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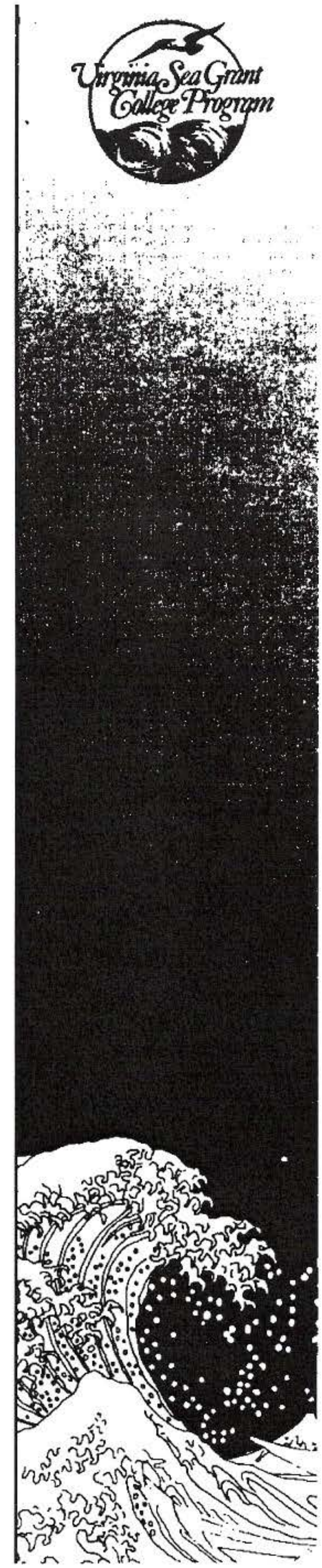

A Preliminary Comparative Analysis of Sea Scallop Harvest Pattern Between Dredge and Trawl Vessels

James E. Kirkley

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A PRELIMINARY COMPARATIVE ANALYSIS OF SEA SCALLOP HARVEST PATTERNS BETWEEN DREDGE AND TRAWL VESSELS

by

James E. Kirkley*

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*James E. Kirkley is Assistant Professor, College of William and Mary, Virginia Institute of Marine Science, School of Marine Science, Gloucester Point, Virginia 23062.

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Introduction

The common property nature of marine fisheries is theorized to cause overfishing in biological and economic terms. The two forms of overfishing, while being different, nevertheless result in higher production costs, lower net earnings, and misallocation of society's resources. The entry of additional vessels in a fully exploited fishery further exacerbates the problem.

The scallop (Placopecten magellanicus) fishery of the Northwest Atlantic is believed to be overfished. In a table prepared by the National Marine Fisheries Service, the stock condition for sea scallops was assessed as being depleted in 1984. The management councils for the New England, Mid-Atlantic, and South-Atlantic regions offered, that in 1982, over-exploitation of the resource was a danger. Furthermore, the World Court ruling in 1984 in which Georges Bank was divided between Canada and the United States reduced the size of the sea scallop resource available for harvest by U.S. fishermen.

Concurrently, imports of all scallops, which compete with domestic scallops, are increasing. A record high (42,035,000 pounds-meat weight) was reported by the National Marine fisheries Service for 1985. These conditions all contribute to a depressed domestic scallop industry.

In 1960, total domestic landings of sea scallop meats were 26,599,000 pounds. Landings in 1985 were 15,829,000 pounds; this represents a reduction of 40-percent in landings.[1] During the period 1978-1984, the gross stock or revenue per scallop dredge vessel, without considering the effects of inflation, declined approximately 18-percent (table 1). Landings per vessel declined approximately 62-percent. During this same period, the number of vessels 5 gross registered tons and over increased by approximately 65-percent. During the period 1968-1984, it has required more vessels, trips, and days at sea to harvest less scallops.

The 1985 "Status of the Fishery Resources Off the Northeastern United States (Northeast Fisheries Center, 1985) indicates that the scallop resource during 1984 was either depressed, overfished, or dependent on one age class (pp. 132-136). The resource for the Gulf of Maine was believed to be comprised of mostly small scallops (greater than a 35-meat count per pound). The Georges Bank resource was summarized as being depressed (p. 135). The Mid-Atlantic population was assessed as being at historically low levels (p. 136). The status report offers the following (p. 136):

> "The USA scallop fleet is expected to continue concentrating much of its activity in the Mid-

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[1]For additional information, see Kirkley (1985), "A Description and Characterization of the Northwest Atlantic Fisheries", National Marine Fisheries Service, Northeast Fisheries Center, Wood's Hole, Massachusetts, 02543.

