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Seasonality in Sea Scallop Shell Height-Meat Weight Relationships:

Review and Analysis of Temporal and Spatial Variability

and

Implications for Management Measures Based on Meat Count

by

Fredric M. Serchuk

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☐ Distribution to F/NWC, F/SWC, F/SEC, F/NWR1, & F/NEC (Technical Writer-Editor)

Signature Vaughn Cantos

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National Marine Fisheries Service
Northeast Fisheries Center
Woods Hole Laboratory
Woods Hole, Massachusetts 02543

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SUMMARY

Seasonal variation in sea scallop condition (i.e., the relation of meat weight to shell height) results from temporal changes in water temperature, food supply, and reproductive processes. These variations are reflected in seasonal differences in shell height-meat weight relationships within various sea scallop populations. Patterns in condition, however, may be highly variable both temporally and spatially within and between populations.

Seasonal variability in scallop meat weight at shell height was examined, as well as temporal patterns in USA commercial sea scallop landings and size frequency distributions, to evaluate the probable effects of seasonal adjustments to the sea scallop meat count management measure. Adjustments between 30 and 35 count, whenever enacted, will only alter the vulnerability on a single age group of scallops to exploitation. However, any adjustments that permit greater exploitation of this age group will reduce yield per recruit and decrease population spawning potential. Any upward adjustments will also make mixing of small scallops easier to accomplish in the commercial catch.

Marked seasonal differences in USA commercial catch composition are not evident although a prominent seasonality exists in the commercial landings with offshore catches peaking in spring-summer and territorial landings in autumn-winter. Hence, depending on timing, meat count adjustments may have a differential impact among fisheries and fleet sectors.

The sea scallop meat count measure, as currently implemented under the Fishery Management Plan for Atlantic Sea Scallops, allows for extensive mixing of small scallops even at a 30-count standard. In the absence of other conservation measures, high fishing mortalities can be generated on both large ($\leq$30 count) and small scallops (>30 count) since the standard refers to an average count. To the extent that the meat count standard is unable, by itself, to effectively minimize the harvest of small scallops, benefits from management will be dissipated.

INTRODUCTION

Seasonal variability in growth is characteristic of most aquatic organisms inhabiting North Temperate waters (Ricker 1979). Generally, this variability is a reflection of temporal changes in water temperature and seasonal fluctutations in the abundance and quality of food (Weatherley 1972). For benthic shellfish species such as sea scallop, geographical variability in growth is also evident resulting from fine-scale differences in hydrographic and environmental conditions among habitats (Bourne 1964).

For stock assessment and management purposes, a statistical description of growth is normally requisite for understanding the dynamics of exploited resources and in formulating management measures. For USA offshore sea scallop populations, growth relationships have been developed relating shell height and age (Serchuk et al. 1979, 1982) and shell height and meat (adductor muscle) weight (Haynes 1966; Serchuk et al. 1982; Serchuk and Rak 1983). Yield per recruit analyses, employing these relationships, were used as a biological basis for selecting meat count and shell size management measures to enhance long-term yield in the Fishery Management Plan (FMP) for Atlantic Sea Scallops (New England Fishery Management Council 1982; Pierce 1983).

The growth rate and shell height-meat weight relationships derived from the USA offshore scallop populations (i.e., Georges Bank, Mid-Atlantic, Gulf of Maine)must be considered as approximations since seasonal variations in growth and condition (i.e., relation of meat weight to shell size) were not incorporated as time-varying parameters in the equations. However, the specific long-term conclusions delineated in the Sea Scallop FMP (New England Fishery Management Council 1982: Summary, Page 2) would not be altered by

the inclusion of seasonality coefficients in the yield per recruit models since these analyses were predicated on long-term equilibrium conditions.

Seasonal differences in condition of sea scallops can be of prime importance under a management regimen in which intra-annual regulation occurs. That seasonal differences in sea scallop shell height-meat weight relations occur has been documented (Haynes 1966; Karlsson 1970) and related to gonadal maturation state (Serchuk et al. 1982, Page 39).

This report reviews the available data on seasonality in sea scallop shell height-meat weight relationships to further elucidate these seasonal changes, to characterize the temporal and spatial variability of these patterns, and to identify probable implications of intra-annual adjustments of meat count management measures in the Sea Scallop FMP on fishery performance and resource status.

GENERAL GROWTH AND CONDITION CYCLE

Although meat weight in sea scallops is proportional to shell size, (i.e., meat weight increases with shell height; Figure 35, Serchuk et al. 1982), this proportionality can be highly variable within a year, or among areas, depending upon season and growth conditions. Regular seasonal variations are primarily due to fluctuations in food supply and the spawning cycle (Mottet 1979). Metabolic growth studies of sea scallops indicate that adductor muscle energy reserves accumulate during the months immediately following spring phytoplankton blooms, but are subsequently transferred to the gonad during late spring and summer for gamete maturation (Thompson 1977; Robinson et al. 1981; Gould 1983). Since the gonad is not an energy storage organ, food reserves must be withdrawn from the adductor muscle to permit

gonadal growth. Resultingly, muscle energy levels decrease as gonad enlargement proceeds. After spawning occurs in autumn (August-early October), the gonad goes through a resting stage for several months during which time meat weight recovers as food reserves are again accumulated. These seasonal changes are depicted for three sea scallop populations in Figure 1; temporal patterns are similar in all three populations although the months in which meat weight and gonad weight maxima and minimal occur differ. Within a single population, both the magnitude of body weight changes as well as the rate of change may vary annually (Figures 1B and 1C). Often, this range of variation can be quite large as evident in monthly meat weight values from a population of sea scallops off New Jersey sampled successively during 1981-1983 (Figure 2).

The differential partitioning of energy reserves between meat (and shell) growth processes and gametogenic demands during the year results in seasonal variation in the average meat weight obtained from a scallop of a given shell size. While on an annual basis, individual scallops increase in both shell size and meat weight, meat weight for any particular shell height will tend to be highest in spring, lowest in late summer-early autumn, and intermediate in winter (Posgay and Haynes 1965; Haynes 1966; Karlsson 1970).

SEASONAL SHELL HEIGHT - MEAT WEIGHT RELATIONSHIPS

For USA scallop resources, seasonal shell height-meat weight relationships are available for the Georges Bank and Cape Cod Bay populations (Haynes 1966) and for an inshore population that was located south of Gould Island in the east passage of Narragansett Bay, Rhode Island (Karlsson 1970). These

relationships were derived for seasons corresponding to the gonadal cycle: ripening (Apr - Sep, Georges Bank; Apr - Jul, Narragansett Bay), spawning (Oct, Georges Bank and Cape Cod Bay; Aug - Sep, Narragansett Bay), and mature (Nov - Mar, Georges Bank and Cape Cod Bay; Oct - Mar, Narragansett Bay) (Table 1).

Calculated meat weights at various shell heights, by season and area, indicate that scallop meat yield for a given shell height is variable in both time and space (Table 1; Figure 3). For Georges Bank scallops, seasonal meat weight values follow the expected general pattern, being highest during April - September and lower at the other times. Contrariwise, calculated meat weight values for Narragansett Bay sea scallops are highest during November - March but lower during April - July. In both the Georges Bank and Narragansett populations, the lowest meat weight at shell height values occur during the spawning period. In the Cape Cod Bay population, however, October (spawning) meat weights are higher than those calculated for the November - March period. While some of these seasonal differences in condition pattern may be statistical artifacts due to small sample sizes used in deriving several of the seasonal shell height-meat weight relationships, they do indicate the range of temporal variation in condition that can exist even among nearby geographical populations.

Comparison of calculated meat weights at shell size among areas also reveals differential relative growth rates between populations (Table 1). During the period of ripening gonads (Nov-Mar), meat weights from Cape Cod Bay are greater for the same shell size scallop than those from Georges Bank or Narragansett Bay. While the condition of Cape Cod scallops is uniformly higher than in the other areas during the two seasons for which

data are available, a similar consistency in condition is not apparent between the Georges Bank and Narragansett Bay sea scallop populations. For a given shell size, Georges Bank scallops possess higher meats than Narragansett Bay scallops during April - September and during the spawning period, but smaller meats per shell size afterward. Although the percentage differences in meat yield for a given size shell are often slight among populations, the differential pattern in seasonal condition between areas implies that the timing of any inter-annual adjustments to management measures based on meat count will not necessarily have a uniform impact across all populations managed, or across the size range of individuals within a single population.

