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James E. Kirkley
Virginia Institute of Marine Science

William D. DuPaul
Virginia Institute of Marine Science

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A PARTIAL ANALYSIS OF THE EQUITY OF MEAT COUNT AND SHELL HEIGHT REGULATIONS IN THE SEA SCALLOP FISHERY

BY

JAMES E. KIRKLEY AND WILLIAM D. DUPAUL

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*Prepared March, 1987. James E. Kirkley is Assistant Professor, College of William and Mary, Schools of Marine Science and Business Administration, Gloucester Point, Virginia 23062. William D. DuPaul is Director, Marine Advisory Services, College of William and Mary, School of Marine Science, Virginia Institute of Marine Science, Gloucester Point, Virginia 23062.

A PARTIAL ANALYSIS OF THE EQUITY OF MEAT COUNT AND SHELL HEIGHT REGULATIONS IN THE SEA SCALLOP FISHERY

In January of 1982, the New England Fishery Management Council in consultation with the Mid-Atlantic and South Atlantic Management Councils proposed that the sea scallop fishery be regulated by minimum size constraints on meat count and shell height. Initially, the proposed regulation restricted nominal catch to a maximum of 40 meats per pound and a minimum shell height of 3.25 inches. After one year, the regulations were changed to a maximum of 30 meats per pound and a minimum shell height of 3.50 inches. As of December, 1986, the latter regulations were in place.

In mid 1986, however, several southern vessels began trawling for sea scallops. In comparison to the conventional practice of dredging for sea scallops and shucking at sea, the trawlers shell stocked scallops (i.e., scallops are landed live on deck and remain in the shell until the boat returns to dock). Traditional dredge boat fishermen viewed shell stocking and trawling as being unfair to them and possibly endangering the resource. The dredge boat fishermen argued that a 3.50 inch shell height regulation yielded a meat count in excess of 30 meats per pound.

In July of 1986, preliminary evidence on the efficiency of trawling vs. dredging for sea scallops was presented to the Scallop Oversight Committee (Kirkley, 1986). It was demonstrated that trawl boats have a higher catch per hour of fishing and harvest disproportionately more smaller scallops than does a dredge boat.

The issue of whether or not simultaneous regulation of the fishery by meat count and minimum shell height regulations offers a comparative advantage to shell stockers has not been analyzed. In this study, a partial analysis of the issue is presented. In addition, the statistical results presented in the plan and used to determine the meat count and shell height regulations are discussed.

Equity and the Regulatory Burden

It has long been recognized that the successful achievement of goals and objectives of a regulation requires the acceptance of a regulation by industry. If a regulation discriminates against one user group or results in a comparative advantage for another group, a regulation will not likely achieve its objectives. Members of the disadvantaged group will not comply with the regulation while those having an advantage will support the regulation.

The 30 meat count vs. the 3.50 inch shell height regulation for the sea scallop fishery is a possible case of a regulation which provides an advantage for one user group. In this case, shell stockers are permitted greater flexibility in harvesting and can legally harvest scallops yielding greater than 30 meats per pound.

This is illustrated by a review of the estimated weight-length relationships on pages 24, 27, and 28 of the sea scallop plan. The estimated relationships are for the Gulf of Maine, Georges Bank, and the mid-Atlantic region:

(1) Gulf of Maine: $W = .000001322*L^{3.481}$

(2) Georges Bank: $W = .000007249*L^{3.175}$

(3) Mid-Atlantic: $W = .000005929*L^{3.234}$

where W is weight in grams per meat and L is shell height in millimeters per scallop. The Gulf of Maine equation yields a 56.4 meat count per pound for a shell height of 3.50 inches; the Georges Bank equation yields a 40-41 meat count per pound; the mid-Atlantic equation yields a 38 meat count.

In comparison, the equations in the plan indicate that a meat count of 30 meats per pound requires a shell height of 4.20 inches in the Gulf of Maine, 3.85 inches on Georges Bank, and 3.77 inches for the mid-Atlantic region. The three shell heights are all larger than the required minimum of 3.50 inches. Interestingly, page 112 of the plan presents a different set of shell-height, meat count equivalents: (1) 3.25 inches-40 meat count, (2) 3.50 inches-30 meat count, and (3) 3.75 inches-25 meat count. It is not known whether or not these latter equivalencies were arbitrarily determined, but they are inconsistent with the statistical results presented in the plan. Also, if these represent a statistically derived lower bound, the asymmetric interval should be presented (Dadkhah, 1984).

The inequity of the regulation is that it creates the potential for shell stockers to legally harvest scallops in excess of 30 meats per pound while restricting production of shucked scallops. Consider a hypothetical example in which a vessel which shell stocks fishes along side of one which shucks in the mid-Atlantic region. Further assume that both vessels harvest identical quantities with the same size distribution. Let the entire catch be comprised of scallops between 3.50 and 3.75 inches.

