woven in rings, first 5 rows of apron	scallops trash size frequency
7/2-7/9	155-293	NJ-NY	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers 1" twine woven in rings, first 5 rows of apron and bottom panel	scallops trash size frequency

Table 4.2

F/V Carolina Capes, September through October 1988

Date	Tows	Area Fished	Gear Configuration	Date Collected
9/22-9/23	1-28	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring no chafing gear	scallops trash size frequency meat count
9/23-9/24	29-92	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring chafing gear no donut spacers	scallops trash size frequency meat count
9/24-9/27	93-136	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash size frequency meat count
9/29-10/7	1-201	NJ-NY	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash meat count
10/8-10/11	226-285	NJ-NY	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash meat count
10/12-10/13	287-316	DelMarVa	13-foot dredge 3-inch ring 3.5-inch ring chafing gear donut spacers	scallops trash

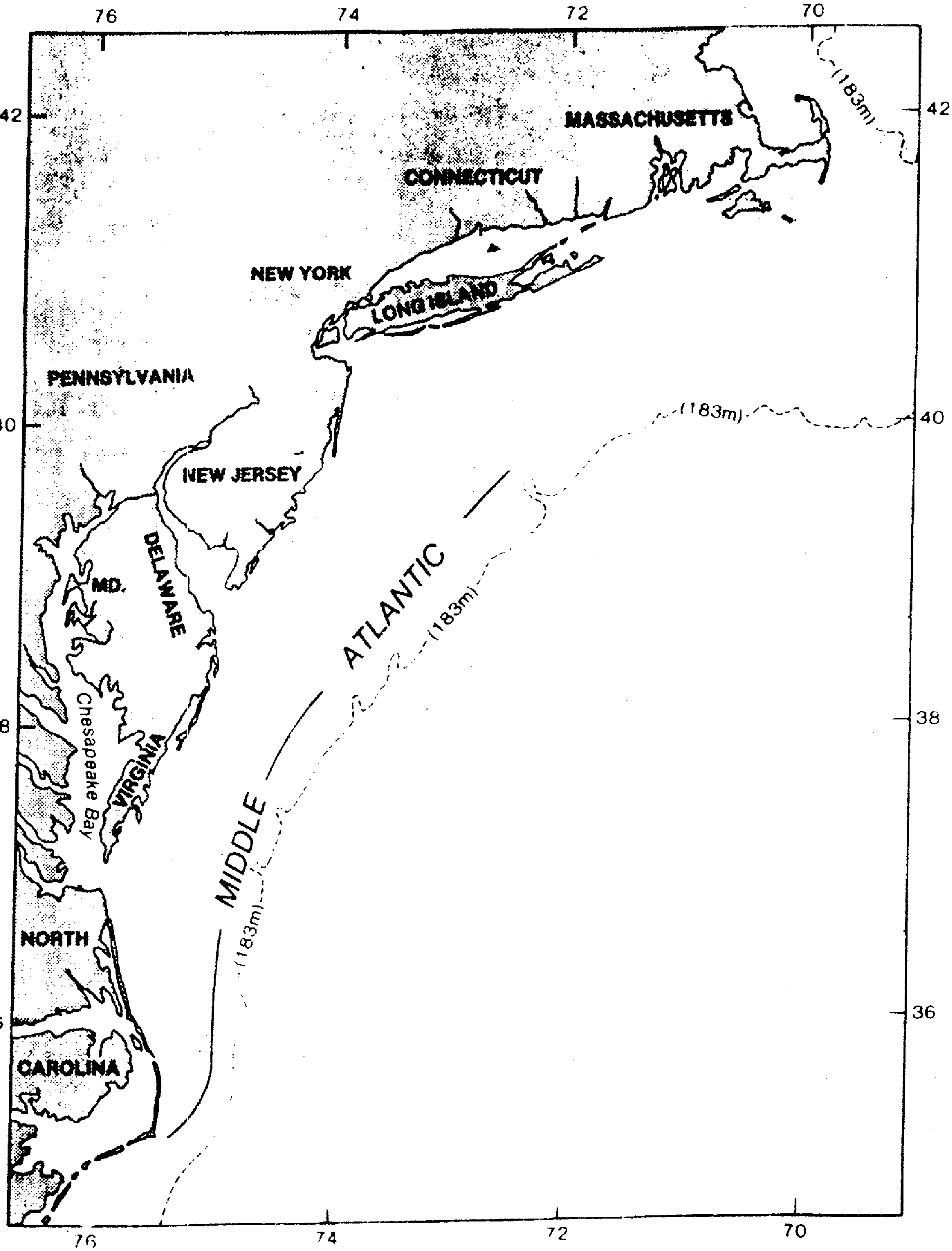
Dawn (6/14/88-6/20/88), fishing operations were conducted in the DelMarVa area of the mid-Atlantic Region (Figure 4.1). The scallop resource in this area was characterized as being moderately abundant and well-mixed in sizes. The framework for experimental conditions and the types of data collected is outlined in Table 4.1. Details on location, water depth, vessel speed, tow time and catch can be found in Appendix I. Weather conditions during this period were calm to moderate with seas averaging 2-4 ft. (.7 - 1.3 M.).

Catch was determined by measuring the quantity (number of baskets) of all scallops and trash per dredge per tow. The two-handled plastic baskets often used on commercial scallop vessels measured 17-inch (43 cm.) across the top, 13-inch (32.5 cm.) across the bottom and 15-inch (38 cm.) high. These baskets contain approximately 1.5 bu.

Meat yields were determined for scallops harvested from the resource areas fished during the gear trials. For both the June and September trips, four baskets of scallops from four separate tows were iced and returned to the laboratory (VIMS) where meat-shell height relationships were estimated. This estimation was used to calculate catch rates in terms of pounds of meats per hour tow or on a per tow basis.

During the second portion of the first trip from 6/24/88 to 7/9/88, the F/V Carolina Dawn concentrated fishing operations in the New Jersey-New York Bight area (Figure 4.1). The scallop resource in this area was characterized as abundant with most scallops in the 3 to 3.5-inch (75 to 88

Figure 4.1. New York-Virginia Resource Areas Fished



mm.) range. The framework for experimental conditions and types of data collected is outlined in Table 4.1. Details on location, water depth, vessel speed, tow time and catch can be found in Appendix II. Catch, size frequency, and meat yields were determined as previously described. Weather conditions were calm to moderate with short periods of weather associated with frontal passages.

Trip 2

The first section or "leg" of the second trip was during 9/22/88 to 9/27/88 on the F/V Carolina Capes. Fishing operations were conducted in the DelMarVa area of the mid-Atlantic region (Figure 4.1). This is the same resource area which was fished during the first portion of Trip 1. The scallops in this area at this time were of low to moderate abundance and sizes were well-mixed. The framework for experimental conditions and types of data collected can be found in Table 4.2. Details on location, water depth, vessel speed, tow time and catch can be found in Appendix III. Weather conditions were moderate to rough with seas consistently ranging from 4-7′ (1.3 to 2.3 m).

Catch, size frequency and meat yields were determined as previously described. Meat counts on shucked scallops from each dredge was made during "bag-up" operations. Three to five counts were made at the wash tank with the commonly used pint frosting cup.

The second portion of Trip 2 was conducted from

9/29/88-10/13/88 in the New Jersey-New York Bight area. The scallop resource in this area was abundant with most in the 3 - 3.5 inch (75-88 mm.) range. Experimental conditions and types of data collected are outlined in Table 4.2. Details on location, water depth, vessel speed, tow time and catch can be found in Appendix 4. Catch, size frequency, meat yields and meat counts were determined as previously described.

Vessels and Gear

For both the June and September trips, identical vessels were used to evaluate the performance of the 3 versus 3.5-inch ring dredge. The F/V Carolina Dawn and F/V Carolina Capes are 75.5 ft. (26 m) LOA steel hull vessels rigged to tow two New Bedford type scallop dredges, one each port and starboard. The vessels have a displacement of 125 GMT, 10.2 ft. (3.4 m) draft and are powered by a 520 horsepower Caterpillar diesel engine. The vessels normally carry a crew of between 9 and 12 depending upon the abundance of scallops and the duration of the trip.

On both trips, two 13 ft. (4.3 m) dredges were used; one constructed with 3-inch rings and the other with 3.5-inch rings. The precise dimensions of the rings are; o.d. 3 7/8 inch (97 mm.), i.d. 3 inch (77 mm.) and o.d. 4.5 inch (114 mm.), i.d. 3 5/8 inch (94 mm.) respectively. The dredges were constructed by the crew and captain of the F/V Carolina Dawn. The pattern for the design and configurations of both dredges are illustrated in Figures 4.2 and 4.3.

The dredges were equipped with two types of chafing gear; donut spacers on the apron and split tire shingles on the chain bag. Five rows of donut spacers or captured rollers (captured roller; F&B Enterprises, New Bedford, MA; pat. no. 4,446,637) were placed across the apron starting one or two rows up from the club-stick. Split tire shingles (6 X 16 inch; 15 X 40 cm.) were attached to the chain bag at 2-ring intervals across the bag and at 3-ring intervals up from the club-stick into the diamond. Both dredges were configured as similar as possible given the limitations presented by the two ring sizes and consequently the difference in the number of rings on the diamond, apron and chain-bag.

The 3.5-inch ring dredge on the F/V Carolina Dawn (Trip 1, second leg, 6/23/88-7/9/88) was modified by weaving a 1-inch rope through 5 rows or rings across the apron (tows 8-154) and subsequently through 5 rows of rings on the chain bag (tows 155-293). The purpose of these modifications was to evaluate whether or not simple gear alterations would minimize the loss of small scallops from the 3.5-inch ring dredge.

Figure 4.2

SCALLOP DREDGE CONFIGURATION
13′ DREDGE; 3″ RINGS

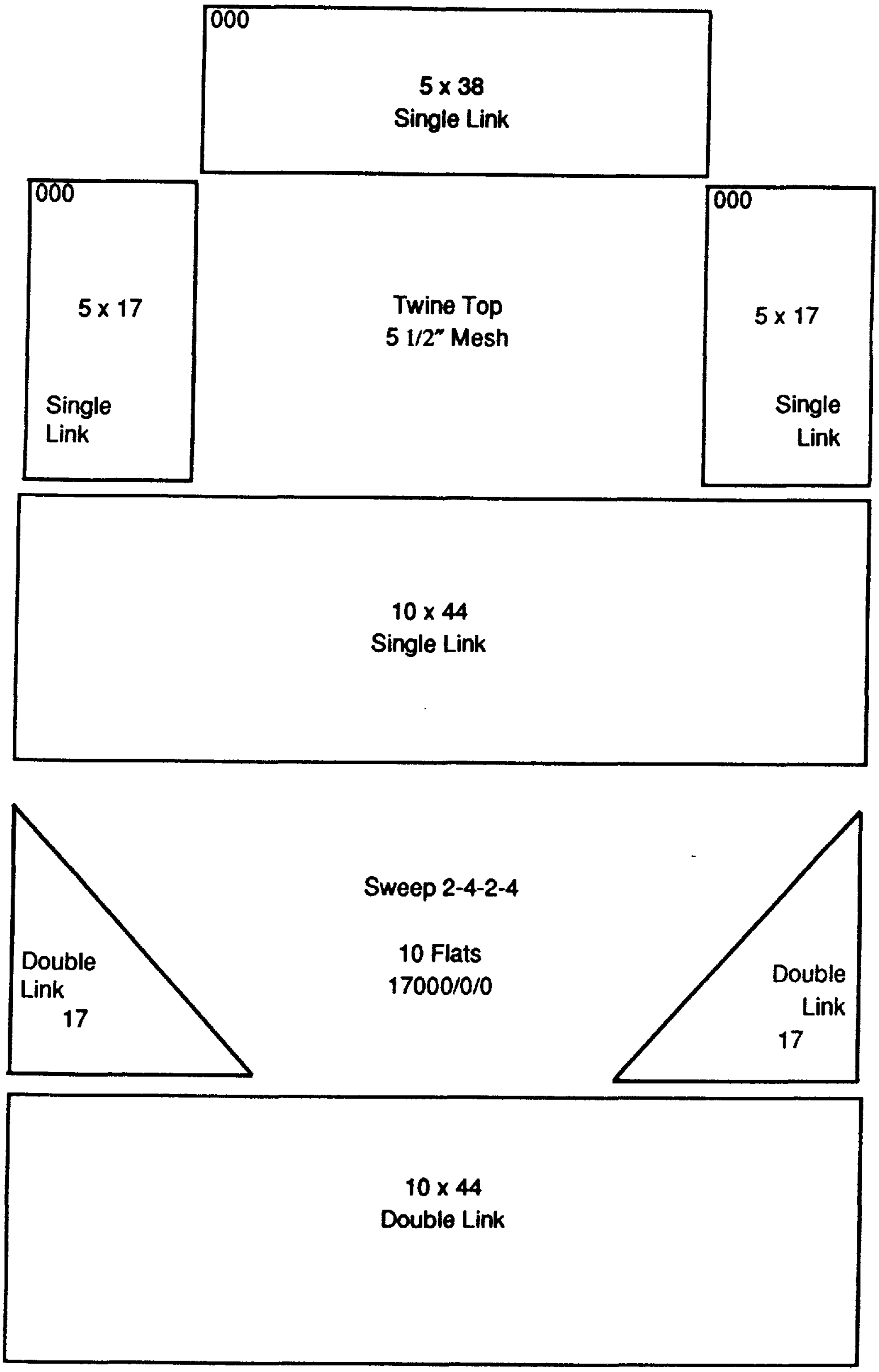
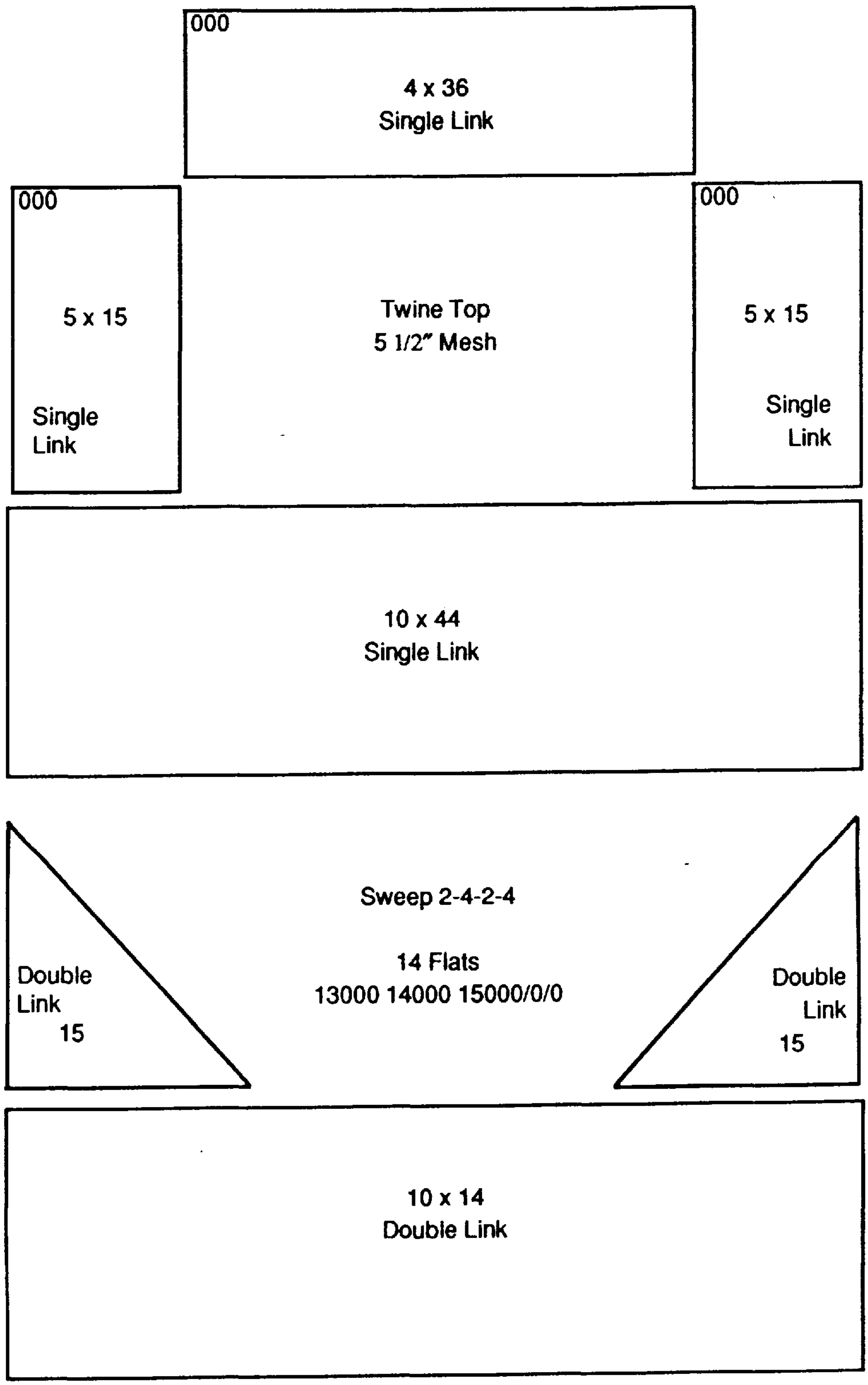


Figure 4.3

SCALLOP DREDGE CONFIGURATION
13′ DREDGE; 3 1/2″ RINGS



V

ACTUAL ACCOMPLISHMENTS AND FINDINGS

Results and analyses of the June and September sea scallop dredge experiments with the F/V Carolina Dawn and F/V Carolina Capes are subsequently presented. Empirical results are summarized with respect to technical efficiency, relative size selectivity, economic ramifications, and potential management and regulatory implications. It is important to realize, however, that results are conditional on existing resource and weather conditions. Different resource and/or weather conditions may affect the relative harvesting efficiency and size selectivity of gear.[1] Thus, comparisons between different resource conditions and time periods are not recommended.

Technical Efficiency and Relative Size Selectivity

Technical efficiency

The concept of efficiency has several meanings and measures (Corbo and Melo 1986). The traditional measure is akin to 'maximum bang for the buck'. That is, production is technically efficient if output (harvest) is as large as

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[1]Bourne (1965) further discusses problems of comparing results of gear experiments for different resource areas and conditions, and different weather conditions.

as possible given the level of inputs (e.g., effort, fuel, vessel size, gear size, number of crew, and the condition of the resource). Two related measures are allocative and scale efficiency. Production is allocatively efficient if input levels are determined via cost minimizing criteria (Henderson and Quandt 1980). Alternatively, allocative efficiency implies that cost of producing a given output level is minimum. Production is scale efficient if input and output levels yield maximum profits.

An examination of technical efficiency, as traditionally defined however, is beyond the scope of this study for several reasons. First, the issue of concern is the efficiency of the 3.0-inch ring dredge relative to the 3.5-inch ring dredge; technical efficiency of the individual ring sizes is not of concern. Second, the scallop fishery is an open-access common property fishery and the determination of technical efficiency would also require determining the optimum fleet size which yields maximum efficiency. Third, estimation of technical efficiency requires estimation of a 'frontier' production function which requires information other than that collected for this study.

In this study, a limited notion of technical efficiency was examined. Efficiency was defined and measured in terms of catch per unit effort and the technical response coefficient between catch and effort. Emphasis of the research was on relative harvesting efficiency. That is, research focused on the catch or performance of the 3.5-inch ring dredge relative to the 3.0-inch ring dredge. In addition, relative harvesting efficiency was examined for 3 cull sizes: (1) 70 mm. (2.8-inches) which is approximately the current cull size, (2) 80 mm. (3.2-inches), and (3) 90 mm. (3.6-inches). All three cull sizes are below the 100-105 mm. (4.0-4.2-inches) cull size observed by Bourne in 1965.

Data resulting from the selection of various cull sizes were examined using meat weights or pounds of meats harvested. Relative efficiency with respect to no culling was also examined with respect to number of baskets harvested. All analyses of relative efficiency were done with respect to three different gear configurations.

Production is expressed in terms of both a 'per tow' and 'per hour' basis. The production on a 'per tow' basis is an average of all tows which varied in time from 30 to 75 minutes. Most tows were of 50 minutes duration. Production of a 'per hour' basis is the resulting harvest normalized to a one-hour towing time.

Relative efficiency in terms of number of baskets and meat weight per tow also was examined by comparing coefficients estimated by seemingly unrelated regression of the relationship between catch (C), effort(E), tow speed (S), and bottom depth (D):

$$C_{ij} = f(E,S,D)$$

$$C_{ik} = f(E,S,D)$$

where C_{ij} and C_{ik} are the number of baskets of scallops or pounds of meats per tow harvested by the 3 and 3.5-inch ring dredges with the ith configuration (e.g., no chafing gear, chafing gear without donut spacers, and fully rigged), effort was the number of hours the gear was towed, and depth was the bottom depth in fathoms. Various functional specifications were considered; these are discussed with respect to each vessel and part of the experiment. Relative efficiency was statistically tested by a likelihood-ratio test of the cross equation restrictions. If the coefficients were not statistically different, it was concluded that there were no differences in the relative harvesting efficiency of the two dredges.

Tests of relative efficiency using meat weights and number of baskets harvested were also made using the F and student-t distributions. The F-distribution was used to examined equality of variances and was one-tailed. A paired t-test was used to test the hypothesis that the mean of differences between catches for the 3 and 3.5-inch ring dredges were zero:

$$H0: \text{MEAN}(\text{CATCH}_{3.5} - \text{CATCH}_{3.0}) = 0$$

$$H1: \text{MEAN}(\text{CATCH}_{3.5} - \text{CATCH}_{3.0}) \neq 0$$

All weight-related data were derived from an empirically determined relationship between shell height and meat weight. Thus, tests using meat weight data may be biased or subject to estimation error. Weights were estimated by the following weight-length relationships:

June:

$$W = 51.05 - 1.83\,SH + .02\,SH^2 - .00005\,SH^3 \qquad R^2 = .90$$
$$\quad (4.90) \quad (5.55) \qquad (5.76) \qquad (4.09)$$

September:

$$\log(W) = -12.54 + 3.39\,\log(SH) - .0025\,SH \qquad R^2 = .90$$
$$\quad (12.78) \quad (12.4) \qquad\qquad (2.88)$$

where W is weight in grams, SH is shell height in millimeters, and log is the natural logarithm. Numbers in parentheses are the respective t-statistics.

F/V Carolina Dawn: 6/14-6/20/88

During the period 6/14-6/20, 121 tows were made (Table 4.1). Tows 1-10 were made without chafing gear; tows 11-34 included chafing gear but no donut spacers; tows 35-121 were made with both chafing gear and donut spacers (fully rigged). Catch of scallops and trash in terms of baskets were collected for all of the 121 tows (Appendix I). Scallops per basket and shell height data were collected for 67 tows. These data were used to estimate total meat weight and the meat weight of scallops for cull sizes of 70, 80, and 90 mm. The total catch of scallops (baskets) was recorded for all 121 tows; these data were used to estimate catch in terms of baskets per tow and baskets per hour.

Number of baskets harvested per hour, with respect to the 121 tows, ranged from .8 to 5.5 baskets. Mean baskets per hour were 2.9 and 2.13 for the 3 and 3.5-inch ring dredges, respectively. In terms of the 3 gear configurations and the 3 and (3.5-inch) ring dredges, the mean number of baskets per hour were 1.62 (1.38) (no chafing), 3.30 (2.38) (chafing without donut spacers), and 2.97 (2.15) (fully rigged) (Table 5.1). The 3-inch ring dredge appeared to be more efficient in terms of baskets per hour for all gear configurations (Figure 5.1). Similar conclusions were derived for number of baskets per tow (Figure 5.2).

In terms of meat weight per hour and per tow, the 3-inch ring dredge harvested more scallops regardless of gear configuration (Table 5.1). Dredges using chafing gear without donut spacers tended to have more pounds of meat; this result may be misleading since the different gear configurations were associated with different resource conditions and areas. Mean pounds of meat per hour for the 3 gear configurations and the 3 and (3.5-inch) ring dredges were 13.48 (10.69), 25.42 (18.43), and 22.25 (16.35), respectively.

The technical efficiency of the dredge constructed with 3-inch rings was also greater for scallops culled at 70 and 80 mm. (Figure 5.3). However, meat weight harvest by the 3.5-inch ring dredge exceeded the harvest by the 3-inch ring dredge for scallops culled at 90 mm. This cull size is larger than that observed for commercially culled scallops; current culling practices appear to be for scallops between 70 and 80 mm.

Analysis of harvest data in terms of pounds of meats

Table 5.1

Number of baskets and meat weight, F/V Carolina dawn, 6/14-6/20/88

Tow Number	Ring Size	Number of Baskets[a]		Pounds of meats[b]	
		Per tow	Per hour	Per tow	Per hour
No chafing gear:					
1-10	3.0	1.62	1.62	13.50	13.48
1-10	3.5	1.54	1.38	11.93	10.69
Chafing gear, no donut spacers:					
11-34	3.0	2.86	3.30	22.39	25.42
11-34	3.5	2.10	2.38	16.86	18.43
Fully rigged:					
35-121	3.0	2.50	2.97	18.71	22.26
35-121	3.5	1.82	2.15	13.86	16.38

[a]Basket data and summary information are with respect to all tows.

[b]Meat weight data are for tows in which only size-frequency information was obtained.