EVALUATION OF MEAT COUNT ADJUSTMENTS UNDER THE SEA SCALLOP FMP

The harvest of USA sea scallop resources is regulated by a meat count management standard. The target meat count is 30 per pound. During the initial year of implementation of the FMP (May 1982 - May 1983), a 40 meat count management measure was adopted. An automatic reduction to a 30 meat count standard was scheduled to occur on May 15, 1983 but due to inconsistencies in management measures between Canadian and USA fishermen harvesting jointly fished stocks on Georges Bank, a 35 meat count measure was imposed for the period May 15 - December 31, 1983. Although seasonal differences in sea scallop condition were recognized in the development of the FMP and in the analytical assessments provided during the development process, adjustments in the meat count measure have not explicitly considered these seasonal variations.

To assess the probable consequences of the timing of meat count adjustments on the scallop resource and fishery, evaluations were performed

using the available seasonal shell height-meat weight relations, and by examining seasonal landings patterns and commercial size frequency samples. Results of each of these analyses are discussed below.

Seasonal Shell Height-Meat Weight Relations

Seasonal changes in calculated meat weight and meat count at shell height, derived from the equations provided by Haynes (1966) and Karlsson (1970), are presented in Figure 3. In all three of the populations depicted, calculated meat weights for scallops less than 92 mm shell height are never equivalent to 35 count, irrespective of season. Accordingly, any seasonal adjustments in the meat count standard between 30 and 35 count would miminally affect scallops of these sizes since their meats remain too small, at any time during the year, to achieve the 35 meat count standard. Similarly, scallops higher than 102 mm shell height would also be minimally impacted by any seasonal adjustments between 30 and 35 count since the meats of these scallops are below 30 count (i.e., 29, 25, etc) throughout the year. Hence, although seasonal changes in meat weight at shell size occur for all sized scallops, these changes are not great enough to make the smallest scallops legal or the largest scallops illegal during any season under the present standards. Of course, since the FMP meat count measure refers to an average count (i.e., not to individual scallop meats), adjustments to the meat count standard, whenever enacted, will affect the degree of mixing possible in attaining the standard count, thereby having some impact on all sizes of scallops in the population fished.

The largest potential impact of a seasonal adjustment in meat count will be on scallops between 92-102 mm shell height since temporal changes in condition occur which make these scallops legal during one season but illegal

during another (assuming the present 35 count standard). Scallops in this shell size range normally comprise a single age group, being in the fifth year of life on Georges Bank and in the Mid-Atlantic (i.e., age 4). They are sexually mature but generally have undergone only one productive spawning since prior to age 4, scallops do not produce very many eggs (Posgay 1982). During their fifth year, ovary weight doubles for both Georges Bank and Mid-Atlantic scallops (Serchuk et al. 1982), implying that any adjustments in the meat count which permit greater harvesting of these scallops will decrease the short-term reproductive potential of the spawning population and reduce the number of eggs per recruit.

The shell height-meat weight relationships used in the FMP and its attendant regulations were not those presented by Haynes (1966) but were independently derived from USA summer research vessel survey data collected during 1977-1981 (Serchuk et al. 1982). Since the survey samples were collected during one season of the year, analyses of seasonal differences in condition of scallops could not be evaluated. However, the seasonal differences in calculated meat weight at shell size from Haynes' equations (Table 1) can be used to adjust the more recent survey relationships to evaluate seasonality in meat yield for a given size shell. To accomplish this, the percentage differences in meat weight between April-September and the October and November-March periods were calculated, by shell height, from the Georges Bank data (Tables 1 and 2). For shell sizes between 92 and 107 mm, October meat weights averaged 20% less than in April-September; meat weights in November-March were about 12% smaller than April-September values (Table 2). Assuming that these percentage declines in meat weight were representative of the seasonal patterns occurring in all of the major USA offshore sea scallop

resources, the calculated meat weight at shell height values from the 1977-1981 survey equations were decremented by 20% and 12% to estimate meat weights in October and November-March, respectively (Table 3).

For both Georges Bank and Mid-Atlantic scallops, the adjusted survey meat weight values exhibit the same pattern with respect to a 30-35 meat count standard as Haynes' original Georges Bank data. That is, irrespective of season, scallops smaller than 92 mm shell height never average 35 count while scallops larger than 102 mm shell height always average less than 30 count (Table 3). Accordingly, the same inferences regarding potential impacts of seasonal meat count adjustments are evident from these results as from the data of Haynes (1966) and Karlsson (1970).

The adjusted Gulf of Maine meat weight at height data show a slightly different trend relative to a 30-35 meat count standard than do the Georges Bank and Mid-Atlantic results (Table 3). At shell heights less than 102 mm, calculated meat weight values are never equivalent to 35 count during any part of the year. It is not until Gulf of Maine scallops attain a shell height of 114 mm that their calculated meat weights are below 30 count during all seasons. This differential in meat weight at size between Gulf of Maine scallops and those from Georges Bank and the Mid-Atlantic is consistent with previous findings that, due to a lower relative growth rate, Gulf of Maine scallops lag about 10 mm behind the more southerly populations in attaining a given meat weight (Serchuk and Rak 1983).

Typically, Gulf of Maine scallops ranging between 102 and 114 mm shell height would be in their sixth year of life (i.e., age 5). They would be sexually mature having probably spawned twice before (Welch 1950; Baird 1956). Ovary weight increases approximately 35% during the time required to grow

from 100 to 110 mm in shell height (Serchuk and Rak 1983) implying that substantial gains in potential egg deposition may be attained under a 30 meat count standard. Since the inshore, territorial water Gulf of Maine sea scallop fishery is limited to the period November 1 to April 15, the harvest of spawning scallops does not occur in this fishery. However, any seasonal adjustments in the meat count standard will affect the inshore Gulf of Maine fishery to the extent that the timing of these adjustments coincide with the fishery season.

Seasonal Landings Patterns

The potential impacts of the timing and magnitude of seasonal adjustments to the sea scallop meat count standard will be influenced not only by the underlying seasonality in scallop condition but also by the seasonality of the fishery itself. To evaluate seasonality in the fishery, USA commercial landings were tabulated, by area, year, and month, during the five-year period 1978-1982 (Table 4). Within each major fishing area (Georges Bank, Mid-Atlantic, and Gulf of Maine), monthly landings were subsequently expressed as a percentage of the annual totals (Table 5). Additionally, percentage distributions, by month, were derived for the total USA scallop catch in each year, and five-year monthly means calculated for each area and for all areas combined.

In toto, the landings distributions indicate a pronounced seasonality. Approximately 50% of the total annual USA harvest is taken during the 4-month period, May-August (Table 5). Two-thirds of the annual landings are harvested during the April-September period. This pattern is virtually

identical in both the Georges Bank and Mid-Atlantic fisheries which together accounted for greater than 90% of the total USA scallop landings during 1978-1982. This seasonality is presumably a function of both increased effort and better fishing conditions during the warmer months of the year.

The seasonal landings pattern in the Gulf of Maine fishery is nearly the inverse of that observed for Georges Bank and the Mid-Atlantic. Less than one-third of the annual Gulf of Maine scallop landings is normally taken during April-September. The bulk of the landings occur during November-March (>75% in most years) and directly reflects the performance of the inshore, territorial fishery in Maine waters which can only be prosecuted, by statute, during November to mid-April. In those years in which an offshore Gulf of Maine fishery flourished (i.e., 1980 and 1981), landings patterns differed from the traditional one since no temporal restrictions on fishing activity exist in the Fishery Conservation Zone (FCZ).

Adjustments in the meat count standard that are operational solely during the late autumn-early winter period will tend to have the least overall impact on total fishery performance and aggregate resource conditions since total USA landings are much less during this period than at other times of the year. This would not hold true, however, in the inshore Gulf of Maine scallop fishery where impacts on fishery performance would likely be large from a temporary winter adjustment to the meat count standard.