Atlantic region during 1985 and 1986 due to exclusion of USA fishermen from the Northeast Peak of Georges Bank and low abundance of scallops in most other offshore grounds. However, the absence of significant recruitment throughout the Mid-Atlantic, coupled with high fishing mortality levels, will impede resource recovery. Unless restrictions in fishing effort occur, sea scallop abundance and landings are expected to decline in the near future."

Proposed Study

The East Coast Fishermen's Association is particularly concerned with the potential ramifications of increasing levels of effort and mortality. In particular, the possible increased mortality on smaller scallops which might occur from the practices of scallop trawling and shell stocking. The association offers that this might occur if the Southern Calico and shrimp trawlers migrate north to harvest sea scallops in response to depressed conditions in their respective fisheries.

In order to examine the possibility that trawling or netting scallops might inflict higher mortality on scallops, particularly smaller scallops, the East Coast Association proposed a joint study with the Virginia Institute of Marine Science, College of William and Mary.[2] The purpose of the study is to specifically evaluate the difference in fishing mortality on different sized scallops caused by two types of scallop gear--dredge and trawl.

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[2]See attachment 1 for review of proposed study.

Table 1. Indices of activity and performance by scallop dredge vessels, 1968 = 100

Year	Number of vessels	Average tonnage	Landings per vessel	Revenue per vessel	Days absent per vessel	Total landings	Total days absent	Total trips
1968	100	100	100	100	100	100	100	100
1969	87	93	73	72	76	67	85	112
1970	65	88	84	102	73	53	66	91
1971	64	83	79	105	58	45	62	106
1972	62	79	71	127	64	51	64	100
1973	64	86	63	101	63	46	51	82
1974	46	98	116	160	92	47	47	51
1975	62	81	111	188	83	73	54	66
1976	122	71	109	183	73	144	85	116
1977	223	71	90	134	61	187	124	203
1978	187	88	110	251	89	224	133	149
1979	290	106	67	206	94	228	175	186
1980	394	115	50	173	91	208	244	268
1981	423	125	54	194	108	219	264	245
1982	191	132	68	227	113	154	226	199
1983	320	114	51	253	94	148	255	270
1984	313	124	41	206	113	133	251	222

Source: National Marine Fisheries Service, Northeast Fisheries Service and Kirkley, J. E. "A Description and Characterization of the Northwest Atlantic Fisheries".

Method of Study

Two vessels were made available--the Richard Wayne (a double rigged trawler) and the Margaret Rose (a double rigged dredge vessel). The vessel specifications are not yet available; however, the Margaret Rose was a substantially larger vessel. Four personnel from the Institute were assigned to the Richard Wayne and three to the Margaret Rose.[3] The trawl vessel had a crew of three. However, the crew of the trawl vessel were not familiar with trawling for scallops, and it was necessary to obtain the services of a captain familiar with this type of fishing. Mr. Frank Peabody, a recognized highliner, supervised fishing operations aboard the Richard Wayne. The Margaret Rose had a crew of approximately 15 individuals with another recognized highliner, Mr. Rodney , serving as captain. The captains of both vessels were informed to operate in accordance with traditional commercial fishing practices.

It was determined that the two vessels were to depart from Cape May, New Jersey on Monday, June 30, 1986. The Hudson Canyon area was selected as the fishing grounds; this area is currently being heavily exploited. The vessels were requested to remain within visual distance of each other during the experiment. Fishing was to commence

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[3]Personnel were as follows: Richard Wayne-Drs. DuPaul and Kirkley, Mr. Phil Cahill, and Mr. Joseph Choromanski; Margaret Rose-Mr. S. Smith, Mr. B. Blaylock, and Mr. D. Boyd.

at approximately the same time and last for a duration of twelve hours. Information was to be obtained on catch, size distribution, mortality, effort, course headings, tow speed, depth fished, and time the gear was engaged in fishing.