In this case, the vessel which shell stocks will be within the legal limits of the regulation and can land all that is harvested. The vessel which shucks, however, will not be able to comply with the meat count regulation; the meat count will be between 30.5 and 38 meats per pound. The marketable catch for the vessel which shucks will be zero. If the example was extended to Georges Bank, the meat count would be between 32.6 and 41 meats per pound. In the Gulf of Maine, the meat count would be between 44.4 and 56 meats per pound. In all three resource areas, the marketable catch for vessels which shuck would be zero, and the entire catch for vessels which shell stock would be legal.

The inequity of the regulations, however, is not only a result of the two regulations. It also is partly the result of statistical limitations of the estimated relationships. Simply, the estimates do not consider seasonality and spatial differences in the stocks or aggregations of scallops.

The plan recognizes four resource components, two major resource components, and one stock (page 2). In addition, the plan notes there are differences in the growth rates for populations in different areas. The differences in growth rates are considered with respect to broad groupings of stock areas: (1) the offshore Gulf of Maine, (2) all of Georges Bank, and (3) the entire mid-Atlantic region. Smaller aggregations of scallops are not recognized. It is strange that while managers recognize differences in the growth rates among stock or resource areas, they do not consider a need for different shell-height regulations.

Failure by managers to consider the different growth-height relationships also results in regulations which provide a comparative advantage to shell stockers. A shell stocker restricted by the minimum shell height of 3.50 inches in the Gulf of Maine can legally harvest 56 meat count scallops; for Georges Bank, a 40-41 meat count is legal; a 38 meat count is legal in the mid-Atlantic (table 1).

Table 1 further illustrates the inequity of the regulations on shell height and meat count. As indicated, shell stockers can harvest a meat count in excess of 30 meats per pound without violating the minimum 3.50 inch regulation. In comparison, fishing firms which shuck at sea are required to harvest larger scallops. Alternatively, the minimum 3.50 inch regulation could contribute or account for violations of the meat count by vessels which shuck; fishermen may sort the catch by size of scallops believing that a 3.50 inch minimum will yield a 30 meat count.

Table 1.: Comparison of meat count and shell height regulations by resource area*

Resource Area	Type of Regulation: Meat count 30	Meat count 35	Meat count 40	Shell height 3.50	Shell height 3.75	Shell height 4.00
	Corresponding shell height inches			Corresponding meat count meats per pound		
Gulf of Maine	4.20	4.01	3.86	56.40	44.36	35.44
Georges Bank	3.85	3.67	3.52	40.60	32.62	26.58
Mid-Atlantic	3.77	3.59	3.45	38.10	30.48	24.74

* Estimates obtained from equations on pages 24, 27, and 28 of scallop plan.

A final example of the inequity of the two regulations when seasonality and differences in resource growth are ignored is presented using data obtained in a previous study (Kirkley, 1986). Seventy observations on meat weight and shell height for the Hudson Canyon area were obtained during the last week of June of 1986. A double-log specification, similar to the three weight-height equations in the plan, was estimated to determine the relationship between meat count and shell height. In addition, a meat-count and length equation was estimated.

The estimated weight-height relationships were quite different than those available in the plan. Estimates were as follows:

(4) $W = .0000044512 * L^{3.24938}$
(26.64) (30.69) N=65 $R^2 = .94$

(5) $MC = 2592.76 * LIN^{-3.16908}$
(44.66) (20.66) N=65 $R^2 = .93$

where MC is meat count, LIN is length in inches, and numbers in parenthesis are t-statistics. Regression diagnostics resulted in the elimination of five observations.

While the limited number of observations are insufficient for making broad generalizations or conclusions about the two regulations, the results of Eqs. (4) and (5) provide evidence of the possible inequity of the regulations for fishermen exploiting the Hudson Canyon area during the last week of June of 1986. The inequity is the result of a uniform single shell height regulation of 3.50

inches and a 30 meat count regulation which may correspond with multiple or several shell heights.

Moreover, if it is possible for the weight-height relationships to be different at one point in time and for one area, the current regulations may be inappropriate since they are based on long-term averages. Furthermore, since violations occur for a specific trip and not over the average of several trips, it is likely that regulations based on averages are inconsistent with the manner in which the sea scallop industry operates. In essence, a minimum 3.50 inch shell height is an easier regulation to comply with than is a 30 meat count regulation. Shell stockers have only to determine that the shell height is 3.50 inches, but shuckers must ascertain that there is a maximum of thirty meats per pound which can occur for several different shell heights.

If the data set and results are restricted to observations in which shell height was greater than or equal to 3.50 inches, the observed meat count in the sample is 40.33 meats per pound (table 2). The mid-Atlantic equation in the plan projects a fitted median value of 32.25 meats per pound.[1] Equation (4) provides a fitted median of 40.07 meats per pound; the conditional mean of (4) yields an estimate of 39.97 meats per pound.