To the extent that seasonal patterns of fishing activity differ among vessel classes, seasonal adjustments in meat count will impact some vessel classes more than others. For example, in the Georges Bank and Mid-Atlantic scallop fisheries, an upward adjustment of the prevailing meat count in winter might be expected to benefit the larger vessels more than the smaller ones

since winter weather conditions normally constrain fishing activity of the smaller vessels to a greater extent than they do for the largest-sized vessels.

USA Commercial Size Frequency Samples

Theoretically, seasonal changes in sea scallop meat yield at shell height should produce seasonal patterns in commercial meat count distributions, assuming cull size remains fairly constant during the year and fishing practices do not markedly vary seasonally (i.e., fishing on small scallops during one season and larger scallops during another). Although neither of these assumptions are fully met in the conduct of the fishery, USA commercial size frequency samples collected from Georges Bank and the Mid-Atlantic during 1978-1983 were analyzed by calendar quarter, to evaluate any underlying seasonality in average shell height or meat count in the commercial landings (Tables 6 and 7).

No obvious seasonal differences in either the mean or range of sample shell heights and calculated meat counts are evident in the commercial samples from Georges Bank (Table 6) or the Mid-Atlantic (Table 7). Quarterly mean shell heights during 1978-1983 were never below 95 mm (Apr-Jun 1981) for Georges Bank samples or less than 104 mm (Jan-Mar 1982) for Mid-Atlantic samples. Correspondingly, calculated quarterly meat counts never exceeded 39 count (Georges Bank: Apr-Jun 1981) in samples from either region. Although individual samples exhibited more extreme shell height and calculated meat weight values, the range in sample variability appears similar among calendar quarters and generally among years. The reduction in average shell height (an increase in meat count) in Georges Bank samples collected during 1981 and 1982 reflects exploitation on small scallops, located primarily in the Northern Edge and Peak area (Serchuk et al. 1982), rather than pronounced seasonal changes in scallop meat weight condition.

To some degree, the calculated meat counts of the commercial samples may not reflect actual meat counts observed directly in the fishery. On a seasonal basis, the calculated meat counts may differ from empirical counts in the fishery since the calculated values were derived by applying the shell height-meat weight equations developed from the summer research surveys to commercial shell height frequency samples obtained during all seasons. However, given Haynes' (1966) results (Table 2) that scallop meat weight at height is about 20% less in October and 12% less during November-March than during April-September (when survey samples were collected), adjusted commercial meat counts for the October-March samples would be no more than 25% higher than the values calculated (i.e., a 20% reduction in meat weight implies a 25% increase in meat count). Accordingly, the highest adjusted individual sample meat count from the Mid-Atlantic would be 45 count (Jan-Mar 1982 sample of 36 count), while the highest value from Georges Bank would be 44 count (excluding 1981 and 1982 samples from exploitation on small scallops) (Tables 7 and 8). The highest adjusted quarterly mean meat counts would be 30 count for the first quarter 1982 Mid-Atlantic samples and 40 count for the last quarter 1982 Georges Bank samples.

A disparity between calculated meat counts and fishery-observed values might also exist if the commercial shell size frequency samples provided by fishermen are biased. Although fishermen are briefed on the rationale and mechanics of providing a representative size frequency sample of their catch, there are various reasons why they might do otherwise and perhaps provide only larger-sized shells. However, sample shell height frequency distributions and meat counts obtained during a sea sampling trip aboard a commercial sea scallop vessel fishing on Georges Bank during July

1983 (Table 8) indicate that there is no a priori reason to suspect that samples comprised primarily of larger-sized shells are per se, biased. Samples with mean shell heights between 110 and 125 mm were common during the sea sampling trip. Equally, observed meat counts (from weights at sea of freshly shucked scallop meats) between 12-25 count were characteristic of almost all of the catch. The correspondence between the sea sampling measurements and those derived from the commercial port samples (Jul-Sept 1983; Table 6) is striking; similar shell height and meat count patterns are evident in both data sets. This congruence, as well as the close agreement between calculated meat and observed meat counts obtained during the sea sampling trip (i.e., 85% of the samples had calculated meat counts within 5 counts of the observed values; Table 8) suggests that the analyses based on commercial samples cannot be presumptively dismissed as being biased.

Since the time series of commercial sampling data indicate that the cull size has generally been greater than 90 mm shell height, except during periods of good recruitment (such as 1981 and 1982 on the Northern Edge and Peak), it is likely that any seasonal adjustments to the meat count standard will have more of an effect on the 'mixing' rate of small scallops than anything else. As previously noted, scallops larger than 102 mm shell height will average 30 count or less during all seasons. Accordingly, during periods in which there is a dearth of small scallops (i.e., relatively low recruitment) or relatively low abundance of small scallops compared with larger-sized ones, attainment of a 30 meat count in the fishery would normally not prove difficult. However, at times when abundance of larger scallops is low, or relatively low compared with smaller-sized scallops, meat counts in the fishery will increase (in the absence of restrictions) or mixing of small

scallops will become more widespread (in the presence of restrictions) in an attempt to maintain yields. In the latter case, for example, it is still possible to achieve a 30-count average by mixing 20 60-count scallops with only 10 15-count scallops (Table 9). Under these conditions, though, the effectiveness of the meat count standard in enhancing yield per recruit and minimizing exploitation on newly recruited scallops is seriously compromised.

That the fishery is capable of achieving a 30 count standard during any season of the year is demonstrated by meat count samples recorded by NMFS Enforcement Agents during 1982 and 1983 (Table 10). Although these data need careful interpretation since the agents often sampled trips in which violations of the prevailing standards were suspected and also because fishing practices responded to changes in the standard itself, it is apparent that conformance with a 30 count measure is not biologically or operationally unattainable. None of the sample meat counts obtained during June-October 1983 exceeded 32 count. Individual meat counts between 14-24 count were frequently recorded during the winter months of 1982 and 1983.

CONCLUSIONS

Sea scallops, like other temperate marine organisms, exhibit seasonality in growth. Additionally, the relationship between meat weight and shell size may vary seasonally due to environmental conditions and reproductive processes. As a consequence, meat yield for a given shell height can be highly variable, both temporally and spatially.

The timing and duration of adjustments in sea scallop meat count management measures will have differential impacts on the resource and the fishery. Based upon examination of seasonal changes in meat weight at height,

commercial landings patterns, and commercial size frequency and meat count samples, seasonal adjustments in a meat count standard between 30 and 35 count will alter the vulnerability of a single age group of scallops to exploitation, but will have little effect on fishery performance other than to influence the mixing rate of small scallops. No seasonal differences in commercial catch composition appear to exist other than those due to seasonal changes in areas fished. There is a marked seasonality in sea scallop landings with offshore FCZ catches peaking in spring and summer and territorial landings during autumn and winter. Hence, short-term meat count adjustments, depending on their timing, can have a differential impact among fleet sectors.

As currently implemented. the FMP meat count measure permits extensive mixing of small scallops even at a 30-count standard. This practice, while legal, can generate a high fishing mortality on young scallops, sacrificing long-term reproductive and yield per recruit benefits for short-term yield. To the extent that the meat count standard is unable to constrain such fishing mortality from occurring, management benefits will be dissipated.

LITERATURE CITED

Baird, F.T., Jr. 1956. The sea scallop (Pecten magellanicus). Maine Dept. Sea Shore Fish., Fish. Ed. Serv., Unit 2:11 p.

Bourne, N. 1964. Scallops and the offshore fishery of the Maritimes. Fish. Res. Board Can., Bull. 145:60 p.

Gould, E. 1983. Seasonal biochemical patterns for a single population of sea scallops, Placopecten magellanicus, and their use in interpreting field data. ICES CM 1983/E:57, 17 p.

Haynes, E.B. 1966. Length-weight relation of the sea scallop, Placopecten magellanicus (Gmelin). Int. Comm. Northw. Atlant. Fish., Res. Bull. 3:32-48.

Jamieson, G.S. 1979. Status and assessment of Northumberland Strait scallop stocks. Fish. Mar. Serv. Tech. Report 904:34 p.

Karlsson, J.D. 1970. Development of management plan for sea scallops in Rhode Island waters. Completion Rept. P.L. 88-309, Project 3-80-D, R.I. Div. Fish and Wildlife: 8 p.

Mottet, M.G. 1979. A review of the fishery biology and culture of scallops. Dept. Fish., State of Washington, Tech. Rept. No. 39, 100 p.