Information necessary for designing the sample was not available. It was, thus, decided that given the limited resources, two baskets (approximately 1.5 bushels per basket) should be sampled from each gear per tow for a total sample of four baskets per tow. The shell height of the scallops were to be measured and recorded in millimeters. It was determined that total landings per tow would have to be estimated by the captain and crew of each vessel. Total weight was to be estimated by using the average weight per basket of six baskets of scallops.

Two forms of mortality were of concern to the experiment. The first form was that of commercial mortality or the harvest of scallops to be shucked. The second form was immediate mortality on the scallops which were to be discarded; this latter form was restricted only to damaged scallops (e.g., crushed shells or separated hinges).

A final part of the experiment was to obtain data for examining the relationship between meat weight and shell height. A sample of scallops were to be measured (shell height), shucked, and placed in individual plastic bags during on-board operations. These samples are to be weighed and examined for water loss at the Virginia

Institute of Marine Science. The relationship between meat weight and shell height will be determined by regression analysis.

Preliminary Results

Fishing operations commenced at approximately 2320 hours, June 30, 1986, and ended at approximately at 0800, July 1, 1986. Vessel operations, excluding course headings, are summarized in table 2.[4] Three tows were made by the Richard Wayne (trawl vessel) and seven were made by the Margaret Rose (dredge vessel). However, it was only possible to sample three tows (twelve baskets) from each vessel. This was due to the volume of scallops which could be sampled given limited resources and gear damage on the Richard Wayne (both extensions of the trawl were damaged). Unfortunately, it has not been possible to process and analyze all data. Additional processing and analyzing of data will be completed at a future date.

The estimated number of baskets and weight of the total catch of each tow are summarized in table 3. As indicated, the trawl gear harvested substantially more per tow. Excluding the third tow in which the Richard Wayne experienced gear damage, catch per minute that the gear was in the water for the trawler was greater than that for the

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[4]Specific course headings of each vessel during the experiment should be requested from the East Coast Fishermen's Association.

dredge vessel (approximately 55 pounds per minute vs. 24 pounds per minute). Total harvest levels, however, are not comparable since the catch over all seven tows made by the Margaret Rose is not available.

More importantly, though, was the observed volume of scallops on-board the trawler due to shell stocking. The dredge vessel sorted and discarded scallops deemed to be too small for shucking. The trawler retained all scallops as in customary for shell stocking. Total on-board harvest for the three tows for the trawl vessels and dredge boat were, respectively, 8,100 pounds and 1,293 pounds. The dredge vessel would have had to harvest in excess of 6,800 pounds over the next four tows to equal the total taken by the trawl vessel.

A visual examination of harvesting mortality or scallops damaged by the gear indicated that neither gear inflicted much mortality or damage.[5] However, a visual examination of the scallops stocked on the trawl vessel at the end of the experiment (0800, July 1, 1986) indicated substantial damage to the scallops resulting from crew members walking through the pile of scallops and subsequent emptying of the scallops from each tow. These two sources of mortality would normally occur on a trawl vessel that shell stocked scallops.

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[5]Staff have not had adequate time to correctly analyze this issue. Additional analysis of this issue will be completed in the future.

The relative distribution of scallops based on ten millimeter intervals is presented in table 4 and depicted in figure 1. As indicated, the trawler has a higher percentage of smaller scallops.[6] Approximately 38-percent of the scallops in the trawl sample were less than 80 millimeters (3.15 inches) in size; twenty-five percent were less than 80 millimeters for the dredge sample.

The difference in the size distribution between the harvests of the two vessels is more pronounced when examined with respect to a cull size of 3.25 inches (82.5 millimeters) which is equal to the minimum cull size required for a 40 meat count. This is shown in figure 2. Approximately 52-percent of the scallops in the trawl sample were smaller than 3.25 inches. In comparison, less than 35-percent of the scallops in the dredge sample were less than 3.25 inches.

Unfortunately, it has not been possible to conduct a more rigorous statistical analysis of the data. Additional processing and analyses are required to examine the difference in mortality inflicted by the two gear types. However, the preliminary results, thus far, indicate that trawl vessels have a higher harvest than dredge vessels, shell stock inflicts greater mortality, and the trawl has a tendency to harvest a higher percentage of small scallops.

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[6]Statistical analysis of the distributions by size will be completed at a later date.

