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THE BIOLOGICAL/TECHNICAL IMPLICATIONS OF AN INCREASE IN MINIMUM TRAWL MESH SIZE FOR GROUNDFISH FISHERIES IN THE SCOTIA-FUNDY REGION

by:

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The Biological/Technical Implications of an Increase in Minimum Trawl Mesh Size for Groundfish Fisheries in the Scotia-Fundy Region

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PREFACE

This analysis was conducted in support of the work of an industry committee which was charged with proposing solutions to the overcapacity problem in the inshore sector of the Scotia-Fundy Region groundfish fleet. A number of staff of the Marine Fish Division of the Biological Sciences Branch participated in the initial project planning and prepared data in common formats for analysis for those stocks for which they had stock assessment responsibility. For these contributions we wish to thank C. Annand, S. Campana, P. Fanning, S. Gavaris, J. Hunt, R. O'Boyle, D. Wallace, and K. Zwanenburg. P. Fanning wrote a number of computer programmes which aided this data preparation. We are also grateful to D. Waldron who facilitated the conduct of the project in a variety of ways, M. Showell for supplying summaries of International Observer Programme data, and to C. Bourbonnais and C. Dale for technical assistance. We are particularly indebted to D. Clay, Biological Sciences Branch, Department of Fisheries and Oceans, Moncton, N.B., and to K. Zwanenburg, who provided scientific reviews of the report.

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Abstract

Halliday, R.G., and G.N. White, III. 1989. The biological/technical implications of an increase in minimum trawl mesh size for groundfish fisheries in the Scotia-Fundy Region. Can. Tech. Rep. Fish. Aquat. Sci. 1691: x + 153 p.

An increase in the regulated trawl mesh size for groundfish fisheries in the Scotia-Fundy Region was proposed by an industry committee as a measure which would mitigate the fleet over-capacity problem in the region. Thus, reduction in fleet efficiency resulting from increased mesh size, and hence increase in fleet capacity utilization, was seen as the primary benefit. Other benefits perceived were an increase in size of fish caught by trawlers and the possibility of increases in long-term yields. The implications of mesh size increases from the present regulation level of 130 mm to as large as 165 mm were examined, and the increased fishing effort required to take the same catches was calculated, for cod, haddock and pollock stocks. On average, increases to 140, 152 and 165 mm mesh would result in 10%, 40% and 100% more fishing effort being required to take the same catch in the year of implementation, but little reliance can be put on the estimate for 165 mm mesh nets. Long-term yields, based on yield-per-recruit calculations, are not greatly affected by mesh size increases over the range considered. Catches of small fish would, however, be reduced — particularly those of haddock. Input parameters were obtained from an analysis of published mesh selection data. Gear-specific partial recruitment patterns were calculated using weighted least-squares. This minimizes subjective data interpretation. A "scaling factor" for the proportionality coefficient between fishing mortality and fishing effort, necessary to take account of the effects of dome-shaped partial recruitment patterns, was introduced.

Résumé

Halliday, R.G., and G.N. White, III. 1989. The biological/technical implications of an increase in minimum trawl mesh size for groundfish fisheries in the Scotia-Fundy Region. Can. Tech. Rep. Fish. Aquat. Sci. 1691: x + 153 p.

Un comité formé de membres de l'industrie a proposé une augmentation de la taille de maille réglementée des chaluts de la peche du poisson de fond dans la région de Scotia-Fundy comme mesure permettant de lutter contre le probleme de la surcapacité de la flottille dans cette région. La réduction de l'efficacité, donc l'accroissement de l'utilization, de la flottille ainsi obtenue était considérée etre le principal avantage de cette mesure. On comptait, parmi les autres avantages, l'accroissement de la taille des poissons capturés au chalut et la possibilité d'accroitre les rendements a long terme. Les effets d'une augmentation de la taille de maille, de la valeur réglementaire actuelle de 130 mm a une valeur pouvant atteindre 165 mm, ont été examinés et l'on a calculé le nouvel effort de peche accru pour réaliser les memes captures du morue, d'aiglefin et de goberge. En moyenne, le fait de porter a 140, 152 et 165 mm la taille de maille supposerait d'accroitre l'effort de peche de 10, 40 et 100% au cours de l'année de mise en oeuvre pour obtenir les memes résultats, mais la derniere valeur estimée est peu fiable. Les rendements a long terme, calculés d'apres le rendement par recrue, ne sont pas fortement modifiés par l'augmentation de la taille de maille, dans la gamme étudiée. Il y aurait cependant réduction des prises des petits poissons — surtout de celles d'aiglefin. Les parametres d'entrée ont été tirés d'une analyse des données publiées sur le choix des mailles. Les modes de recrutement partiel par engin ont été calculés par moindres carrés pondérés et un "facteur d'échelle" a été utilizé afin de tenir compte des effets des allures de recrutement en forme d'ogive.