New England Fishery Management Council. 1982. Fishery Management Plan for Atlantic Sea Scallops (Placopecten magellanicus), Saugus, Massachusetts, 149 p.

Pierce, D.E. 1983. Development and evolution of the sea scallop fishery management plan. Mass. Div. Mar. Fish., Pub. No. 13232-75-50-5-83-C.R., Boston, Mass., 75 p.

Posgay, J.A. 1982. Sea Scallop Placopecten magellanicus, p. 130-133. In Grosslein, M.D., and T.R. Azarovitz (ed.), Fish Distribution, MESA New York Bight Atlas Monograph 15, New York Sea Grant Institute, New York.

Posgay, J.A., and E.B. Haynes. 1965. The weight-length ratio of Georges Bank sea scallops. Bur. Comm. Fish., Woods Hole Lab. Ref. Doc. No. 65-9, 6 p.

Ricker, W.E. 1979. Growth rates and models, p. 677-743. In Hoar, W.S., D.J. Randall, and J.R. Brett (ed.), Fish Physiology, Vol. VIII, Bioenergetics and Growth, Academic Press, New York.

Robinson, W.E., W.E. Wehling, M.P. Morse, and G.C. McLeod. 1981. Seasonal changes in soft-body component indices and energy reserves in the Atlantic deep-sea scallop, Placopecten magellanicus. Fish. Bull., U.S. 79:449-458.

Serchuk, F.M., and R.S. Rak. 1983. Biological characteristics of offshore Gulf of Maine sea scallop populations: Size distributions, shell height-meat weight relationships and relative fecundity patterns. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. Doc. No. 83-07, 42 p.

Serchuk, F.M., P.W. Wood, J.A. Posgay, and B.E. Brown. 1979. Assessment and status of sea scallop (Placopecten magellanicus) populations off the northeast coast of the United States. Proc. Nat. Shelf. Assoc. 69: 161-191.

Serchuk, F.M., P.W. Wood, Jr., and R.S. Rak. 1982. Review and assessment of the Georges Bank, Mid-Atlantic and Gulf of Maine Atlantic sea scallop (Placopecten magellanicus) resources. Nat. Mar. Fish. Serv., Woods Hole Lab. Ref. Doc. No. 82-06, 132 p.

Thompson, R.J. 1977. Blood chemistry, biochemical composition, and the annual reproductive cycle in the giant scallop, Placopecten magellanicus, from southeast Newfoundland. J. Fish. Res. Board Can. 34:2104-2116.

Weatherley, A.H. 1972. Growth and ecology of fish populations. Academic Press Inc., London, 293 p.

Welch, W.R. 1950. Growth and spawning characteristics of the sea scallop, Placopecten magellanicus (Gmelin) in Maine waters. Masters Thesis, Univ. of Maine, Orono, 95 p.

Table I. Calculated meat weight (g) at shell height (mm), by season, for Georges Bank, Cape Cod Bay, and Narragansett Bay sea scallops. Georges Bank and Cape Cod Bay meat weight values calculated from shell height-meat weight equations given in Haynes 1966; Narragansett Bay meat weight values calculated from shell height-meat weight equations given by Karlsson 1970.

Shell Height (mm)	Georges Bank			Cape Cod Bay		Narragansett Bay		
	Apr-[1] Sep	Oct[2]	Nov-[3] Mar	Oct [4]	Nov-[5] Mar	Apr-[6] Jul	Aug-[7] Sep	Oct-[8] Mar
72	6.15	5.25	5.17	6.68	6.22	5.51	4.61	5.85
77	7.52	6.38	6.38	8.16	7.65	6.63	5.54	7.13
82	9.08	7.55	7.77	9.85	9.27	7.89	6.59	8.58
87	10.84	8.90	9.35	11.75	11.11	9.30	7.75	10.21
92	12.81	10.40	11.14	13.89	13.19	10.85	9.04	12.03
97	15.01	12.05	13.15	16.27	15.51	12.56	10.45	14.05
102	17.45	13.86	15.39	18.91	18.08	14.44	12.00	16.29
107	20.14	15.84	17.88	21.81	20.94	16.48	13.69	18.75

Georges Bank:

[1]ln Meat Weight (g)= -10.9926 + 2.995 ln Shell Height (mm).

[2]ln Meat Weight (g)= -10.2516 + 2.785 ln Shell Height (mm).

[3]ln Meat Weight (g)= -11.7472 + 3.131 ln Shell Height (mm).

Cape Cod Bay:

[4]ln Meat Weight (g)= -10.8845 + 2.989 ln Shell Height (mm).

[5]ln Meat Weight (g)= -11.2666 + 3.062 ln Shell Height (mm).

Narragansett Bay:

[6]ln Meat Weight (g)= -10.1274 + 2.767 ln Shell Height (mm).

[7]ln Meat Weight (g)= -10.2246 + 2.748 ln Shell Height (mm).

[8]ln Meat Weight (g)= -10.8022 + 2.939 ln Shell Height (mm).

Table 2. Percentage differences in calculated meat weight (g) at shell height (mm) for sea scallops from Georges Bank and Narragansett Bay between the spring-summer season of gonad maturity (Apr-Sept: Georges Bank; Apr-Jul: Narragansett Bay) and the spawning (S) and gonad ripening (R) seasonal periods. Percentages derived from values in Table 1.

Shell Height (mm)	Georges Bank		Narragansett Bay	
	Oct (S)	Nov-Mar (R)	Aug-Sept (S)	Oct-Mar (R)
72	-14.6	-15.9	-16.3	+ 6.2
77	-15.8	-15.2	-16.4	+ 7.5
82	-16.9	-14.4	-16.5	+ 8.7
87	-17.9	-13.7	-16.7	+ 9.8
92	-18.8	-13.0	-16.7	+10.9
97	-19.7	-12.4	-16.8	+11.9
102	-20.6	-11.8	-16.9	+12.8
107	-21.4	-11.2	-16.9	+13.8

Table 3. Calculated meat weight (g) at shell height (mm), by season, for Georges Bank, Mid-Atlantic and Gulf of Maine sea scallops. April-September meat weight values calculated from areal shell height-meat weight equations given in Serchuk (1982) and used in Sea Scallop Fishery Management Plan (NEFMC, 1982). October values are 20% less than Apr-Sept values, and Nov-Mar values are 12% less than Apr-Sept values based on percentage decreases in meat weight at height for 92-107 mm scallops from data in Haynes (1966) and Table 2. Values in parentheses are meat counts.

Shell Height (mm)	Georges Bank			Mid-Atlantic			Gulf of Maine		
	Apr-[1] Sep (M)	Oct (s)	Nov-Mar (R)	Apr-[2] Sep (M)	Oct (S)	Nov-Mar (R)	Apr-[3] Sep (M)	Oct (S)	Nov-Mar (R)
72	5.71	4.57	5.02	6.01	4.81	5.29	3.87	3.10	3.41
	(79)	(99)	(90)	(75)	(94)	(86)	(117)	(146)	(133)
77	7.07	5.66	6.22	7.46	5.97	6.56	4.89	3.91	4.30
	(64)	(80)	(73)	(61)	(76)	(69)	(93)	(116)	(105)
82	8.63	6.90	7.59	9.15	7.32	8.05	6.08	4.86	5.35
	(53)	(66)	(60)	(50)	(62)	(56)	(75)	(93)	(85)
87	10.42	8.34	9.17	11.08	8.86	9.75	7.48	5.98	6.58
	(44)	(54)	(49)	(41)	(51)	(47)	(61)	(76)	(69)
92	12.44	9.95	10.95	13.27	10.62	11.68	9.08	7.26	7.99
	(36)	(46)	(41)	(34)	(43)	(39)	(50)	(62)	(57)
97	14.72	11.78	12.95	15.75	12.60	13.86	10.92	8.47	9.61
	(31)	(39)	(35)	(29)	(36)	(33)	(42)	(52)	(47)
102	17.26	13.81	15.19	18.53	14.82	16.31	13.00	10.40	11.44
	(26)	(33)	(30)	(24)	(31)	(28)	(35)	(44)	(40)
107	20.10	16.08	17.69	21.63	17.30	19.03	15.36	12.29	13.52
	(23)	(28)	(26)	(21)	(26)	(24)	(30)	(37)	(34)

[1]Georges Bank: ln Meat Weight (g) = -11.8347 + 3.1748 ln Shell Height (mm) (N =3036, r = 0.97).