FIGURE 5.1. MEAN CATCH (BASKETS OF SCALLOPS) PER HOUR FOR SELECTED GEAR CONFIGURATIONS, 6/14–6/20/88

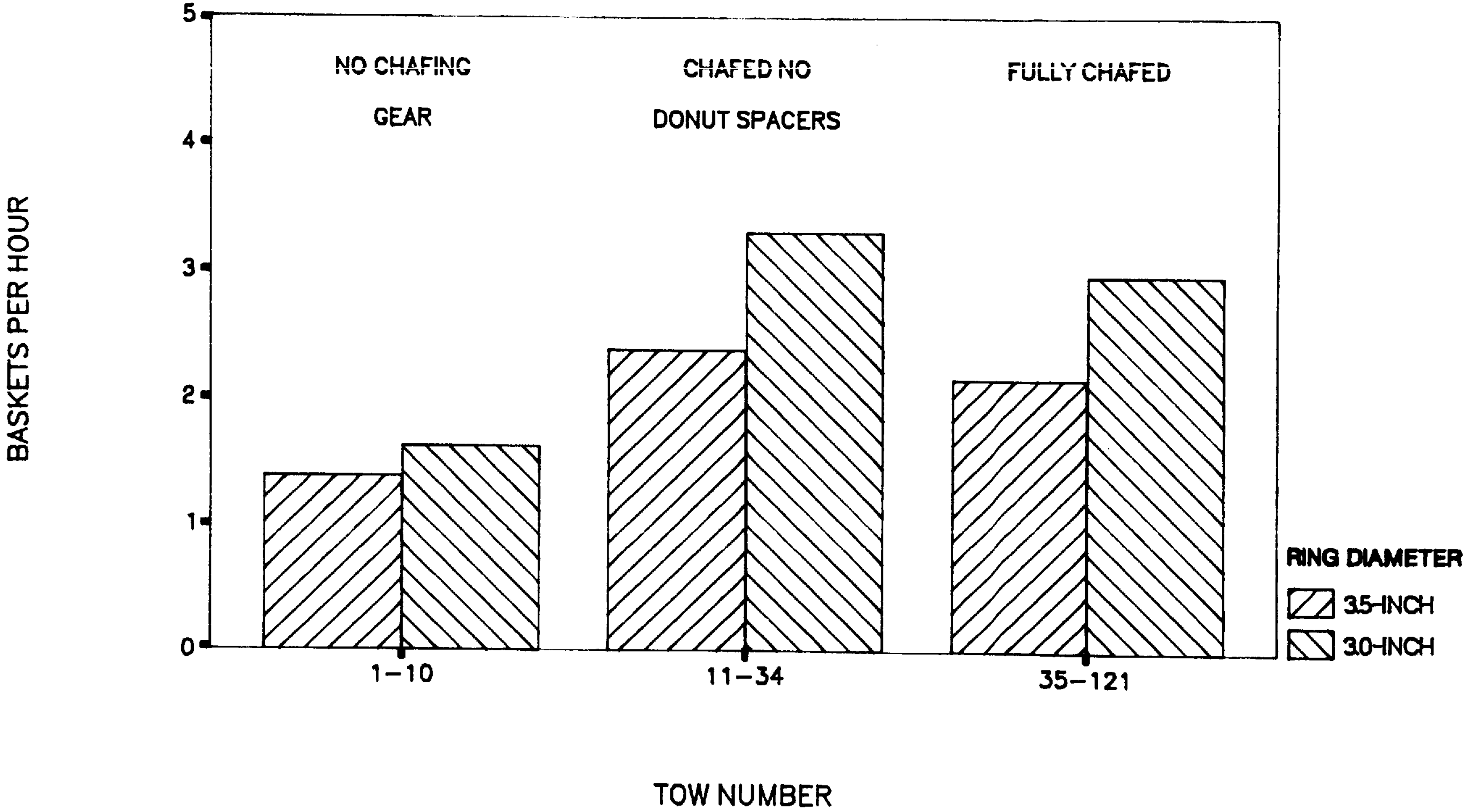


FIGURE 5.2. MEAN CATCH (BASKETS OF SCALLOPS) PER TOW FOR SELECTED GEAR CONFIGURATIONS, 6/14–6/20/88

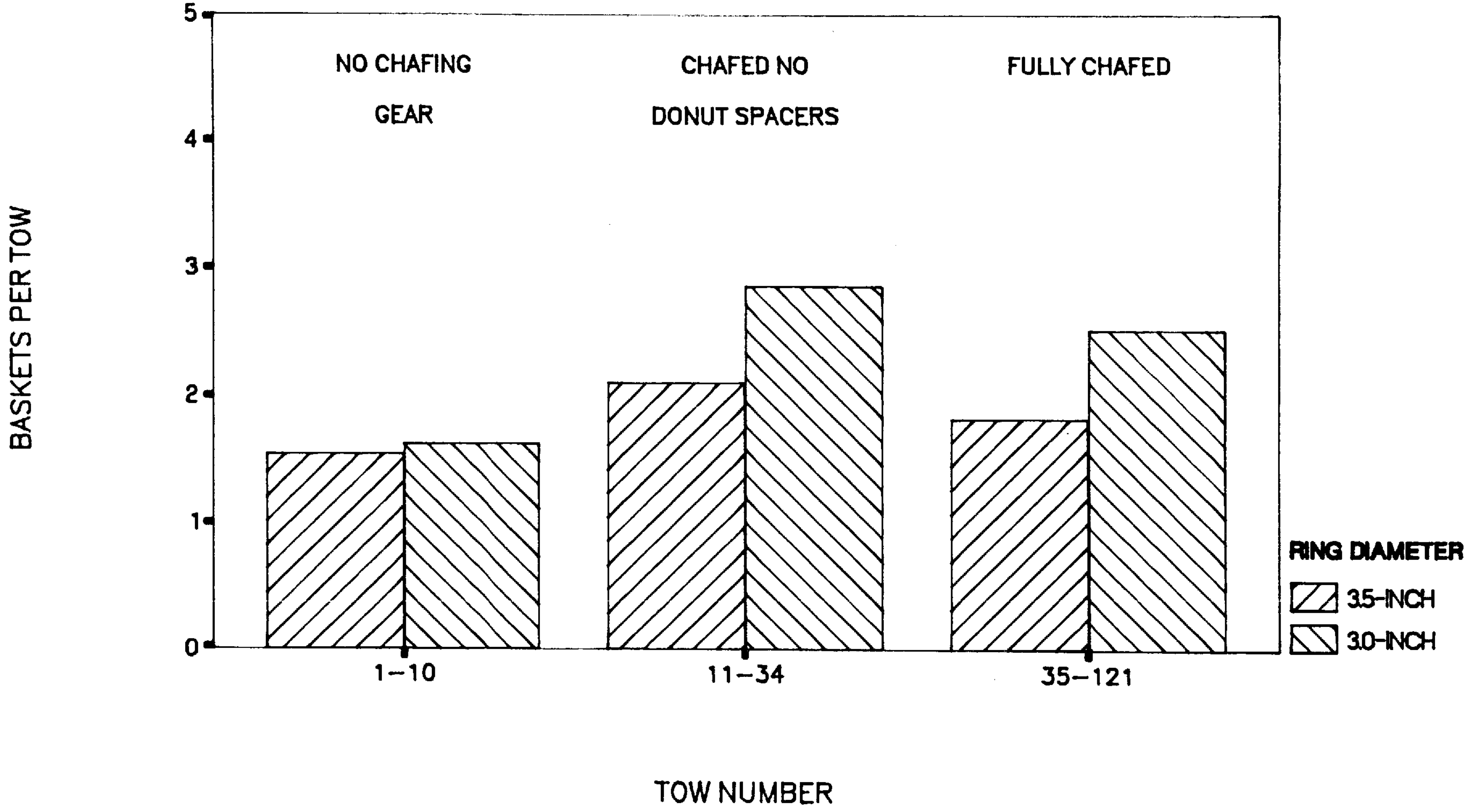
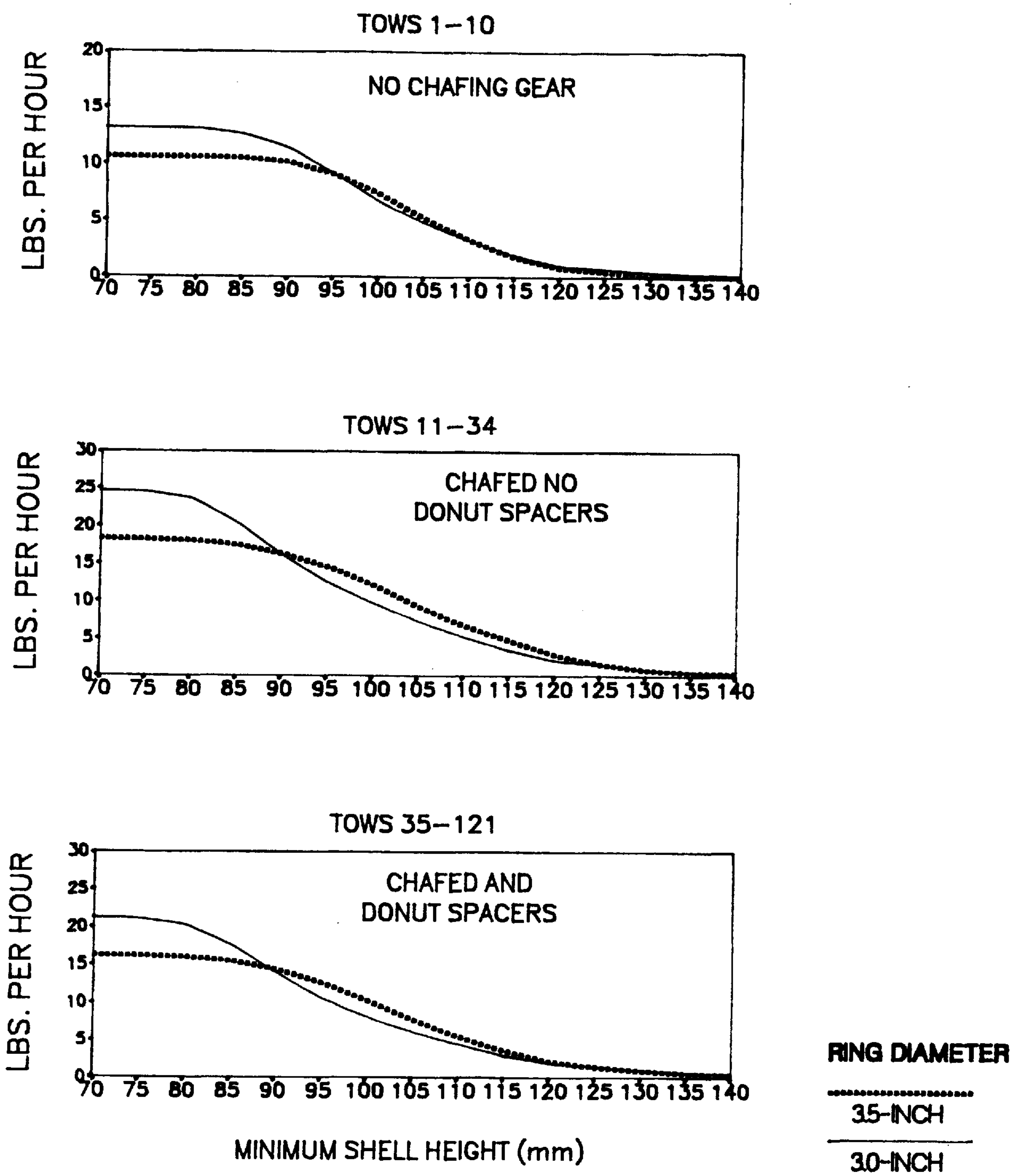


FIGURE 5.3. ESTIMATED POUNDS OF MEATS FOR VARIOUS RING DIAMETERS AND SELECTED CULL SIZES AND GEAR CONFIGURATIONS

JUNE 14–20, 1988



per hour and the percentage difference between the two dredges indicated considerable differences (Table 5.2). Culling resulted in larger reductions in catch by the 3.0-inch ring dredge; that is, as the cull size increased, differences in the meat weight harvest increased at an increasing rate. However, the difference between the harvested meat weight for 3 and 3.5-inch ring dredges became smaller.

Statistical analyses of the relative harvesting efficiency included tests that the mean of differences equalled zero (paired t-tests), and that estimated production technologies for the 3 and 3.5-inch ring dredges were equal. The mean of differences was examined for both baskets and pounds of meats per tow and per hour. The mean of differences between meat weights were also examined with respect to no culling and the three cull sizes.

Statistical tests indicated that there were no differences in the mean number of baskets per tow or per hour between the 3 and 3.5-inch ring dredge without chafing gear (Table 5.3). However, the null hypothesis that the mean of differences equalled zero was rejected for gear configurations of chafing gear without donut spacers and fully rigged dredges. More important, tests' results indicated that the mean of differences for dredges rigged with chafing gear and no donut spacers and fully rigged was less than zero; thus, implying that the 3.5-inch ring dredge was technically inferior to the 3-inch ring dredge in terms of baskets of scallops harvested.

Table 5.2

Pounds of meats per hour for 3 and 3.5-inch ring dredges, 3 gear configurations, and 3 cull sizes, F/V Carolina Dawn, 6/14-6/20/88

Tow Number	Ring Size	Pounds of meats per hour						
		No culling	Cull @ 70 mm.	%[a]	Cull @ 80 mm.	%	Cull @ 90 mm.	%
No chafing								
1-10	3.0	13.48	13.23	-1.85	13.24	-2.52	11.50	-14.69
1-10	3.5	10.69	10.64	-.47	10.62	-.65	10.23	-4.30
% change in weight for 3 vs. 3.5-inch ring		-20.70	-19.58		-19.18		-11.04	
Chafed no donuts								
11-34	3.0	25.42	24.67	-2.95	23.73	-6.65	16.20	-36.27
11.34	3.5	18.44	18.32	-.65	18.13	-1.68	16.37	-11.23
% change in weight for 3 vs. 3.5-inch ring		-27.46	-25.74		-23.60		1.05	
Fully rigged								
35-121	3.0	22.25	21.39	-4.27	20.33	-8.63	14.00	-37.08
35-121	3.5	16.38	16.26	-.73	16.06	-1.95	14.47	11.66
% change in weight for 3 vs. 3.5-inch ring		-26.38	-23.66		-21.00		3.36	

[a]% indicates difference in weight between unculled and culled scallops.

Table 5.3

Results of paired t-tests that mean of differences of baskets per hour between 3 and 3.5-inch ring dredges equals zero, F/V Carolina Dawn, 6/14-6/20/88

Gear Configuration (tows)	Baskets per tow		Baskets per hour	
	t-value[a]	degrees of freedom	t-value	degrees of freedom
No chafing				
(1-10)	-.30	9	-1.01	9
Chafing with no donut spacers				
(11-34)	-4.31**[b]	23	-4.51**	23
Fully rigged:				
(35-121)	-8.43**	83	-8.31**	83

[a]Five (1) percent two-tailed critical values for 9, 23, and 83 degrees of freedom are 2.26 (3.25), 2.07 (2.81), and 1.96 (2.58), respectively.

[b]** indicates statistically significant at 1% level of significance.

Results of tests of differences in meat weight per tow and per hour for the 3 gear configurations and 4 cull scenarios indicated considerable differences (Table 5.4). Calculated t-statistics indicated statistical differences for all gear configurations except dredges without chafing gear and scallops culled at 90 mm. The results of the t-tests also indicated that the 3-inch ring dredge was generally more technically efficient than was the 3.5-inch ring dredge.

Examination of the harvesting efficiency in terms of the catch-effort response or production models was accomplished by statistical analysis of estimated coefficients. Several functional forms were determined to provide reasonable statistical estimates of the production responses. However, the transcendental model was assumed to be a valid representation of the production technology. Moreover, this form facilitated tests of several characteristics of the technology. Preliminary analysis indicated inadequate variability of towing speed; thus, the initial transcendental specification was:

$$\text{Catch}_{ij} = \alpha_{oj}\ \text{Effort}^{\beta_{1j}}\ \text{Depth}^{\beta_{2j}}\ \exp(\beta_{3j}\ \text{effort} + \beta_{4j}\ \text{Depth})$$
$$\text{Catch}_{ik} = \alpha_{ok}\ \text{Effort}^{\beta_{1k}}\ \text{Depth}^{\beta_{2k}}\ \exp(\beta_{3k}\ \text{effort} + \beta_{4k}\ \text{Depth})$$

Estimation was accomplished by iterative seemingly unrelated regression (Zellner 1962).

Initial parameter estimates and test results of the production technology are presented in Table 5.5. Likelihood-ratio tests at the 5% level of significance (LOS)

Table 5.4

Results of paired t-tests that mean of differences, meat weight, equals zero, F/V Carolina Dawn, 6/14-6/20/88

Culling Gear Configuration	Pounds per tow		Pounds per hour	
	t-value[a]	degrees of freedom	t-value	degrees of freedom
No culling:				
No chafing	-.76	9	-1.48	9
Chafing without donuts	-2.44*[b]	12	-2.76*	12
Fully rigged	-5.58**	43	-5.42**	43
Culling @ 70 mm.:				
No chafing	-.68	9	-1.42	9
Chafing without donuts	-2.42*	12	-2.72*	12
Fully rigged	-5.33**	43	-5.17**	43
Culling @ 80 mm.:				
No chafing	-.65	9	-1.39	9
Chafing without donuts	-2.31*	12	-2.64*	12
Fully rigged	-4.94**	43	-4.81**	43
Culling @ 90 mm.:				
No chafing	-.00	9	-.75	9
Chafing without donuts	.46	12	.17	12
Fully rigged	.68	43	.78	43

[a]Five and (1%) level of significance for 9, 12, and 43 degrees of freedom are 2.26 (3.25), 2.18 (3.06), and 2.02 (2.70), respectively.

[b]** indicates mean of differences is statistically different than 0 at 5% level of significance; * indicates mean of differences is statistically different than 0 at 1% LOS.

Table 5.5

Initial estimated coefficients and likelihood-ratio tests of equality of production response between 3 and 3.5-inch ring dredges, F/V Carolina Dawn, 6/14-6/20/88

Form of output (Tows)	Ring Size	Coefficients[a] α_0	β_1	β_2	β_3	β_4	Chi-squared[b]
Baskets:							
1-10	3.0	607.3*[c]	2.4**	255.2*	-2.0**	-8.6*	
	3.5	150.7	2.2*	-64.5	-1.0	2.3	8.91 (5)
Pounds of meats:							
1-10	3.0	-426.0	2.1	179.3	-1.7	-6.0	
	3.5	80.7	2.4	-34.4	-1.2	1.3	9.11 (5)
Baskets:							
11-34	3.0	21.0	3.1**	-8.9	-2.3	.4	
	3.5	58.0**	2.5**	-25.2**	-.9	.9**	25.23(5)
Pounds of meats:							
11-34	3.0	33.4**	3.6**	-15.4	-3.0**	.7**	
	3.5	19.2	2.7*	-7.4	-1.5	.3	20.27(5)
Baskets:							
35-121	3.0	2.1	1.1	-1.2	-.6	.1**	
	3.5	7.0	.7	-3.2	-.1	.2	64.06(5)
Pounds of meats:							
35-121	3.0	-19.6	-.8	7.5	1.5	-.2	
	3.5	-8.2	-.4	3.0	1.1	-.02	31.85(5)

[a]The coefficients β_1, β_2, β_3, and β_4 are for the variables logarithm of effort, logarithm of depth, effort, and depth, respectively.

[b]Test of equality between all coefficients. Numbers in parentheses are degrees of freedom.

[c]* and ** indicate significant at 10 and 5% LOS.

indicated no difference in the technology of the 3 and 3.5-inch ring dredges without chafing gear. Significant differences were found for the cases of chafing gear without donut spacers and fully rigged dredges.

The large number of statistically insignificant parameters and apparent multicollinearity required additional estimation and testing. Final form estimates were determined by tests and are presented in Table 5.6. As indicated, only the technology for the unchafed 3 and 3.5-inch ring dredges were equivalent. However, the final form estimates indicate considerable similarities between the technologies of the different gear configurations (e.g., coefficients for effort and depth for chafed dredges without donuts were equal when output was measured in number of baskets).

In order to further assess relative harvesting efficiency, the average product of effort (catch per hour fished) for the 3 and 3.5-inch ring dredges and 3 gear configurations were estimated and compared (Table 5.7). Estimates were based on the mean values of effort and depth. Average product was estimated as follows:

$$\text{Average Product of Effort} = \frac{\text{Estimated catch} \mid \text{effort, depth}}{\text{Mean of Effort}}$$

where | indicates conditional evaluation of catch.

Estimated average products of the 3 gear configurations indicated that the 3-inch ring dredge was more

Table 5.6

Final form parameter estimates of the catch equation for 3 AND 3.5-inch ring dredges, F/V Carolina Dawn, 6/14-6/20/88

Form of output (Tows)	Ring Size	Coefficients[a] α_0	β_1	β_2	β_3	β_4
Baskets:						
1-10	3.0	0.0[b]	1.8**	-1.0**	-1.1**	.2**
	3.5	0.0	1.8**	-1.0**	-1.1**	.2**
Pounds of meats:						
1-10	3.0	0.0	1.8**	-.4**	-1.1**	.2**
	3.5	0.0	1.8**	-.4**	-1.1**	.2**
Baskets:						
11-34	3.0	40.8**	1.4**	-18.2**	0.0	.7**
	3.5	40.5**	1.4**	-18.2**	0.0	.7**
Pounds of meats:						
11-34	3.0	37.0**	4.2**	-14.4**	-3.7**	.6**
	3.5	0.0	4.2**	2.0**	-3.7**	0.0
Baskets:						
35-121	3.0	0.0	.6**	-.6**	0.0	.09**
	3.5	0.0	.6**	-.3**	0.0	.05**
Pounds of meats:						
35-121	3.0	0.0	1.7**	1.2**	-1.1**	0.0
	3.5	0.0	1.7**	1.1**	-1.1**	0.0

[a]The coefficients β_1, β_2, β_3, and β_4 are for the variables logarithm of effort, logarithm of depth, effort, and depth, respectively.

[b]* and ** indicate significant at 1 and 5% LOS.

Table 5.7

Estimated average products of effort and evaluation of relative harvesting efficiency, F/V Carolina Dawn, 6/14-6/20/88

Gear Configuration	Tows[a]	Estimated Average Product[b]	
		Baskets	Meat Weight
No chafing:			
3-inch rings	1-10	1.50	12.19
3.5-inch rings	1-10	1.50	12.19
Chafing without donut spacers:			
3-inch rings	11-34	2.59	23.64
3.5-inch rings	11-34	1.90	20.51
Fully rigged:			
3-inch rings	35-121	2.68	21.17
3.5-inch rings	35-121	2.05	16.46

[a]Estimated weights are based only on tows for which shell height data were obtained.

[b]Mean values for tow time and depth of the 3 gear configurations were, respectively, 1.08, .88, and .86 hours; 29.25, 30.65, and 29.92 fathoms.

efficient than was the 3.5-inch ring dredge except for the case of no chafing gear. Results derived from the estimated model were consistent with the results obtained from the paired t-tests. Although the catch equations were not estimated for the various cull scenarios, it is likely that the models would yield results consistent with the previous paired t-tests (Table 5.4). A peculiar result of the model, particularly with respect to the two gear configurations which involved chafing gear, was the differential effect of depth. A 1% increase in depth yielded a larger increase in harvested meat weight for the 3-inch ring dredge. Reasons for these differences are not known. They may accurately reflect differences due to gear or may simply be a result of the data and models.

F/V Carolina Dawn: 6/23-7/9/88

At the completion of the initial experiment aboard the F/V Carolina Dawn, the vessel conducted another experiment with the 3 and 3.5-inch ring dredges. During this portion of the experiment, the captain and crew were asked to examine possible gear configurations that would result in the 3.5-inch ring dredge fishing similar to the 3.0-inch ring dredge. This was further facilitated by exempting the vessel from the current meat count restriction of 30 MPP. However, the captain was advised that the use of a liner was prohibited.

A total of 293 tows were made with 3 gear configurations: (1) fully-rigged with chafing gear and donut spacers, (2) fully rigged with 1-inch twine woven through the rings of the first 5 rows on the apron, and (3) fully rigged with 1-inch twine woven through the rings of the first 5 rows of the apron and through the bottom panel (Table 4.1). Tow numbers corresponding to the 3 gear configurations were 1-7, 8-154, and 155-293, respectively. It is stressed, though, that results from this experiment should not be compared to results from the initial experiment since different resource areas were fished.

Data on baskets of scallops harvested, trash, fishing effort, and depth were collected for 279 of the 293 tows (Appendix II). Shell-height or size-frequency data were collected for 35 tows. Meat weight samples were not collected during this trip. Similar to the analysis of the initial experiment, technical efficiency was defined in terms of mean catch per hour and per tow and the catch-effort response coefficients.

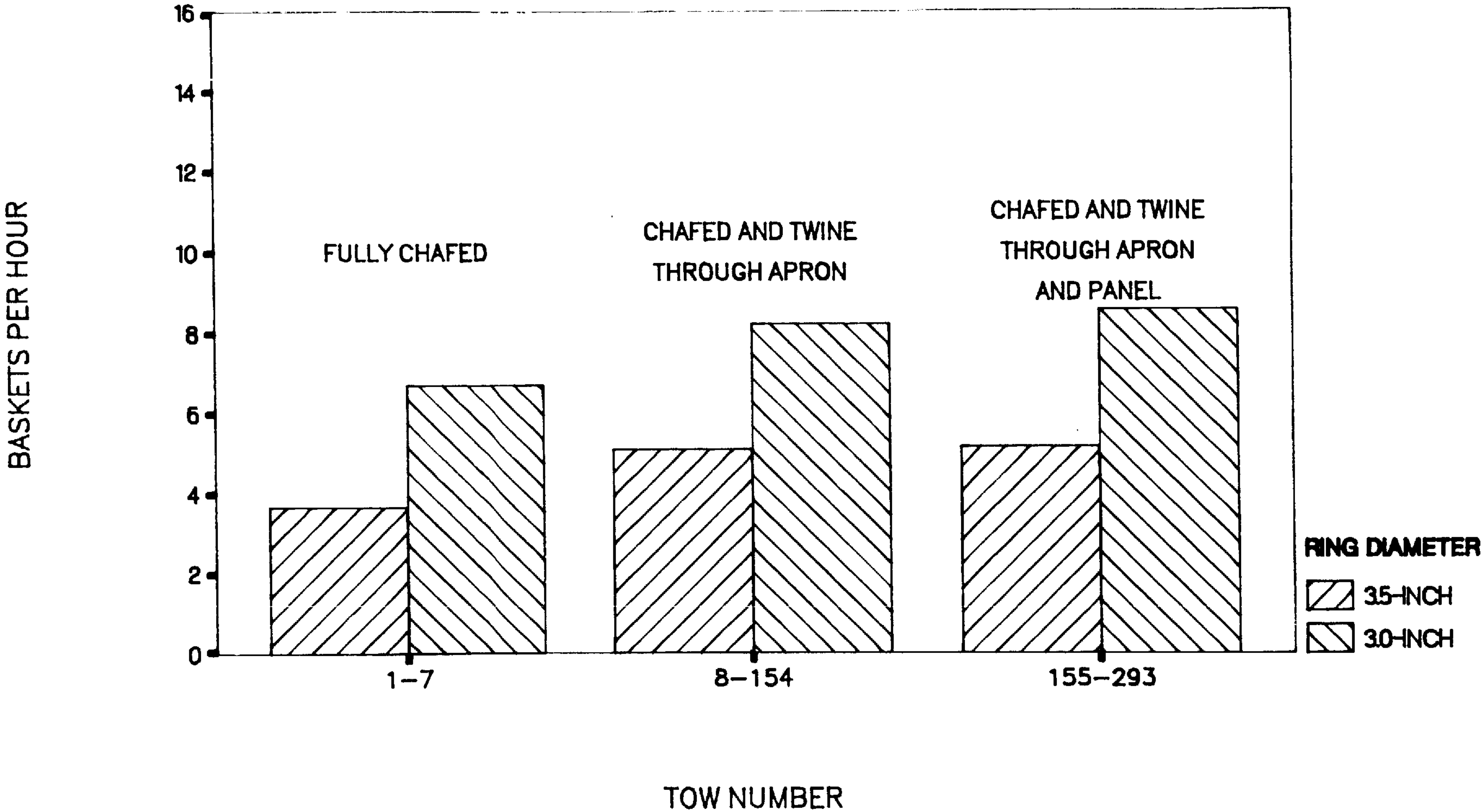
Catch per hour and per tow exhibited little variation for a given dredge and gear configuration. There were, however, differences between the catch of the 3 and 3.5-inch ring dredges and the 3 gear configurations (Table 5.8). Average catch per hour for the 3 and (3.5-inch) ring dredges and 3 gear configurations were as follows: (1) tows 1-7--6.7 (3.66) baskets per hour (BPH); (2) tows 8-154--8.21 (5.09) BPH; (3) tows 155-293--8.56 (5.15) BPH (Figure 5.4). Tow

Table 5.8

Number of baskets per hour and per tow for 3 and 3.5-inch ring dredges and 3 selected gear modifications, F/V Carolina Dawn, 6/23-7/9/88

Tows	Rings	Number of baskets		Coefficient of variation	
		Per hour	Per tow	Per hour	Per tow
Fully rigged					
1-7					
	3.0	6.70	5.39	38.45	39.87
	3.5	3.66	2.89	35.69	31.50
Fully rigged with twine through apron					
8-154					
	3.0	8.21	7.78	40.16	40.96
	3.5	5.09	4.82	52.53	53.64
Fully rigged with twine through apron and bottom panel					
155-293					
	3.0	8.56	8.29	35.31	27.57
	3.5	5.15	5.01	40.94	41.52

FIGURE 5.4. MEAN CATCH (BASKETS OF SCALLOPS) PER HOUR FOR SELECTED GEAR CONFIGURATIONS, 6/23–7/9/88



times varied between 22 (.37 hours) and 116 minutes (1.16 hours); average tow time was 57 minutes (.96 hours). However, the variation in tow time was quite small as indicated by a coefficient of variation of 12.1%.

Differences between the mean catch per hour and per tow suggested that the 3-inch ring dredge was more efficient than was the 3.5-inch ring dredge. This result applied to all 3 gear configurations. Although not statistically examined, the last gear modification did not appear to improve the catch with respect to the first gear modification (i.e., tows 155-293 vs. tows 8-154). However, modifications appeared to slightly improve the efficiency of the 3.5-inch ring dredge relative to the 3-inch ring dredge. The ratios of catch per hour by the 3.5-inch ring dredge to the catch per hour by the 3.0-inch ring dredge increased from 55% for tows 1-7 to 62% for tows 8-154, and 60% for tows 155-289.

The relative harvesting efficiency was further examined by statistical tests of the mean of differences (paired t-tests). The null and alternative hypotheses were

$$HO: \text{Mean}(CATCH_3 - CATCH_{3.5}) = 0$$

$$H1: \text{Mean}(CATCH_3 - CATCH_{3.5}) \neq 0$$

where HO and H1 are the null and alternative hypotheses and mean catch is the mean of the catch per tow or per hour for the respective dredge. The hypothesis that the mean of differences was greater than zero was also tested. Calculated t-statistics are presented in Table 5.9.

Table 5.9

Results of statistical tests of the mean of differences of catch between 3 and 3.5-inch ring dredges

Tows	Baskets per hour		Baskets per tow	
	T-value[a]	Degrees of freedom	T-value	Degrees of freedom
Fully rigged				
1-7	3.13	6	3.15	6
Fully rigged with twine through apron				
8-154	14.29	135	14.31	135
Fully rigged with twine through apron and bottom panel				
155-293	19.44	135	19.64	135

[a]Critical values for two tailed tests at 5% level of significance with 6 and 135 degrees of freedom are 2.45 and 1.96, respectively. Tests based only on data for which catch of 3 and 3.5-inch ring dredges were both nonzero.

Statistical tests rejected the null hypothesis for all cases. Results suggested that catch per hour and per tow for both dredges were statistically different. Moreover, the calculated t-values compared to the one-tailed critical values indicated that the 3-inch ring dredge was more efficient than the 3.5-inch ring dredge for all gear modifications.

Relative harvesting efficiency between the 3 and 3.5-inch ring dredges was also examined using estimated production technologies. The transcendental model, as in the initial experiment, was assumed to characterize the technology. Estimation was accomplished by iterative seemingly unrelated regression and ordinary least squares available on LIMDEP (Green 1985). Likelihood-ratio tests were used to determine the characteristics of the technology. However, results should be examined with caution; system R^2's, particularly for tows 8-154 and 155-293, were quite low.

Likelihood-ratio tests indicated that production responses for the 3 and 3.5-inch ring dredges were different (Table 5.10). The null hypothesis that the estimated coefficients for the 3 and 3.5-inch ring dredges were equal was rejected for all 3 gear modifications. Additional estimation was conducted to obtain final estimates (Table 5.11)

As indicated by the estimated coefficients of the production technology, the technologies corresponding to the 3 and 3.5-inch ring dredges were different. There were, however, similarities between the technologies of both

Table 5.10

Chi-squared statistics for tests of the equality of the production technology of 3 and 3.5-inch ring dredges, F/V Carolina Dawn, 6/24-7/9/88

Tows	Chi-square[a]	Degrees of freedom	Critical chi-square	
			5% LOS	1% LOS
Fully rigged				
1-7	15.85	5	11.07	15.09
Fully rigged with twine through apron				
8-154	145.46	5	11.07	15.09
Fully rigged with twine through apron and bottom panel				
155-293	216.75	5	11.07	15.09

[a]Tests that all estimated parameters of equation for 3-inch ring dredge equal parameters of equation for 3.5-inch ring dredge. Estimates and tests based only on tows with nonzero catch by 3 and 3.5-inch ring dredges.

Table 5.11

Final form estimates of the production technologies for the 3 and 3.5-inch ring dredges and selected gear modifications, F/V Carolina Dawn, 6/23-7/9/88

Tows	Ring Size	Variables and parameters[a]				
		Constant α_0	log(hours) α_1	log(depth α_2	hours α_3	depth α_4
Fully rigged						
1-7						
	3.0	0.00	119.15	58.81	-157.70	-1.55
			(5.88)	(5.72)	(5.85)	(5.20)
	3.5	0.00	116.83	58.81	-159.10	-1.55
			(5.78)	(5.72)	(5.90)	(5.20)
Fully rigged with twine through apron						
8-154						
	3.0	-87.52	.58	37.15	0.00	-1.23
		(2.12)	(2.56)	(2.22)		(2.32)
	3.5	-168.24	.58	68.81	0.00	-2.14
		(3.78)	(2.56)	(3.80)		(3.76)
Fully rigged with twine through apron and bottom panel						
155-293						
	3.0	-143.94	3.53	61.29	-3.61	-1.96
		(3.43)	(2.18)	(3.56)	(2.07)	(3.55)
	3.5	-59.51	2.46	25.37	-2.16	-.77
		(1.30)	(1.39)	(1.35)	(1.13)	(1.27)

[a]System R^2 values for tows 1-7, 8-154, and 155-293 are 59, 14, and 9%, respectively. Asymptotic t-statistics are in parentheses.

unmodified dredges (tows 1-7) and for the gear with twine woven through the first 5 rows of the apron (tows 8-154). For the unmodified gear, the influence of effort on catch was nearly equal for both dredges; the influence of depth was equal. The influence of effort on catch for the gear modified by weaving twine through the first 5 rows (tows 8-154) was approximately equal for both dredges; however, the effects varied by the value of the constant term.

Relative harvesting efficiency in terms of estimated catch (baskets) per hour fished as derived from the models indicated that the 3-inch ring dredge was more efficient that the 3.5-inch ring dredge (Table 5.12). However, the estimates should be interpreted with caution; the models did not provide a good fit of the data. Estimates obtained from the models, however, were consistent with observed data.

In conclusion, analyses indicated that the 3-inch ring dredge was more efficient in terms of baskets of scallops harvested. The precision of the relative efficiency was difficult to determine, however, because of variations in hours, resource areas, and bottom depth. Moreover, the evaluation of relative efficiency should consider harvested meat weight; these data were not collected for this part of the experiment.