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Symbols

A - availability to the fishery

α - shape parameter of selection ogive

B_T - fishable population biomass to trawlers

C - catch numbers

C' - catchability

$C(a)$ - catch numbers at age ($C_T(a)$, $C_0(a)$ - by trawlers, other gears, respectively)

c - catch numbers at length (so $c(\ell)$ - at length (ℓ))

c_m - catch numbers at length with mesh (m) (so $c_m(\ell)$ - at length (ℓ))

F - instantaneous rate of fishing mortality

$F(s)$ - F during time interval (s)

F^* - fully-recruited F (F_T^*, F_0^* - for trawlers, other gears, respectively)

F_i - F by gear (i) (so F_T, F_0)

F_m - F for mesh size (m) (also $F_m(a)$ - F at age (a) for mesh size (m),
F_{m1} - F for new mesh size,
F_{m0} - F for present mesh size)

f - fishing effort by a standard vessel (f_T - by standard trawler)

k - scaling factor for the relationship between fishing mortality (F) and fishing effort (f), obtained by normalization of partial recruitment to a maximum of one

ℓ - fish length

ℓ_{50} - length at which 50% of fish are retained by a codend mesh size

M - instantaneous rate of natural mortality

m - mesh size

N - population numbers

N_o - population numbers at beginning of period (so $N_o(s)$ - beginning of period (s))

$\bar{N}$ - mean population numbers (so $\bar{N}(a)$ - at age (a),
$\bar{N}(s)$ - in time period (s))

PR - partial recruitment (see also R)

q - catchability coefficient

R - partial recruitment (so $R(a)$ - at age (a) [also $R_T(a)$, $R_0(a)$],
R_m - for mesh (m),
R_{m1} - for new mesh size,
R_{m0} - for present mesh size)

r - mesh selection range

SF - mesh selection factor

S - selectivity (so $S(\ell)$ - selection at length (ℓ))

S_m - selection at length with mesh (m) (so S_{130} - with 130 mm mesh)

s - time or age within a cohort

V - vulnerability

V_1 - vulnerability resulting from non-mesh selection effects

$w_i(a)$ - weight at age (a) in catches by gear (i)

Y - yield in weight (so Y_i - to gear (i), therefore Y_T, Y_0)

y - year

Y/R - yield-per-recruit

Introduction

Soon after extension of fisheries jurisdiction in 1977, there was a substantial investment in new vessels for the groundfish fishery in the Scotia-Fundy Region (Fig. 1). Harvesting capacity, particularly of the inshore fleet sector based in southwestern Nova Scotia, expanded rapidly as a result. It was clear by the early 1980s that fleet capacity had come to exceed resource availability, i.e., that its ability to exert fishing effort (generate fishing mortality) was greater than that required to fully exploit the available resource under the prevailing management strategy. Despite an increasingly complex and restrictive regulatory regime, exploitation rates consistently exceeded target levels (i.e., $F_{0.1}$), and industry resistance to Department of Fisheries and Oceans (DFO) regulatory measures escalated.

In early 1985, DFO senior management charged Scotia-Fundy Region with identifying the extent of over-capacity in the groundfish fleet in southwestern Nova Scotia and with developing options for addressing this problem in the long-term. A regional working group reported back in 1986 that licensed capacity of this fleet exceeded, by a factor of four, that required to exploit the resource at target levels (unpublished data). In recent years the utilized capacity had been, on average, twice that required (i.e., exploitation was at about twice the $F_{0.1}$ level for the major resources). A variety of solutions was proposed. The first measure attempted (a temporary suspension of some inactive licences) met strong industry resistance. As a result, the suspensions were lifted, but the Minister made this conditional on the industry itself coming up with solutions to the over-capacity problem. An Industry Groundfish Capacity Advisory Committee, composed of representatives of the regional inshore groundfish fishing industry, was established in June 1987 to take on this task. Technical support was provided by DFO.

The industry capacity committee decided to provide advice by October 1987 on measures to control fishing effort in the short-term and to formulate long-term solutions to control capacity in 1988. The short-term measures, intended to "buy time" for implementation of long-term solutions, were presented to the Atlantic Groundfish Advisory Committee (AGAC) at its meeting of 12-13 November 1987. One of the short-term recommendations was as follows:

> "Trawl mesh size should be increased to allow for utilization of more capacity while maintaining yields and increasing fish size in catches."