[2]Mid-Atlantic: ln Meat Weight (g) = -12.0356 + 3.2335 ln Shell Height (mm) (N = 8992, r = 0.98).

[3]Gulf of Maine: ln Meat Weight (g) = -13.5356 + 3.4813 ln Shell Height (mm) (N = 1726, r = 0.94).

M = mature gonads

S = spawning

R = ripening gonads

Table 4. USA commercial sea scallop landings (metric tons, meats) by area, year, and month, 1978-1982. Landings that could not be associated with an area or a month (i.e., Mass. canvass data; North Carolina landings in some years) have not been included.

Area / Year	Month												
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Georges Bank													
1978	253.1	521.7	399.0	497.2	338.8	190.1	535.7	818.5	627.7	531.2	540.3	315.6	5568.9
1979	243.2	181.5	517.8	415.1	744.0	762.6	823.8	741.6	608.8	587.0	459.8	301.7	6386.9
1980	207.5	296.7	295.6	479.3	663.7	760.1	790.3	629.2	608.4	389.5	251.6	183.0	5554.9
1981	131.4	299.9	377.0	605.4	1135.3	1474.3	1517.8	962.4	674.9	535.9	321.3	331.1	8366.7
1982	200.2	357.2	495.2	428.8	726.6	888.9	960.3	735.1	527.4	459.5	394.9	298.3	6472.4
Mid-Atlantic													
1978	151.4	160.5	360.9	623.7	1289.4	1513.8	1452.7	1036.4	632.0	704.7	425.6	233.4	8584.5
1979	168.0	197.7	509.8	774.0	985.4	901.8	947.4	747.5	466.6	346.9	228.0	169.5	6442.6
1980	175.5	217.8	231.5	591.9	769.4	623.0	597.4	403.7	431.3	312.2	266.9	203.6	4824.2
1981	122.3	149.5	206.7	267.7	329.6	266.9	139.2	74.5	131.8	100.6	62.0	38.9	1889.7
1982	20.8	75.5	92.3	172.0	218.8	258.0	161.5	157.3	158.1	119.1	145.5	122.6	1701.5
Gulf of Maine													
1978	40.2	40.4	48.6	19.4	2.4	2.5	2.5	1.7	1.2	0.6	34.6	48.4	242.5
1979	39.2	31.5	47.8	24.8	12.2	7.9	8.6	9.9	13.6	25.2	89.8	95.3	405.8
1980	103.3	198.3	248.3	263.0	197.2	150.3	70.1	76.6	59.4	29.8	93.9	130.1	1620.3
1981	153.1	140.6	144.2	80.1	45.3	37.3	115.7	104.2	109.2	96.1	136.7	92.0	1254.5
1982	63.6	45.5	57.8	17.1	24.6	32.9	15.6	31.5	33.5	63.7	110.3	167.8	663.9
So. New England													
1978	-	-	-	-	-	5.5	4.9	0.4	6.9	8.2	2.0	0.8	28.7
1979	0.3	0.3	3.3	16.8	1.7	3.9	9.3	16.9	6.3	9.3	12.4	11.8	92.3
1980	14.7	3.9	1.6	42.4	47.2	23.8	32.2	20.0	17.5	4.8	2.4	6.5	217.0
1981	6.0	7.2	8.4	1.6	0.3	14.0	15.7	4.7	12.8	26.3	16.7	12.0	125.7
1982	3.6	1.0	18.9	14.5	1.4	20.8	37.9	16.6	15.7	8.3	7.1	4.0	149.8
All Areas													
1978	444.7	722.6	808.5	1140.3	1630.6	1711.9	1995.8	1857.0	1267.8	1244.7	1002.5	598.2	14424.6
1979	450.7	411.0	1078.7	1230.7	1743.3	1676.2	1789.1	1515.9	1095.3	968.4	790.0	578.3	13327.6
1980	501.0	716.7	777.0	1376.6	1677.5	1557.2	1490.0	1129.5	1116.6	736.3	614.8	523.2	12216.4
1981	412.8	597.2	736.3	954.8	1510.5	1792.5	1788.4	1145.8	928.7	758.9	536.7	474.0	11636.6
1982	288.2	479.2	664.2	632.4	971.4	1200.6	1175.3	940.5	734.7	650.6	657.8	592.7	8987.6

Table 5. Percentage distribution of annual USA commercial sea scallop landings (metric tons) from Georges Bank (Area 5Ze), the Mid-Atlantic (Area 6) and the Gulf of Maine (Area 5Y), by month, 1978-1982.

Area / Year	Month														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	Apr-Sept	Oct-Mar
Georges Bank															
1978	4.5	9.4	7.2	8.9	6.1	3.4	9.6	14.7	11.3	9.5	9.7	5.7	100.0	54.0	46.0
1979	3.8	2.9	8.1	6.5	11.7	11.9	12.9	11.6	9.5	9.2	7.2	4.7	100.0	64.1	35.9
1980	3.8	5.3	5.3	8.6	12.0	13.7	14.2	11.3	11.0	7.0	4.5	3.3	100.0	70.8	29.2
1981	1.6	3.6	4.5	7.2	13.6	17.6	18.1	11.5	8.1	6.4	3.8	4.0	100.0	76.1	23.9
1982	3.1	5.5	7.7	6.6	11.2	13.7	14.8	11.4	8.2	7.1	6.1	4.6	100.0	65.9	34.1
1978-1982[1]	3.4	5.3	6.5	7.6	10.9	12.1	13.9	12.1	9.6	7.8	6.3	4.5	100.0	66.2	33.8
Mid-Atlantic															
1978	1.8	1.9	4.2	7.3	15.0	17.6	16.9	12.1	7.4	8.2	4.9	2.7	100.0	76.3	23.7
1979	2.6	3.1	7.9	12.0	15.3	14.0	14.7	11.6	7.3	5.4	3.5	2.6	100.0	74.9	25.1
1980	3.6	4.5	4.8	12.3	16.0	12.9	12.4	8.4	8.9	6.5	5.5	4.2	100.0	70.9	29.1
1981	6.5	7.9	10.9	14.2	17.4	14.1	7.4	3.9	7.0	5.3	3.3	2.1	100.0	64.0	36.0
1982	1.2	4.4	5.4	10.1	12.9	15.2	9.5	9.2	9.3	7.0	8.6	7.2	100.0	66.2	33.8
1978-1982[1]	3.1	4.4	6.6	11.2	15.3	14.8	12.2	9.0	8.0	6.5	5.1	3.8	100.0	70.5	29.5
Gulf of Maine															
1978	16.6	16.7	20.0	8.0	1.0	1.0	1.0	0.7	0.5	0.2	14.3	20.0	100.0	12.2	87.8
1979	9.7	7.8	11.8	6.1	3.0	1.9	2.1	2.4	3.4	6.2	22.1	23.5	100.0	18.9	81.1
1980	6.4	12.2	15.3	16.2	12.2	9.3	4.3	4.7	3.7	1.9	5.8	8.0	100.0	50.4	49.6
1981	12.2	11.2	11.5	6.4	3.6	3.0	9.2	8.3	8.7	7.7	10.9	7.3	100.0	39.2	60.8
1982	9.6	6.9	8.7	2.6	3.7	5.0	2.3	4.7	5.0	9.6	16.6	25.3	100.0	23.3	76.7
1978-1982[1]	10.9	11.0	13.5	7.9	4.7	4.0	3.8	4.1	4.3	5.1	13.9	16.8	100.0	28.8	71.2
All Areas[2]															
1978	3.1	5.0	5.6	7.9	11.3	11.9	13.8	12.9	8.8	8.6	7.0	4.1	100.0	66.6	33.4
1979	3.4	3.1	8.1	9.2	13.1	12.6	13.4	11.4	8.2	7.3	5.9	4.3	100.0	67.9	32.1
1980	4.1	5.9	6.4	11.3	13.7	12.8	12.2	9.2	9.1	6.0	5.0	4.3	100.0	68.3	31.7
1981	3.6	5.1	6.3	8.2	13.0	15.4	15.4	9.8	8.0	6.5	4.6	4.1	100.0	69.8	30.2
1982	3.2	5.3	7.4	7.0	10.8	13.4	13.1	10.5	8.2	7.2	7.3	6.6	100.0	63.0	37.0
1978-1982[1]	3.5	4.9	6.7	8.7	12.4	13.2	13.6	10.7	8.5	7.1	6.0	4.7	100.0	67.1	32.9

[1]Mean of percentages.

