# SOME IMPLICATIONS OF YIELD PER RECRUIT MANAGEMENT FOR GEORGES BANK SCALLOPS

by

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## INTRODUCTION

Increases in yield per recruit that would occur from raising the age at entry into the fishery have been documented previously (Posgay 1962) and recently outlined for the Council by Russell (New England Regional Fishery Management Council - Preliminary Analysis of Landings Quotas as a Management Technique for the Mid-Atlantic Sea Scallops Fishery July 5, 1977). An increase in age from 3.5 years (76 mm; 65 meat weight per pound) to 6.5 years (130 mm; 14 meats per pound) would give an equilibrium yield gain at present fishing mortality rates of about 50%. However, in any adoption of such a management technique the initial effect depends on the extent of the difference between the new situation and the previous one and the current population structure. This discussion examines the estimated effect of yield per recruit regulations which might be established for 1978.

## METHODS AND ASSUMPTIONS

The length frequency distribution of the 1977 samples from the Georges Bank scallop fishery are given in Table 1 along with their probable age, based on a general growth curve (Table 2). It can be seen that the present fishery is based on a single year class which exists in considerably greater abundance then others available to the fishery.

To perform this analysis, the length frequency values were moved ahead one year to account for growth increments and the smaller sizes added in identical numbers as currently observed and the values normalized on a per mille basis. Few scallops are available below 90-95 mm (40-34 meats per pound). (Calculating from the pooled length-weight equation for Georges Bank provided by Haynes (1968) the mean weight of 90 mm and 95 mm scallops would be 11.3 gm (40 meats/lb) and 13.3 gm (34 meats/lb), respectively). Therefore, it is obvious that a size limit change of from 90-95 mm would have at present a non-measurable effect in terms of both short term loss and long term gain, unless fishermen were to shift their fishing effort to smaller sizes than currently being landed.

Making the following assumptions: current fishing mortality (F) is equal to 0.7 and natural mortality (M) equals 0.1 (Posgay 1976), the size composition of the catches remains the same, and fishermen return all scallops below a certain size to the sea with no additional mortality, the short term loss and long term gain can be calculated using Gulland's (1961) procedures. The equivalent meat weight per pound in this analysis is assumed to be at the estimated average in the size frequency interval just below the size limit, e.g. size limit 100 mm has equivalent regulations of 34 meats per pound (the estimated average for a shell length of 95 mm). This is because the estimated value from the equation is the average size which means that 50 percent of the individuals of that size have smaller weights. Calculations were performed for increasing the size from 95 mm to 100 mm (40 to 34 meats per pound), i.e., age at first capture from 4.4 to 4.7 years and also for increasing the size from 95 mm to 110 mm (40 to 25 meats/lb), i.e., age of first capture from 4.4 to 5.4 years.

## RESULTS AND DISCUSSIONS

The immediate loss from increasing the size limit from 95 to 100 mm is only 1% and the long term gain would be 0.3 percent as the difference at age at first

capture is only 0.3 years. If the size is increased to 110 mm (age at capture increased 1.0 years) the initial loss would be 51 percent with a long term gain of 8 percent beginning the following year. Of course, all of this depends on fishermen adhering to the size limit. Attempts to avoid violation of the meats per pound regulation by putting mixtures of large and small scallops in the same bag will abrogate any gains. Gains will also be reduced by any mortality of the discarded scallops.

While the increase yield and immediate loss calculated here is based on the current age structure, the actual amount of gain will depend on the size of future recruiting year classes and fishing mortality. If large year classes appear the greater the absolute gain in yield per recruit. The equilibrium gain point of increasing age from 4.4 to 5.4 years at age on entry would be about 17% (F = 0.7; M = 0.1).

It must be stressed that yield per recruit gains refer only to getting the maximum weight for a given number of recruits. High fishing mortality rates lower the numbers available for harvest and can significantly reduce the spawning stock size to the point at which the likelihood of good recruitment is reduced. Where this occurs, size regulations are self defeating, as obviously, for example actual yield of a 10 percent gain in yield per recruit is much greater when the population size is large than when it is small.