[1] The estimated equation in the plan yields conditional medians rather than conditional means.

Table 2 indicates that shell stockers fishing the Hudson Canyon area had a comparative advantage during the last week of June of 1986 because they could harvest 3.50 inch scallops. Compliance with the regulation permitted them to harvest an average 40 meat count per pound. If shell stockers had been regulated by the meat count regulation, they would not have been able to legally harvest the smaller scallops.

In comparison, shuckers during this same period would have to harvest scallops larger than or equal to approximately 4 inches. The equations in the plan indicate that the median shell size would be 3.77 inches for a 30 meat count. The actual regulation used in the plan, however, equates a 3.50 inch shell height to a 30 meat count. Thus, shell stockers could legally harvest less than 30 meat count scallops with the 3.50 minimum shell height regulation while shuckers would have to harvest scallops larger than 3.50 inches to comply with the meat count regulation.

Table 2.: Observed and estimated meat counts for Hudson Canyon area during last week of June, 1986 for shell height restricted to minimum 3.50 inches

	Shell height length in inches 3.50[a]	4.53[a]	Mean of Values
	meat count		
Conditional median equation (4)	47.19	20.52	40.07[b]
Conditional mean equation (4)	46.53	20.23	39.97[b]
Plan equation (3)	37.96	16.57	32.25[b]
Observed	52.38	25.96	40.33

[a]Observed minimum and maximum shell heights in sample. Mean observed shell height was 3.71 inches.

[b]Equation (4) and those in the plan yield conditional medians rather than conditional means. The fitted values must be adjusted by the error variance to obtain the conditional mean.

Limitations of statistical estimates in the plan

Thus far, statistical problems of the estimates in the plan have only been briefly mentioned. In this section, a more detailed discussion of the statistical deficiencies in the plan are discussed.

First, the estimates for the relationship between weight and shell height for the three resource areas appear to be conditional medians rather than conditional means. Also, if a double-log specification was estimated, they have biased parameter estimates of the constant terms (Goldfeld and Quandt, 1972). The conditional median yields lower estimated weights for given lengths than does the conditional mean. In turn, if the conditional median of the weight-height relationship is used to determine the meat count, the estimated meat count will be higher than that estimated by the conditional mean. For example, consider a meat weighing 10.02 grams and measuring 90 millimeters from the sample taken in June of 1986. Equation (4) yields a conditional mean of 9.94 grams and a conditional median of 9.64 grams. The respective meat count estimates are 45.64 and 47.06 meats per pound. If the plan uses the conditional median to determine the relationship between meat count and shell height, it is contrary to the claim of the plan which specifies a target value of 30 meat count as a maximum average or mean value.

Second, the plan provides no regression diagnostics or descriptive statistics on the estimated equations. It is not possible to assess or validate the estimates used to formulate the regulations. Preliminary examination of the data or pre-testing might result in different estimates.

Last, the plan provides no basis for the selection of functional form. While a double-log specification is typically used to examine the weight-length relationships, there is no reason why other functional forms could not be used.

A polynomial of the fourth degree was estimated using the sample data subject to elimination of seven out-lying observations. The results were as follows:

$$(6) \quad MC = \underset{(6.03)}{6935.44} - \underset{(5.14)}{7635.93\ LIN} + \underset{(4.52)}{3189.44\ LIN^2}$$

$$- \underset{(4.06)}{592.08\ LIN^3} + \underset{(3.70)}{41.02\ LIN^4}$$

$$N = 63 \text{ and } R^2 = .95$$

where MC is the meat count of sea scallops, LIN is the length or height of the shell in inches, and numbers in parenthesis are t-statistics. A comparison of the error of sum of squares for the fitted values of meat counts based on equations (4) to (6) indicate that equation (6) provides a better fit of the relationship between meat count and height.

It also is important to recognize that the double-log specification may impose unrealistic conditions on the relationship between weight and shell height. For example, the mid-Atlantic equation in the plan imposes the condition that a one-percent increase in shell height will always yield a 3.234-percent increase in weight regardless of the observed shell height. The specification also imposes the condition that weight will increase without limit for increasing values of shell height. In contrast, equation (6) results in an elasticity of meat count which varies with shell height and a maximum meat count, shell height relationship.

Conclusions and Summary

Despite the limitations of the study, the results indicate that shell stockers have a comparative advantage over shuckers. Shell stockers can harvest 3.50 inch scallops in all resource areas. Scientific evidence in the plan and contained in this study indicate that a 3.50 inch scallop yields a meat count in excess of 30 meats per pound. The continued use of the current regulations results in maintaining the comparative advantage for shell stockers. More equitable regulations are necessary. Alternatively, vessels which currently shuck at sea should, perhaps, explore the possibilities of shell stocking.

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