[2]Includes Southern New England (Area 5ZW) landings as well as Georges Bank, Mid-Atlantic, and Gulf of Maine.

Table 6. Mean shell height (mm) and calculated meat count (number of meats per pound) of USA commercial sea scallop samples from Georges Bank by calendar quarter, 1978-1983. Only samples taken by scallop dredges are listed.

Year / Quarter	Shell Height(mm) Mean of Samples	Shell Height(mm) Range of Sample Means	Calculated Meat Count[1] Mean of Samples	Calculated Meat Count[1] Range of Sample Counts	Number of Samples
1978					
Jan-Mar	112	106-126	19	13-23	3
Apr-Jun	110	101-125	21	13-27	7
Jul-Sep	118	91-134	17	11-36	26
Oct-Dec	118	97-138	17	10-30	24
Total	117	91-138	18	10-36	60
1979					
Jan-Mar	118	96-136	17	10-28	15
Apr-Jun	117	101-142	18	9-26	22
Jul-Sep	121	84-139	16	9-48	30
Oct-Dec	119	93-136	16	10-35	24
Total	119	84-142	17	9-35	91
1980					
Jan-Mar	114	93-133	19	11-33	20
Apr-Jun	118	91-144	17	9-33	22
Jul-Sep	118	93-144	17	9-33	22
Oct-Dec	114	92-143	20	9-35	10
Total	116	91-144	18	9-35	74
1981					
Jan-Mar	103	77-147	32	8-58	10
Apr-Jun	95	76-132	39	11-64	28
Jul-Sep	99	75-141	33	9-67	16
Oct-Dec	97	80-122	33	13-69	14
Total	98	75-147	35	8-69	68
1982					
Jan-Mar	105	77-145	29	7-60	18
Apr-Jun	107	73-131	25	10-74	28
Jul-Sep	111	94-147	20	8-33	19
Oct-Dec	97	79-115	32	16-56	5
Total	107	73-147	25	7-60	70
1983					
Jan-Mar	108	100-114	20	16-26	4
Apr-Jun	111	95-123	19	12-28	18
Jul-Sep	114	93-145	19	8-33	12
Oct-Dec					
Total					

[1]Calculated meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was obtained by applying the 1978-1981 USA Georges Bank research survey sea scallop shell height-meat weight equation,

$$\ln \text{Meat Weight(g)} = -11.8347 + 3.1748 \ln \text{Shell Height(mm)}$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample (for 1978-1982 samples). For 1983 samples, the 1978-1982 USA Georges Bank shell height-meat weight equation was used

$$\ln \text{Meat Weight(g)} = -11.7656 + 3.1693 \ln \text{Shell Height(mm)}.$$

Table 7. Mean shell height (mm) and calculated meat count (number of meats per pound) of USA commercial sea scallop samples from the Mid-Atlantic, by calendar quarter, 1978-1983. Only samples taken by scallop dredges are listed.

Year / Quarter	Shell Height(mm) Mean of Sample	Shell Height(mm) Range of Sample Mean	Calculated Meat Count[1] Mean of Samples	Calculated Meat Count[1] Range of Sample Counts	Number of Samples
1978					
Jan-Mar	118	102-129	15	11-23	5
Apr-Jun	108	98-116	20	16-27	15
Jul-Sep	125	106-144	13	8-21	16
Oct-Dec	115	108-123	16	13-19	6
Total	116	98-144	16	8-27	42
1979					
Jan-Mar	105	101-108	22	20-24	2
Apr-Jun	112	96-138	18	9-29	14
Jul-Sep	116	99-144	17	8-27	5
Oct-Dec	124	119-131	13	11-14	3
Total	113	96-144	18	8-29	24
1980					
Jan-Mar	115	100-122	16	13-25	7
Apr-Jun	116	105-139	16	10-21	18
Jul-Sep	117	96-141	15	8-27	30
Oct-Dec	119	94-139	15	9-30	16
Total	117	94-141	16	8-30	71
1981					
Jan-Mar	118	104-126	15	12-22	4
Apr-Jun	114	93-120	17	13-29	8
Jul-Sep	124	82-141	17	8-48	6
Oct-Dec	117	116-119	15	14-16	2
Total	118	82-141	16	8-48	20
1982					
Jan-Mar	104	88-120	24	14-36	3
Apr-Jun	113	94-123	18	13-30	8
Jul-Sep	120	113-132	14	10-16	12
Oct-Dec	120	113-131	14	10-17	9
Total	117	88-132	16	10-36	32
1983					
Jan-Mar	115	101-129	17	11-25	10
Apr-Jun	113	95-137	18	9-30	32
Jul-Sep	117	95-141	16	12-25	16
Oct-Dec					
Total					

[1] Calculated meat count for each sample was derived by calculating the average meat weight per scallop in each sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was obtained by applying the 1977-1981 USA Mid-Atlantic research survey sea scallop shell height-meat weight equation,

$$\ln \text{Meat Weight(g)} = -12.0356 + 3.2335 \ln \text{Shell Height(mm)}$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products and dividing by the total number of scallops in the sample (for 1978-1982 samples). For 1983 samples, the 1977-1982 USA Mid-Atlantic shell height-meat weight equation was used:

$$\ln \text{Meat Weight(g)} = -12.1628 + 3.2539 \ln \text{Shell Height(mm)}.$$

Table 8. Comparison of calculated and observed sea scallop meat counts (number of meats per pound) from samples collected and processed at sea during 11-20 July 1983 on a sea sampling trip aboard a commercial New Bedford sea scallop vessel fishing on Georges Bank.

Sample Number	Number of Scallop Shells Measured	Shell Height Range (mm)	Mean Shell Height (mm)	Calculated[1] Meat Count	Observed[2] Meat Count	Difference in Calculated and Observed Meat Counts
1	165	50-119	78	55	N/A[3]	N/A
2	219	55-114	79	56	86	30
3	195	80-154	126	12	17	5
4	123	75-154	124	13	17	4
5	118	85-144	118	15	N/A	N/A
6	85	90-149	127	12	N/A	N/A
7	139	75-169	109	18	N/A	N/A
8	155	80-154	122	13	16	3
9	254	85-144	119	15	15	0
10	168	70-134	104	22	23	1
11	219	70-154	107	21	23	2
12	203	80-139	107	21	27	6
13	184	70-144	106	21	30	9
14	287	75-144	101	25	N/A	N/A
15	204	85-134	104	23	25	2
16	174	85-144	110	19	N/A	N/A
17	146	80-144	107	21	23	2
18	304	75-139	106	22	24	2
19	267	75-129	101	25	26	1
20	309	75-134	104	23	24	1
21	229	85-159	124	13	12	1
22	258	80-149	113	17	17	0
23	256	75-144	109	19	24	5
24	368	80-139	111	19	15	4
25	358	85-154	114	17	18	1
26	256	85-154	122	14	13	1
27	270	75-149	110	19	20	1
28	368	85-144	110	19	19	0
Total	6,277					

A. 45% of samples had calculated meat counts within 1 count of observed values (10 of 22)

B. 68% of samples had calculated meat counts within 3 counts of observed values (15 of 22)

C. 86% of samples had calculated meat counts within 5 counts of observed values (19 of 22)

[1]Meat count for each shell sample was derived by calculating the average meat weight per scallop in the sample and dividing this value into 453.6 grams (1 pound). The average meat weight per scallop was obtained by applying the 1978-1982 USA Georges Bank research survey sea scallop shell height-meat weight equation.

$$\ln \text{Meat Weight(g)} = -11.7656 + 3.1693 \ln \text{Shell Height (mm)}$$

to each shell height in the sample frequency distribution, multiplying by the frequency at each height, summing the products, and dividing by the total number of scallops in the sample.

[2]Based on weighing, at sea, 2 one-pound samples of shucked scallop meats on a scale in the wheel house. Values listed are the average of the two sample counts.