Table 2. Summary of vessel operations[a]

	Vessel					
	Richard Wayne			Margaret Rose		
	Tow 1	Tow 2	Tow 3	Tow 1	Tow 2	Tow 3
Time on bottom	2320	0110	0237	2325	0005	0105
Time gear returned	0020	0210	0437	2355	0055	0155
Length of tow-minutes	60	60	120	30	50	50
Depth-fathoms	36	38	38	36	38	38

[a]Additional information should be requested from the East Coast Fishermen's Association.

Table 3. Estimated number of baskets and weight of total catch, by tow

Tow	Vessel			
	Richard Wayne[a]		Margaret Rose[a]	
	Baskets	Weight	Baskets	Weight
	-number-	-pounds-	-number-	-pounds-
1	50	3000	9	540
2	60	3600	23	1380
3	25[b]	1500[b]	18.5	1110

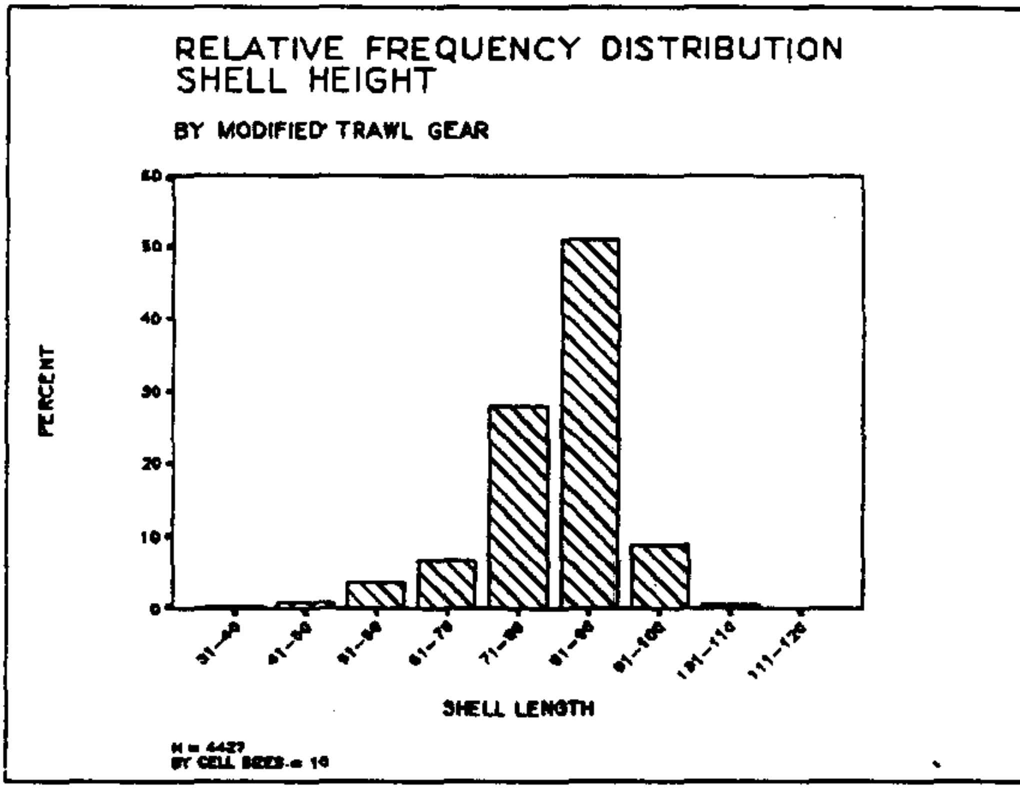
[a]Number of baskets estimated by captain of each vessel. Average weight per basket of six baskets equalled 60 pounds. There were no discards for the Richard Wayne; discards per tow for the Margaret Rose were, respectively, 6 baskets (289 pounds), 14 baskets (674 pounds), and 13 baskets (774 pounds).

[b]Extensions torn out of both trawls on third tow.