F/V Carolina Capes: 9/22-9/27/88

In September 1988, the dredge experiment was repeated. Objectives were to determine whether or not

Table 5.12

Estimated relative efficiency of 3 and 3.5 inch ring dredges as measured by baskets per hour fished[a]
F/V Carolina Dawn, 6/23-7/9/88

Tow numbers	Baskets per hour fished		Relative efficiency %[b]
	3-inch ring	3.5-inch ring	
Fully rigged			
1-7	2.40	1.98	121
Fully rigged with twine through apron			
8-154	6.79	5.55	122
Fully rigged with twine through apron and bottom panel			
155-293	8.65	4.75	182

[a]Estimates are conditional on observed mean values for hours fished and bottom depth; average hours fished for tows 1-7, 8-154, and 155-279 were, respectively, .80, .95, and .98 hours; average depth for the three groups of tows were, respectively, 34.07, 31.64, and 30.32 fathoms.

[b]Relative efficiency measured by ratio of baskets per hour by 3-inch ring dredge to baskets per hour by 3.5-inch ring dredge.

results would be similar to those obtained in June and to further assess the 3.5-inch ring dredge. The same resource areas and gear configurations were investigated (Table 4.2). If technical efficiency and relative size selectivity were different between June and September, use of the 3.5-inch ring dredge to regulate the fishery would have to be assessed relative to varying resource and weather conditions.

A total of 136 tows were made with 3 gear configurations: (1) no chafing gear (tows 1-28), (2) chafing gear without donut spacers (tows 29-92), and (3) chafing gear with donut spacers (fully rigged) (tows 93-136) (Appendix III). Since the experiment was conducted in the same resource areas as the initial June experiment, results of the June and September experiments were compared.

Catch and effort data were recorded for most tows; shell height data were recorded for a subset of tows in which catch and effort were recorded. The number of tows for which catch and effort and shell height data were recorded was: (1) 27 and 61 for no chafing gear, (2) 57 and 30 for chafing gear without donut spacers, and (3) 41 and 31 for fully rigged dredges. Meat weight and meat count data were estimated using the estimated relationship between weight and shell-height which was previously discussed.

Total effort or tow time varied between 15 and 60 minutes with a mean of 40.05 (Table 5.13). Most tows were between 30 and 45 minutes duration. Total catch by the 3-inch ring dredge varied between 0.5 and 9 baskets per

Table 5.13

Catch and effort for 3 AND 3.5-inch ring dredges for selected gear modifications, F/V Carolina Capes, 9/22-9/27/88

Tow number	Effort minutes	Baskets per hour	
		3-inch rings	3.5-inch rings
No chafing gear			
1-28			
Minimum	20	.50	.50
Maximum	60	9.00	5.70
Average	41	2.44	1.87
Coefficient of variation	16	74.74	55.93
Chafing gear no donut spacers:			
29-92			
Minimum	15	1.05	.75
Maximum	50	6.60	4.20
Average	40	2.36	1.70
Coefficient of variation	13	44.24	36.00
Fully rigged:			
93-136			
Minimum	30	1.50	1.00
Maximum	60	3.45	2.63
Average	41	2.27	1.67
Coefficient of variation	10	21.30	19.38
All tows:			
1-136			
Minimum	15	.50	.50
Maximum	60	9.00	5.70
Average	40	2.35	1.73
Coefficient of variation	13	48.00	38.33

hour; catch by the 3.5-inch ring dredge varied between .5 and 5.7 baskets per hour (Figure 5.5). There was more variation in the catch of the 3-inch ring dredge. Mean meat weight or pounds of meats per hour for the 3 and (3.5)-inch ring dredges and 3 gear configurations were, respectively, 19.87 (14.24), 20.43 (13.51), and 19.22 (12.87) (Table 5.14).

As a result of inadequate variation in either effort or catch, it was not possible to estimate the relationship between catch and effort. Analysis of technical efficiency was, thus, limited to a statistical analysis of the equality of the mean number of baskets and meat yield per hour fished (Table 5.15). The number of baskets and pounds of meats per hour were statistically different between the 3 and 3.5-inch ring dredges for chafed without donuts and fully rigged dredges. The results were inconclusive for unchafed dredges. Significant differences were found at the 1% level of significance and no differences were found at the 5% level.

In the September and June experiments, the 3-inch ring dredge was technically more efficient than was the 3.5-inch ring dredge (Table 5.16). This result applied to all 3 gear configurations. Interestingly, the relative efficiency, ratio of catch by 3-inch ring dredge to catch of 3.5-inch ring dredge, of the 3-inch ring dredge increased between June and September when pounds of meats were used to measure output. When baskets were used as the output measure, there was little difference in the relative efficiency between June and September. Except for unchafed gear, the

FIGURE 5.5. MEAN CATCH (BASKETS OF SCALLOPS) PER HOUR FOR SELECTED GEAR CONFIGURATIONS, 9/22–9/27/88

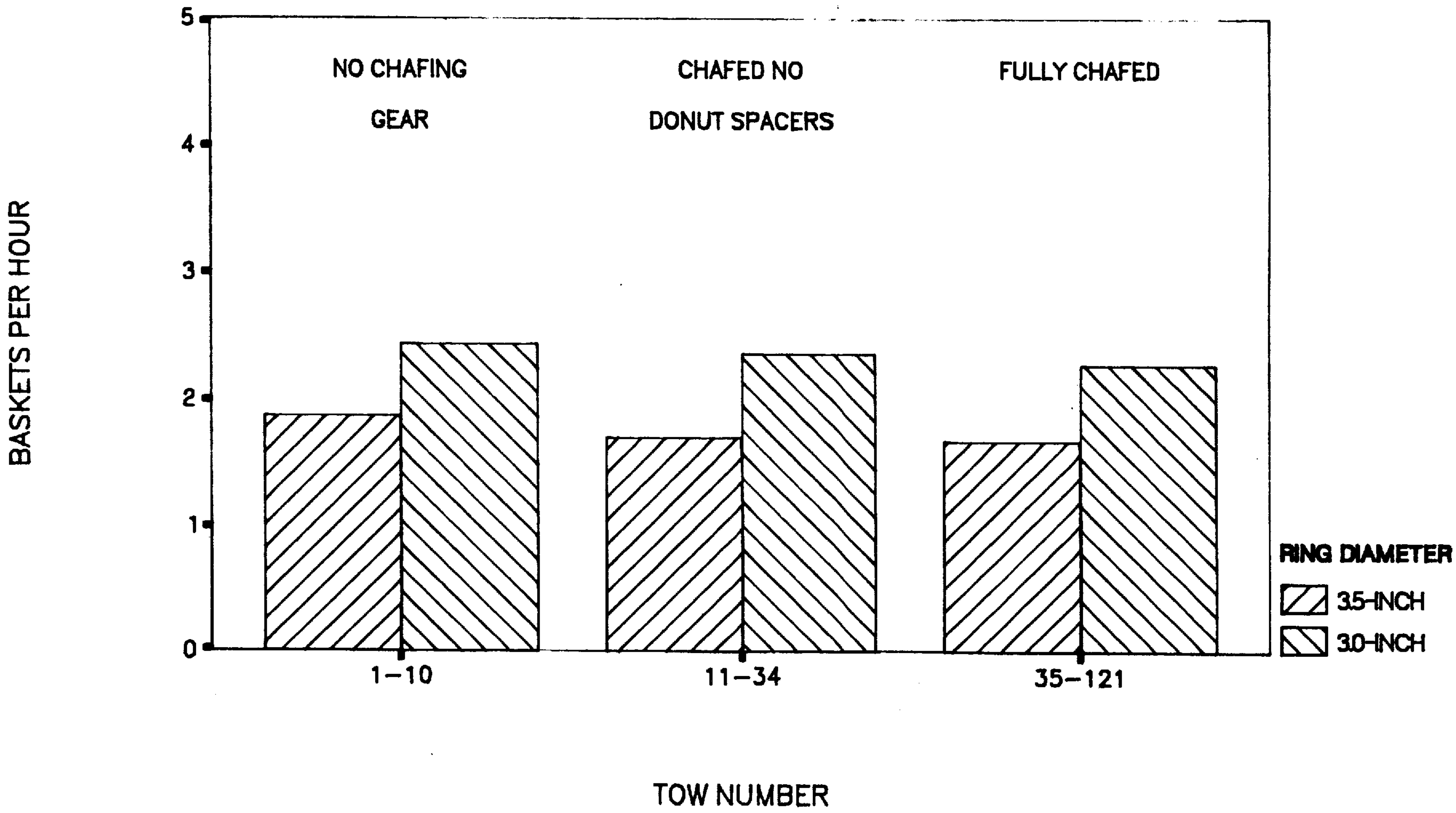


Table 5.14

Mean of meat weight (pounds) per hour for 3 gear modifications, F/V Carolina Capes, 9/22-9/27/88

Tow numbers	Pounds of meats per hour	
	3.0-inch ring dredge	3.5-inch ring dredge
No chafing gear		
1-28	19.87	14.24
Chafing gear and no donut spacers		
29-92	20.43	13.51
Fully rigged		
93-136	19.22	12.87

Table 5.15

Results of paired t-tests that mean of differences equals zero, F/V Carolina Capes, 9/22-9/27/88

Gear configuration (tows #'s)	Baskets per hour		Pounds of meats per hour	
	t-value	degrees of freedom	t-value	degrees of freedom
No chafing				
1-28	-3.38	26	-2.37	15
Chafing no donuts				
29-92	-6.87	56	-5.64	28
Fully rigged				
93-136	-9.80	40	-9.68	30

[a]HO: mean($CATCH_{3.5\ RING}$ - $CATCH_{3.0\ RING}$) = 0

H1: mean($CATCH_{3.5\ RING}$ - $CATCH_{3.0\ RING}$) ≠ 0

[b]Critical t-values at the 5% LOS for 26, 15, 56, 28, 40, and 30 degrees of freedom are 2.056, 2.131, 1.96, 2.048, 1.96, and 2.042.

Table 5.16

Baskets and pounds of meat per hour for June and September experiments

Gear	Ring size	Baskets per hour		Pounds per hour	
		June	September	June	September
No chafing					
	3.0	1.62	2.44	13.48	19.87
	3.5	1.38	1.87	10.69	14.24
Relative efficiency[a]		1.17	1.30	1.26	1.40
Chafing no donuts					
	3.0	3.30	2.36	25.42	20.43
	3.5	2.38	1.70	18.43	13.51
Relative efficiency[a]		1.39	1.39	1.38	1.51
Fully rigged					
	3.0	2.97	2.27	22.26	19.22
	3.5	2.15	1.67	16.38	12.87
Relative efficiency[a]		1.38	1.36	1.36	1.49

[a]Ratio of catch by 3-inch ring dredge to catch by 3.5-inch ring dredge.

relative efficiency exhibited little variation regardless of gear configuration and month of experiment.

In comparison to the June results, a different pattern of efficiency characterized the September experiment when different cull sizes were considered. In June, the meat yield per hour for scallops culled at 90 mm. was higher for the 3.5-inch ring dredge and chafed dredges. In September, meat yield associated with the 3-inch ring dredge was larger for all cull sizes and gear configurations (Figure 5.6).

Potential losses in yield for the 3 gear configurations and selected cull sizes were generally larger than the estimated potential losses for the June experiment (Table 5.17). In particular, losses associated with the 3.5-inch ring dredge were consistently larger; losses associated with cull sizes varied. Statistical tests of differences in pounds per hour for the various cull sizes and gear configurations indicated that the unchafed 3 and 3.5-inch ring dredges were the only gear configurations in which there were no differences in pounds per hour (Table 5.18). Conflicting results were obtained at different levels of significance.

F/V Carolina Capes: 9/29-10/13/88

The Carolina Capes continued the gear experiment between 9/29 and 10/13. During this part of the experiment, the vessel was exempted from all regulations. The only conditions imposed on the captain and crew were as follows: (1) they had to record baskets of scallops and trash caught

FIGURE 5.6. ESTIMATED POUNDS OF MEAT FOR VARIOUS RING DIAMETERS AND SELECTED CULL SIZES AND GEAR CONFIGURATIONS

SEPTEMBER 22-27, 1988

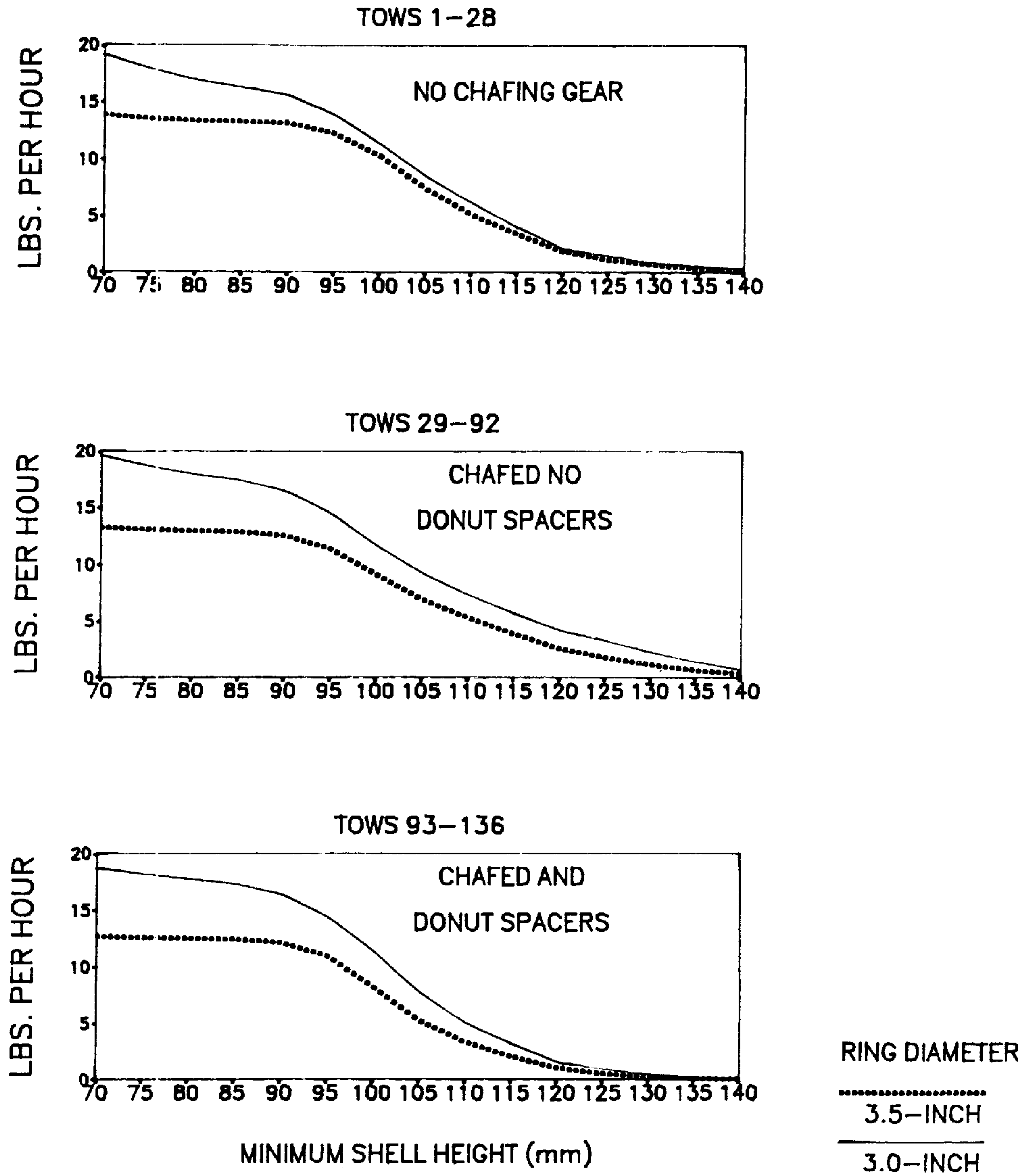


Table 5.17

Pounds of meats per hour for selected cull sizes and gear modifications, F/V Carolina Capes, 9/22-9/27/88

Tow number	Ring size	Pounds of meat per hour						
		No culling	Cull @ 70 mm.	%[a]	Cull @ 80 mm.	%	Cull @ 90 mm.	%
Unchafed								
1-28								
	3.0	19.87	19.12	-3.77	16.87	-15.10	15.61	-21.44
	3.5	14.24	13.90	-2.39	13.38	-6.04	13.17	-7.51
% change 3 vs. 3.5		-28.33	-27.30		-20.69		-15.63	
Chafed no donuts:								
29-92								
	3.0	20.43	19.56	-4.26	17.95	-12.14	16.46	-19.43
	3.5	13.51	13.30	-1.55	13.03	-3.55	12.61	-6.66
% change 3 vs. 3.5		-33.87	-32.00		-27.41		-23.39	
Fully rigged:								
92-136								
	3.0	19.22	18.71	-2.65	17.73	-7.75	16.41	-14.62
	3.5	12.87	12.72	-1.17	12.57	-2.33	12.17	-5.44
% change 3 vs. 3.5		-33.04	-32.01		-29.10		-25.84	

[a]Percent change in weight from culling.

Table 5.18

Results of paired t-tests that mean of differences equals zero, F/V Carolina Capes, 9/22-9/27/88

Culling Gear configuration (tow #'s)	Pounds of meats per hour	
	t-value	degrees of freedom
No culling		
No chafing	-2.37	15
Chafing without donuts	-5.64	28
Fully rigged	-9.68	30
Culling @ 70 mm.:		
No chafing	-2.34	15
Chafing without donuts	-5.76	28
Fully rigged	-9.94	30
Culling @ 80 mm.:		
No chafing	-2.54	15
Chafing without donuts	-5.97	28
Fully rigged	-9.92	30
Culling @ 90 mm.:		
No chafing	-2.47	15
Chafing without donuts	-5.78	28
Fully rigged	-9.13	30

[a]HO: mean($CATCH_{3.5\ RING}-CATCH_{3.0\ RING}$) = 0
H1: mean($CATCH_{3.5\ RING}-CATCH_{3.0\ RING}$) $\neq$ 0

for each dredge, meat counts for each bag-up, effort, bottom depth, Loran, and time of day, and (2) they had to continued using the 3 and 3.5-inch ring dredges without modification.

A total of 316 tows were made by the vessel; however, only 284 tows provided adequate data (Appendix IV). Similar to the preceding trip, there was little variation in effort (Table 5.19). Tow time ranged from 30 to 65 minutes with a mean of 47 minutes; the coefficient of variation was only 11.8%. The most common tow time was 50 minutes; 40 and 45 minute tows were also quite common. Over all tows, the 3-inch ring dredge was approximately 122% more efficient than was the 3.5-inch ring dredge. Average catch per hour of the 3 and 3.5-inch ring dredges were 9.61 and 4.39 baskets, respectively. The average of the ratio of the catch by the 3-inch ring dredge to the catch by the 3.5-inch ring dredge was 2.51. Average depth fished was 30.9 fathoms.

Tows were divided into 3 groups based on resource areas fished (Table 4.2). Resource areas and tow numbers were as follows: (1) New Jersey-New York (tows 1-201), (2) New Jersey-New York (tows 226-285), and (3) Delaware, Maryland, and Virginia (tows 287-316). Except for the last set of tows, 287-316, results of tows in the two New Jersey-New York resource areas were quite similar (Table 5.19). However, the relative efficiency and average length of tow were lower for tows 226-285, which was the more southern resource area of the two New Jersey-New York areas.

In all three resource areas, the 3-inch ring dredge

Table 5.19

Catch, effort, depth, and relative efficiency of 9/29-10/13/88 experiment, F/V Carolina Capes

Resource areas (Tow numbers)	Minimum	Average	Maximum	Coefficient of variation
New Jersey-New York (Tows 1-201)				
Catch (3.0-inch)	2.80	8.03	16.00	36.88
Catch (3.5-inch)	.50	3.13	8.50	39.56
Effort (minutes)	30.00	48.10	65.00	11.30
Depth (fathoms)	27.50	30.73	34.50	5.25
Relative efficiency[a]	1.25	2.85	22.00	64.38
New Jersey-New York (Tows 226-285)				
Catch (3.0-inch)	2.80	8.56	17.00	52.62
Catch (3.5-inch)	1.00	5.30	10.00	53.52
Effort (minutes)	30.00	43.14	55.00	10.52
Depth (fathoms)	32.00	32.24	32.50	.78
Relative efficiency	1.00	1.70	3.50	25.63
Delaware-Maryland-and Virginia (Tows 287-316)				
Catch (3.0-inch)	1.00	1.55	2.10	23.30
Catch (3.5-inch)	.10	1.07	1.75	30.16
Effort (minutes)	35.00	47.67	55.00	10.21
Depth (fathoms)	29.00	29.33	29.50	.82
Relative efficiency	.67	1.90	15.00	131.71
All areas and tows				
Catch (3.0-inch)	1.00	7.46	17.00	50.85
Catch (3.5-inch)	.10	3.36	10.00	60.15
Effort (minutes)	30.00	47.02	65.00	11.82
Depth (fathoms)	27.50	30.89	34.50	5.07
Relative efficiency	.67	2.51	22.00	71.77

[a]Relative efficiency measured by ratio of catch by 3.0-inch ring dredge to catch of 3.5-inch ring dredge.

was technically more efficient than was the 3.5-inch ring dredge (Table 5.20). Statistical tests that the mean of differences equalled zero indicated that catch per hour was different for the two dredges and the 3-inch ring dredge was technically superior. T-values corresponding to the three resource areas were -30.07 (194), -11.56 (58), and -6.59 (29), respectively; degrees of freedom are in parentheses.

Similar to preceding experiments, catch models were specified and estimated. The models were further tested to determine the relative efficiency. However, since catches were from a wide geographic area, Loran readings were included as indicators of latitude and longitude:

$$Catch_{3.0} = f(\text{effort, loran1, loran2, depth})$$

$$Catch_{3.5} = f(\text{effort, loran1, loran2, depth})$$

where loran1 and loran2 corresponded to longitude and latitude, effort was minutes of tow time, and depth was the mean depth (fathoms) over each tow. Final form estimates corresponding to the three resource areas appear in Table 5.21.

Estimates of the catch equations impose rather odd restrictions on the technology. The estimated catch equation for the 3.5-inch ring dredge for tows 1-201 and both catch equations for tows 226-285 suggest that effort has no effect on catches. This was believed to be a result of inadequate variation in effort or the fact that tows tended to be of fixed duration (e.g., 40 and 50 minute tows). Alternatively, this could have resulted from gear saturation (e.g., maximum

Table 5.20

Mean number of baskets per hour for selected resource areas, F/V Carolina Capes, 9/29-10/13/88

Resource areas (Tow numbers)	Mean number of baskets per hour	
	3.0-inch rings	3.5-inch rings
New Jersey-New York (Tows 1-201)	10.07	3.95
New Jersey-New York (Tows 226-285)	12.01	7.40
Delaware-Maryland-and Virginia (Tows 287-316)	1.96	1.36

Table 5.21

Final form estimates of the catch equations for the 3 and 3.5-inch ring dredges, F/V Carolina Capes, 9/29-10/13/88

Resource areas (Tow numbers)	Ring size	Constant α_0	Effort β_1	Loran1 β_2	Loran2 β_3	Depth β_4
New Jersey-New York (Tows 1-201)	3.0	2458.96	.082	-.061	-.020	.26
		(5.39)[a]	(2.72)	(7.77)	(3.29)	(4.18)
	3.5	753.48	.002	-.019	-.006	.26
		(3.38)	(.15)	(5.03)	(1.89)	(4.18)
New Jersey-New York (Tows 226-285)	3.0	-4178.84	0.00	.150	0.00	9.75
		(8.83)		(8.50)		(6.30)
	3.5	-2829.02	0.00	.099	0.00	6.17
		(10.40)		(10.06)		(6.94)
Delaware-Maryland-and Virginia (Tows 287-316)	3.0	Unable to determine appropriate model				
	3.5					

[a]Numbers in parentheses are asymptotic t-statistics.

catch occurred during the first 15 to 30 minutes). However, it is believed that inadequate variation was the reason for the insignificant relationship between catch and effort.

Results of the estimation of the catch equations do not clearly indicate relative technical efficiency. Examination of the relative efficiency, however, can be accomplished by comparing estimated catches for the two dredges conditional on equal values of effort, loran, and depth (Table 5.22). As indicated, the 3.0 inch ring dredge was more efficient in terms of catch per tow. This was consistent with results of the three previous experiments.

Conclusions: Technical efficiency

As indicated by the analyses, the 3.0-inch ring dredge was more efficient than the 3.5-inch ring dredge. Relative efficiency, however, varied with resource conditions (abundance and size composition), time of year, and weather conditions. Results also indicated that industry would experience losses in pounds of meats harvested if they were required to use 3.5-inch ring dredges; estimated losses ranged from approximately 26 to 33-percent. Losses would, though, be relatively short lived; scallops not harvested by the 3.5-inch ring dredge would advance in age and size and be available for harvesting in the future.

Results obtained from different gear configurations suggested that the use of donut spacers may not, in fact, improve harvesting efficiency. Catches with chafed dredges

Table 5.22

Estimated catch by 3.0 and 3.5-inch ring dredges, F/V Carolina Capes, 9/29-10/13/88

Resource areas (Tow numbers)	Estimated catch by ring size	
	3.0-inch	3.5-inch
	Baskets of scallops	
New Jersey-New York (Tows 1-201)[a]	8.03	3.13
New Jersey-New York (Tows 226-285)[b]	8.56	5.31

[a]Mean of effort, loran1, loran2, and depth equal 48.10 minutes, 26377.3, 43242.8, and 30.73 fathoms.

[b]Mean of effort, loran1, loran2, and depth equal 43.14 minutes, 26500, 43012, and 32.24 fathoms.

without donut spacers were typically higher than catches with fully rigged dredges. Additional experimentation on the effects of donut spacers on catch, however, is necessary before definitive conclusions can be derived. Results presented in this study were based on different resource areas which may have affected the catches.

Last, attempts by the captain and crew to modify the 3.5-inch ring dredge to mitigate the escapement of small scallops appeared unsuccessful. The 3.0-inch ring dredge harvested more scallops than did the 3.5-inch ring dredge, regardless of the modification (Table 5.12). These results suggest that the 3.5-inch ring dredge offers considerable promise for reducing fishing mortality.

Size selectivity

In general, selectivity is any factor that causes the size composition of a catch to be different than that of the fish population (Pope et al. 1975). Alternatively, it is those factors which cause fishing mortality to vary with size or other physical and behavioral characteristics. In mathematical terms, size selectivity equals the catchability coefficient, q_{ij}, for each size (i) of fish from the standard fishing mortality (F_{ij}) equation:

$$F_{ij} = q_{ij} \cdot f_j$$

where f is effort and j is the j^{th} gear type. A plot of q_{ij} against size yields the form of selectivity.

Typically, q_{ij} is difficult to measure in absolute terms, but relative measures may be obtained. If another gear (k) is used and the catches by the two gears of fish size i are given by C_{ij} and C_{ik}, relative size selectivity can be determined as follows:

$$C_{ij}/C_{ik} = F_{ij}/F_{ik} = (q_{ij}/q_{ik}) * (f_j/f_k)$$

The ratio of the two catches permits the selectivity of one gear relative to the other to be determined.

Size selectivity of the 3.5-inch ring dredge relative to the 3.0-inch ring dredge is examined in this study. The 3.0-inch ring dredge is the more common size dredge used in the commercial United States Atlantic sea scallop, Placopecten magellanicus, fishery. It is stressed, however, that the form of size selectivity examined in this study is relative size selectivity; thus, it is not a true measure of size selectivity.

The closely similar mesh method of Davis (1934) was used to collect the data for examining size selection. However, the alternate haul method was used to estimate relative size selectivity. Both approaches have problems with respect to estimating size selectivity (Beverton and Holt 1957; FAO 1960; Pope et al. 1975; Caddy 1968; Serchuk and Smolowitz 1980). Moreover, Beverton and Holt (1957) demonstrated that estimates of the 50% retention points based on the alternate haul method applied to closely similar mesh (ring) sizes are biased and incorrect estimates of the true 50% retention points.

Determination of relative size selectivity was based on data obtained during two June experiments and one September experiment. Shell heights for 5 mm. (0.2-inches) intervals were recorded for 1 to 3 baskets per dredge per tow. These data were collected for all gear and resource area combinations. Relative size selectivity was subsequently examined with respect to the June and September experiments.

Relative size selectivity was estimated by the procedures of Hodder and May (1965), Pope et al. (1975), and Serchuk and Smolowitz (1980). Ratios of the number of scallops, by size, obtained in the 3.5-inch ring dredge to the number of scallops in the 3.0-inch ring dredge were computed for 5 mm. shell height intervals. The ratios were subsequently smoothed by a moving geometric mean of 3; the upper asymptote of the size selectivity curve for each gear configuration was estimated by taking the geometric mean of the ratios over several shell height intervals at which the catch of the 3.5-inch ring dredge exceeded the catch of the 3.0-inch ring dredge.

Percent retention was adjusted by dividing the value of smoothed retention by the value of the geometric mean of the 3-point geometric means which exceeded 1. Selection points corresponding to 25%, 50%, and 75% retention values were estimated by linear regressions of logits. It is stressed that these estimates are not true estimates of size selection or % retention heights. Moreover, estimates are subject to error because of the use of estimated number of scallops for a given shell size in a tow. It was necessary to estimate number of scallops because it was not practical to measure all scallops from a particular tow.

Relative size selectivity: June 1988

In June, size or shell height frequency data were obtained from 102 tows; 67 were from the initial experiment aboard the F/V Carolina Dawn, and 35 were from the second part of the experiment. Gear configurations and tow numbers were previously discussed in the section on technical efficiency.