[3]N/A - no weights were taken on scallop meats from this sample (i.e., not available).

Table 9. Possible mixing combinations of sea scallops of different meat counts under an average 30 meat count standard.

Meat Count	Meat Count			
	25	20	15	10
80	7/23	13/17	18/12	22/ 8
75	7/23	13/17	18/12	23/ 7
70	7/23	14/16	19/11	23/ 7
65	8/22	14/16	19/11	23/ 7
60	8/22	15/15	20/10	24/ 7
55	9/21	15/15	20/10	24/ 6
50	10/20	16/14	21/ 9	25/ 5
45	11/19	18/12	22/ 8	25/ 5
40	13/17	20/10	24/ 6	26/ 4
35	17/13	23/ 7	26/ 4	28/ 2

Table 10. Summary of sea scallop meat counts from landings samples taken by NMFS Enforcement Agents in New Bedford, Massachusetts, by month and area fished, 1982-1983.

Year	Month	Georges Bank			Mid-Atlantic			Gulf of Maine		
		Mean of Samples	Range of Sample Means	Number of Samples	Mean of Samples	Range of Sample Means	Number of Samples	Mean of Samples	Range of Sample Means	Number of Samples
1982										
	Jul	27	26-27	2	-	-	-	-	-	-
	Aug	27	27	1	-	-	-	-	-	-
	Sep	24	15-40	8	-	-	-	-	-	-
	Oct	30	27-38	3	-	-	-	-	-	-
	Nov	37	14-91	8	-	-	-	33	33	1
	Dec	31	24-41	6	-	-	-	-	-	-
1983										
	Jan	36	29-40	9	-	-	-	-	-	-
	Feb	32	18-38	24	28	23-33	3	24	20-32	3
	Mar	31	19-37	15	34	20-39	16	-	-	-
	Apr	32	26-35	15	34	28-39	5	-	-	-
	May	30	28-36	10	27	23-30	7	-	-	-
	Jun	24	14-31	15	27	25-29	2	-	-	-
	Jul	29	27-31	4	-	-	-	-	-	-
	Aug	23	15-31	4	27	27	1	-	-	-
	Sep	25	18-32	15	21	19-23	2	-	-	-
	Oct	25	23-28	3	27	27	1	29	29	1

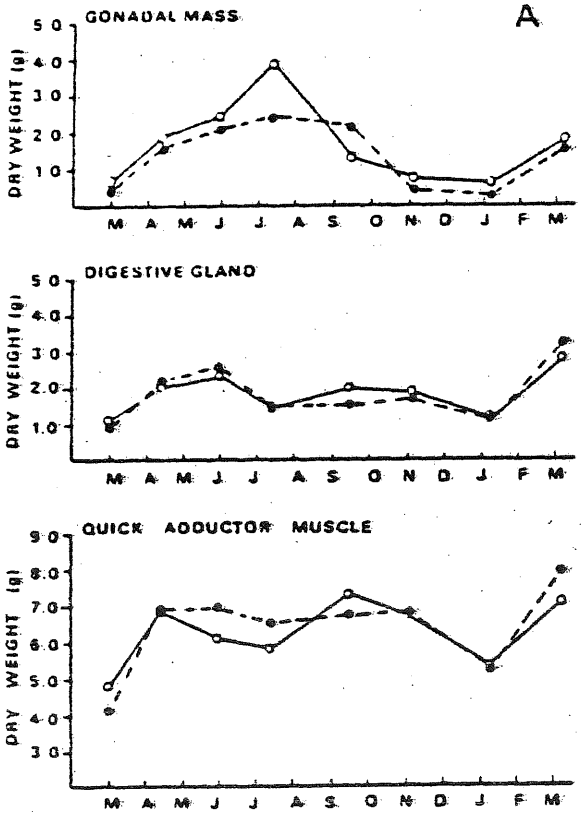

FIGURE 3. Standard deep-sea scallop (120 mm shell height) annual tissue dry weight fluctuations. ● = female; ○ = male.

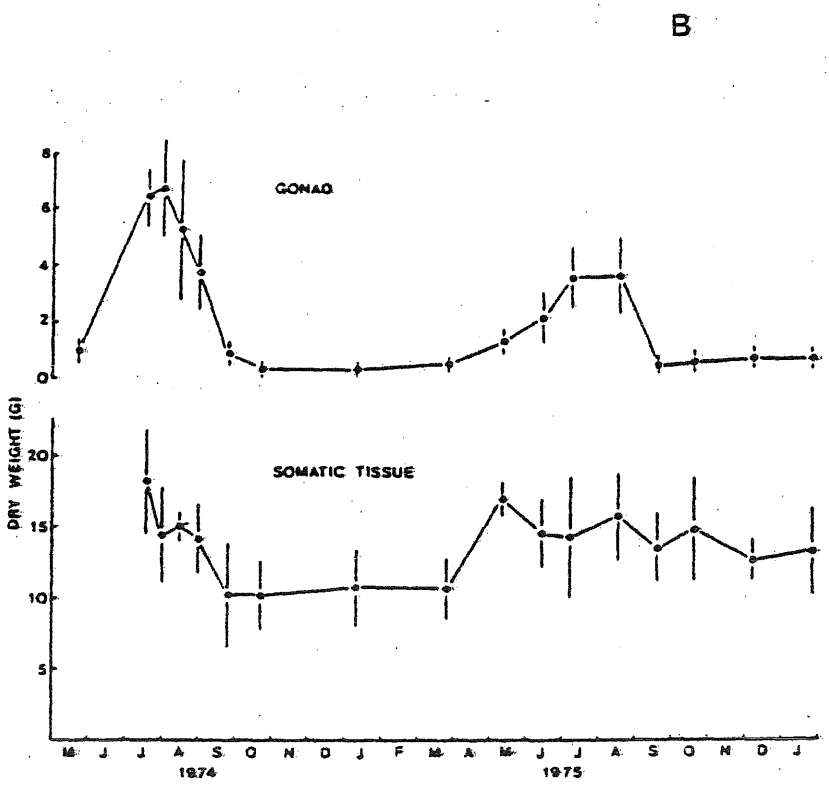

FIG. 1. Gonad and somatic tissue dry weights for North Harbour scallops. Means ± 95% confidence limits.

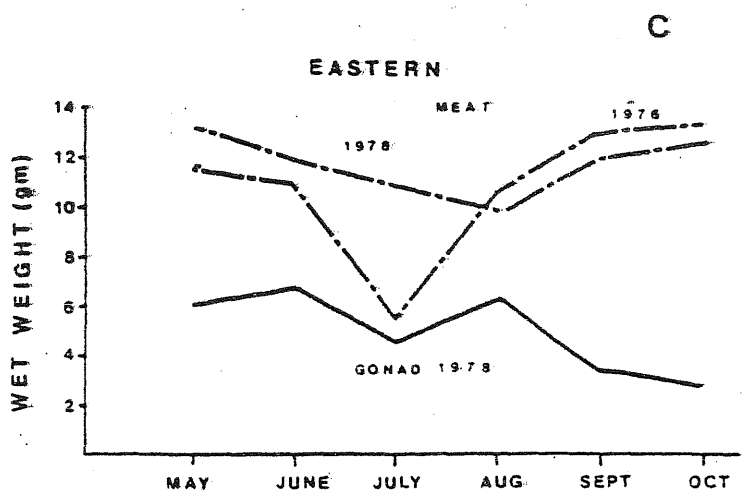

Figure 4. Seasonal fluctuations in meat (1976 and 1978) and gonad (1978) wet weights (g) for 90 mm scallops in the three regions of Northumberland Strait.

Figure 1. Seasonal changes in sea scallop meat (adductor muscle) weight:

(A) Gulf of Maine sea scallops (Robinson et al. 1981).
(B) Southeast Newfoundland sea scallops, 140-190 mm shell height (Thompson 1977).
(C) Northumberland Strait sea scallops (Jamieson 1979).