Table 4. Mean shell height, percent, and cumulate percent of sample, ten millimeter intervals

Shell height	Richard Wayne			Margaret Rose		
	Mean shell height	Percent of number sampled	Cumulative percent of number sampled	Mean shell height	Percent of number sampled	Cumulative percent of number sampled
31-40	37.43	.16	.16	38.10	.36	.36
41-50	46.92	.86	1.02	46.40	1.24	1.60
51-60	57.20	3.64	4.66	56.06	3.94	5.54
61-70	66.32	6.78	11.44	65.28	5.40	10.94
71-80	77.01	27.90	39.34	77.93	14.26	25.20
81-90	85.34	51.01	90.35	85.78	56.77	81.97
91-100	93.31	8.97	99.32	93.96	16.16	98.13
101-110	103.71	.63	99.95	103.11	1.64	99.77
111-120	112.33	.05	100.00	115.50	.07	99.84
>121				128.00	.16	100.00
Total	81.15			83.41		

Figure 1. Comparative relative frequency distributions, ten millimeter intervals



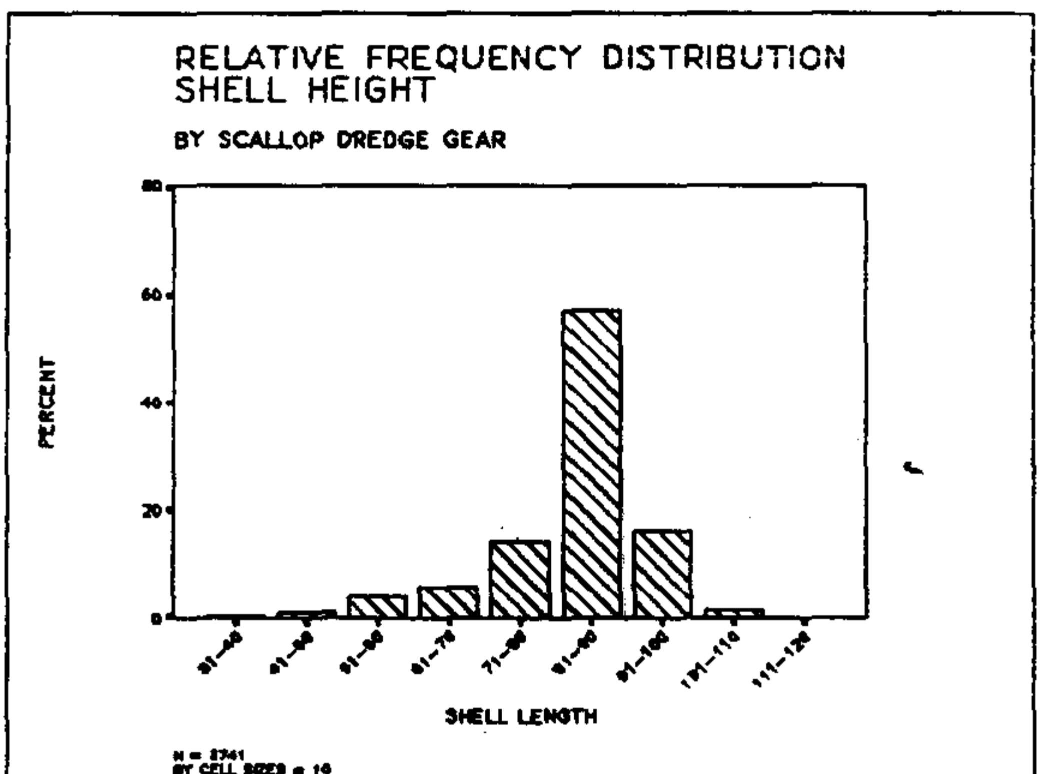
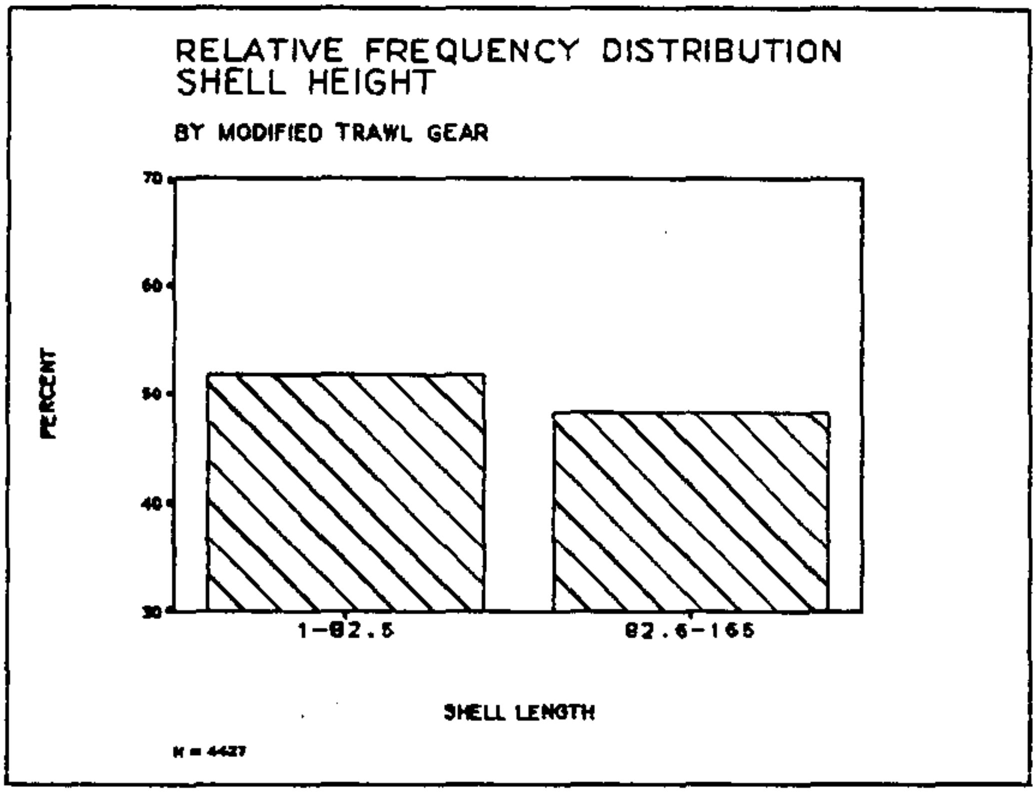
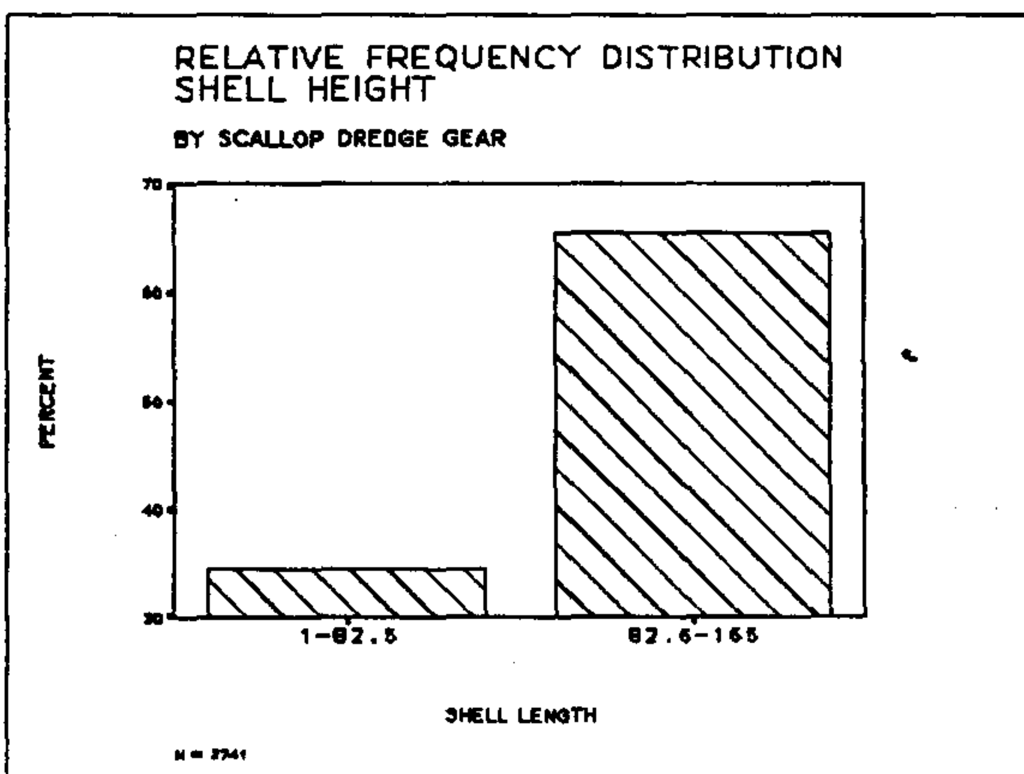


Figure 2. Comparative relative frequency distributions for minimum cull size required for 40 meat count





ATTACHMENT 1

EXPERIMENT FOR DETERMINING DIFFERENCE IN MORTALITY BETWEEN SCALLOP DREDGE AND MODIFIED CALICO TRAWL GEAR IN THE MID-ATLANTIC REGION

The East Coast Fishermen's Association has proposed a joint-study on mortality with the Virginia Institute of Marine Science, College of William and Mary. The purpose of the study is to evaluate the difference in fishing mortality on adults and various size classes of sea scallops (Placopecten magellanicus) caused by two types of scallop gear--scallop dredge and a modified calico trawl.