F/V Carolina Dawn: 6/14-6/20/88

During the initial June experiment, shell height data for 5 mm shell height intervals were obtained for 57,034 scallops. In terms of the 3 gear configurations, shell height frequency data were summarized for 7116, 11148, and 38770 scallops, respectively (Table 5.23). The corresponding number of scallops used for analyses were 7116, 16109, and 47008, respectively; differences are the result of the need to estimate total number of scallops because of sub-sampling. As expected, the 3-inch ring dredge consistently harvested a larger proportion of small scallops, and the 3.5-inch ring dredge harvested a larger proportion of large scallops (Figure 5.7)

Table 5.23

Number and cumulative percent of scallops caught by 3 and 3.5-inch ring dredges, F/V Carolina Dawn, 6/14-6/20/88

	Unchafed				Chafed without donut spacers				Fully rigged			
Shell size	Number of scallops		Cumulative percent		Number of scallops		Cumulative percent		Number of scallops		Cumulative percent	
	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5
12.5									3		.0	
17.5									5		.0	
22.5									9		.1	
27.5					2		.0		15		.1	
32.5					10		.1		74	2	.4	.0
37.5					52	3	.6	.1	191	10	1.0	.1
42.5	1	1	.0	.0	145	6	2.0	.2	416	36	2.3	.3
47.5	25	2	.6	.1	245	35	4.4	.8	601	69	4.3	.7
52.5	80	18	2.6	.7	248	44	6.7	1.6	795	106	6.8	1.4
57.5	74	26	4.3	1.6	129	65	8.0	2.7	452	115	8.3	2.1
62.5	142	35	7.8	2.8	200	47	9.9	3.6	917	141	11.3	3.0
67.5	55	6	9.1	3.0	52	13	10.4	3.8	607	111	13.2	3.7
72.5	21	5	9.6	3.1	125	33	11.6	4.4	639	123	15.3	4.4
77.5	51	14	10.8	3.6	627	122	17.5	6.5	1987	388	21.7	6.8
82.5	262	52	17.2	5.3	1926	366	35.9	13.0	5234	995	38.7	13.0
87.5	568	160	30.9	10.7	2097	594	55.9	23.6	5873	1696	57.7	23.5
92.5	830	416	50.9	24.7	1482	707	70.1	36.2	4491	2317	72.2	37.9
97.5	715	568	68.2	43.8	947	805	79.1	50.4	2860	2548	81.5	53.7
102.5	460	601	79.3	64.0	675	843	85.5	65.4	1814	2356	87.4	68.3
107.5	346	470	87.7	79.7	509	624	90.4	76.5	1298	1811	91.6	79.5
112.5	244	309	93.6	90.1	391	444	94.1	84.4	1060	1304	95.0	87.6
117.5	152	174	97.3	96.0	295	388	96.9	91.3	707	916	97.3	93.3
122.5	41	51	98.2	97.7	85	230	97.8	95.4	221	417	98.0	95.9
127.5	32	36	99.0	98.9	121	124	98.9	97.6	209	256	98.7	97.5
132.5	17	18	99.4	99.5	42	52	99.3	98.5	157	155	99.2	98.5
137.5	12	10	99.7	99.8	26	26	99.6	98.9	94	102	99.5	99.1
142.5	7	2	99.9	99.9	20	33	99.7	99.5	71	75	99.7	99.6
147.5	2	3	99.9	100.0	20	12	99.9	99.7	49	48	99.9	99.9
152.5	2		100.0		4	7	100.0	99.9	19	19	99.9	100.0
157.5						6	100.0	100.0	15	2	100.0	100.0
162.5					2	2	100.0	100.0	4	1	100.0	100.0
167.5					1		100.0		2		100.0	
172.5												
Total[a]	4139	2977			10479	5630			30890	16119		

[a]Number of scallops actually measured were 4139, 2977, 6491, 4657, 23404, and 15366.

Figure 5.7

PERCENT SIZE FREQUENCY OF SCALLOPS, 6/14–6/20/88

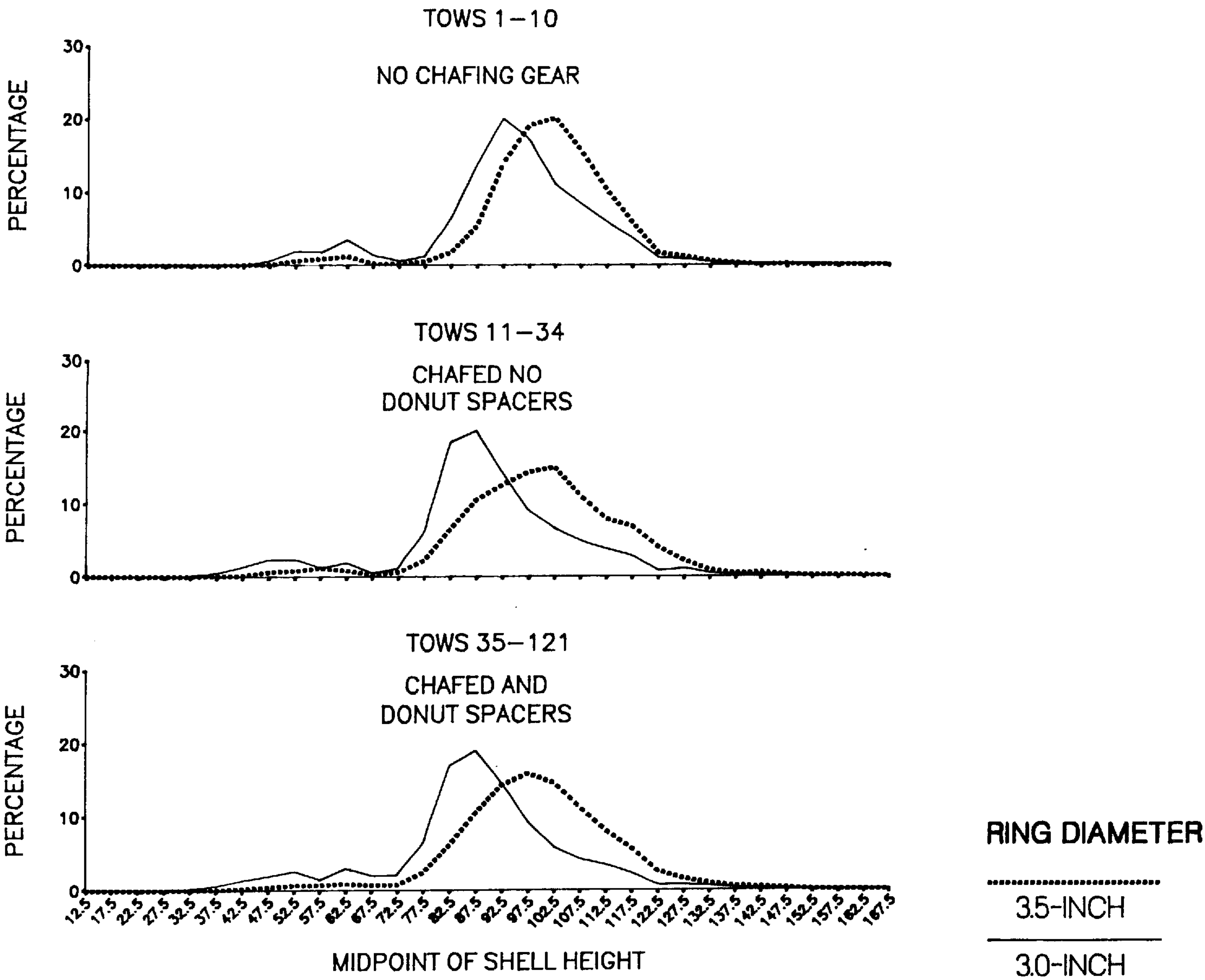


Table 5.24

Percent size frequency of selected gear configurations,
F/V Carolina Dawn, 6/14-6/20/88

Shell size	Percent of total catch					
	Unchafed		Chafed without donuts spacers		Fully rigged	
	3.0	3.5	3.0	3.5	3.0	3.5
12.5					.0	
17.5					.0	
22.5					.0	
27.5					.1	
32.5			.1		.2	.0
37.5			.4	.1	.6	.1
42.5	.0	.0	1.4	.1	1.4	.2
47.5	.6	.1	2.3	.6	2.0	.4
52.5	1.9	.6	2.4	.8	2.6	.7
57.5	1.8	.9	1.2	1.2	1.5	.7
62.5	3.4	1.2	1.9	.8	3.0	.9
67.5	1.3	.2	.5	.2	2.0	.7
72.5	.5	.2	1.2	.6	2.1	.8
77.5	1.2	.5	6.0	2.2	6.4	2.4
82.5	6.3	1.8	18.4	6.5	16.9	6.2
87.5	13.7	5.4	20.0	10.6	19.0	10.5
92.5	20.1	14.0	14.1	12.6	14.5	14.4
97.5	17.3	19.1	9.0	14.3	9.3	15.8
102.5	11.1	20.2	6.4	15.0	5.9	14.6
107.5	8.4	15.8	4.9	11.1	4.2	11.2
112.5	5.9	10.4	3.7	7.9	3.4	8.1
117.5	3.7	5.8	2.8	6.9	2.3	5.7
122.5	1.0	1.7	.8	4.1	.7	2.6
127.5	.8	1.2	1.1	2.2	.7	1.6
132.5	.4	.6	.4	.9	.5	1.0
137.5	.3	.3	.3	.5	.3	.6
142.5	.2	.1	.2	.6	.2	.5
147.5	.1	.1	.2	.2	.2	.3
152.5	.1		.0	.1	.1	.1
157.5				.1	.1	.0
162.5			.0	.0	.0	.0
167.5			.0		.0	
172.5						

The size of scallops over the 3 gear configurations ranged from 10-170 mm. (0.4 - 6.8-inches) shell height. However, scallops smaller than 25 mm shell height were observed only for the fully rigged, 3-inch ring, dredge. Scallops smaller than 40 mm shell height were not observed for the unchafed dredges.

Percent size frequencies of scallops exhibited pronounced differences between the two dredges and for the 3 gear configurations (Figure 5.7). The 3-inch ring dredge had larger concentrations of scallops between 80-100 mm. (3.2 -4.0-inches) shell height, and the 3.5-inch ring dredge had concentrations between 85-110 mm. (3.4 -4.4-inches) shell height (Table 5.24). For scallops smaller than 70 mm. (2.8-inches) shell height (pre-recruits), the 3.0-inch ring dredge had a higher percentage of its catch comprised of this size range. Percentages of scallops smaller than 70 mm. (2.8-inches) by the 3 (3.5)-inch ring dredge for unchafed, chafed without donut spacers, and fully rigged dredges were 9.1% (3.0%), 10.4% (3.8%), and 13.2% (3.7%), respectively. There was little difference in the percent size frequency for scallops larger than 130 mm. (5.1-inches) shell height with respect to the 3 vs. 3.5-inch ring dredges and 3 gear configurations: 1.1% vs. 1.0%, 2.4% vs. 1.1%, and 2.5% vs. 1.3%.

Adjusted relative retention percentages by shell height for the catch by the 3.5-inch ring dredge relative to the 3.0-inch ring dredge and 3 gear configurations were quite similar (Table 5.25). As would be expected, retention ratios were higher for chafed dredges. Retention ratios higher than 1 in value were calculated for scallops larger than 105 mm. (4.1-inches) shell height; this varied by gear configuration. The adjusted relative retention percentages for the fully rigged gear was higher than the retention percentages for the other 2 gear configurations for scallops ≥ 90 mm. (3.54-inches) shell height. Comparison of the results for different gear configurations, however, may be misleading since, during the course of the experiment, different resource areas were fished. In addition, weather and sea conditions were in a constant state of flux which conceivably affected efficiency and selectivity performance parameters of the dredges.

Relative size selection curves were estimated by generalized least squares (Table 5.26). In actuality, size selection curves should be estimated via a limited dependent variable model since the lower and higher values are truncated at 0 and 1 (100%). The standard logit model available on most software packages, however, recognizes the upper limit and adjusts accordingly.

Estimated parameters were statistically significant and R^2's were adequate. Estimates of the 50% relative selection points for the 3.5-inch ring dredge and 3 gear configurations were 87.08 (3.48-in.), 76.64 (3.06-in.), and 83.08 (3.32) mm. shell height, respectively (Table 5.27). The respective 25-75% selection points ranged from

Table 5.25

Retention percentages for sea scallops obtained by 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Dawn, 6/14-6/20/88

	Unchafed			Chafed without donut spacers			Fully rigged		
Shell size	Ratio[a]	Smoothed retention[b]	Adjusted[c] % retention	Ratio	Smoothed retention	Adjusted % retention	Ratio	Smoothed retention	Adjusted % retention
12.5							.0	.0	
17.5							.0	.0	
22.5							.0	.0	
27.5				.0			.0	.0	.3
32.5				.0	.0	.3	.0	.0	.9
37.5				.1	.0	1.0	.1	.1	4.2
42.5	1.0	.0	3.6	.0	.1	5.6	.1	.1	6.5
47.5	.1	.3	21.7	.1	.1	8.0	.1	.1	9.0
52.5	.2	.2	15.3	.2	.2	18.8	.1	.2	12.7
57.5	.4	.3	22.3	.5	.3	22.1	.3	.2	14.0
62.5	.3	.2	17.8	.2	.3	24.7	.2	.2	15.6
67.5	.1	.2	15.7	.3	.2	19.7	.2	.2	14.3
72.5	.2	.2	16.0	.3	.2	18.8	.2	.2	15.7
77.5	.3	.2	19.6	.2	.2	17.2	.2	.2	16.0
82.5	.2	.3	20.6	.2	.2	17.6	.2	.2	18.4
87.5	.3	.3	25.3	.3	.3	23.6	.3	.3	25.3
92.5	.5	.5	40.0	.5	.5	38.8	.5	.5	42.4
97.5	.8	.8	66.9	.9	.8	64.0	.9	.8	69.9
102.5	1.3	1.1	93.4	1.3	1.1	87.5	1.3	1.2	97.2
107.5	1.4	1.3	109.4	1.2	1.2	96.2	1.4	1.3	108.3
112.5	1.3	1.3	104.4	1.1	1.2	98.0	1.2	1.3	108.0
117.5	1.1	1.2	101.3	1.3	1.6	127.5	1.3	1.4	119.4
122.5	1.2	1.2	97.4	2.7	1.5	123.2	1.9	1.4	119.0
127.5	1.1	1.1	95.1	1.0	1.5	120.7	1.2	1.3	109.0
132.5	1.1	1.0	83.2	1.2	1.1	86.7	1.0	1.1	90.4
137.5	.8	.6	52.8	1.0	1.3	100.2	1.1	1.0	86.6
142.5	.3	.7	59.3	1.6	1.0	78.2	1.1	1.0	86.3
147.5	1.5			.6	1.2	95.2	1.0	1.0	84.1
152.5	.0			1.8			1.0	.5	41.7
157.5							.1	.3	26.4
162.5							.3		
167.5									
172.5									

[a]Catch of 3.5-inch ring divided by catch of 3.0-inch ring dredge.

[b]Smoothed by moving geometric average of threes.

[c]100 (smoothed retention/geometric mean of values exceeding 1).

Table 5.26

Estimated coefficients of size selectivity curves for 3.5-inch ring dredge relative to 3.0-inch ring dredge and 3 gear configurations, F/V Carolina Dawn, 6/14-6/20/88

Gear configuration (Tows)	Estimated coefficients[a]			
	α_0 (constant)	α_1 (shell height)	N[b]	R^2
Unchafed (1-10)	5.77 (4.51)[c]	-.066 (3.90)	17	.76
Chafed without donut spacers (11-34)	8.38 (5.29)	-.110 (5.24)	16	.85
Fully rigged (35-121)	7.70 (7.19)	-.093 (6.06)	16	.85

[a]Parameter estimates obtained by generalized least squares.

[b]Number of observations based on 5 mm shell height intervals.

[c]Numbers in parentheses are t-statistics.

Table 5.27

Estimated percent selection retention sizes of 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Dawn, 6/14-6/20/88

Gear configuration (Tows)	Shell height for % selection point			Selection point for shell height	
	25%	50%	75%	70 mm.	100 mm.
	----millimeters----			-----percent-----	
Unchafed (1-10)	70.5	87.1	103.7	24.4	70.2
Chafed without donut spacers (11-34)	66.6	76.6	86.7	32.6	92.8
Fully rigged (35-121)	71.2	83.1	94.9	22.9	82.7

70.05-103.7 (2.80-4.14-in.), 66.6-86.7 (2.66-3.46-in.), and 71.2-94.9 (2.84-3.79-in.) mm. shell height.

The estimated selection points were quite different. Differences, however, were not subjected to statistical validation. Interestingly, size selectivity on 70 mm scallops by the fully rigged dredge was lower than that of the unchafed dredge.

F/V Carolina Dawn: 6/23-7/9/88

In this experiment, shell height data were obtained for 22,934 scallops. In terms of the fully rigged-unmodified gear and 2 gear modifications, shell height frequency data were summarized over 1899, 11734, and 9301 scallops, respectively. The corresponding number of scallops used for analyses were 9962, 87808, and 59434; differences were the result of the need to estimate number of scallops per tow (Table 5.28). Similar to the initial experiment, the 3-inch ring dredge harvested disproportionately more small scallops while the 3.5-inch ring dredge harvested a larger proportion of large scallops (Figure 5.8). These percentages were observed for all gear modifications. Results for the last modification, though, appeared to reflect the effects of technical efficiency rather than actual size selectivity.

Percent size frequencies for the 3.0 and 3.5-inch ring dredges for this experiment were similar to the frequencies observed in the previous June experiment.

Table 5.28

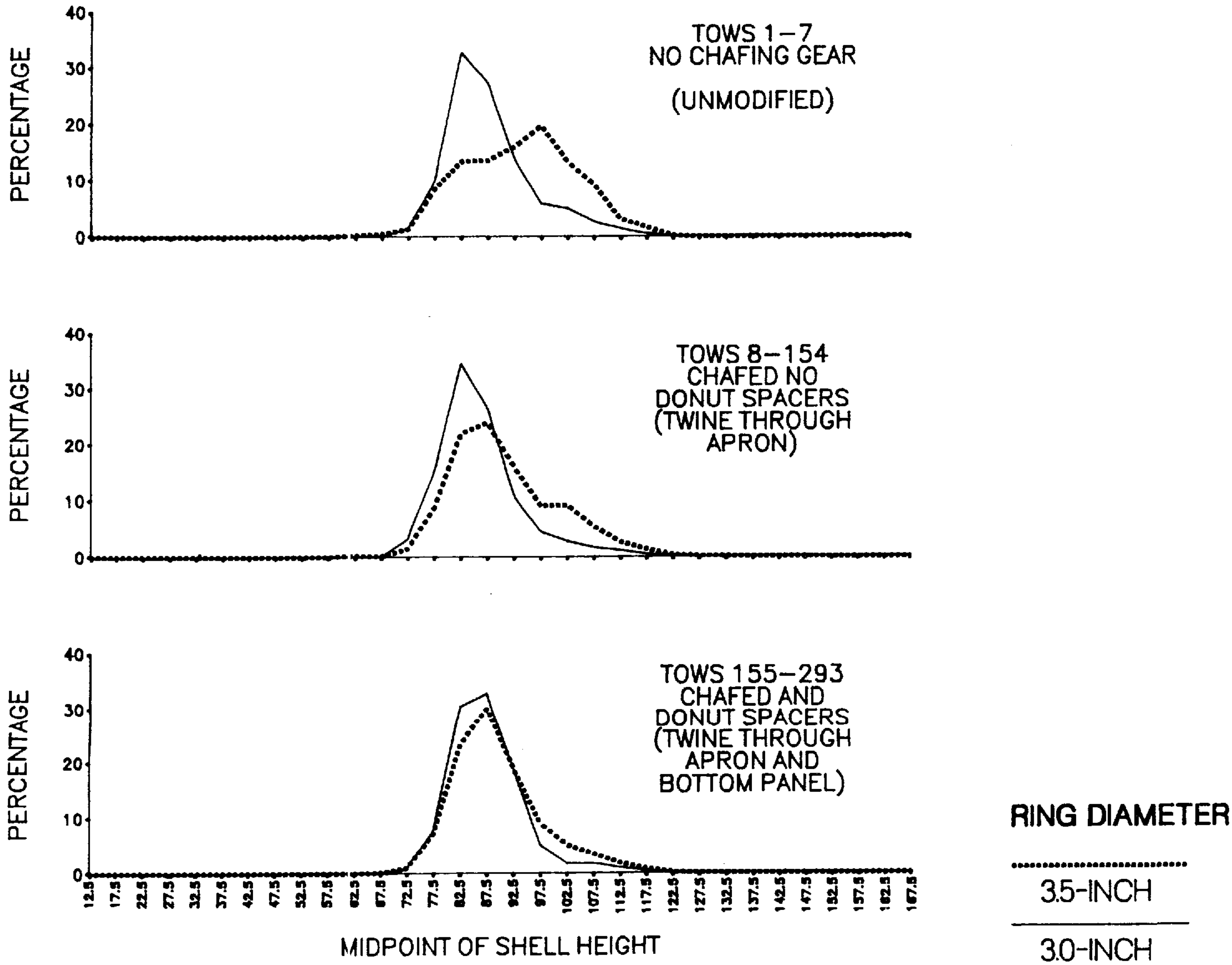
Number and cumulative percent of scallops caught by 3 and 3.5-inch ring dredges, F/V Carolina Dawn, 6/23-7/9/88

	Fully rigged				Fully rigged-twine in apron				Fully rigged-twine in apron and bottom panel			
Shell size	Number of scallops		Cumulative percent		Number of scallops		Cumulative percent		Number of scallops		Cumulative percent	
	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5
12.5												
17.5												
22.5												
27.5												
32.5												
37.5												
42.5												
47.5												
52.5					11		.0					
57.5					24		.1					
62.5		4		.2	24	58	.1	.2				
67.5	4	11	.1	.6	47	44	.2	.3	58	10	.2	.0
72.5	103	32	1.4	1.8	1792	425	3.3	1.8	261	168	.8	.8
77.5	716	217	11.1	10.3	8671	2581	18.2	10.4	2878	1506	8.4	7.9
82.5	2419	343	43.9	23.6	20024	6553	52.8	32.4	11609	4955	38.9	31.1
87.5	2022	347	71.2	37.1	15394	7112	79.3	56.2	12500	6388	71.7	61.1
92.5	1008	408	84.8	53.0	6139	4738	89.9	72.1	7121	3989	90.3	79.8
97.5	433	507	90.7	72.7	2499	2670	94.2	81.1	1940	1893	95.4	88.7
102.5	371	340	95.7	85.9	1512	2699	96.8	90.1	630	1082	97.1	93.7
107.5	186	236	98.2	95.1	868	1573	98.3	95.4	637	740	98.8	97.2
112.5	96	80	99.5	98.2	618	758	99.4	97.9	311	392	99.6	99.0
117.5	34	43	100.0	99.9	203	401	99.7	99.3	96	157	99.8	99.8
122.5		4		100.0	85	97	99.9	99.6	40	39	99.9	100.0
127.5					13	49	99.9	99.8	20	10	100.0	100.0
132.5					18	36	99.9	99.9	7		100.0	
137.5					25	15	100.0	99.9				
142.5					12	7	100.0	100.0				
147.5					6	14	100.0	100.0				
152.5												
157.5												
162.5												
167.5												
172.5												
Total[a]	7392	2570			57981	29827			38107	21327		

[a]Number of scallops actually measured were 1103, 796, 6436, 5298, 4901, and 4400.

Figure 5.8

PERCENT SIZE FREQUENCY OF SCALLOPS, 6/23-7/9/88



Notable differences were observed for the 3 and 3.5-inch ring dredges (Table 5.29). A large proportion of the scallops harvested by the 3-inch ring dredge were between 75 and 95 mm. shell height; in comparison, a large proportion of the scallops from the 3.5-inch ring dredge were between 75 and 105 mm. shell height. The percentages of scallops 70 mm. or smaller harvested by the 3 and 3.5-inch ring dredges were minimal for all gear modifications: (1) .05% vs. .58%, (2) .12% vs. .34%, and (3) .15% vs. .04%.

The 3-inch ring dredge had a larger percentage of scallops 90 mm. or smaller than did the 3.5-inch ring dredge for each gear configuration: (1) 71.2% vs. 37.1%, (2) 79.2% vs. 56.2%, and (3) 71.7% vs. 61.1%. It should also be remembered that the 3-inch ring dredge harvested considerably more scallops than did the 3.5-inch ring dredge, regardless of the gear configuration. The increasing percentage of smaller scallops for the 2 gear modifications suggested that the modifications may have altered the size selectivity of the 3.5-inch ring dredge. However, the alteration did not appear to have substantially altered the technical efficiency of the 3.5-inch ring dredge .

Adjusted relative retention percentages were quite variable (Table 5.30). In addition, adjusted percent retention values exceeded 1 for different shell sizes with respect to the 3 gear configurations. Large smoothed and adjusted % retention values characterized scallops between 65 and 70 mm. shell height for the first gear modification.

Table 5.29

Percent size frequency of selected gear modifications, F/V Carolina Dawn, 6/23-7/9/88

Shell size	Percent of total catch					
	Fully rigged		Fully rigged-twine through apron		Fully rigged-twine through apron and bottom panel	
	3.0	3.5	3.0	3.5	3.0	3.5
12.5						
17.5						
22.5						
27.5						
32.5						
37.5						
42.5						
47.5						
52.5			.0			
57.5			.0			
62.5		.2	.0		.2	
67.5	.1	.4	.1	.2	.2	.0
72.5	1.4	1.3	3.1	.7	1.4	.8
77.5	9.7	8.4	15.0	7.6	8.7	7.1
82.5	32.7	13.4	34.5	30.5	22.0	23.2
87.5	27.4	13.5	26.6	32.8	23.8	30.0
92.5	13.6	15.9	10.6	18.7	15.9	18.7
97.5	5.9	19.7	4.3	5.1	9.0	8.9
102.5	5.0	13.2	2.6	1.7	9.1	5.1
107.5	2.5	9.2	1.5	1.7	5.3	3.5
112.5	1.3	3.1	1.1	.9	2.5	1.8
117.5	.5	1.7	.4	.3	1.4	.7
122.5		.2	.2	.1	.3	.2
127.5			.0	.1	.2	.1
132.5			.0	.0	.1	
137.5			.0		.1	
142.5			.0		.0	
147.5			.0		.1	
152.5						
157.5						
162.5						
167.5						
172.5						

Table 5.30

Retention percentages for sea scallops obtained by 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Dawn, 6/23-7/9/88

	Fully rigged			Fully rigged with twine through apron			Fully rigged with twine through apron and panel		
Shell size	Ratio[a]	Smoothed retention[b]	Adjusted[c] % retention	Ratio	Smoothed retention	Adjusted % retention	Ratio	Smoothed retention	Adjusted % retention
12.5									
17.5									
22.5									
27.5									
32.5									
37.5									
42.5									
47.5									
52.5				.0					
57.5				.0	.0	.8			
62.5				2.5	.1	8.2			
67.5	2.8	.0	.0	.9	.8	51.2	.2	.0	3.6
72.5	.3	.0	4.3	.2	.4	25.4	.6	.4	28.9
77.5	.3	.2	22.1	.3	.3	17.9	.5	.5	40.2
82.5	.1	.2	18.1	.3	.4	22.2	.4	.5	37.3
87.5	.2	.2	19.9	.5	.5	30.4	.5	.5	38.2
92.5	.4	.4	40.4	.8	.7	45.1	.6	.7	50.3
97.5	1.2	.8	70.9	1.1	1.1	70.9	1.0	1.0	76.1
102.5	.9	1.1	104.2	1.8	1.5	94.2	1.7	1.3	96.2
107.5	1.3	1.0	93.0	1.8	1.6	98.7	1.2	1.4	104.6
112.5	.8	1.1	103.2	1.2	1.6	102.1	1.3	1.3	102.9
117.5	1.3			2.0	1.4	87.5	1.6	1.3	96.6
122.5				1.1	2.1	128.3	1.0	.9	71.5
127.5				3.9	2.1	128.1	.5		
132.5				2.0	1.7	103.4	.0		
137.5				.6	.9	54.9	1.1	1.0	86.6
142.5				.6	.9	58.1	1.1	1.0	86.3
147.5				2.3					
152.5				1.8			1.0	.5	41.7
157.5							.1	.3	26.4
162.5							.3		
167.5									
172.5									

[a]Catch of 3.5-inch ring divided by catch of 3.0-inch ring dredge.

[b]Smoothed by moving geometric average of threes.

[c]100 (smoothed retention/geometric mean of values exceeding 1).

Given the variation and inconsistent results, estimates of size selectivity based on data from the 2nd June experiment may be limited or incorrect.

Nevertheless, size selection curves were estimated (Table 5.31). Selection appeared to be quite sharp for scallops between 95 and 105 mm shell height, regardless of the gear configuration. Estimated 50% retention points were 94.12, 84.86, and 86.02 mm. for the 3 gear configurations (Table 5.32). The 25-75% selection ranges were quite large for the 3 gear combinations: (1) 85.25-102.98, (2) 77.38-92.34, and (3) 78.26-93.78 mm. shell height.

Selection points for the 2 gear modifications were associated with smaller scallops and were nearly equal. This result further suggested that the modifications may have altered the size selectivity of the 3.5-inch ring dredge, but that the last modification did not improve the selectivity relative to the first gear modification.

In view of the possible improved size selectivity by the two gear modifications, the relative technically efficiency should also be considered. The 3-inch ring dredge consistently harvested more than the 3.5-inch ring dredge regardless of the modification. Thus, while the modifications possibly improved size selectivity, they did not improve the harvesting efficiency of the 3.5-inch ring dredge relative to that of the 3.0-inch ring dredge.

Table 5.31

Estimated coefficients of size selectivity curves for 3.5-inch ring dredge relative to 3.0-inch ring dredge and 3 gear modifications, F/V Carolina Dawn, 6/23-7/9/88

Gear configuration (Tows)	Estimated coefficients[a]			
	α_0 (constant)	α_1 (shell height)	N[b]	R^2
Fully rigged (1-7)	11.67 (5.63)[c]	-.12 (5.11)	6	.86
Fully rigged with twine through apron (8-154)	12.46 (5.04)	-.15 (5.02)	11	.84
Fully rigged with twine through apron and bottom panel (155-293)	12.18 (5.00)	-.14 (4.99)	13	.82

[a]Parameter estimates obtained by generalized least squares.

[b]Number of observations based on 5 mm shell height intervals.

[c]Numbers in parentheses are t-statistics.

Table 5.32

Estimated percent selection retention sizes of 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Dawn, 6/23-7/9/88

Gear configuration (Tows)	Shell height for % selection point			Selection point for shell height	
	25%	50%	75%	70 mm.	100 mm.
	----millimeters----			-----percent-----	
Fully rigged (1-7)	82.3	94.1	103.0	4.8	67.5
Fully rigged with twine through apron (8-154)	77.4	84.9	90.2	10.1	90.2
Fully rigged with twine through apron and bottom panel (155-293)	78.3	86.0	93.8	9.4	87.9

Relative size selectivity: September 1988

F/V Carolina Capes: 9/22-9/27/88

Gear experiments were also conducted in September 1988. Shell height data for 5 mm. intervals were collected on 44,239 scallops (Table 5.33). Gear configurations examined were unchafed, chafed without donut spacers, and fully rigged or chafed. For each of the gear configurations, shell height frequency data were summarized over 8663, 16433, and 19433 scallops, respectively. Number of scallops used for analyses because of sub-sampling per tow, however, were 9517, 16746, and 19143; 100% of the scallops were measured for the fully rigged dredges.

Similar to the 2 previous experiments, the 3-inch ring dredge had a higher harvest rate and harvested a larger proportion of small scallops (shell height ≤ 90 mm.) (Figure 5.9). In comparison to the other 2 experiments, however, the 3.5 inch ring dredge harvested a larger proportion of scallops between 100-110 mm. shell height.