## LITERATURE CITED


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TABLE: 1

GEORGES BANK SCALLOPS
YIELD PRE-RECRUIT CALCULATIONS

| Shell length | Age[1] | No Sampled | Moved[2] ahead 1yr. | Per[3] Mille | $\bar{x}$wt (g) | OPTION 1 Nr[3] | OPTION 1 Nk[4] | OPTION 2 Nr | OPTION 2 Nk |
|---|---|---|---|---|---|---|---|---|---|
| 40 - 44.9 | 2 | 8 | (8) | 1 | | | | | |
| 45 - 49.9 | 2 | 3 | (3) | 1 | | | | | |
| 50 - 54.9 | 3 | 7 | (7) | 1 | | | | | |
| 55 - 59.9 | 3 | 9 | (9) | 2 | | | | | |
| 60 - 64.9 | 3 | 9 | (9) | 2 | | | | | |
| 65 - 69.9 | 3 | 19 | (19) | 3 | | | | | |
| 70 - 74.9 | 3 | 39 | 8 | 1 | | | | | |
| 75 - 79.9 | 3-4 | 103 | 3 | 1 | | | | | |
| 80 - 84.9 | 4 | 386 | 16 | 3 | 8.0 | | | | |
| 85 - 89.9 | 4 | 1188 | 9 | 2 | 9.5 | | | | |
| 90 - 94.9 | 4 | 1748 | 58 | 10 | 11.3 | | | | |
| 95 - 99.9 | 4-5 | 1364 | 103 | 17 | 13.3 | 17 | 0 | 17 | |
| 100 - 104.9 | 5 | 451 | 1574 | 266 | 15.5 | 0 | 266 | 266 | |
| 105 - 109.9 | 5-6 | 187 | 1748 | 295 | 17.9 | 0 | 295 | 295 | |
| 110 - 114.9 | 5-6 | 85 | 1365 | 231 | 20.5 | 0 | 231 | | 231 |
| 115 - 119.9 | 6 | 66 | 638 | 108 | 23.4 | 0 | 108 | | 108 |
| 120 - 124.9 | 6 | 50 | 85 | 14 | 26.5 | 0 | 14 | | 14 |
| 125 - 129.9 | 6 | 40 | 116 | 20 | 29.9 | 0 | 20 | | 20 |
| 130 - 134.9 | 7 | 37 | 40 | 7 | 33.5 | 0 | 7 | | 7 |
| 135 - 139.9 | 8 | 23 | 37 | 6 | 37.5 | 0 | 6 | | 6 |
| 140 - 144.9 | 9 | 27 | 50 | 8 | 41.7 | 0 | 8 | | 8 |
| 145 - 149.9 | 9 | 8 | 8 | 8 | 46.3 | 0 | 1 | | 1 |
| 150 - 154.9 | 9 | 2 | 2 | - | 51.1 | 0 | - | | - |
| 155 - 159.9 | 9 | 2 | 2 | - | 56.3 | 0 | - | | - |
| | | 5861 | 5916 | 1000 | | 956 | | 395 | |

[1]From Red book 1972, page 39 (>80 cm), smaller from applying

$$Lt = 146.4\ (1-e^{-.35(t-1.4)}) \qquad \text{\{Posgay, 1976\}}$$

L = Length in mm
t = Time in year

[2]From applying above Von Bertalanfy equation

40 meats/lbs → 95 ( = 11.34 g meat/scallop → l=90.0)
34 meats/lbs →100 ( = 13.34 g meat/scallop → l=95.1)

[3] Nr = Pre-Recruits

[4] Nk = Recruited sizes

TABLE 2 Shell length, age, meat weight and count per pound for Georges Bank Scallops.

| Shell Length (mm) | Approximate Age (years) | Average* Weight (gm) | No. of meats per pound |
|---|---|---|---|
| 80-84.9 | 4 | 8.0 | 56.7 |
| 85-89.9 | 4 | 9.5 | 47.2 |
| 90-94.9 | 4 | 11.3 | 40.2 |
| 95-99.9 | 5 | 13.3 | 34.1 |
| 100-104.9 | 5 | 15.5 | 29.4 |
| 105-109.9 | 5-6 | 17.9 | 25.5 |
| 110-114.9 | 5-6 | 20.5 | 22.1 |
| 115-119.9 | 6 | 23.4 | 19.5 |
| 120-124.9 | 6 | 26.5 | 17.2 |
| 125-129.9 | 6 | 29.9 | 15.2 |
| 130-134.9 | 7 | 33.5 | 13.6 |
| 135-139.9 | 8 | 37.5 | 12.1 |
| 140-144.9 | 9 | 41.7 | 10.9 |
| 145-149.9 | 9 | 46.3 | 9.8 |
| 150-154.9 | 9 | 51.1 | 8.9 |
| 155-159.9 | 9 | 56.3 | 8.1 |