The specific hypothesis to be examined is as follows:

$$H0: F_{MD} - FMT = 0, \text{ and}$$
$$H1: F_{MD} - FMT \neq 0,$$

where F_{MD} and FMT represent fishing mortality caused by dredge (D) and trawl (T), respectively. Another hypothesis to be examined is

$$H0: C_{JD} - CJT = 0, \text{ and}$$
$$H1: C_{JD} - CJT \neq 0,$$

where C_{JD} and CJT are the catch of scallops by various size classes for the two gear types. The classes to be examined are determined by a review of the Scallop plan.[1] Six size

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[1]The Fishery Management Plan, Final Environmental Impact Statement, Regulatory Impact Review for Atlantic Sea Scallops, (1982, p. 112) provides the following shell height-meat count equivalents: (1) 3.25"-40 meat count, (2) 3.50"-30 meat count, and (3) 3.75"-25 meat count.

classes are to be examined (Table 1). The final hypothesis to be examined is that there is no difference in mortality caused by dredge and trawl for the six meat-count per pound size classes.

Methodology

The East Coast Fishermen's Association is to provide two vessels--a dredge and modified calico trawl vessel. The two are to commence operations at the same time and in the same area. They are to be within visual distance of one another. Fishing is to be done in accordance with commercial fishing practices for a duration of approximately twelve hours.

In addition to the vessel crews, the Virginia Institute of Marine Science will provide three individuals for each vessel. An attempt will be made to randomly sample ten, one-two (1.5), bushel baskets of scallops per tow for each vessel. This is necessary since a sample design cannot be ascertained with data available. Length-frequency will be recorded. Hail or estimated total and commercial harvest will be used to indicate total catch. Mortality in accordance with the six meat-count classes will be determined during the recording of length by visual observation.

The results will be analyzed to assess the previously stated hypotheses. Additional analysis, if time permits, will be to model the relationships between catch, mortality, and effort for the two vessels. This will

Table 1. Weight, Length, and Meat-count Relationships[a]

Shell Height		Weight		Meat-count per pound
millimeters	inches	grams	ounces	number
101.27	3.99	18.14	.64	25
95.72	3.77	15.12	.53	30
91.27	3.59	12.96	.46	35
87.57	3.45	11.34	.40	40
77.25	3.04	7.56	.27	60
70.68	2.78	5.67	.20	80

[a]Estimates based on equation on page 28
of Fishery Management Plan for Sea Scallops, January, 1982.

The equation is

$$W = 5.929 \times 10^{-6} L^{3.234}$$

where W is weight in grams and L is length in millimeters.

permit more rigouroure statistical testing of the differences in catch and mortality between the two gear types. A report, subject to review by Institute personnel, will be made available to the East Coast Association.

Materials Required

The following materials are necessary:

(1) two vessels--similar size and design

  (a) modified calico trawl
  (b) scallop dredge

(2) two - four scales

(3) twenty 1-2 (1.5) bushel baskets

(4) length-frequency recording sheets

(5) two to four measuring boards

(6) video and/or photography equipment

  (a) camcorder for calico trawl

  (b) 35mm for dredge vessel

(7) six to ten shucking knives

(8) plastic bags

(9) two-dozen pencils

(10) foul-weather gear for six

Tentative Schedule

Depart Gloucester Point, 6/69, by van, at 05:00 AM

Arrive Cape May, 6/29, by 4:00 PM

Depart Cape May, 6/29-6/30, according to discretion of vessel captains

Commence experiment approximately 6:00 AM, 6/30

Complete operations approximately 6:00 PM, 6/30

Return to Cape May, 6/30

Depart Cape May, 7/1, by van, to return to Gloucester Point, Virginia