The percent size frequencies exhibited a bi-modal distribution (Table 5.34). For all 3 gear configurations, there were peak concentrations of scallops 65-80 mm. and 95-110 mm. shell height. A similar pattern was observed for the first June experiment, but it is not as nearly pronounced as the September experiment. In terms of pre-recruits (shell height ≤ 70 mm), the 3-inch (3.5) ring dredge harvested 11.3% (8.1), 13.1% (5.7%), and 9.6% (4.8%)

Table 5.33

Number and cumulative percent of scallops caught by 3 and 3.5-inch ring dredges, F/V Carolina Capes, 9/22-9/27/88

	Unchafed				Chafed without donut spacers				Fully rigged			
Shell size	Number of scallops		Cumulative percent		Number of scallops		Cumulative percent		Number of scallops		Cumulative percent	
	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5	3.0	3.5
12.5												
17.5												
22.5	1		.0									
27.5												
32.5												
37.5												
42.5												
47.5	2		.1							1		.0
52.5	3	1	.1	.0	3		.0		20	3	.2	.1
57.5	25	19	.5	.6	35	22	.4	.4	60	23	.7	.4
62.5	176	111	3.5	3.6	435	112	4.4	2.2	451	120	4.4	2.1
67.5	461	161	11.3	8.1	937	206	13.1	5.7	624	193	9.6	4.8
72.5	727	199	23.6	13.6	1058	196	23.0	8.9	820	151	16.4	6.9
77.5	509	96	32.3	16.3	694	88	29.4	10.4	565	79	21.1	8.0
82.5	261	35	36.7	17.2	429	82	33.4	11.8	433	107	24.7	9.5
87.5	251	58	40.9	18.8	682	232	39.8	15.6	800	258	31.4	13.1
92.5	510	269	49.6	26.3	1135	685	50.3	27.1	1441	848	43.4	25.0
97.5	705	540	61.5	41.2	1457	1188	63.9	46.8	1874	1675	58.9	48.6
102.5	700	725	73.3	61.3	1132	1025	74.4	63.9	1961	1580	75.3	70.8
107.5	536	508	82.4	75.4	785	651	81.8	74.8	1241	904	85.6	83.5
112.5	413	347	89.4	85.0	536	490	86.7	82.9	724	517	91.6	90.7
117.5	331	272	95.0	92.5	475	392	91.2	89.5	596	359	96.6	95.8
122.5	101	120	96.7	95.9	248	221	93.5	93.1	176	154	98.0	97.9
127.5	94	66	98.3	97.7	252	169	95.8	96.0	121	76	99.0	99.0
132.5	48	41	99.1	98.8	189	110	97.6	97.8	68	44	99.6	99.6
137.5	19	25	99.4	99.5	139	70	98.9	98.9	33	18	99.9	99.9
142.5	14	10	99.7	99.8	62	42	99.4	99.6	11	9	100.0	100.0
147.5	10	7	99.8	100.0	37	17	99.8	99.9	5		100.0	
152.5	8	1	100.0	100.0	18	5	100.0	100.0				
157.5	1		100.0		6		100.0					
162.5	1		100.0									
167.5												
172.5												
Total[a]	5906	3611			10743	6003			12024	7119		

[a]Number of scallops actually measured were 5052, 3611, 10442, 5991, 12024, and 7119.

Figure 5.9

PERCENT SIZE FREQUENCY OF SCALLOPS, 9/22–9/27/88

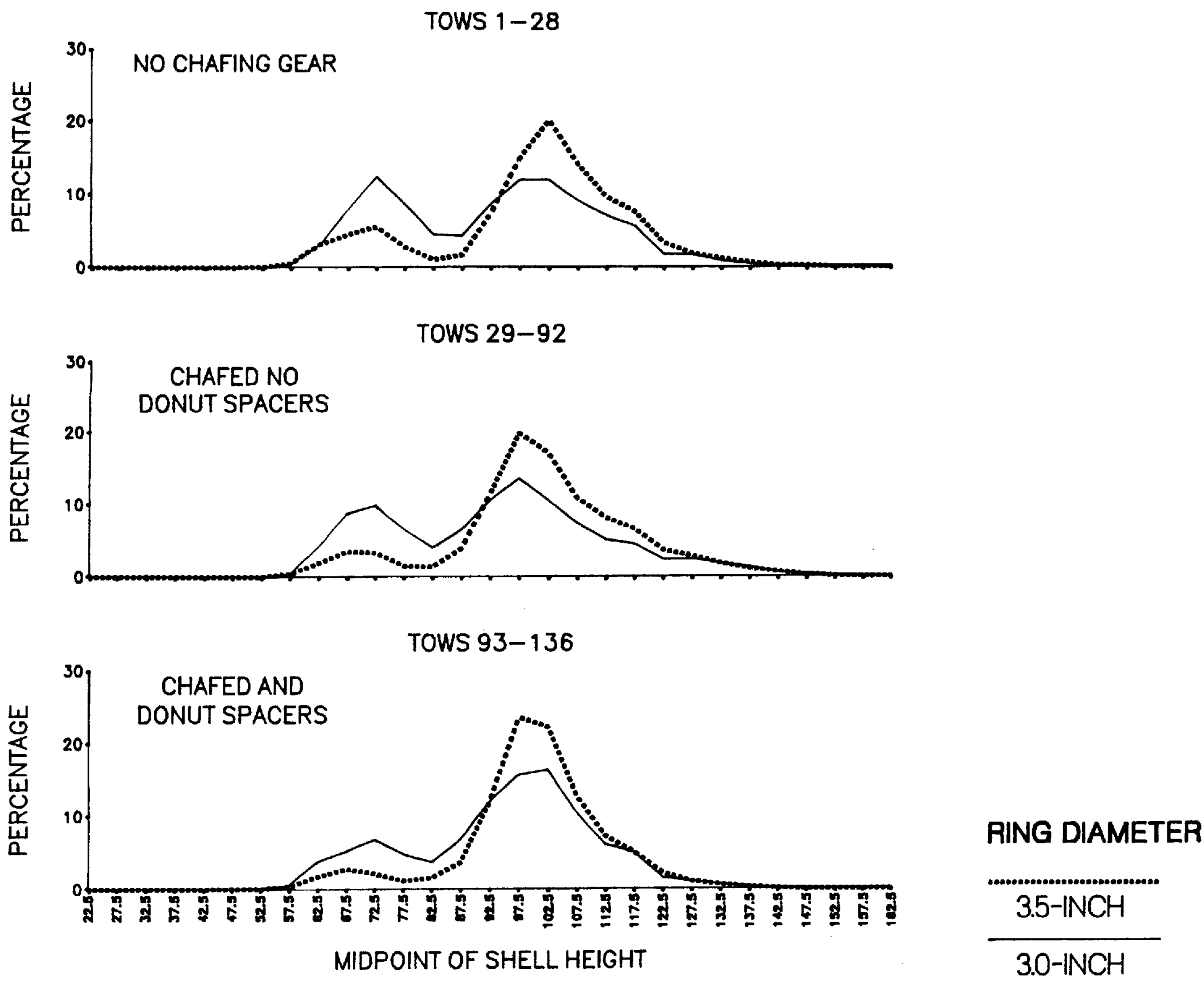


Table 5.34

Percent size frequency of selected gear configurations, F/V Carolina Capes, 9/22-9/27/88

Shell size	Percent of total catch					
	Unchafed		Chafed without donuts spacers		Fully rigged	
	3.0	3.5	3.0	3.5	3.0	3.5
12.5						
17.5						
22.5	.0					
27.5						
32.5						
37.5						
42.5						
47.5	.0					.0
52.5	.1	.0	.0		.2	.0
57.5	.4	.5	.3	.4	.5	.3
62.5	3.0	3.1	4.1	1.9	3.8	1.7
67.5	7.8	4.5	8.7	3.4	5.2	2.7
72.5	12.3	5.5	9.9	3.3	6.8	2.1
77.5	8.6	2.7	6.5	1.5	4.7	1.1
82.5	4.4	1.0	4.0	1.4	3.6	1.5
87.5	4.2	1.6	6.4	3.9	6.7	3.6
92.5	8.6	7.5	10.6	11.4	12.0	11.9
97.5	11.9	15.0	13.6	19.8	15.6	23.5
102.5	11.9	20.1	10.5	17.1	16.3	22.2
107.5	9.1	14.1	7.3	10.9	10.3	12.7
112.5	7.0	9.6	5.0	8.2	6.0	7.3
117.5	5.6	7.5	4.4	6.5	5.0	5.0
122.5	1.7	3.3	2.3	3.7	1.5	2.2
127.5	1.6	1.8	2.3	2.8	1.0	1.1
132.5	.8	1.1	1.8	1.8	.6	.6
137.5	.3	.7	1.3	1.2	.3	.3
142.5	.2	.3	.6	.7	.1	.1
147.5	.2	.2	.3	.3	.0	
152.5	.1	.0	.2	.1		
157.5	.0		.1			
162.5	.0					
167.5						
172.5						

with respect to unchafed, chafed without donut spacers, and fully rigged configurations. The 3-inch ring dredge consistently harvested a larger proportion of scallops smaller than 90 mm. shell height; the 3.5-inch ring dredge harvested proportionately more larger scallops.

Adjusted percent retentions via the use of moving averages were not estimated. Smoothed retention values larger than 1 could not be obtained for any of the gear configurations. Moreover, data for the chafed gear without donuts did not appear to need to be smoothed. Thus, the analyses of retention and size selectivity for the September experiment were based on either smoothed values or observed unsmoothed ratios of catch by shell size.

High retention ratios, although less than 1, were calculated for shell sizes larger than 102 mm shell height for all gear configurations (Table 5.35). Large changes in retention appeared to characterized scallops between 90-100 mm. shell height.

Size selectivity curves were estimated using ratios restricted to the highest value and followed by a lower value (Table 5.36). Estimated 50% selection points were 83.8, 82.64, and 84.61 mm. shell height for unchafed, chafed without donut spacers, and fully rigged dredges (Table 5.37). The respective 25-75% selection intervals were 73.53-94.07, 69.77-95.51, and 70.23-98.99 mm. shell height. Estimated selection points were quite close in value; thus, suggesting little difference in relative size

Table 5.35

Retention percentages for sea scallops obtained by 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Capes, 9/22-9/27/88

Shell size	Unchafed			Chafed without donut spacers			Fully rigged		
	Ratio[a]	Smoothed retention[b]	Adjusted[c] % retention	Ratio	Smoothed[c] retention	Adjusted[c] % retention	Ratio	Smoothed retention	Adjusted[c] % retention
12.5									
17.5									
22.5									
27.5									
32.5									
37.5									
42.5									
47.5	.0	.0							
52.5	.3	.1		.0			.2	.0	
57.5	.8	.5		.6			.4	.2	
62.5	.6	.6		.3			.3	.3	
67.5	.4	.4		.2			.3	.2	
72.5	.3	.3		.2			.2	.2	
77.5	.2	.2		.1			.1	.2	
82.5	.1	.2		.2			.3	.2	
87.5	.2	.3		.3			.3	.4	
92.5	.5	.5		.6			.6	.5	
97.5	.8	.8		.8			.9	.7	
102.5	1.0	.9		.9			.8	.8	
107.5	1.0	.9		.8			.7	.7	
112.5	.8	.9		.9			.7	.7	
117.5	.8	.9		.8			.6	.7	
122.5	1.2	.9		.9			.9	.7	
127.5	.7	.9		.7			.6	.7	
132.5	.9	.9		.6			.7	.6	
137.5	1.3	1.0		.5			.6	.8	
142.5	.7	.9		.7			1.1		
147.5	.7	.4		.5					
152.5	.1			.3					
157.5							.1	.3	
162.5							.3		
167.5									
172.5									

[a]Catch of 3.5-inch ring divided by catch of 3.0-inch ring dredge.

[b]Smoothed by moving geometric average of threes.

[c]Not calculated

Table 5.36

Estimated coefficients of size selectivity curves for 3.5-inch ring dredge relative to 3.0-inch ring dredge and 3 gear configurations, F/V Carolina Capes, 9/22-9/27/88

Gear configuration (Tows)	Estimated coefficients[a]			
	α_0 (constant)	α_1 (shell height)	N[b]	R^2
Unchafed (1-28)	8.97 (3.60)[c]	-.107 (3.49)	13	.78
Chafed without donut spacers (29-92)	7.06 (2.43)	-.085 (2.50)	9	.80
Fully rigged (93-136)	6.46 (5.54)	-.076 (5.19)	11	.82

[a]Parameter estimates obtained by generalized least squares.

[b]Number of observations based on 5 mm shell height intervals.

[c]Numbers in parentheses are t-statistics.

Table 5.37

Estimated percent selection retention sizes of 3.5-inch ring dredge relative to 3.0-inch ring dredge, F/V Carolina Capes, 9/22-9/27/88

Gear configuration (Tows)	Shell height for % selection point			Selection point for shell height	
	25%	50%	75%	70 mm.	100 mm.
	----millimeters----			-----percent-----	
Unchafed (2-28)	73.5	83.8	94.1	18.6	85.0
Chafed without donut spacers (22-92)	69.8	82.6	95.5	25.4	81.5
Fully rigged (93-136)	70.2	84.6	99.0	24.5	76.4

selectivity between the 3 gear configurations. Similarly, there was little difference in the estimated selection points corresponding to 70 and 100 mm. shell height.

Although relative size selection was estimated for the September experiment, results should be viewed with caution. Sea conditions were rough (6-8 foot seas) which likely affected the retention of scallops in the dredges due to the constant motion of the vessel and dredges. Rain and/or cloudy skies occurred throughout the experiment; this may have also affected the retention of scallops by the dredges. Retention ratios higher than 1 could not be calculated; ratios used to estimated size selection curves were arbitrarily determined. Also, there is the strong possibility that the size distribution of scallops in the resource area had been alter due to harvesting activities and subsequent growth of individuals in the population.

Conclusions: Relative Size Selectivity

Data and supporting analyses indicated that the 3.5-inch ring dredge permitted escapement of small scallops. The 3-inch ring dredge consistently harvested a larger proportion and absolute quantity of small scallops. With respect to all 3 experiments, the percentage of scallops ≤ 90 mm. harvested by the 3 and 3.5-inch ring dredges were 64.2% and 40.6%, respectively. Moreover, the 3-inch ring dredge harvested 87% more scallops of all sizes and 195% more scallops ≤ 90 mm shell height. The 3-inch ring dredge also harvested 12.7% more scallops ≥ 90 mm. shell height over all 3 experiments.

Estimated relative percentages for the 3 experiments and various gear configurations were quite variable (Table 5.38). With respect to scallops ≤ 90 mm shell height, the chafed without donut spacers had higher retention rates than did the other gear configurations. Retention of approximately 100% for all gear configurations occurred for scallops of approximately 130 mm. shell height. Relative retention of pre-recruits (≤ 70 mm.) was less than 27% and average 15.9% over all gear configurations and experiments. Although seemingly small, the 15.9% retention could be quite important when considered relative to the number of small scallops harvested by the 3-inch ring dredge. More important, estimates of size selection, although limited, illustrate that use of 3.5-inch ring dredges would reduce total mortality and mortality on small scallops.

Selectivity, Efficiency, and Meat Counts

Interestingly, the exemption from the meat count regulation offered an opportunity to determine the meat counts which might occur without regulations relative to a particular piece of gear. It is currently believed that scallops of 70 mm. shell height are recruited in the mid-Atlantic commercial fishery. That is, commercial fishermen harvest and shuck scallops as small as 70 mm. shell height. As part of the 9/29-10/13/88 experiment, the captain of the

Table 5.38

Estimated percent retention by 3.5-inch ring dredge relative to 3.0-inch ring dredge, June and September experiments

	June			June			September		
Shell size	Unchafed	Chafed-no donuts	Fully rigged	Fully rigged	Fully rigged-twine through apron	Fully rigged-twine through apron and panel	Unchafed	Chafed-no donuts	Fully rigged
12.5	.7	.1	.1	.0	.0	.0	.0	.3	.4
17.5	1.0	.2	.2	.0	.0	.0	.1	.4	.6
22.5	1.4	.3	.4	.0	.0	.0	.1	.6	.9
27.5	1.9	.5	.6	.0	.0	.0	.2	.9	1.3
32.5	2.6	.8	.9	.0	.0	.1	.4	1.4	1.8
37.5	3.6	1.4	1.4	.1	.1	.1	.7	2.1	2.7
42.5	5.0	2.3	2.3	.2	.2	.2	1.2	3.1	3.9
47.5	6.8	4.0	3.6	.3	.4	.4	2.0	4.7	5.5
52.5	9.2	6.7	5.6	.6	.9	.9	3.4	7.1	7.9
57.5	12.3	11.0	8.5	1.1	1.8	1.7	5.7	10.5	11.2
62.5	16.4	17.6	12.9	1.9	3.6	3.5	9.3	15.2	15.6
67.5	21.5	26.9	19.1	3.6	7.2	6.8	14.9	21.5	21.3
72.5	27.6	38.9	27.3	6.4	14.0	12.9	23.2	29.6	28.4
77.5	34.6	52.4	37.3	11.3	25.3	23.0	33.8	39.2	36.7
82.5	42.5	65.5	48.6	19.2	41.4	37.8	46.5	49.7	46.0
87.5	50.7	76.6	60.1	30.6	59.6	55.2	59.8	60.2	55.5
92.5	58.9	85.0	70.5	45.0	75.4	71.4	71.7	69.9	64.6
97.5	66.6	90.7	79.2	60.3	86.5	83.5	81.2	78.0	72.8
102.5	73.5	94.4	85.8	73.9	93.0	91.2	88.1	84.5	79.7
107.5	79.5	96.7	90.6	84.0	96.5	95.4	92.7	89.3	85.2
112.5	84.4	98.1	93.9	90.7	98.3	97.7	95.6	92.8	89.4
117.5	88.2	98.9	96.0	94.8	99.2	98.9	97.4	95.1	92.5
122.5	91.3	99.3	97.5	97.1	99.6	99.4	98.4	96.8	94.8
127.5	93.6	99.6	98.4	98.4	99.8	99.7	99.1	97.9	96.4
132.5	95.3	99.8	99.0	99.1	99.9	99.9	99.5	98.6	97.5
137.5	96.6	99.9	99.4	99.5	100.0	99.9	99.7	99.1	98.3
142.5	97.5	99.9	99.6	99.8	100.0	100.0	99.8	99.4	98.8
147.5	98.2	100.0	99.7	99.9	100.0	100.0	99.9	99.6	99.2
152.5	98.7	100.0	98.8	99.9	100.0	100.0	99.9	99.7	99.4
157.5	99.1	100.0	99.9	100.0	100.0	100.0	100.0	99.8	99.6
162.5	99.3	100.0	99.9	100.0	100.0	100.0	100.0	99.9	99.7
167.5	99.5	100.0	100.0	100.0	100.0	100.0	100.0	99.9	99.8
172.5	99.7	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9
177.5	99.8	100.0	100.0	100.0	100.0	100.0	100.0	100.0	99.9

F/V Capes was requested to take separate meat counts for the 3 and 3.5-inch ring dredges at the time of bagging.

Meat count data obtained by the captain indicated that counts would be considerably higher without the current 30 meat count restriction (Table 5.39). Moreover, results revealed that 70 mm. is approximately the minimum size of scallop which is shucked. Interestingly, 70 mm. is approximately the diameter of a 12 ounce soda can which is often used as a reference size for determining which scallops to shuck. In the event that the scallop resource was characterized by areas of large concentrations of small scallops, it would be expected that vessels would exploit these areas. In this case, the 3.5-inch ring dredge reduces total mortality and juvenile mortality, but it would not eliminate mortality on small scallops.

In terms of size selectivity, the 3.5-inch ring dredge consistently harvested a lower average meat count. The count for the 3.0-inch ring dredge was approximately 20.5% higher than the count for the 3.5-inch ring dredge. However, counts for the 3.5-inch ring dredge were higher than the legal count of 30 meats per pound (MPP). MPP for the 3.5-inch ring dredge averaged 78.8% more than the legal count of 30 MPP. It should be remembered that the 3.5-inch ring dredge was considerably less efficient than the 3.0 inch ring dredge. On average, the 3.5-inch ring dredge harvested 1 basket of scallops for every 2.5 baskets harvested by the 3.0-inch ring dredge. Thus, the 3.5-inch ring dredge, while

Table 5.39

Mean meat-count for 3 and 3.5-inch ring dredges, F/V Carolina Capes, 9/29-10/13/88

Date of bagging	Meats per pound	
	3.0-inch ring dredge	3.5-inch ring dredge
	-------------meats per pound-------------	
9/29	63.8	44.4
9/29	64.2	46.2
9/30	66.2	44.6
9/30	65.4	61.0
9/30	62.4	60.0
10/1	52.4	50.0
10/1	52.0	49.0
10/1	71.0	55.6
10/1	69.4	56.6
10/2	72.8	57.4
10/2	74.2	57.6
10/2	73.0	55.6
10/3	73.2	63.8
10/3	79.4	68.0
10/4	77.8	67.8
10/4	50.6	44.4
10/5	55.2	44.4
10/5	69.2	55.4
10/6	64.6	53.6
10/6	58.8	49.4
10/7	54.0	48.0
10/7	52.2	47.6
Average	64.6	53.7

not preventing the harvest of small scallops, did effectively reduce the level of harvest and increase the average size of harvested scallops.

Economic Ramifications of 3.5-inch Ring Dredge

Determination of the economic ramifications of industry using 3.5-inch ring dredges rather than 3.0-inch ring dredges is complicated by several factors. First and foremost is that the underlying population dynamics are not known. Second, all potential gear modifications which might improve the performance of the 3.5-inch ring dredges have not been examined (e.g., changing the links or using larger donut spacers). Third, the production technology for the fleet and the market interactions are unknown. Fourth, data necessary to conduct a comprehensive economic analysis of the effects of industry using 3.5-inch ring dredges are not available. Necessary information could be obtained and/or developed to conduct a more comprehensive economic analysis, but that was beyond the scope of this study.

In the short-run, the economic effects of using 3.5-inch ring dredges would be primarily in the form of reduced landings and revenues. Fixed and variable costs would not be significantly affected by using 3.5-inch ring dredges. However, it is possible that crew size per vessel could be reduced by one person since the total catch and volume of trash would be reduced.

In the long-run, however, the economic effects are less clear. For one thing, the 3.5-inch ring dredge would likely advance the average age of capture and increase the average yield per recruit. It also may result in an increase in stock size; this would depend on entry and catch rates of vessels. Moreover, the role of imports could become a critical consideration in determining the effects of industry using 3.5-inch ring dredges.

In this study, a limited short-run economic analysis of the effects of using 3.5-inch ring dredges is conducted. The analysis is primarily with respect to the vessel. However, inferences about the fleet are made when possible. The analysis of the economic ramifications was limited to potential changes in catch and revenues associated with unmodified fully rigged dredges.

Changes in catch

Previous analysis demonstrated that catches by the 3.5-inch ring dredges would be lower than catches by the 3.0-inch ring dredges. For the 4 experiments between June and September 1988, the 3.0-inch ring dredge harvested 2.06 baskets per 1 basket harvested by the 3.5-inch ring dredge. Alternatively, the 3.5-inch ring dredge harvested slightly less than 50% (48.5%) of the 3.0-inch ring dredge harvest. Thus, if scallop dredge vessels were restricted to using 3.5-inch ring dredges and there was no meat count or shell height restriction, a 50% reduction in the number of baskets harvested would be expected.

However, a 3.5-inch ring dredge generally harvests larger scallops which would be expected to yield more pounds of meats per basket than would occur for 1 basket of scallops harvested by a 3.5-inch ring dredge. The average meat weight for 3 and 3.5-inch ring dredges for all tows were 7.56 and 7.70 pounds basket, respectively. However, estimated differences in meat weight were nearly equal to differences in numbers of baskets; in terms of meat weight, the 3.5-inch ring dredges harvested 49.4% of the level harvested by the 3.0-inch ring dredges.

The potential reduction in landed meat weight per vessel was quite significant. If the vessels participating in the experiments had been restricted to using 3.5-inch ring dredges on both sides of the vessel, it is estimated that the average catch per vessel per trip would have been 8,122 pounds less than what was harvested.

The estimated loss is artificially high since the vessels were allowed to harvest small scallops. Alternatively, if the vessels had 3.0-inch ring dredges and were exempted from all regulations, the average catch would have been approximately 32,488 pounds of meats. The average catch for 3.5-inch ring dredges used on both sides of the vessel would have been approximately 16,514 pounds of meats. At an average price of $4-$6 per pound, revenues per vessels would have been reduced by approximately $64,000 - $96,000.

Vessels are, however, subject to a restriction of 30

MPP. Data available from the latter experiments of June and September indicated that a large percentage of the scallops were quite small. In June, the average shell sizes for the 3 and 3.5-inch rings dredges were 87.8 and 93.7 mm. shell height, respectively. This corresponded to average meat counts of 42.6 and 32.4 MPP.[2] In comparison, the average counts from the September experiment for the 3 and 3.5-inch ring dredges were 64.6 and 53.6 MPP; this corresponded to average shell sizes of approximately 75 and 80 mm.[2]

In the June experiment, 39-53% of the scallops harvested by the 3.0-inch ring dredge were smaller than 85 mm.; 24-32% by the 3.5-inch ring dredge were smaller than 85 mm. Moreover, there were few large scallops (≥ 100 mm.). For the catch of the 3.0-inch ring dredge to satisfy the 30 mpp restriction, it was estimated that approximately 34.1% of the catch (all scallops ≤ 85 mm.) would have to be discarded.[3] This in turn would yield an estimated count of 32.91 MPP. The count for the 3.5-inch ring was within the 30 MPP standard plus 10% tolerance limit. On this basis, the difference between landed meats by the two dredges was estimated to be equal to 71.7%. That is, with respect to the regulated count of 30 + 10% tolerance, the catch of the 3.5-inch ring dredge was 71.7% of the catch by the 3.0-inch ring dredge.

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[2]Derived from weight-length relationships for June and September.

[3]Based on information in Table 5.28 and the estimated weight length relationship.

Based on confidential data, average catch per vessel in the Mid-Atlantic region in 1988 was estimated to equal approximately 179,000 pounds of meats. Assuming that a 3.5-inch ring dredge harvests 71.7% as much as does a 3.0-inch ring dredge, average vessel catch would have been reduced to 128,514 pounds in 1988 if vessels had been required to use 3.5-inch ring dredges. Meats would be within the legal limits.[4] Assuming an average price of $3.78 per pound, use of the 3.5-inch ring dredge was estimated to reduce reduce revenues by approximately $191,000 per year.

Changes in ex-vessel prices and revenues

Applying the estimated catch rate of the 3.5-inch ring dredge, 71.7% of the catch by the 3.0-inch ring dredge, to fleet landings in 1987, it was estimated that landings of meats would have declined from 32 million pounds to 23 million pounds if fishermen had been required to use 3.5-inch ring dredges. However, this large a drop in landings would likely affect the ex-vessel price.

Price Flexibilities

In order to further examine the economic effects of requiring all dredge vessels to use 3.5-inch ring dredges, a simple ex-vessel price model was specified and estimated by

[4] This conclusion is based on information obtained in June. It is doubtful that vessels would be within the 30 MPP limit without a meat count restriction. In the second September experiment, meat counts were well in excess of 30 MPP.

2-stage-least-squares. The model was as follows:

$$EXPR = .81 - .31\ EXPR_{t-1} - .00004\ SSLAND + 1.23\ CANPR \qquad R^2 = .98$$

$$CANPR = -6.20 + .9986\ RESTPR - .00005\ CANIMPQ + .10\ YEAR \qquad R^2 = .97$$

$$RESTPR = .70 - .25\ RESTPR_{t-1} + .82\ CANPR - .00002\ RESTIMPQ \qquad R^2 = .93$$

where EXPR equals ex-vessel price ($/lb.), t-1 is a one period lag, SSLAND equals landings of sea scallops (1000 lbs.), CANPR equals U.S. price of scallops imported from Canada, RESTPR equals price of scallops imported from all countries except Canada, CANIMPQ equals imports of sea scallops from Canada (1000 lbs.), RESTIMPQ equals imports of scallops from all countries except Canada (1000 lbs.), and YEAR is the year of the observation (1977-1987). The R^2's are adjusted ordinary least squares values. All parameters except $RESTPR_{t-1}$ were significant at the 5% level.

Assuming imports and foreign prices remained the same in 1987, a reduction of landings to 23 million pounds was estimated to increase ex-vessel price to $4.46 per pound. The observed prices in 1987 was $4.13 per pound. Thus, total revenues for the fleet, if required to use 3.5-inch ring dredges, would have declined from $132.3 million to $102.6 million in 1987. This represented an estimated loss of 22.3% in ex-vessel revenues.

Potential impacts and role of imports

However, if United States' imports had increased, further reductions in revenues would have occurred. Using the estimated price model and observed values, price flexibilities were estimated for 1981-1987 (Table 5.40). A 1% increase in either imports from Canada or from other Nations was estimated to reduce annual ex-vessel prices by .22% and .16% in 1987, respectively. It is also worth noting that the effect of imports from Canada on U.S. ex-vessel prices is nearly equal to the effect of domestic landings on ex-vessel prices. The two are nearly perfect substitutes. Increasing levels of imports, thus, would have considerable effects on revenues if imports increased and 3.5-inch ring dredges were required.

Individual vessels and variation in impacts

However, vessels and captains are likely to respond differently to a restriction of 3.5-inch ring dredges. Many captains are more adept at using a new piece of gear. It is quite likely that in a relatively short-period of time, it would be possible for these captains to fish the 3.5-inch ring dredge at its maximum potential given various resource conditions, bottom types, and weather conditions. In fact, vessels of identical size, age, design, and fishing the same resource areas over a period of a year are likely to have different production technologies.

Table 5.40

Estimated domestic ex-vessel price sensitivity to changes in domestic landings, imports from Canada, and imports from other nations

Year	Estimated price flexibility[a]		
	Domestic landings	Imports from Canada	Imports from other nations
1981	.314	.320	.050
1982	.222	.252	.050
1983	.143	.156	.096
1984	.132	.101	.090
1985	.129	.155	.165
1986	.156	.167	.181
1987	.295	.222	.155

[a]Price flexibility indicates percentage change in ex-vessel price resulting from 1% change in landings or imports. A negative sign (-) is implied for all flexibilities. As an example, consider a 1% increase in domestic landings in 1987; ex-vessel prices would have decreased by .295%. All estimates were evaluated at the observed price and quantity.

Using confidential trip level data and estimates of stock abundance in DuPaul and Kirkley (1989), the production technologies for 2 identical scallop vessels were estimated:

$$POUNDS = \exp^{.21\ D3}\ DAS^{1.96}\ CREW^{2.23}\ \exp^{(-.39\ LNCREW\ LNDAS)}\ SA^{.68} \qquad R^2 = .96$$

$$POUNDS = \exp^{.02\ D3}\ DAS^{4.11-.97 LNDAS}\ CREW^{5.04-.52 LNCREW}\ \exp^{-.64\ LNDAS\ LNCREW}\ SA^{-6.15\ +\ 2.38\ LNDAS} \qquad R^2 = .99$$

where POUNDS equals pounds of meats per trip, DAS equals days at sea per trip, CREW equals crew size, SA equals geometric mean of stock abundance (baskets per hour) for all vessels providing shell stock samples (See DuPaul and Kirkley 1988), LN equals natural logarithm, exp equals exponential operator, and D3 equals a dummy variable for 3rd quarter of year--a period in which meat weights for given shell sizes tend to be largest (See DuPaul and Kirkley 1988). Estimation was accomplished by seemingly unrelated regression. The system R^2 was .98 and all parameters except that for D3 for the second vessel were statistically different than zero.