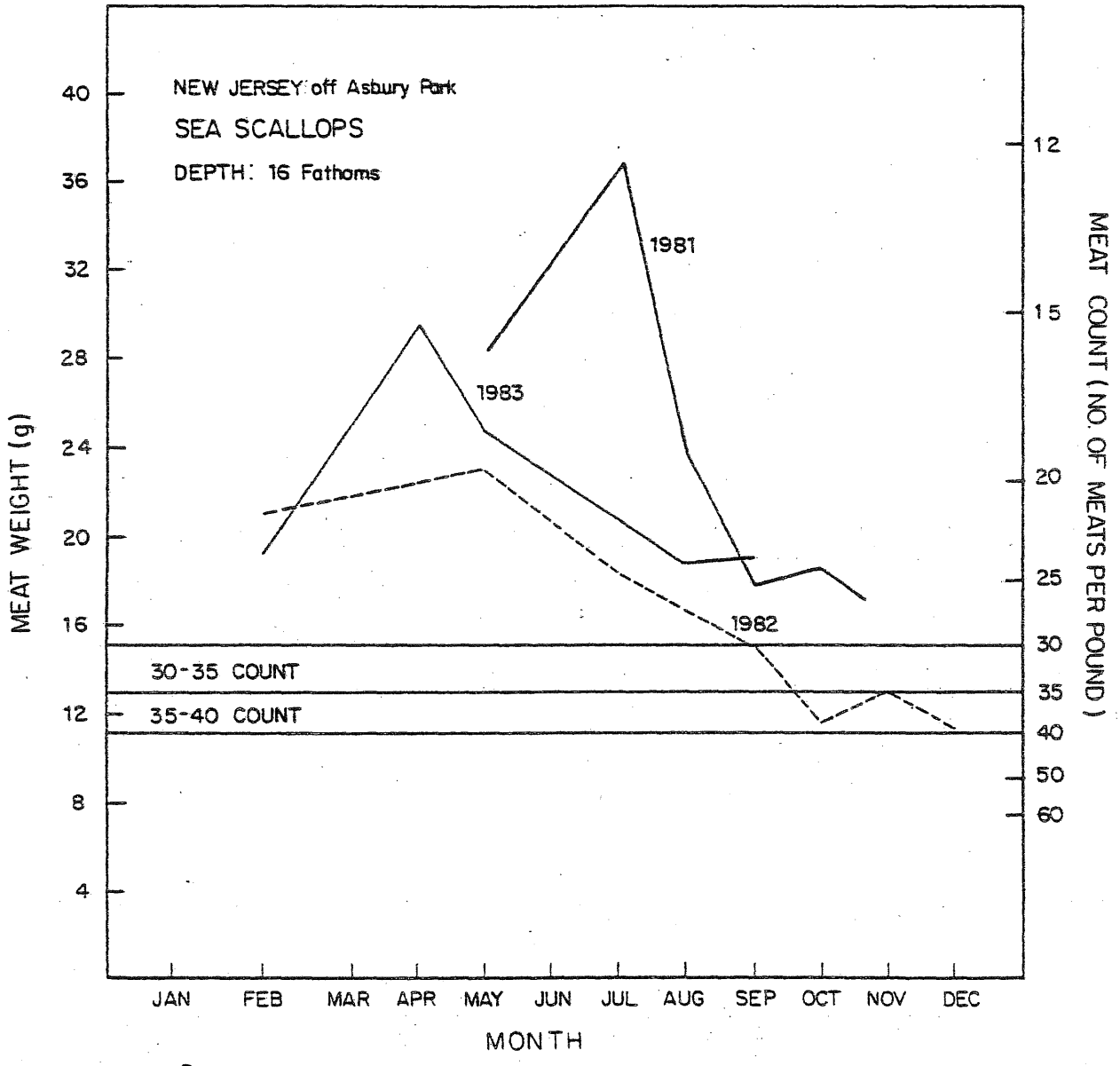

Figure 2. Seasonal changes in sea scallop meat (adductor muscle) weight and associated meat count for a population off Asbury Park, New Jersey (Mid-Atlantic), 1981-1983. Samples were obtained monthly, when possible, and consisted of approximately 10-12 individuals, ranging between 100-110 mm shell height. Data from Gould (1983) and Gould (pers. comm.).

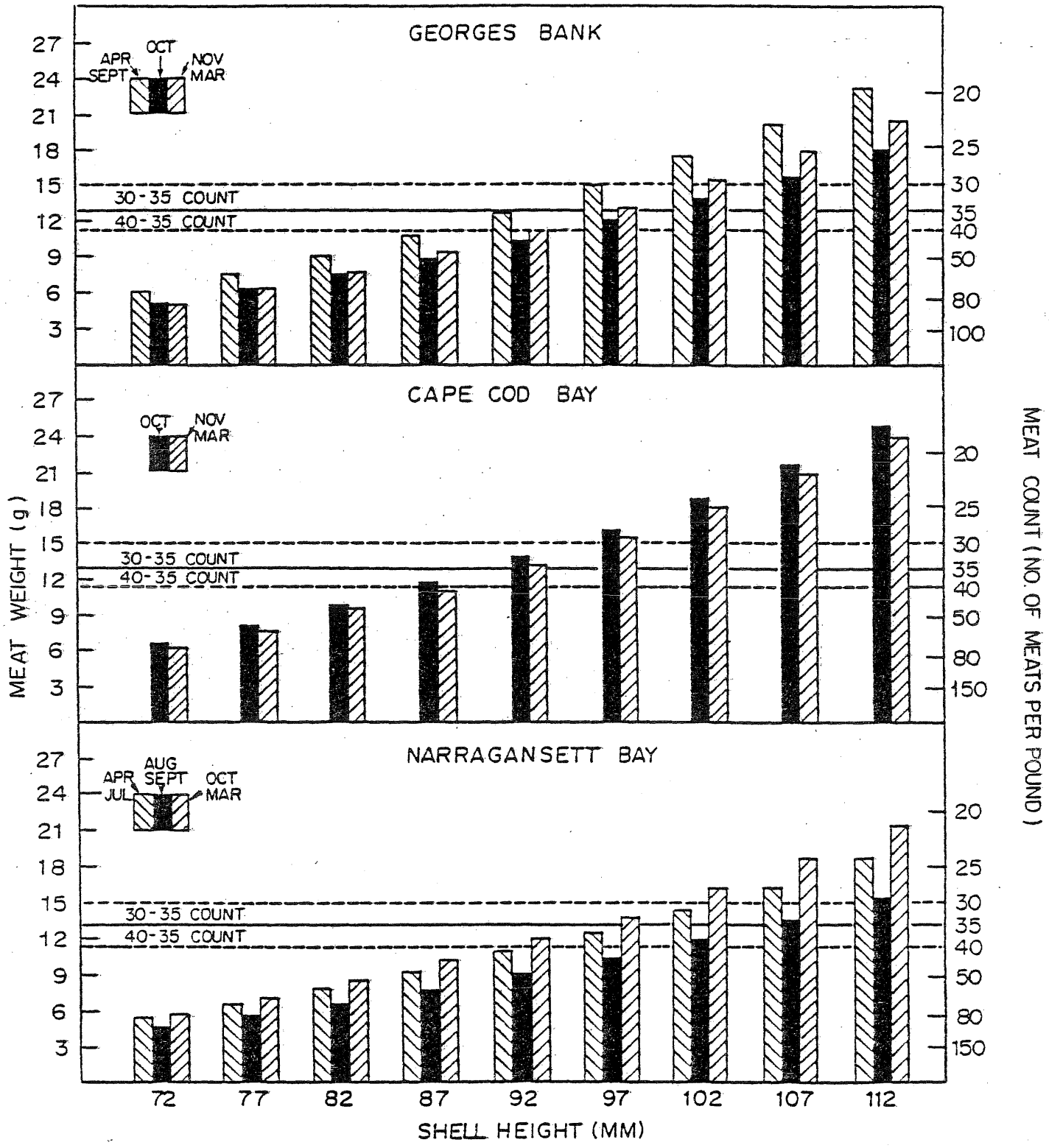

Figure 3. Comparison of calculated meat weight(g) and meat count (number of meats per pound) among seasons for 72-112 mm shell height sea scallops from Georges Bank, Cape Cod Bay, and Narragansett Bay. For Georges Bank and Cape Cod Bay, the seasonal shell height-meat weight equations given by Haynes (1966) were used to derive meat weight and associated meat count values. For Narragansett Bay, the seasonal equations given by Karlsson (1970) were utilized.