The imposition of a 3.5-inch ring dredge would alter the effects of days at sea and crew size on catch. Alternatively, it would the same effect as reducing the harvestable stock abundance. In any event, the two identical vessels would respond differently to the imposition of 3.5-inch ring dredges. The second vessel exhibits more flexibility and would be less affected by the use of 3.5-inch ring dredges.

The possibility of vessel to vessel differences should be considered if management authorities are interested in regulating the fishery via 3.5-inch ring dredges.

Conclusions: Economic ramifications

The preceding analyses illustrated that the imposition of 3.5-inch ring dredges would reduce catch and revenues in the short-run. Accurate determination of the impacts, however, was complicated by several factors: (1) the population dynamics were unknown; (2) potential changes in gear and/or behavioral responses to imposition of 3.5-inch ring dredges were not fully evaluated; (3) necessary data for estimating the technology of a fleet comprised of many different size vessels were not available.

More important, it is the long-run impacts which need to be evaluated. Simply, what would be the effects of using 3.5-inch ring dredges on harvestable biomass, age composition, market structure, economic performance, and entry and exit decisions. These components are interrelated.

Intuitively, use of 3.5-inch rings in a dredge would initially reduce catch. Ex-vessel prices would subsequently increase. Over time, stocks and the average age and size of scallops would likely increase. As a result, ex-vessel harvest levels would eventually increase; revenues and profits per vessels would be expected to initially increase. However, the realization of increased profits would likely attract new entrants. Subsequently with increased entry, industry landings and vessel production costs would both increase and profits would likely decline. The net result in the long-run of requiring 3.5-inch ring dredges would likely be increased age composition, higher yield per recruit, and increased fleet size.

Regulatory Ramifications

The success of fishery regulations in realizing goals and objectives of management plans depends, in part, on acceptance by industry. As illustrated in this study, the 3.5-inch ring dredge does effectively reduce the harvests of small scallops relative to the 3.0-inch ring dredge. However, the 3.5-inch ring dredge also reduces total catch; catch was estimated to decrease by an average 28.3%. Revenues were estimated to decrease by approximately 22.3%. Additional reductions in revenue would occur if imports increased. Given these outcomes, it is difficult to envisage support of the 3.5-inch ring dredge by industry.

Given the current regulatory framework, a critical issue is whether or not use of the 3.5-inch ring dredge could accomplish the goals and objectives of the Fishery Management Plan (FMP) in the absence of other regulations. That is, if the only regulation was a 3.5-inch ring dredge, would yield per recruit be increased and biological overfishing be prevented. Without more detailed data and analyses, these issues cannot be completely answered.

However, it is possible to gain insight into these issues using available data and analyses. The issue of biological overfishing is, in part, predicated on knowing maximum sustainable yield (MSY) and total fishing effort. Additional information includes the harvesting capacity, market structure, and economic responses.

The combined maximum sustainable yield for Georges Bank, Gulf of Maine, and the mid-Atlantic resource area is 29.3 million pounds of meats (NMFS 1988a). However, Canada harvests approximately 35% of the total harvest and 55% of the annual Georges Bank harvest. On this basis, domestic MSY is approximately 20-24 million pounds of meats.

In 1987, 234 vessels harvested scallops by dredge (NMFS 1988b). The number of vessels using trawls is not available. Approximately 31 million pounds were harvested by the 234 vessels in 1987. Assuming that the 3.5-inch ring dredge can harvest 71.7% of the harvest of 3.0-inch ring dredges, it was estimated that the harvest in 1987 would have been approximately 22.3 million pounds if the 234 vessels had been restricted to using 3.5-inch ring dredges.

Considering an MSY of approximately 24 million pounds and the level of landings in 1987, MSY would have been exceeded if 18 additional vessels harvested 71.7% of the average per vessel harvest of vessels using 3.0-inch ring dredges. That is, 252 vessels harvesting at the rate of 71.7% of vessels which used 3.0-inch ring dredges would result in harvest levels higher than estimated MSY. Harvest levels and fleet size are believed to be larger in 1988 and

1989. The preliminary analysis, thus, suggest that regulating the fishery with only a 3.5-inch ring size restriction would not prevent overfishing of the biomass. Additional restrictions on fishing effort and/or fleet size and/or catch would also have to be considered.

Data available on meat count for the second portion of the September trip indicates that the 3.5-inch ring dredge would advance the average age of capture. However, without additional restrictions, the average age in the short run would still be well below that associated with the current 30 MPP target specified in the FMP (NEFMC et al. 1982, pp. 24-28). Average meat count from the 3.5-inch ring dredge was 53.65 MPP; the average count for the 3.0-inch ring dredge was 64.63 MPP.

An associated issue is, however, the long-run implications of using 3.5-inch ring dredges. The larger rings did advance the size of capture but they also harvested larger quantities of scallops 95 + mm. shell height. The "Status of the Stocks" (NMFS 1988a) indicates that size at 50% maturity is 60-90 mm. shell height. Larger harvest of large scallops may affect future stocks via effects on spawning and recruitment. The exact effect, however, would need to be determined by additional empirical analyses. The precise relationship between stock size, average animal size, and recruitment is not known. It would be expected, though, that fewer large scallops in the spawning stock would result in lower recruitment and stock size in the future.

Thus, while a 3.5-inch ring dredge advances the average age of capture, it does not appear to do so in a manner that ensures the size of the stock in the future. Moreover, it does not do so in a manner consistent with realizing the FMP target specification of 30 MPP.

The 3.5-inch ring dredge does not appear to offer a viable sole-source regulatory tool. The larger ring size does advance the age of capture, but it also increases the harvest of larger scallops which have higher fecundity than the smaller scallops. The 3.5-inch ring dredge reduces but does not eliminate the capture of small scallops. The 3.5-inch ring dredge is less technically efficient than the 3.0-inch ring dredge, but given current fleet size, its use would not appear to prevent harvest levels from exceeding MSY.

However, the 3.5-inch ring dredge could be used in conjunction with other regulations. In particular, restrictions on fleet size and fishing effort should be considered. Restricting or even reducing the fleet size would mitigate the problem of economic waste and overfishing caused by too many vessels. It would not eliminate the problem. It would offer an opportunity for increasing revenues and profits per vessel. Restricting effort would reduce total mortality, and if done in conjunction with regulating the ring size, would reduce mortality on small scallops. However, considerably more detailed analyses are necessary before appropriate regulations can be formulated.

Summary and Conclusions

This study presented analyses of the technical efficiency and size selectivity of a 3.5-inch ring dredge relative to the common commercially-used 3.0-inch ring dredge. It was shown that the 3.0-inch ring dredge was more technically efficient and harvested larger quantities of small scallops. In general, the 3.5-inch ring dredge harvested more large scallops. This observation, however, was not consistent over all resource areas, tows, and time periods examined. Thus, while it is possible to make general conclusions about the 3 and 3.5-inch ring dredges, broad regulatory conclusions should not be based only on results presented in this study. There were considerable deviations from the general pattern.

On average, the catch associated with the 3.0-inch ring dredge was approximately 106% higher than the catch by the 3.5-inch ring dredge when catch was measured in terms of baskets. It must be remembered, though, that these harvest rates apply to an unregulated fishery; vessels participating in the experiments were exempted from the current meat count and shell size standards. The 3.0-inch ring dredge harvested approximately 39.5% more than the 3.5-inch ring dredge when catch was measured in pounds of meats. However, catches widely varied among tows, fishing areas, and time periods in which the studies were conducted.

As would be expected, the 3.5-inch ring dredge allowed more escapement of small scallops relative to the 3.0-inch ring dredge. However, the larger ring dredge exhibited the capability to harvest small scallops. This was particularly evident in the second June and September experiments in which the average meat counts for the 3.5-inch rings dredges were well in excess of the regulated 30 MPP count. Over all tows in which size frequency data were obtained, the average shell heights for the 3 and 3.5-inch ring dredges were 88.2 and 98.5 mm., respectively. The corresponding meat counts for the 3 and 3.5-inch ring dredges were 35.1 and 25.1, respectively.

Although the meat count associated with the 3.5-inch ring dredge was lower, the total meat weight was also lower; it was approximately 29% lower. Given current ex-vessel price levels, it is doubtful that vessels could sustain a 29% reduction in catch and a 20-29% reduction in revenues. Thus, it would be doubtful that industry would overwhelmingly support implementation of a 3.5-inch ring size restriction.

In closing, the 3.5-inch ring dredge reduced technical efficiency and permitted some escapement of small scallops. Its use, however, would not likely be supported by industry because of the possible reductions in revenue. It does not offer a viable replacement to the current 30 MPP restriction; it could if implemented with other regulations. However, additional research and analyses are necessary to further assess its viability as a replacement to the current regulation. More important, it is simply inappropriate to make broad conclusions on the results of limited experimentation. Conflicting results for the June and September experiments were obtained. These results suggest a need for additional research on the effects of using 3.5-inch ring dredges. Last, consideration of using the 3.5-inch ring dredge by management authorities will require additional information on the population dynamics and economic characteristics of the scallop fishery.

APPENDIX I

APPENDIX 1. TOW DATA FROM THE CAROLINA DAWN, JUNE 14 TO 20, 1988.

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	VESSEL SPEED (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
001	2016	30	26887.50	41728.50	26879.00	41745.00	29.00	4.40	0.50	1.00
002	2057	46	26878.50	41747.80	26881.50	41776.90	28.50	4.40	0.75	1.75
003	2158	60	26880.80	41779.40	26871.90	41823.30	31.00	4.25	1.60	2.10
004	2310	75	26871.60	41827.80	26865.30	41881.30	30.50	4.20	2.50	2.30
005	0043	92	26864.20	41882.30	26874.70	41812.30	30.50	4.25	3.30	1.30
006	0225	120	26874.70	41811.10	26902.10	41891.50	29.50	4.05	2.00	1.90
007	0433	60	26902.40	41891.80	26899.80	41935.50	27.50	4.25	1.00	1.10
008	0542	45	26900.00	41938.90	26896.20	41970.60	28.00	4.55	1.00	1.10
009	0635	60	26895.30	41974.80	26868.00	41975.40	28.00	4.20	1.50	1.40
010	0743	60	26866.00	41976.60	26861.50	41961.60	30.00	4.20	1.20	2.20
011	0955	45	26860.50	41962.70	26852.30	41996.30	30.50	4.20	0.70	1.50
012	1059	50	26851.50	42001.80	26850.40	42047.20	30.50	4.20	1.20	1.70
013	1158	45	26850.40	42048.40	26870.20	42067.50	28.50	4.15	1.10	1.60
014	1253	49	26870.50	42067.80	26870.60	42105.90	26.50	4.30	0.90	1.80
015	1352	41	26870.10	42106.50	26869.70	42141.10	25.00	4.25	0.80	1.00
016	1442	60	26869.70	42142.00	26845.70	42172.00	24.00	4.25	2.20	1.90
017	1554	75	26845.10	42172.90	26812.50	42199.80	26.00	4.20	1.80	1.70
018	1716	88	26812.00	42200.70	26781.50	42246.60	30.00	4.15	3.10	2.90
019	1854	59	26781.20	42247.80	26780.60	42296.10	33.00	4.25	3.50	3.80
020	2005	30	26779.40	42295.30	26776.60	42272.10	35.00	4.20	1.40	2.30
021	2048	46	26776.20	42273.00	26793.30	42304.10	34.00	4.20	2.30	3.90
022	2148	60	26793.00	42305.30	26783.60	42258.60	34.50	4.20	2.40	5.00
023	2301	49	26783.00	42258.60	26774.20	42296.60	35.00	4.20	3.50	2.00
024	0001	52	26774.30	42295.50	26779.10	42256.60	33.50	4.50	2.50	4.00
025	0102	54	26778.30	42258.00	26779.30	42299.90	33.00	4.20	2.50	3.90
026	0205	52	26778.90	42298.40	26780.30	42256.80	32.50	4.25	2.50	3.00
027	0306	51	26780.70	42258.60	26780.70	42297.20	33.00	4.35	2.80	4.00
028	0406	51	26780.60	42297.60	26780.40	42256.80	33.00	4.30	2.70	4.50
029	0505	52	26780.40	42257.40	26780.80	42298.90	33.00	4.30	2.50	4.30
030	0606	51	26781.00	42298.70	26780.30	42261.00	33.00	4.30	3.10	4.60
031	0700	57	26780.30	42261.10	26783.60	42305.70	33.50	4.20	3.50	4.50
032	0823	45	26784.00	42309.10	26799.50	42280.50	30.00	4.15	1.30	1.80
033	0919	50	26799.40	42283.40	26811.40	42255.60	24.00	3.90	0.80	1.00
034	1019	61	26811.40	42256.40	26804.80	42304.30	24.50	4.00	1.40	2.00

APPENDIX 1. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	VESSEL SPEED (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
035	1313	45	26801.30	42314.90	26813.90	42289.10	25.00	3.65	1.20	1.80
036	1408	60	26813.70	42289.60	26821.10	42248.40	22.50	4.00	1.00	0.80
037	1518	47	26821.20	42249.10	26845.20	42239.70	22.50	4.20	1.00	1.00
038	1620	75	26845.20	42240.60	26811.00	42256.20	23.50	4.00	2.00	2.00
039	1816	45	26786.80	42254.90	26781.50	42286.90	34.00	4.25	1.80	1.90
040	1911	50	26781.60	42288.20	26784.30	42249.20	34.50	4.30	2.60	2.30
041	2012	50	26784.50	42249.20	26780.40	42289.00	35.00	4.25	2.30	3.80
042	2111	50	26780.60	42290.00	26781.60	42251.70	33.50	4.20	2.50	3.20
043	2213	47	26781.30	42252.20	26779.90	42290.80	33.50	4.20	2.70	3.00
044	2309	48	26779.80	42291.70	26783.10	42253.30	35.00	4.10	1.30	3.50
045	0006	47	26783.10	42253.70	26779.70	42290.10	35.00	4.30	1.30	3.00
046	0100	50	26779.50	42290.60	26783.00	42251.40	34.50	4.00	2.80	4.30
047	0158	57	26782.80	42250.90	26780.50	42293.10	34.50	4.25	2.90	3.70
048	0304	47	26780.40	42291.30	26779.80	42255.30	33.00	4.35	2.00	3.00
049	0400	58	26779.70	42255.40	26780.10	42299.90	32.50	4.20	3.00	3.00
050	0507	50	26780.20	42299.80	26780.20	42259.60	34.00	4.20	3.00	3.70
051	0605	50	26780.30	42212.50	26780.80	42297.50	34.50	4.30	2.00	2.50
052	0702	45	26780.80	42297.30	26785.00	42205.90	33.00	4.25	2.10	3.40
053	0803	45	26786.80	24267.90	26782.50	42302.20	32.50	4.30	2.50	3.20
054	0859	47	26782.80	42303.30	26782.40	42265.50	35.00	4.25	2.00	4.00
055	0957	60	26782.40	42265.60	26778.00	42312.40	35.50	4.15	2.50	3.00
056	1113	44	26778.60	42315.70	26785.40	42347.30	35.00	4.25	1.20	1.00
057	1209	60	26784.90	42348.50	26772.20	42388.50	30.50	4.15	1.80	2.70
058	1320	45	26790.00	42416.70	26711.80	42389.50	28.50	4.15	1.80	2.80
059	1419	47	26790.00	42417.90	26785.80	42380.00	28.00	4.20	1.10	2.10
060	1516	48	26785.60	42380.20	26789.60	42419.70	28.00	4.25	1.50	2.40
061	1615	90	26789.60	42420.20	26801.40	42354.40	28.50	4.20	2.20	3.50
062	1756	50	26801.20	42354.30	26803.20	42396.00	29.00	4.15	1.40	2.70
063	1910	51	26803.00	42396.80	26805.30	42439.00	27.00	4.25	1.80	3.20
064	2017	45	26806.20	42451.30	26783.40	42456.40	27.00	4.20	1.10	1.80
065	2116	37	26783.50	42456.90	26801.70	42452.50	27.50	4.30	1.70	1.30
066	2203	56	26802.80	42450.50	26804.20	42408.30	27.50	4.20	2.30	1.70
067	2310	50	26803.60	42408.00	26794.80	42361.70	31.00	4.10	1.30	2.50
068	0008	53	26794.70	42360.80	26791.10	42323.20	31.00	4.10	1.30	1.30

APPENDIX 1. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	VESSEL SPEED (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
069	0109	51	26790.80	42317.70	26810.00	42304.90	28.50	4.20	1.50	2.70
070	0208	52	26809.80	42304.60	26814.10	42305.10	23.50	4.45	2.00	3.80
071	0307	53	26812.00	42303.60	26785.40	42296.80	29.00	4.40	1.90	2.50
072	0408	52	26784.90	42396.60	26780.20	42253.60	32.50	4.35	2.20	3.50
073	0514	46	26780.60	42253.60	26780.40	42291.10	33.50	4.35	1.70	4.00
074	0607	48	26780.40	42291.40	26780.90	42253.30	33.00	4.30	1.80	.
075	0702	50	26780.80	42253.80	26780.90	42293.80	33.00	4.35	2.00	3.00
076	0812	57	26781.00	42292.10	26780.80	42249.80	33.00	4.25	2.30	4.00
077	0917	54	26780.90	42251.00	26779.80	42291.60	33.00	4.20	2.30	3.00
078	1023	50	26780.20	42291.50	26780.10	42252.60	33.00	4.35	2.20	3.80
079	1127	54	26780.90	42256.70	26799.70	42270.20	27.50	3.65	.	.
080	1514	46	26799.40	42278.70	26773.50	42275.10	33.00	4.25	1.70	1.40
081	1619	45	26773.50	42274.80	26798.10	42279.00	31.00	4.35	1.40	3.00
082	1705	45	26798.60	42278.10	26775.10	42274.30	30.00	4.25	1.80	3.00
083	1809	41	26775.70	42272.50	26774.30	42304.70	35.50	4.25	1.90	2.80
084	1900	45	26774.70	42305.20	26776.50	42267.10	35.50	4.25	2.20	3.50
085	1955	45	26776.80	42266.70	26793.10	42297.20	33.70	4.25	2.00	3.50
086	2050	50	26794.20	42297.00	26776.60	42264.80	32.00	4.25	2.00	4.40
087	2150	50	26777.60	42263.80	26794.50	42299.30	32.00	4.25	2.40	3.50
088	2253	59	26794.80	42300.10	26776.30	42366.20	32.00	4.25	2.00	.
089	2358	60	26726.30	42266.10	26790.80	42290.80	34.00	4.25	2.30	3.50
090	0106	44	26791.80	42292.60	26774.50	42265.80	35.00	4.35	2.60	4.00
091	0159	53	26775.30	42266.90	26793.90	42294.80	34.50	4.20	2.20	3.50
092	0259	53	26793.60	42295.90	26775.70	42260.50	32.50	4.25	2.50	3.80
093	0405	53	26775.50	42260.40	26792.50	42293.80	33.00	4.25	2.00	3.50
094	0620	59	26789.70	42286.80	26780.30	42254.90	32.00	4.20	1.90	4.00
095	0727	68	26781.40	42250.80	26801.60	42212.00	28.50	4.25	1.60	2.00
096	0845	50	26799.90	42212.00	26782.20	42238.60	29.50	4.25	1.60	1.40
097	0950	75	26783.20	42237.00	26800.70	42216.10	31.00	4.30	1.20	1.70
098	1043	53	26800.80	42214.80	26781.00	42239.10	30.00	4.25	1.50	2.00
099	1144	91	26781.10	42239.40	26814.80	42194.60	28.00	4.20	2.90	2.90
100	1327	33	26815.40	42194.40	26831.20	42188.10	26.00	4.30	1.00	1.00
101	1416	45	26832.20	42187.40	26811.40	42183.80	27.00	4.40	1.10	2.00
102	1508	41	26810.70	42183.90	26803.50	42182.10	27.50	4.15	1.30	1.40

APPENDIX 1. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	VESSEL SPEED (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
103	1602	46	26803.70	42181.70	26800.10	42180.20	29.00	4.25	1.20	2.00
104	1656	46	26800.10	42181.30	26824.50	42176.90	30.00	4.25	1.50	1.50
105	1750	50	26825.40	42177.80	26849.90	42166.00	26.00	4.20	1.60	1.10
106	1847	53	26850.40	42166.40	26868.80	42344.80	23.00	4.30	1.50	1.40
107	1950	50	26869.70	42144.40	26873.30	42103.90	24.00	4.25	1.00	1.00
108	2048	52	26873.60	42104.20	26881.30	42065.00	26.00	4.25	1.00	1.10
109	2150	53	26881.60	42065.30	26892.60	42028.40	26.00	4.30	1.40	1.50
110	2253	47	26893.10	42028.70	26896.30	42001.40	26.00	4.20	1.20	1.50
111	2348	51	26895.10	47998.40	26893.40	41959.80	27.00	4.20	1.30	1.50
112	0047	47	26893.20	41956.90	26914.70	41969.90	25.50	4.30	2.30	1.90
113	0143	57	26913.70	41971.00	26868.00	41977.80	26.00	4.40	1.80	1.50
114	1449	60	26886.10	41977.30	26906.50	41963.20	26.50	4.20	1.50	1.50
115	0400	45	26908.10	41963.40	26922.80	41984.00	23.00	4.20	1.30	1.70
116	0458	47	26922.90	41982.40	26933.00	41949.20	20.50	4.30	1.20	1.50
117	0553	53	26933.00	41948.60	26932.90	41957.70	20.50	4.15	1.40	1.10
118	0654	49	26932.90	41957.50	26932.00	41956.90	20.00	4.30	1.50	1.30
119	0937	50	26860.90	41892.80	26870.60	41855.70	31.50	4.30	2.00	2.00
120	1036	51	26870.90	41855.10	26874.10	41812.80	31.00	4.40	2.10	2.10
121	1135	50	26874.30	41812.20	26869.70	41851.20	31.00	4.30	2.00	2.00

APPENDIX II

APPENDIX 2. TOW DATA FROM THE CAROLINA DAWN, JUNE 23 TO JULY 9, 1988.

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
001	1405	040	26503.9	42948.1	26483.0	27979.1	4.3	4.4	33	34	03.50	03.50
002	1504	049	26482.2	42976.8	26465.0	43006.1	4.2	4.4	35	35	03.25	03.00
003	1603	049	26463.3	43002.4	26442.2	43030.3	4.2	4.3	33	32	02.50	05.00
004	1700	050	26441.0	43032.3	26417.8	43055.4	4.2	4.4	32	33	01.50	06.25
005	1759	051	26415.5	43056.1	26382.7	43062.7	4.2	4.4	33	37	02.00	04.00
006	1901	050	26386.7	43061.8	26386.6	43098.9	4.4	4.4	38	34	03.50	07.00
007	2003	048	26386.7	43100.6	26383.1	43132.9	4.1	4.4	34	34	04.00	09.00
008	2140	050	26386.5	43137.1	26417.0	43157.7	4.1	4.3	31	32	03.00	06.50
009	2240	063	26419.2	43159.4	26447.7	43176.0	4.1	4.0	32	33	06.50	10.75
010	2352	050	26449.5	43177.0	26420.5	43176.0	3.8	4.1	34	32	05.25	06.75
011	0051	059	26418.5	43176.7	26457.4	43176.3	4.2	4.2	32	34	06.25	09.00
012	0201	059	26459.3	43176.7	26419.3	43177.2	4.1	4.4	33	32	05.00	09.00
013	0313	050	26418.6	43175.7	26458.6	43176.8	4.3	4.3	34	33	05.50	07.25
014	0412	054	26460.1	43177.1	26471.4	431[illegible]3.1	3.8	4.2	33	25	04.50	05.00
015	0515	060	26473.1	43172.4	26422.5	43141.2	4.0	4.0	25	32	06.50	10.00
016	0644	061	26423.2	43180.9	26464.4	43173.1	4.4	4.2	33	32	04.00	08.00
017	0806	059	26466.0	43172.1	26425.2	43176.7	3.9	4.3	32	33	07.50	12.75
018	0917	060	26423.3	43176.1	26462.4	43170.4	4.1	4.4	33	32	.	.
019	1505	046	26466.4	43171.7	26436.6	43178.3	4.1	4.3	32	32	05.50	07.00
020	1601	054	26433.3	43178.8	26479.1	43195.1	4.2	4.2	33	34	03.25	11.00
021	1705	055	26408.2	43198.1	26390.8	43229.5	4.3	4.3	33	38	02.75	04.50
022	1813	053	26390.7	43231.5	26391.9	43269.0	4.1	4.3	37	38	01.00	01.00
023	1920	050	26393.1	43268.3	26410.9	43241.2	4.2	4.4	38	39	.	.
024	2034	022	26419.0	43225.8	.	.	4.2	4.3	34	34	02.00	03.00
025	2102	053	26424.7	43213.7	26448.0	43186.7	4.3	4.3	33	33	04.50	05.50
026	2206	054	26449.9	43184.5	26422.7	43177.0	4.1	4.4	32	32	05.00	10.00
027	2311	049	26420.7	43177.0	26454.7	43177.0	4.1	4.4	32	32	06.75	04.50
028	0008	056	26454.4	43176.9	26419.0	43180.2	4.1	4.3	34	33	03.75	06.50
029	0109	058	26420.1	43179.8	26455.9	43175.6	4.1	4.1	33	34	03.50	06.75
030	0218	060	26455.9	43175.8	26418.9	43178.1	4.4	4.1	35	33	04.75	10.00
031	0329	061	26417.7	43177.7	26458.9	43175.3	4.2	4.5	33	34	07.75	07.75
032	0444	061	26460.4	43175.8	26419.1	43178.7	4.2	4.5	31	33	04.75	07.25
033	0555	055	26417.8	43178.9	26454.1	43176.3	4.1	4.3	33	34	05.75	06.75
034	0700	060	26454.9	43175.7	26421.2	43179.1	4.1	4.4	34	34	06.50	07.50

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
035	0813	057	26922.1	43179.2	26462.3	43175.0	4.1	4.3	33	33	04.00	08.00
036	0919	056	26461.0	43173.0	26422.2	43177.8	4.1	4.3	33	33	06.50	09.00
037	1025	040	26421.2	43177.1	26408.5	43149.6	4.1	4.4	33	31	.	.
038	1542	053	26418.8	43150.8	26395.0	43125.6	4.1	4.3	32	32	04.50	05.50
039	1650	058	26396.1	43124.2	26383.6	43083.7	4.1	4.3	32	33	05.00	07.00
040	1804	051	26384.1	43078.6	26383.6	43060.2	4.0	4.3	33	33	02.50	04.50
041	1917	055	26384.0	43067.1	26386.2	43101.9	4.3	4.1	32	34	05.75	07.25
042	2022	060	26386.3	43103.6	26385.6	43087.7	4.1	4.2	31	33	04.50	05.00
043	2131	059	26385.8	43086.4	26389.8	43130.5	4.1	4.1	32	32	04.00	06.00
044	2245	060	26390.9	43132.1	26418.3	43165.4	4.1	4.4	32	32	03.50	07.00
045	2353	067	26418.3	43167.8	26447.4	43206.2	4.1	4.5	32	33	04.50	10.00
046	0109	063	26447.9	43207.0	26466.9	43177.3	3.6	4.3	32	29	02.50	03.00
047	0220	065	26467.1	43180.9	26447.5	43211.0	4.1	4.5	29	33	02.00	04.00
048	0332	061	26445.5	43210.6	26415.8	43179.2	4.2	4.2	33	33	05.00	09.00
049	0442	063	26414.6	43178.7	26446.8	43206.9	4.1	4.3	33	32	04.50	10.00
050	0555	060	26747.1	43207.6	26463.8	43179.9	3.4	3.8	32	31	03.00	05.00
051	0705	050	26464.0	43179.8	26445.7	43205.9	4.1	4.3	32	31	04.50	04.75
052	0805	055	26445.0	43207.8	26445.5	43171.0	4.0	4.0	32	33	04.50	06.50
053	0912	053	26444.1	43170.5	26430.0	43200.1	4.0	4.1	34	34	05.50	12.50
054	1014	060	26431.7	43203.6	26435.9	43160.7	4.1	4.3	33	32	.	.
055	1439	055	26427.8	43166.8	26428.4	43203.9	4.1	4.3	33	33	05.00	09.00
056	1545	055	26427.5	43208.5	26480.0	43182.1	4.1	4.3	33	35	05.00	08.25
057	1653	054	26448.9	43181.3	26447.2	43208.7	4.3	3.9	35	32	02.50	03.00
058	1759	053	26447.8	43206.3	26449.2	43170.0	4.3	4.0	31	34	07.00	06.00
059	1903	052	26435.7	43163.4	26447.2	43207.6	4.2	4.3	32	33	06.00	05.25
060	2005	050	26448.2	43206.3	26435.3	43163.4	4.4	4.1	32	33	05.50	08.25
061	2104	051	26435.7	43163.4	26446.1	43205.8	4.0	4.4	33	33	05.75	07.00
062	2205	050	26435.7	43163.4	26449.1	43170.4	4.3	4.3	32	32	03.50	03.50
063	2305	050	26435.7	43163.4	26435.2	43163.4	4.1	4.1	35	35	05.50	07.50
064	0005	050	26444.8	43205.4	26449.0	43171.2	4.0	4.0	32	32	05.00	03.25
065	0105	063	26448.9	43170.6	26446.6	43209.7	4.3	4.3	32	33	03.50	08.00
066	0216	059	26446.1	43207.8	26449.0	43171.3	3.9	4.1	32	33	03.50	09.50
067	0324	066	26449.9	43170.6	26446.4	43211.3	3.6	3.9	32	33	05.75	04.75
068	0442	060	26447.1	43209.3	26447.1	43171.1	4.2	4.2	32	33	04.75	03.75
069	0553	063	26446.3	43166.9	26448.8	43204.8	3.4	3.6	32	33	05.50	04.75
070	0704	053	26448.9	43205.5	26444.9	43168.5	4.3	4.4	32	33	04.00	04.00

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
071	0805	055	26444.8	43168.9	26445.5	43203.5	3.5	4.2	34	34	04.00	05.50
072	0908	055	26445.3	43209.3	26434.0	43166.3	4.2	4.2	32	32	06.00	12.00
073	1015	065	26434.4	43163.1	26446.5	43181.1	4.1	4.3	32	33	05.50	08.00
074	1130	055	26446.4	43178.8	26442.1	43215.1	4.0	4.2	33	33	06.25	07.50
075	1234	052	26442.0	43217.0	26440.1	43178.9	4.2	4.2	32	32	06.00	07.00
~~076~~	~~1336~~	~~051~~	~~26440.2~~	~~43176.8~~	~~26497.3~~	~~43218.3~~	~~4.4~~	~~4.4~~	~~33~~	~~33~~	~~05.00~~	.
077	1439	059	26431.8	43178.7	26447.7	43218.8	3.9	3.9	34	34	03.25	03.75
078	1549	056	26437.5	43178.3	26414.2	43178.2	4.0	4.3	33	33	05.00	10.00
079	1654	053	26413.7	43178.6	26444.7	43208.2	4.1	4.3	33	33	05.00	10.50
080	1757	057	26445.0	43208.9	26415.1	43180.8	4.2	4.3	33	33	05.00	06.50
081	1900	055	26415.0	43180.8	26418.0	43204.0	4.2	4.2	34	34	.	.
082	2005	020	26447.2	43205.0	.	.	4.3	4.3	31	31	02.50	.
083	2035	060	26427.0	43190.0	.	.	4.1	4.4	34	34	05.00	06.50
084	2144	053	26454.0	43173.1	26416.7	43177.7	4.1	4.1	33	33	04.00	09.00
085	2249	058	26415.4	43177.8	26455.0	43176.6	4.2	4.2	33	33	.	.
086	2355	060	26453.2	43187.1	26415.0	43176.8	4.3	4.3	34	32	03.50	06.00
087	0104	068	26416.4	43177.3	26458.3	43174.1	4.1	4.1	32	31	03.75	05.25
088	0220	065	26459.0	43174.0	26444.1	43209.9	4.0	4.3	32	31	07.50	09.75
089	0334	063	26442.8	43212.4	26465.3	43174.7	4.1	4.1	32	31	03.00	04.00
090	0446	069	26446.3	43173.6	26428.8	43180.0	4.3	4.3	32	33	03.25	04.25
091	0604	046	26449.8	43179.9	26461.1	43178.8	4.1	4.1	33	32	03.75	03.25
092	0659	059	26461.3	43178.7	26421.7	43182.4	4.2	4.2	33	33	05.00	05.25
093	0809	051	26420.4	43182.7	26455.6	43174.5	4.2	4.3	39	33	04.00	08.50
094	0910	052	26456.2	43174.4	26418.5	43175.4	4.2	4.4	34	33	05.00	06.25
095	1012	058	26417.1	43175.5	26400.5	43172.3	4.3	4.4	32	33	04.00	06.00
096	1120	060	26404.1	43174.7	26380.3	43203.0	4.2	4.4	33	33	.	.
097	1400	060	26353.4	43244.2	26330.9	43278.2	4.4	4.4	36	36	05.00	08.00
098	1511	053	26332.1	43281.2	26326.9	43279.0	4.3	4.3	29	29	07.00	11.50
099	1616	052	26327.3	43279.2	26367.6	43291.0	4.2	4.2	30	30	05.00	10.00
100	1730	055	26360.1	43291.8	26322.7	43275.7	4.3	4.3	30	30	10.00	11.00
101	1834	061	26322.3	43775.9	26360.2	43290.5	4.1	4.1	29	29	08.00	05.00
102	1944	058	26360.7	43291.2	26321.7	43277.2	4.3	4.3	30	30	09.00	04.50
103	2050	060	26320.7	43277.4	26361.7	43288.9	4.2	4.2	29	29	03.75	09.75
104	2213	052	26360.3	43290.2	26332.5	43310.1	4.2	4.2	29	29	01.50	06.00
105	2312	048	26331.4	43311.1	26360.0	43299.0	.	.	29	29	.	.

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
106	0000	058	26359.6	43299.3	26328.7	43277.3	4.1	4.1	29	29	04.25	08.50
107	0108	058	26331.8	43277.8	26368.7	43285.1	4.1	4.3	29	30	03.75	07.00
108	0215	056	26369.3	43285.2	26328.2	43279.4	4.3	4.3	30	29	03.50	06.75
109	0319	066	26327.3	43279.4	26320.4	43286.9	4.1	4.4	29	30	04.00	08.25
110	0433	064	26370.6	43287.1	26322.9	43279.1	4.2	4.2	30	29	03.75	09.25
111	0546	054	26322.5	43278.6	26362.6	43277.1	4.1	4.1	29	30	03.25	07.75
112	0651	064	26362.0	43277.5	26317.9	43278.9	4.0	4.3	31	30	05.50	13.00
113	0805	056	26315.3	43278.5	26354.1	43277.7	4.4	4.4	30	29	03.75	10.50
114	0912	053	26356.4	43276.8	26315.6	43277.3	4.2	4.2	31	30	02.50	07.25
115	1017	060	26314.3	43277.4	26364.3	43277.2	4.3	4.3	29	29	05.00	09.75
116	1508	057	26394.0	43769.4	26367.4	43277.6	4.3	3.7	31	34	05.00	09.00
117	1616	059	26361.9	43277.8	26324.6	43272.2	3.9	4.1	30	29	02.50	10.00
118	1724	059	26324.9	43277.4	26319.0	43280.6	4.1	4.3	30	31	07.00	10.50
119	1735	050	26320.5	43281.2	26313.7	43280.8	4.3	4.3	31	30	04.00	06.00
120	1834	116	26314.4	43281.8	26324.6	43277.4	4.2	4.2	31	30	08.50	10.00
121	2041	059	26324.9	43277.5	26311.0	43274.3	4.2	4.2	31	29	05.00	09.50
122	2152	058	26313.0	43278.2	26308.4	43236.9	4.2	4.3	30	30	02.50	08.00
123	2303	050	26311.1	43276.2	26319.5	43281.4	4.2	4.2	30	30	02.50	09.00
124	0007	058	26320.2	43281.4	26319.5	43280.8	4.4	4.4	30	30	03.50	09.00
125	0116	056	26318.8	43279.4	26317.6	43281.8	4.3	4.3	29	30	03.00	08.00
126	0220	070	26315.2	43280.5	26329.5	43279.8	4.4	4.4	30	29	04.00	12.00
127	0339	066	26318.7	43279.2	26312.3	43279.8	4.3	4.3	29	29	03.75	08.50
128	0453	064	26313.5	43279.1	26329.8	43279.1	4.1	4.1	30	30	.	08.25
129	0606	049	26329.5	43279.3	26318.0	43279.2	4.2	4.2	29	30	04.00	07.25
130	0701	057	26319.0	43278.9	26292.5	43294.7	4.2	4.2	30	29	06.50	12.00
131	0807	060	26294.0	43295.0	26334.3	43297.7	4.0	4.1	31	31	17.50	17.00
132	0915	059	26335.1	43297.4	26275.6	43294.7	4.3	4.3	31	31	13.00	20.00
133	0406	054	26279.7	43272.2	26305.1	43298.0	4.2	4.2	30	31	05.00	07.00
134	0510	050	26302.1	43295.5	26338.0	43298.6	4.3	4.3	31	31	06.00	14.00
135	0610	057	26339.0	43298.2	26796.3	43294.2	4.1	4.1	31	30	10.25	15.75
136	0746	058	26311.2	43285.9	26294.7	43295.5	4.3	4.3	30	30	12.50	19.50
137	0854	057	26293.2	43295.3	26332.5	43295.3	4.3	4.3	31	31	20.00	19.50
138	0712	056	26302.2	43274.2	26311.0	43781.9	4.0	4.2	30	30	03.50	10.00
139	0817	060	26342.3	43282.2	26383.0	43296.1	4.3	4.3	30	30	02.50	05.00
140	0929	062	26384.8	43295.7	26340.1	43280.5	4.4	4.4	30	30	03.00	09.00

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
141	1040	060	26337.6	43279.6	26295.3	43277.9	4.2	4.2	31	31	03.50	07.50
142	1150	060	26292.8	43277.6	26326.9	43279.8	3.5	3.9	30	30	02.25	06.75
143	1259	055	26327.7	43279.3	26360.0	43280.7	3.6	3.9	29	29	01.33	05.50
144	1400	054	26361.0	43284.7	26340.8	43279.8	4.1	4.4	29	29	03.00	06.00
145	1502	053	26338.8	43279.0	26301.4	43276.0	4.1	3.8	29	29	03.50	05.50
146	1608	057	26299.4	43275.8	26341.1	43274.3	4.3	4.3	29	29	03.00	06.00
147	1715	045	26347.2	43275.4	26350.4	43275.4	4.2	4.2	31	31	02.00	07.00
148	1809	053	26352.1	43176.3	26340.2	43274.4	4.3	4.3	30	30	02.75	06.50
149	1912	058	26338.3	43274.2	26321.9	43275.8	4.1	4.1	29	29	02.50	06.00
150	2022	060	26321.5	43275.7	26333.6	43277.1	4.1	3.8	29	29	02.00	07.50
151	2131	061	26334.1	43276.7	26376.8	43289.7	3.9	4.2	29	29	03.50	07.75
152	2243	059	26399.5	43290.2	26421.7	43299.6	4.3	4.3	31	31	03.50	07.25
153	2350	050	26422.5	43299.1	26387.9	43294.3	4.3	4.3	32	31	03.00	05.00
154	0048	067	26387.8	43294.2	26435.3	43300.6	4.1	4.1	31	35	02.75	06.00
155	0205	070	26434.8	43300.3	26384.7	43297.1	4.3	4.3	35	30	03.50	04.75
156	0322	058	26384.3	43297.7	26420.8	43316.0	4.0	4.0	30	27	03.25	06.50
157	0427	058	26420.8	43316.0	26393.5	43284.4	4.3	4.3	27	32	03.00	05.50
158	0535	065	26388.8	43283.9	26344.5	43281.2	4.2	4.2	32	29	03.25	04.75
159	0649	052	26339.2	43280.2	26306.1	43277.3	4.3	4.3	30	31	02.00	07.50
160	0756	049	26301.9	43278.0	26304.8	43277.9	4.5	4.5	31	30	.	.
161	0854	060	26303.9	43277.8	26331.8	43290.0	3.5	4.1	30	30	02.50	08.75
162	1007	060	26331.1	43291.6	26317.2	43250.0	4.1	4.3	32	32	06.75	10.75
163	1149	056	26310.2	43243.0	26324.4	43270.6	3.5	4.1	32	32	03.50	05.50
164	1255	060	26324.6	43271.2	26326.2	43272.7	3.8	4.3	29	29	06.75	09.00
165	1404	057	26325.1	43269.7	26326.4	43271.1	4.3	3.5	28	28	03.25	05.50
166	1514	060	26329.2	43271.7	26336.1	43419.2	4.2	4.4	29	29	05.00	11.00
167	1631	057	26336.9	43290.2	26317.9	43254.1	3.9	4.2	30	30	03.50	04.50
168	1741	052	26317.3	43254.1	26335.4	43290.5	4.0	4.3	32	32	05.00	10.00
169	1842	061	26336.3	43290.8	26316.1	43255.6	4.4	3.3	30	30	04.50	08.00
170	1956	060	26216.3	43255.8	26312.9	43262.1	4.0	4.2	30	30	03.00	07.50
171	2106	054	26310.9	43262.0	26312.4	43261.7	4.0	4.1	30	30	03.50	06.00
172	2205	058	26310.1	43261.6	26334.3	43291.6	4.2	4.2	30	30	06.00	11.50
173	2315	054	26335.0	43292.6	26314.8	43255.8	4.2	4.2	31	31	05.75	11.00
174	0015	064	26314.4	43255.9	26339.3	43291.0	4.4	4.4	29	31	05.50	10.00
175	0126	054	26339.1	43291.7	26318.0	43258.1	4.3	4.3	31	29	05.75	08.50

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
176	0228	055	26317.2	43258.9	26334.1	43288.4	3.9	4.0	29	30	05.50	08.00
177	0331	058	26334.1	43288.4	26315.3	43251.4	4.3	4.3	30	31	04.50	07.75
178	0434	061	26315.4	43251.3	26332.8	43289.3	4.1	4.1	31	30	04.75	10.50
179	0552	055	26337.7	43288.2	26317.4	43254.4	4.5	4.5	30	32	06.25	09.50
180	0653	057	26317.4	43254.4	26335.5	43289.3	4.0	4.4	30	30	05.00	10.00
181	0758	057	26336.2	43290.0	26316.6	43254.5	4.1	4.4	30	30	05.00	08.00
182	0901	054	26316.7	43254.7	26339.6	43288.9	4.1	4.1	32	32	06.00	08.00
183	1540	060	26339.7	43289.9	26316.3	43252.8	4.4	4.4	30	30	06.00	07.75
184	1648	056	26316.0	43252.9	26335.5	43289.3	4.4	4.4	31	31	05.00	09.25
185	1755	056	26336.0	43290.1	26315.8	43252.3	4.3	4.3	30	30	06.00	09.00
186	1900	065	26315.2	43252.2	26339.5	43299.2	4.1	4.1	31	31	07.00	07.00
187	2015	060	26337.1	43292.2	26322.1	43252.1	4.1	3.9	30	30	09.50	08.00
188	2126	059	26321.7	43252.3	26338.7	43291.0	4.1	4.4	31	31	06.00	09.00
189	2234	056	26337.2	43294.1	26419.0	43253.2	4.1	4.4	30	30	04.50	07.00
190	2338	060	26318.8	43253.1	26334.8	43287.1	4.1	4.1	32	32	04.00	08.00
191	0048	051	26334.5	43287.5	26317.3	43253.9	4.3	4.3	30	32	.	07.00
192	0146	057	26316.7	43254.1	26332.3	43283.7	.	.	32	32	04.25	07.75
193	0252	063	26332.8	43284.4	26318.8	43258.2	4.4	4.4	29	30	04.00	08.00
194	0403	060	26320.5	43259.7	26335.4	43285.0	4.0	4.0	30	29	05.25	11.50
195	0511	053	26335.3	43284.9	26318.0	43254.4	4.4	4.4	29	32	02.50	06.00
196	0611	056	26318.3	43254.7	26338.9	43289.5	4.6	4.6	32	30	04.50	08.00
197	0718	062	26339.6	43290.5	26318.3	43255.2	3.9	3.9	30	32	02.50	08.00
198	0832	058	26318.3	43253.3	26342.1	43292.1	4.4	4.4	32	32	04.50	12.00
199	0940	060	26342.6	43293.1	26317.9	43254.8	4.0	3.8	31	31	05.00	09.00
200	1506	060	26294.1	43273.7	26334.2	43287.3	3.5	4.1	30	30	04.50	08.50
201	1627	056	26335.2	43288.4	26314.0	43248.0	4.4	4.4	30	30	04.50	06.50
202	1730	062	26314.9	43248.8	26335.6	43285.9	3.5	4.1	30	30	03.75	07.50
203	1846	054	26335.9	43286.0	26347.5	43255.5	4.4	4.4	29	29	04.50	09.00
204	1949	060	26348.0	43254.6	26328.9	43284.6	3.8	4.1	33	33	04.50	07.50
205	2058	048	26328.9	43285.0	26347.2	43255.8	4.3	4.3	29	29	04.00	06.00
206	2153	060	26348.1	43254.2	26326.8	43284.2	4.2	4.2	32	32	05.50	06.50
207	2300	060	26326.6	43284.5	26329.7	43281.4	4.2	4.2	30	30	04.00	06.00
208	0009	081	26530.2	43280.6	26359.0	43234.9	4.1	4.1	30	31	04.00	06.00
209	0146	060	26359.6	43236.2	26355.1	43216.8	4.4	4.4	30	31	02.50	03.25
210	0255	055	26354.5	43278.3	26326.4	43300.3	4.1	4.1	31	30	06.00	12.25

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
211	0359	041	26326.2	43300.2	26306.1	43276.4	4.0	4.0	30	29	06.00	12.00
212	0448	052	26307.5	43276.5	26299.1	43279.2	4.2	4.2	29	29	04.00	07.75
213	0549	051	26299.2	43279.9	26304.5	43279.5	4.1	4.1	29	29	04.00	05.00
214	0650	050	26304.5	43279.5	26335.1	43271.4	4.2	4.2	29	28	03.50	08.50
215	0750	060	26335.9	43271.9	26326.8	43278.5	4.4	4.4	28	28	07.25	12.00
216	0901	059	26326.6	43279.0	26342.8	43257.2	4.3	4.3	29	29	05.00	11.00
217	1011	049	26342.6	43257.7	26341.2	43287.7	4.3	4.3	31	31	05.50	08.50
218	1434	061	26340.0	43240.0	26346.0	43256.5	4.4	4.4	30	30	05.50	08.50
219	1545	060	26346.3	43255.0	26325.6	43285.2	4.0	4.0	30	30	05.50	08.00
220	1655	050	26325.5	43285.4	26343.7	43257.3	4.4	4.4	30	30	03.50	06.50
221	1754	048	26344.0	43259.6	26327.7	43285.1	4.4	4.4	31	31	05.00	06.75
222	1859	061	26329.8	43287.2	26350.7	43249.7	4.3	4.3	30	30	03.75	06.25
223	2009	060	26351.2	43249.1	26330.4	43278.7	4.0	4.0	36	36	05.00	05.00
224	2130	063	26333.3	43280.0	26328.5	43272.1	4.1	4.1	30	30	.	.
225	2242	060	26328.5	43272.1	26327.8	43279.0	4.1	4.4	29	29	06.00	08.00
226	2352	063	26327.5	43279.5	26325.2	43270.8	4.2	4.2	30	30	05.00	10.00
227	0104	068	26325.0	43270.4	26323.4	43263.8	4.3	4.3	30	30	07.00	08.00
228	0219	067	26323.9	43263.9	26338.5	43269.4	4.0	4.0	30	30	04.00	07.00
229	0337	060	26338.6	43269.2	26337.3	43265.2	4.3	4.3	30	30	04.25	07.50
230	0444	061	26337.5	43265.3	26338.6	43265.7	4.0	4.0	30	30	05.00	06.00
231	0553	058	26338.9	43263.9	26336.5	43269.2	4.3	3.9	30	30	06.00	09.00
232	0700	060	26335.2	43271.6	26337.8	43264.0	4.3	4.3	28	30	05.00	07.00
233	0810	060	26337.4	43264.3	26338.3	43271.5	4.3	4.0	30	29	04.50	09.00
234	0920	055	26338.4	43271.5	26340.3	43263.7	4.0	4.0	28	28	05.00	08.50
235	1024	056	26340.1	43264.1	.	.	4.3	4.3	30	30	06.00	09.00
236	1530	060	26349.0	43278.9	26346.8	43266.6	4.4	4.4	29	29	04.50	08.00
237	1640	057	26346.3	43266.5	26347.1	43266.1	4.3	4.3	31	31	04.50	09.00
238	1745	059	26346.9	43266.1	26342.7	43264.7	4.2	4.2	31	31	04.50	09.00
239	1853	060	26342.2	43264.7	26346.2	43267.5	4.2	4.2	30	30	03.75	08.75
240	2004	057	26346.1	43267.4	26344.0	43265.1	4.3	4.3	30	30	05.00	06.25
241	2110	061	26384.9	43266.9	26343.9	43266.3	4.2	4.2	29	29	03.00	07.00
242	2220	060	26849.1	43267.2	26346.6	43267.9	4.4	4.4	30	30	03.00	07.50
243	2330	063	26346.6	43269.9	26338.7	43268.0	4.3	4.3	29	29	04.00	07.25
244	0043	060	26338.7	43268.0	26347.8	43267.5	4.3	4.3	30	31	04.25	10.00
245	0151	059	26346.8	43267.2	26346.8	43266.7	4.1	4.1	31	31	03.00	09.00

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	END	DEPTH (fathoms) BEGIN	END	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
246	0258	057	26345.7	43266.8	26343.6	43266.5	4.1	4.1	31	31	04.00	08.00
247	0403	057	26343.9	43261.4	26347.8	43266.1	4.4	4.4	31	31	03.75	06.00
248	0511	059	26347.1	43265.1	26347.7	43267.6	4.2	4.2	31	31	03.75	06.00
249	0618	057	26347.3	43267.5	26346.5	43268.0	4.0	4.0	31	29	04.00	06.00
250	0725	060	26345.7	43268.4	26347.6	43269.0	4.4	4.4	29	29	04.00	07.75
251	0835	062	26347.5	43269.5	26346.9	43266.9	4.2	4.2	28	28	04.00	06.00
252	0945	060	26346.9	43266.3	26346.6	43275.4	4.1	4.4	31	29	04.00	06.25
253	1053	057	26346.1	43275.5	26239.3	43274.5	4.1	4.1	29	29	03.00	03.00
254	1203	057	26348.5	43277.1	26307.8	43276.9	4.2	4.2	31	31	04.00	06.25
255	1310	060	26307.5	43276.9	26488.7	43442.5	4.2	4.2	30	30	06.00	08.75
256	1423	072	26488.8	43444.2	26300.2	43278.4	4.3	4.3	30	30	04.75	06.00
257	1545	055	26298.3	43278.5	26342.5	43277.7	3.9	4.2	29	29	05.00	07.50
258	1652	053	26343.3	43277.9	26298.3	43277.7	4.1	4.1	30	30	04.50	06.25
259	1810	030	26298.2	43277.8	.	.	4.2	4.2	30	30	02.50	04.25
260	1857	058	26318.9	43277.8	26362.8	43278.5	4.3	4.3	29	29	03.00	05.00
261	2004	056	26362.9	43278.5	26326.3	43278.0	4.2	4.2	30	30	02.50	04.00
262	2110	060	26326.6	43276.2	26300.9	43278.1	4.2	4.2	29	29	02.50	05.00
263	2221	064	26300.1	43278.1	26349.3	43274.9	4.1	4.1	29	29	08.00	05.00
264	2337	063	26349.1	43274.7	26306.4	43278.3	4.2	4.2	29	29	03.00	05.25
265	0047	059	26306.4	43278.3	26270.1	43287.7	4.4	4.4	32	32	07.50	15.25
266	0155	085	26268.9	43287.4	26282.3	43288.7	4.4	4.4	30	30	04.00	06.00
267	0327	063	26281.2	43288.7	26251.7	43284.8	4.1	4.1	30	30	02.50	08.75
268	0436	057	26251.6	43285.5	26252.4	43288.1	4.2	4.2	36	36	01.75	01.50
269	0543	060	26253.3	43289.6	26290.5	43285.6	4.2	4.2	36	30	11.00	15.00
270	0654	058	26293.1	43284.5	26337.2	43277.4	4.2	4.2	30	30	05.00	10.50
271	0809	052	26337.2	43277.5	26289.7	43279.1	4.1	4.1	29	29	04.00	06.50
272	0910	051	26299.2	43279.4	26336.8	43278.0	4.0	4.2	30	30	04.50	09.00
273	1600	060	26337.6	43301.3	26312.2	43278.4	4.2	4.2	29	29	05.00	10.00
274	1710	060	26312.0	43278.4	26314.9	43277.8	3.9	3.9	30	30	02.50	07.00
275	1818	060	26313.8	43276.5	26307.2	43279.0	4.0	4.0	29	29	02.50	05.00
276	1928	052	26306.7	43279.2	26275.6	43292.9	4.4	4.4	29	29	06.00	12.00
277	2027	058	26275.6	43292.9	26308.8	43276.4	4.0	4.0	32	32	06.75	07.50
278	2135	057	26308.9	43276.5	26272.3	43292.8	4.2	4.2	29	29	11.25	11.00
279	2244	060	26271.8	43292.9	26309.2	43277.4	3.9	3.9	32	32	08.00	10.50
280	2354	061	26309.6	43277.5	26271.9	43295.5	4.2	4.2	33	33	07.25	15.00

APPENDIX 2. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn) BEGIN	VESSEL SPEED (kn) END	DEPTH (fathoms) BEGIN	DEPTH (fathoms) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
281	0104	062	26271.2	43295.7	26308.2	43277.8	4.0	4.0	30	30	05.75	08.50
282	0216	060	26308.9	43277.7	26270.8	43294.7	4.5	4.5	29	29	05.25	16.00
283	0327	068	26269.7	43295.0	26306.5	43277.2	3.7	3.7	33	33	07.25	12.25
284	0444	060	26306.8	43277.7	26269.7	43294.6	4.4	4.4	30	30	06.00	08.00
285	0553	066	26268.8	43295.3	26306.7	43279.1	3.9	3.9	33	33	07.50	10.00
286	1203	059	26308.9	43274.2	26309.2	43297.5	4.2	4.2	31	31	07.25	11.25
287	1310	065	26309.6	43277.4	26268.5	43293.9	4.2	4.2	34	34	10.50	11.50
288	1425	065	26268.1	43293.2	26308.7	43278.9	4.0	4.0	30	30	08.50	12.00
289	1547	053	26308.8	43278.1	26272.1	43292.5	4.4	4.4	30	30	09.25	15.75
290	1656	060	26270.4	43295.8	26307.0	43280.3	4.0	4.0	31	31	10.00	12.50
291	1805	059	26307.9	43279.3	26269.3	43193.2	4.3	4.3	31	31	16.00	20.50
292	1917	061	26270.5	43291.9	26308.3	43278.1	4.1	4.1	33	33	09.00	14.00
293	2030	050	26308.8	43275.2	26345.1	43277.5	4.2	4.2	30	30	01.50	03.00

APPENDIX III

APPENDIX 3. TOW DATA FROM THE CAROLINA CAPES, SEPTEMBER 22 TO 27, 1988.

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn)	DEPTH (fa.) BEGIN	DEPTH (fa.) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
001	0020	40	26920	41564	26909	41586	4.30	23	26	0.75	1.12
002	0110	40	26908	41585	26898	41604	4.00	26	31	1.25	1.12
003	0157	40	26897	41603	26898	41626	3.50	26	26	0.33	0.33
004	0245	40	26891	41624	26877	41650	3.50	26	27	1.00	1.33
005	0337	36	26889	41649	26887	41670	4.00	27	31	1.00	1.33
006	0420	40	26878	41666	26878	41683	4.00	29	31	1.00	.
007	0507	40	26877	41684	26870	41709	3.70	29	31	0.75	0.75
008	0555	40	26870	41707	26874	41685	4.20	31	29	0.40	0.70
009	0642	40	26873	41687	26879	41707	3.80	28	31	0.85	0.90
010	0732	40	26880	41705	26888	41722	3.70	28	29	0.70	0.50
011	0819	40	26888	41723	26894	41746	3.60	29	24	0.60	0.50
012	0906	60	26894	41745	26899	41769	3.80	24	27	1.20	1.30
013	1011	39	26900	41765	26878	41779	3.90	24	27	1.00	0.90
014	1056	44	26897	41782	26889	41802	3.80	27	27	1.10	1.10
015	1150	40	26889	41801	26890	41834	3.80	27	25	1.00	1.30
016	1240	40	26891	41835	26887	41868	3.80	25	28	1.00	1.10
017	1330	40	26888	41869	26888	41902	4.20	28	29	1.30	1.60
018	1420	44	26888	41902	26887	41941	4.40	29	28	1.00	1.00
019	1510	40	26889	41941	26878	41970	4.20	28	29	1.10	1.40
020	1600	40	26878	41970	26864	41998	4.30	29	30	1.50	1.10
021	1650	40	26863	41999	26848	42026	4.30	30	31	2.00	3.00
022	1740	20	26849	42026	26861	42000	4.20	31	29	1.90	3.00
023	1830	40	26861	42000	26847	42025	4.30	29	30	1.50	2.50
024	1920	40	26848	42025	26862	41999	4.30	30	29	1.90	3.00
025	2010	40	26862	41999	26848	42026	4.30	29	30	1.75	2.00
026	2100	40	26848	42026	26862	41999	4.20	30	29	1.50	3.00
027	2150	55	26862	41999	26862	41997	4.20	29	28	2.20	3.10
028	2255	50	26862	41997	26862	41997	4.30	29	28	2.80	4.10
029	0030	40	26860	41995	26847	42018	4.20	28	30	1.10	2.00
030	0120	40	26847	42018	26847	41995	4.40	30	28	1.10	2.00
031	0210	50	26861	41995	26861	41997	4.30	28	29	2.50	2.70
032	0310	40	26861	41997	26858	42005	4.20	29	28	1.50	2.80
033	0357	45	26857	42007	26857	42002	4.20	29	28	2.10	3.00
034	0450	42	26857	42003	26854	42013	4.20	28	31	1.30	2.30

APPENDIX 3. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn)	DEPTH (fa.) BEGIN	DEPTH (fa.) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
035	0539	41	26853	42012	26856	42001	4.20	29	28	1.20	2.20
036	0627	41	26855	42000	26847	42023	4.30	29	30	1.40	2.00
037	0715	40	26845	42027	26842	42055	4.20	30	31	1.20	1.90
038	0802	40	26842	42056	26846	42027	4.10	30	30	1.00	1.10
039	0850	40	26847	42027	26851	42019	4.30	30	29	1.10	1.40
040	0938	42	26852	42019	26855	41996	4.30	29	29	1.00	2.00
041	1028	40	26855	41999	26856	42008	.	29	28	0.90	1.60
042	1115	40	26856	42006	26858	42003	4.00	28	29	0.90	1.80
043	1205	40	26858	42003	26860	41999	4.10	28	28	1.60	1.70
044	1255	40	26860	41999	26867	41993	3.90	28	28	1.20	2.00
045	1345	20	26867	41993	26862	41997	3.90	29	28	1.40	2.20
046	1435	15	26862	41997	26856	42005	4.20	28	28	0.90	1.40
047	1500	30	26856	42005	26869	41996	4.00	28	30	.	.
048	1543	32	26868	41997	26868	42010	4.20	30	29	.	.
049	1630		26854	42010			.			.	.
050	1720	30	26865	41997	26852	42010	4.30	29	30	1.00	2.50
051	1800	40	26850	42011	26831	42015	4.30	29	32	0.75	1.20
052	1850	40	26830	42015	26819	42018	4.40	33	35	0.50	1.40
053	1940	40	26819	42020	26819	41982	4.30	35	32	0.75	1.40
054	2030	40	26819	41983	26837	41971	4.10	32	34	1.00	1.60
055	2120	50	26837	41971	26845	42009	4.00	30	30	1.00	1.80
056	2220	40	26845	42000	26853	42041	4.10	30	29	0.80	1.30
057	2310	40	26853	42041	26862	42069	4.30	29	27	0.80	1.20
058	0000	40	26862	42068	26863	42104	4.10	27	27	1.00	1.20
059	0050	40	26863	42104	26846	42085	4.20	27	28	1.50	1.20
060	0140	40	26847	42084	26828	42064	4.10	28	31	1.50	1.60
061	0230	40	26828	42064	26813	42047	4.30	31	34	0.75	1.25
062	0320	40	26813	42047	26816	42032	4.20	34	35	1.00	1.50
063	0410	40	26817	42034	26824	42059	4.20	34	31	0.80	1.20
064	0500	40	26829	42061	26844	42082	4.10	31	29	1.70	1.00
065	0550	40	26844	42082	26841	42071	4.20	29	31	1.20	1.40
066	0640	40	26841	42077	26832	42068	4.30	29	33	1.10	1.30
067	0730	40	26832	42066	26845	42079	4.20	32	29	1.00	1.20
068	0820	40	26845	42079	26831	42064	4.30	29	32	1.20	1.00

APPENDIX 3. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn)	DEPTH (fa.) BEGIN	DEPTH (fa.) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
069	0910	40	26831	42064	26833	42090	4.10	32	31	.	1.30
070	1000	40	26831	42089	26841	42061	4.20	31	30	1.00	1.20
071	1050	40	26841	42059	26839	42075	4.10	30	29	1.10	1.40
072	1140	40	26840	42075	26858	42067	4.20	29	28	1.10	1.00
073	1230	40	26860	42068	26881	42075	4.20	28	25	1.00	1.20
074	1320	40	26881	42075	26869	42102	4.10	25	26	1.00	1.40
075	1410	40	26869	42102	26853	42118	4.10	27	27	0.90	1.00
076	1500	40	26853	42118	26844	42148	4.20	27	26	1.10	0.70
077	1550	40	26844	42148	26832	42180	4.20	26	24	1.00	1.00
078	1640	40	26832	42180	26822	42201	4.20	26	25	0.90	0.80
079	1730	40	26822	42201	26802	42217	4.20	26	28	1.00	1.20
080	1820		26801	42217	26808	42180	4.20	28	26	1.00	1.00
081	1920	40	26808	42178	26815	42148	4.20	28	30	1.00	1.00
082	2010	40	26815	42148	26833	42150	4.30	30	28	0.90	1.00
083	2100	40	26835	42150	26844	42120	4.20	28	27	0.80	0.80
084	2150	40	26844	42120	26825	42132	4.20	27	30	1.50	1.75
085	2245	35	26825	42132	26829	42127	4.20	30	30	1.10	1.40
086	2330	40	26829	42127	26821	42133	4.10	30	30	1.00	1.20
087	0040	40	26822	42129	26819	42097	4.40	31	31	1.00	1.50
088	0130	40	26819	42093	26817	42060	4.30	32	33	1.10	1.40
089	0220	40	26818	42055	26809	42044	4.00	33	37	0.75	1.20
090	0310	40	26811	42043	26831	42038	4.40	36	31	0.00	1.60
091	0400	40	26834	42037	26829	42040	3.80	31	33	0.50	1.20
092	0450	40	26831	42039	26834	42035	4.10	31	33	1.00	.
093	0540	40	26833	42036	26833	42038	4.20	33	31	1.00	1.75
094	0700	40	26840	42030	26827	42042	.	30	33	0.90	1.40
095	0750	40	26827	42041	26847	42036	.	33	30	0.80	1.80
096	0840	35	26847	42038	26838	42037	4.30	33	30	1.00	1.20
097	0925	35	26840	42036	26838	42044	4.20	33	30	0.80	1.00
098	1010	60	26839	42042	26836	42031	4.20	30	31	1.00	1.50
099	1125	35	26836	42301	26842	42017	.	31	29	.	1.50
100	1210	30	26844	42014	26860	41993	.	30	28	0.90	1.70
101	1305	40	26859	41993	26864	41992	4.30	28	28	1.10	2.00
102	1355	40	26864	41992	26856	41960	4.30	28	27	1.10	1.50

APPENDIX 3. (CONTINUED).

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	VESSEL SPEED (kn)	DEPTH (fa.) BEGIN	DEPTH (fa.) END	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
103	1445	45	26856	41958	26872	41935	4.30	27	28	1.10	1.60
104	1540	40	26873	41933	26867	41965	4.10	28	28	1.30	1.70
105	1630	45	26867	41965	26859	41967	4.20	28	28	1.40	1.70
106	1725	45	26859	41967	26873	41935	4.20	31	28	1.40	1.90
107	1820	40	26873	41935	26866	41966	4.20	28	28	1.00	2.00
108	1910	40	26866	41966	26873	41933	4.20	28	28	1.50	1.50
109	2000	40	26873	41933	26867	41969	4.20	28	28	1.60	1.90
110	2050	40	26867	41967	26871	41935	4.20	28	28	1.50	1.80
111	2140	40	26871	41935	26867	41966	4.20	28	28	1.20	1.90
112	2230	40	26867	41964	26873	41933	4.30	28	28	1.20	1.60
113	2320	40	26873	41933	26865	41965	4.10	29	29	.	2.20
114	0130	40	26869	41946	26872	41939	4.20	28	28	1.10	1.30
115	0220	40	26871	41938	26865	41964	4.00	28	28	1.00	1.40
116	0310	40	26866	41962	26873	41932	4.10	28	28	1.75	2.30
117	0400	40	26874	41932	26808	41956	4.40	28	28	0.90	1.10
118	0450	40	26868	41953	26876	41924	4.20	28	28	0.90	1.20
119	0540	40	26876	41925	26868	41951	4.10	29	29	1.00	1.10
120	0630	40	26869	41952	26869	41949	4.20	28	30	1.10	1.20
121	0720	40	26869	41950	26868	41953	4.30	29	29	1.10	1.50
122	0810	40	26868	41953	26871	41953	4.30	29	31	1.25	1.60
123	0900	40	26870	41950	26869	41954	4.30	28	31	1.00	1.30
124	1000	40	26871	41948	26870	41959	4.30	28	31	1.00	1.50
125	1050	40	26869	41957	26875	41929	4.30	28	29	1.00	1.20
126	1140	40	26875	41929	26868	41961	4.30	28	28	1.00	1.40
127	1230		26868	41957			.	27		.	.
128	1320	40	26871	41925	26867	41955	4.20	30	30	1.00	1.20
129	1410	40	26868	41955	26873	41922	4.30	30	30	1.00	1.20
130	1500	43	26873	41920	26876	41882	4.00	30	29	1.00	1.30
131	1550	40	26876	41882	26860	41860	4.10	29	31	1.10	1.40
132	1640	40	26860	41860	26855	41827	4.20	31	33	1.30	2.00
133	1730	50	26855	41827	26876	41807	4.30	33	29	1.20	1.90
134	1830	40	26877	41807	26880	41783	4.40	29	27	1.20	1.60
135	1920	40	26892	41783	26900	41756	4.30	27	26	1.40	1.40
136	2010	42	26900	41756	26904	41720	4.20	27	25	1.10	1.20

APPENDIX IV

APPENDIX 4. TOW DATA FORM THE CAROLINA CAPES, SEPTEMBER 29 TO OCTOBER 12, 1988.

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
001	0915	40	26354	43286	26339	43286	4.0	30 29	0.75	4.30
002	1005	35	26341	43286	26340	43286	4.2	29 30	1.20	6.50
003	1050	35	26342	43286	26339	43286	4.2	30 29	1.20	6.75
004	1140	40	26341	43286	26339	43289	4.2			
005	1230	40	26339	43289	26338	43289	4.2	30 31	04.00	11.50
006	1320	40	26341	43290	26335	43292	4.3	31 30	04.50	11.00
007	1410	43	26335	43291	26337	43291	4.2	31 30	04.70	11.20
008	1503	42	26337	43291	26342	43289	4.2	31 30	03.50	09.00
009	1600	45	26343	43391	26339	43289	4.2	31 30	04.50	11.00
010	1655	50	26339	43289	26336	43297	4.3	31 30	02.80	10.00
011	1755	45	26336	43296	26339	43286	4.2	31 30	04.00	10.00
012	1850	50	26339	43286	26333	43290	4.1	31 30	05.40	12.00
013	1950	50	26333	43290	26333	43292	4.2	31 30	05.20	11.00
014	2050	45	26333	43292	26336	43286	4.2	31 30	04.00	10.00
015	2155	55	26334	43291	26333	43290	4.2	31 30	02.00	07.00
016	2300	50	26334	43290	26362	43288	4.2	31 30	04.00	08.00
017	0000	50	26362	43288	26362	43287	3.9	31 30	02.00	05.00
018	0100	50	26363	43286	26328	43291	4.2	31 30	03.50	11.00
019	0200	45	26328	43291	26359	43284	4.1	29 30	04.50	11.00
020	0255	45	26359	43284	26331	43295	4.0	29 30	03.70	08.00
021	0350	50	26331	43295	26362	43286	4.0	29 30	01.30	07.00
022	0450	45	26362	43286	26331	43290	4.1	29 30	03.00	08.00
023	0545	45	26329	43293	26340	43288	4.0	29 30	05.00	12.50
024	0640	50	26339	43290	26338	43290	4.2	29 30	05.50	12.75
025	0740	50	26339	43290	26339	43289	4.2	29 30	06.00	14.20
026	0840	50	26339	43289	26337	43292	4.2	29 30	04.50	13.00
027	0940	50	26338	43292	26332	43299	4.2	29 30	06.30	13.00
028	1040	50	26332	43299	26332	43297	4.2	29 30	05.25	13.00
029	1140	50	26333	43297	26334	43295	4.3	29 30	06.50	12.25
030	1240	50	26335	43294	26329	43301	4.2	29 30	05.00	12.00
031	1340	50	26330	43301	26360	43291	3.9	29 30	04.00	10.00
032	1440	50	26360	43291	26387	43308	4.0	29 29	01.20	03.40
033	1540	45	26387	43308	26379	43274	4.3	29 33	02.00	03.60
034	1635	55	26379	43274	26362	43307	4.2	33 28	03.00	05.00

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
035	1740	55	26362	43307	26391	43337	4.1	28 28	2.20	4.50
036	1845	50	26391	43337	26364	43312	3.8	28 28	2.00	5.00
037	1945	50	26364	43312	26334	43307	3.8	27 28	2.00	3.50
038	2045	40	26334	43309	26329	43301	4.2	30 31	3.80	10.00
039	2135	45	26329	43301	26328	43300	4.0	30 31	4.50	11.00
040	2230	45	26328	43300	26327	43300	4.0	30 31	5.00	12.00
041	2325	45	26327	43300	26327	43301	4.3	30 31	4.50	12.00
042	0020	50	26327	43301	26327	43302	4.2	30 31	5.20	11.00
043	0120	50	26327	43302	26327	43302	4.2	30 31	4.30	10.00
044	0220	50	26327	43302	26326	43301	4.1	30 31	6.00	13.00
045	0320	50	26326	43301	26323	43304	4.2	30 31	5.00	11.00
046	0420	50	26323	43304	26326	43299	4.2	30 31	5.00	13.00
047	0520	45	26326	43299	26356	43309	4.3	30 31	2.00	3.70
048	0615	40	26336	43301	26380	43335	3.8	30 31	2.50	5.00
049	0705	50	26380	43335	26385	43332	4.0	30 31	2.20	4.50
050	0805	50	26385	43332	26361	43319	4.1	30 31	2.00	3.00
051	0905	50	26361	43319	26332	43301	4.1	30 31	2.00	3.00
052	1005	35	26332	43301	26337	43291	4.0	29 31	3.00	10.00
053	1050	50	26336	43293	26339	43288	4.2	29 31	3.00	10.00
054	1150	50	26339	43288	26337	43290	4.2	29 31	4.00	11.00
055	1250	55	26336	43291	26330	43294	4.2	29 31	5.00	15.00
056	1350	50	26330	43296	26327	43301	4.2	29 31	4.50	11.50
057	1450	50	26328	43301	26328	43303	4.2	29 31	3.50	9.70
058	1550	55	26328	43303	26330	43292	4.1	29 31	4.00	12.50
059	1655	45	26329	43299	26331	43292	4.1	29 31	3.50	12.00
060	1750	40	26331	43293	26319	43317	4.1	30 29	2.60	6.00
061	1840	40	26319	43317	26351	43324	4.0	28 29	1.50	3.10
062	1930	45	26351	43324	26319	43318	4.3	28 29	1.20	2.80
063	2025	45	26319	43318	26330	43304			3.00	6.00
064	2120	40	26330	43304	26324	43299	4.2	30 31	4.00	7.50
065	2210	45	26324	43299	26323	43299	4.3	30 31	8.50	11.50
066	2305	45	26323	43299	26324	43299	4.4	30 31	6.00	11.00
067	0000	45	26324	43299	26323	43299	4.3	30 31	5.00	10.00
068	0055	45	26322	43299	26322	43299	4.3	30 31	5.50	10.00

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
069	0150	55	26322	43299	26328	43286	4.0	30 31	4.80	10.00
070	0255	50	26328	43286	26324	43293	4.0	30 31	4.00	9.50
071	0355	50	26324	43293	26326	43290	4.0	30 31	3.50	10.00
072	0455	40	26326	43290	26328	43289	4.1	30 31	3.00	8.00
073	0545	50	26328	43289	26327	43292	4.1	30 31	5.50	11.00
074	0645	55	26327	43292	26333	43280	4.0	28 29	4.00	9.00
075	0750	60	26333	43280	26354	43300	4.1	29 29	2.50	6.00
076	0900	50	26354	43300	26345	43305	4.1	29 29	2.20	7.00
077	1000	50	26345	43305	26350	43298	4.1	29 29	2.00	4.00
078	1100	45	26355	43299	26324	43293	4.1	29 31	3.10	9.00
079	1155	50	26305	43292	26330	43288	4.0	29 31	2.50	12.00
080	1255	50	26329	43288	26326	43293	4.2	29 31	3.50	16.00
081	1355	50	26325	43292	26329	43290	4.2	29 31	2.50	12.00
082	1455	50	26329	43290	26326	43292	4.2	29 31	2.50	13.75
083	1555	50	26326	43292	26328	43293	4.2	29 31	1.50	11.00
084	1655	50	26328	43293	26331	43287	3.9	29 31	2.50	10.00
085	1755	45	26330	43286	26328	43292	4.1	29 31	3.00	11.00
086	1850	60	26328	43292	26326	43292	4.1	29 31	2.50	8.00
087	2000	50	26326	43292	26322	43297	3.9	29 31	3.00	12.00
088	2100	60	26322	43297	26326	43297	4.3	29 31	4.00	14.00
089	2200	60	26336	43297	26324	43305	4.1	29 31	3.00	11.00
090	2310	45	26324	43305	26324	43301	4.0	29 31	2.50	7.00
091	0005	50	26321	43301	26326	43314	3.9	29 31	3.00	8.00
092	0105	50	26326	43314	26326	43307	4.0	29 31	2.50	7.00
093	0205	50	26326	43307	26325	43301	4.0	29 31	4.50	11.00
094	0305	60	26325	43301	26325	43285	4.1	29 31	5.00	12.00
095	0415	55	26325	43285	26323	43305	4.2	29 31	3.50	11.00
096	0520	50	26323	43305	26329	43297	4.0	29 31	4.00	13.00
097	0620	50	26329	43297	26358	43308	4.3	30 30	2.00	3.20
098	0720	50	26358	43308	26357	43303	4.0	30 30	2.00	4.00
099	0820	45	26357	43303	26346	43298	4.0	29 30	2.00	5.00
100	0915	40	26346	43298	26338	43282	4.1	29 30	3.50	6.00
101	1005	50	26338	43280	26333	43281	4.0	29 30	3.50	10.00
102	1105				26334	43277	4.2	29 30	5.00	11.00

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
103	1205	50	26334	43279	26331	43282	4.2	29 30	3.50	10.50
104	1305	50	26330	43284	26332	43280	4.2	29 30	4.25	11.00
105	1405	50	26332	43280	26331	43292	4.2	29 30	2.75	11.00
106	1505	50	26331	43292	26333	43283	4.2	29 30	4.00	12.00
107	1605	50	26334	43284	26335	43291	4.2	29 30	2.00	11.00
108	1705	50	26336	43288	26329	43290	4.2	29 30	3.25	12.50
110	1805	45	26336	43288	26336	43281	4.1	29 30	4.50	11.00
111	1900	50	26336	43281	26336	43282	4.0	29 30	4.50	12.00
112	2000	50	26336	43282	26350	43290	4.3	29 30	2.50	8.00
113	2100	50	26350	43290	26354	43285	4.3	29 30	3.00	9.00
114	2200	50	26354	43285	26354	43285	4.2	29 30	1.50	5.50
115	2300	40	26354	43285	26335	43293	4.2	29 30	1.70	8.00
116	2350	50	26325	43293	26334	43290	4.1	29 30	2.00	6.00
117	0050	60	26334	43290	26333	43285	4.1	29 30	2.20	6.00
118	0200	55	26333	43285	26330	43286	4.1	29 30	2.80	9.00
119	0305	55	26330	43286	26332	43280	4.2	29 30	2.00	11.00
120	0410	55	26332	43280	26334	43285	4.2	29 30	2.00	8.00
121	0515	60	26334	43285	26336	43279	4.1	29 30	2.00	7.00
122	0625	50	26336	43279	26339	43275	4.1	29 30	2.00	6.00
123	0725	30	26339	43275	26348	43256	4.2	29 30	2.00	5.00
124	0940	40	26441	43200	26442	43171	4.2	29 30	2.00	5.00
125	1030	50	26442	43171	26442	43176	4.2	31 33	2.00	7.00
126	1130	50	26442	43175	26441	43169	4.2	31 33	0.75	8.75
127	1230	50	26442	43168	26440	43168	4.0	31 33		8.00
128	1330	50	26440	43168	26444	43173	4.1	31 33	2.00	8.00
129	1430	60	26444	43173	26441	43172	4.1	31 33	1.00	7.00
130	1530	50	26447	43169	26445	43173	4.2	30 31		5.00
131	1630	50	26445	43173	26444	43167	4.2	30 31	2.00	7.00
132	1730	50	26445	43168	26448	43168	4.2	30 31	2.00	7.00
133	1830	60	26448	43167	26440	43174	4.0	30 31	2.50	7.00
134	2000	45	26440	43174	26439	43170	3.9	30 31	3.00	8.00
135	2055	65	26439	43170	26439	43170	3.9	30 31	2.70	7.00
136	2310	50	26439	43170	26439	43169	4.0	30 31	1.60	5.00

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
137	0010	50	26442	43171	26442	43172	3.9	30 31	2.10	5.00
138	0110	50	26442	43172	26440	43170	4.0	30 31	2.50	6.00
139	0210	55	26440	43170	26439	43154	3.9	30 31	1.00	5.00
140	0315	60	26439	43154	26446	43170	3.6	30 31	2.50	6.20
141	0425	50	26446	43190	26438	43195	3.8	30 31	2.00	5.00
142	0520	55	26438	43195	26441	43200	4.0	30 31	1.50	6.00
143	0625	50	26441	43199	26441	43198	4.2	30 31	2.00	6.00
144	0735	50	26441	43195	26440	43191	4.2	30 31	2.00	5.00
145	0835	40	26440	43192	26443	43177	4.2	30 31	3.00	8.50
146	0925	45	26443	43175	26442	43171	4.2	30 31	2.80	8.00
147	1020	50	26443	43171	26443	43173	4.2	30 31		8.00
148	1120	40	26444	43173	26442	43180	4.2	30 31	2.75	6.25
149	1210	45	26444	43180	26444	43166	4.2	30 31	2.50	7.00
150	1305	50	26444	43165	26449	43167	4.0	30 31	2.70	5.70
151	1405	45	26450	43167	26442	43164	4.0	30 31	3.00	6.00
152	1500	45	26442	43164	26445	43164	4.2	30 31	2.70	5.40
153	1550	40	26445	43164	26444	43166	4.0	30 31	3.00	8.00
154	1640	40	26445	43163	26444	43167	4.1	30 31	3.00	7.00
155	1730	45	26444	43166	26444	43164	4.3	30 31	5.00	7.00
156	1825	40	26444	43164	26443	43165	4.2	30 31	3.00	7.00
157	1915	50	26444	43165	26444	43166	4.1	30 31	3.20	6.80
158	2015	45	26444	43166	26443	43167	4.2	30 31	3.50	7.20
159	2100	50	26443		26444	43168	4.1	30 31	3.00	6.00
160	2210	50	26444	43168	26444	43170	4.0	30 31	3.50	7.00
161	2310	50	26446	43170	26447	43168	4.2	30 31	3.60	6.00
162	0010	50	26444	43165	26445	43167	4.2	34 35	3.00	6.00
163	0110	50	26445	43167	26447	43165	4.1	34 35	3.50	6.00
164	0210	40	26443	43165	26443	43164	4.3	34 35	3.20	7.00
165	0300	40	26446	43163	26447	43167	4.1	34 35	3.40	5.00
166	0350	40	26446	43162	26444	43165	4.3	34 35	3.00	5.00
167	0440	45	26444	43165	26447	43167	4.2	34 35	3.00	6.00
168	0535	40	26448	43166	26445	43165	4.2	34 35	2.75	6.50
169	0625	50	26446	43164	26446	43167	4.2	34 35	3.00	9.50
170	0725	55	26446	43166	26443	43165	4.2	34 35	3.00	7.50

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
171	0825	50	26443	43165	26445	43168	4.2	34 35	3.00	7.75
172	0925	50	26447	43167	26448	43168	4.2	34 35	3.00	7.00
173	1025	45	26448	43168	26449	43163	4.2	34 35	3.00	6.00
174	1120	50	26449	43163	26445	43166	4.2	34 35	3.00	6.20
175	1220	50	26447	43166	26446	43165	4.2	34 35	3.00	6.00
176	1320	40	26448	43164	26446	43167	4.2	34 35	3.25	6.00
177	1410	45	26448	43166	26446	43168	4.2	34 35	3.50	6.00
178	1505	45	26446	43168	26447	43166	4.1	34 35	3.70	6.10
179	1600	50	26447	43166	26444	43167	4.1	34 35	3.50	5.00
180	1715	45	26444	43167	26446	43163	4.0	34 35	3.30	6.00
181	1810	50	26446	43163	26446	43161	4.1	34 35	4.00	5.00
182	1910	50	26446	43161	26446	43163	4.1	34 35	3.50	5.00
183	2010	50	26446	43163	26433	43167	4.2	34 35	2.00	6.00
184	2110	50	26433	43167	26435	43147	4.2	32 33	3.50	7.20
185	2210	45	26435	43147	26435	43144	4.1	32 33	3.00	5.00
186	2305	50	26435	43144	26435	43140	4.3	32 33		6.00
187	0005	55	26436	43140	26437	43109	4.1	32 33	3.30	4.70
188	0110	50	26437	43109	26435	43092	4.3	32 33	3.30	6.00
189	0210	45	26435	43092	26433	43124	4.1	30 31	3.00	4.60
190	0305	45	26433	43124	26436	43092		30 31	2.70	5.20
191	0355	45	26436	43192	26435	43095	4.1	30 31	2.50	5.10
192	0450	40	26433	43098	26435	43098	4.2	30 31	2.50	4.50
193	0540	50	26434	43100	26434	43103	4.2	30 31	2.50	5.00
194	0640	40	26434	43104	26433	43095	4.2	31 30	2.50	4.50
195	0730	45	26433	43095	26436	43100	4.2	31 30	2.70	5.00
196	0825	45	26436	43102	26434	43090	4.2	31 30	2.50	3.75
197	0920	45	26434	43090	26440	43116	4.2	31 30	1.00	5.25
198	1015	40	26439	43116	26439	43141	4.0	33 34	2.50	5.20
199	1105	40	26439	43139	26443	43149	4.0	34 33	2.50	5.50
200	1155	50	26443	43149	26445	43164	4.2	34 35	3.00	5.75

DATA RECORDING SUSPENDED DUE TO ROUGH WEATHER

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	3.0-INCH
226	2300	40	26500	43018	26500	43019	3.9	31 33	2.50	5.50
227	2350	40	26500	43019	26503	43019	3.9	31 33	2.50	4.20
228	0040	40	26503	43019	26511	43007	4.0	31 33	4.25	7.25
229	0130	40	26511	43007	26508	43006	4.1	31 33	6.00	6.50
230	0220	40	26508	43006	26510	43008	4.1	31 33		10.00
231	0310	40	26510	43008	26510	43008	4.1	31 33	6.50	9.50
232	0400	40	26510	43008	26510	43008	4.1	31 33	4.00	9.00
233	0450	40	26510	43008	26510	43000	4.1	31 33	6.00	10.50
234	0540	40	26510	43010	26509	43006	4.1	31 33	6.25	10.50
235	0630	45	26509	43006	26510	43006	4.1	31 33	6.00	13.00
236	0725	45	26510	43006	26510	43006	4.1	31 33	6.00	11.00
237	0820	45	26510	43006	26510	43006	4.1	31 33	6.00	11.00
238	0915	45	26510	43006	26510	43006	4.1	31 33	6.00	12.00
239	1010	45	26510	43006	26511	43006	4.1	31 33	6.00	10.00
240	1105	45	26511	43006	26510	43006	4.1	31 33	5.00	12.00
241	1200	40	26511	43006	26495	43021	3.6	31 33	2.50	3.50
242	1250	40	26495	43021	26434	42995	4.0	31 33	1.20	2.80
243	1340	40	26484	42995	26506	43008	4.3	31 33	3.80	3.80
244	1430	45	26505	43008	26483	42993	4.0	31 33	2.50	3.00
245	1525	45	26483	42933	26507	43014		31 33	4.00	4.20
246	1620	50	26507	43014	26497	43011	4.0	31 33	5.00	6.00
247	1720	50	26497	43011	26501	43011	4.2	31 33	4.00	4.50
248	1850	50	26501	43011	26505	43015	4.1	31 33	5.00	6.00
249	1950	40	26505	43015	26512	43006	4.0	31 33	5.00	6.00
250	2040	40	26512	43006	26513	43010	4.1	31 33	4.00	6.00
251	2130	45	26512	43010	26498	43033	4.1	31 33	2.50	4.00
252	2225	40	26498	43033	26520	43027	4.0	31 33	2.00	5.00
253	2315	40	26520	43027	26516	42997	4.0	31 33	5.00	6.00
254	0005	40	26516	42997	26504	43014	4.2	31 33	4.10	6.00
255	0055	40	26504	43014	26514	43007	4.1	31 33	4.00	5.80
256	0145	40	26514	43007	26514	42975	4.3	31 33	3.80	5.00
257	0235	30	26514	42975	26514	42997	4.3	31 33	7.80	14.00
258	0405	50	26514	42990	26491	43011	4.3	32 33	3.00	7.00
259	0505	45	26491	43011	26465	43029	4.3	32 33	2.00	3.20
260	0600	45	26465	43029	26448	43053	4.3	32 33	2.00	3.70

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
261	0655	45	26448	43053	26438	43087	4.3	32 33	2.00	4.00
262	0750	40	26438	43087	26425	43113	4.3	32 33	2.00	4.00
263	0840	40	26425	43113	26437	43090	4.0	32 33	2.00	4.00
264	0930	40	26437	43080	26446	43066	4.0	32 33	1.00	3.50
265	1020	40	26446	43066	26455	43041	4.2	32 33	2.00	4.00
266	1115	40	26455	43041	26472	43024	4.0	32 33	2.00	4.00
267	1210	40	26472	43029	26492	43012	4.2	32 33	1.50	3.50
268	1300	45	26492	43012	26498	43011	4.0	32 33	3.00	5.00
269	1355	45	26498	43011	26515	42992	4.1	32 33	4.00	6.00
270	1450	50	26515	42992	26514	42992	4.2	32 33	8.00	13.00
271	1550	50	26514	42992	26514	42992	4.0	32 33	8.50	13.00
272	1650	50	26513	42992	26514	42995	4.1	32 33	9.00	13.00
273	1750	50	26514	42995	26512	42997	4.2	32 33	9.00	13.00
274	1850	55	26512	42998	26515	42992	4.2	32 33	9.00	13.00
275	1955	50	26515	42992	26514	42996	4.2	32 33	8.70	13.00
276	2055	50	26514	42986	26513	42994	4.0	32 33	9.00	13.00
277	2155	50	26513	42994	26513	42994	4.2	32 33	9.00	13.00
278	2255	50	26513	42994	26514	42992	4.2	32 33	10.00	15.00
279	2345	40	26514	42994	26512	42993	4.3	32 33	10.00	16.00
280	0035		26512	42996	26513	42995	4.3	32 33	10.00	15.00
281	0055		26513	42995	26512	42986	4.2	32 33	10.00	17.00
282	0115	40	26512	42996	26514	42997	4.0	32 33	8.00	16.00
283	0205	40	26514	42996	26514	42996	4.1	32 33	10.00	17.00
284	0255	40	26514	42996	26514	42994	4.1	32 33	10.00	16.00
285	0345	40	26514	42992	26514	42994	4.1	32 33	9.00	14.00
287	0525	40	26879	41982	26874	41954	4.2	28 30	0.75	1.00
288	0615	40	26874	41953	26866	41957	4.2	28 30	1.25	1.50
289	0705	50	26866	41957	26871	41943	4.2	28 30	1.00	2.00
290	0805	40	26871	41943	26866	41971	4.2	28 30	1.00	1.75

APPENDIX 4. (CONTINUED)

TOW	TOW TIME	TOW LENGTH (min)	BEGIN LORAN (X)	BEGIN LORAN (Y)	END LORAN (X)	END LORAN (Y)	DEPTH (fa.)	SPEED RANGE (kn)	BASKETS OF SCALLOPS 3.5-INCH	BASKETS OF SCALLOPS 3.0-INCH
291	0855	35	26866	41971	26854	41977	4.2	29 30	1.00	1.75
292	0940	45	26859	41967	26869	41946	4.1	29 30	1.25	1.50
293	1035	35	26869	41946	26871	41932	4.2	29 30	1.00	1.50
294	1120	40	26871	41932	26874	41901	4.2	29 30	1.20	1.50
295	1210	50	26874	41910	26865	41935	4.1	29 30	1.10	1.80
296	1310	50	26865	41935	26872	41897	4.2	29 30	1.30	2.10
297	1410	50	26872	41897	26870	41899	4.3	29 30	1.00	1.30
298	1510	50	26870	41899	26871	41895	4.2	29 30	1.00	2.00
299	1610	50	26871	41895	26871	41929	4.1	29 30	0.10	1.50
300	1710	50	26871	41929	26870	41922	4.2	29 30	1.00	1.00
301	1810	50	26870	41922	26870	41935	4.3	29 30	1.00	1.50
302	1910	50	26870	41935	26874	41897	4.3	29 30	1.00	1.75
303	2010	50	26874	41897	26870	41936	4.2	29 30	1.00	2.00
304	2110	50	26870	41936	26873	41899	4.0	29 30	1.00	1.75
305	2210	50	26873	41899	26868	41840	4.1	29 30	1.00	1.20
306	2310	55	26868	41940	26866	41939	4.2	29 30	1.00	2.00
307	0015	45	26866	41939	26872	41905	4.1	29 30	1.50	1.00
308	0110	40	26871	41905	26873	41902	4.0	29 30	0.50	1.00
309	0200	50	26873	41901	26866	41921	4.1	29 30	0.75	1.00
310	0300	55	26866	41921	26871	41910	4.2	29 30	0.75	1.00
311	0405	50	26871	41910	26886	41881	4.2	28 30	1.50	1.50
312	0505	50	26886	41881	26886	41881	4.2	28 30	1.50	1.50
313	0605	50	26886	41881	26887	41877	4.2	28 30	1.25	1.50
314	0705	50	26887	41877	26886	41880	4.2	28 30	1.25	1.50
315	0805	50	26886	41880	26888	41874	4.1	28 30	1.75	2.00
316	0905	50	26888	41874	26884	41884	4.0	28 30	1.50	2.00
317	1005	45	26884	41884	26887	41875	4.2	28 30		
318	1100	45	26887	41875	26887	41835	4.1			
319	1155	50	26887	41835	26888	41792		27 28		

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