The present fleet capacity is, in substantial part, recently acquired, and fishermen are predisposed to favour regulatory measures which allow them to use it. An increase in mesh size, by forcing trawlers to fish harder on larger, older, fish to take the available yield, does this. Whether or not it is wise to take this approach can be judged only by weighing the costs against potential benefits. The industry recommendation anticipates that the primary benefits will be derived through an increase in size of fish in catches, and that there need be no costs in terms of loss in yields. Thus, the motivation for the current proposal differs from historical reasons for increasing mesh size. These have usually related to increasing long-term yield or reducing wastage at sea (through reduced discarding of small fish).

In the Scotia-Fundy Region, fishing for groundfish with an otter trawl that has a mesh size less than 130 mm (5 1/8 inches) is prohibited except when fishing is directed for redfish or for silver hake and argentine. There is also an exemption for vessels fishing a portion of St. Mary's Bay, where a 120 mm minimum mesh size applies. This exemption applies to a small number of vessels in a restricted area and can be ignored in the current analysis. Its basis is documented by Waldron et al. (1985). In the context of this regulation "otter trawl" encompasses not only bottom trawls but also midwater trawls, Danish and Scottish seines, and any like gear. Thus, of the fisheries which would be affected, those for haddock, cod and pollock are of greatest regional importance. Although there have been efforts to promote the use of square-mesh netting, conventional diamond-mesh netting continues to be used by the regional groundfish industry almost without exception. Current mesh size regulations apply irrespective of type of netting.

The present report gives results of analyses of the implications of an increase in mesh size for the regional groundfish fishery in terms of short-term capacity utilization, long-term yields, and fish sizes in the catch. These results provide a basis for evaluation of the industry committee's proposal in quantitative terms and, if a change is implemented, for deciding upon the particular size of mesh which best suits current objectives. Quantitative calculations were conducted for the major cod, haddock and pollock stocks in the Scotia-Fundy Region, for which mathematical models of population dynamics are available from CAFSAC assessments. For secondary species (flatfishes, white hake, cusk and wolffish), there are insufficient data to support such calculations. Whatever information was available for these species has been summarized. January 1988 has been adopted as the implementation date for an increase in mesh size in these calculations. Although implementation will be later, the date cannot be predicted. While the details of the calculations will be affected by implementation date, the overall conclusions will not be significantly affected. The range of mesh size likely to be of practical interest was assumed not to exceed 130-165 mm (5 1/8 - 6 1/2 inches). The calculations also assumed continued use of diamond-mesh netting.

The current DFO management strategy is to exploit resources at a fishing mortality (F) of $F_{0.1}$ in the long-term. An increase in mesh size causes the fishery to depend more on older age groups, with the result that the $F_{0.1}$ level of mortality increases, i.e., there is a redefinition of the target level of F. If a stock has had a recent history of being fished at the $F_{0.1}$ level, an increase in mesh size would allow it to be fished at the higher, revised level of $F_{0.1}$. Thus more fishing effort could be utilized. The present situation is more complicated than this, however, as F on regional gadoid resources needs to be halved to meet the current target F levels. Thus, in practical terms, a strategy is required which will use a mesh size increase to best advantage in regulating exploitation rate in the fishery down to the $F_{0.1}$ level (the absolute F level that this implies being dependent on mesh size), without causing unacceptable disruption in the fishery in the process.

This report examines the potential impact over a five year period of two alternative approaches to such a transition. These were thought to encompass the bounds of practicality. One involves an immediate reduction in exploitation rate to the new $F_{0.1}$ level when a new mesh size is introduced. The other involves maintaining constant catches at the levels in the 1988 Groundfish Management Plan. Given average recruitment, the latter strategy would, for most stocks, result in fishing mortalities tending towards the appropriate $F_{0.1}$ level over time. Strategies requiring increases in catches, at least in the short-term, were discounted, as it was thought likely that these would cause exploitation rate to increase over time.

Mesh Selection

Theory

The mesh size in trawl nets is a primary determinant of the size of fish which will be retained by the net, small fish being able to escape through the holes. The bigger the holes, the larger the fish which can escape. The "selection" of large fish by the mesh is not sharp (or knife-edged); an increasing proportion are retained with increasing size of fish until, at some size, all are retained. The shape of the curve describing trawl mesh selection by fish length is usually sigmoid, the proportion of fish retained at length rising to a maximum of 1.0. This curve is referred to as a selection ogive.

If the construction of fishing gear was the only factor influencing how "catchable" fish in a population were, all would be equally catchable by a gear which was non-selective with regard to fish size or other characteristics. Use of very small-mesh trawls would approximate this situation. By increasing mesh size in these trawls, an increasing proportion of small fish would escape through the meshes and hence become less "vulnerable" to the gear than larger fish. Thus, in this simple conception, catchability (C') of the fish is equal to their vulnerability (V) to the gear, vulnerability being a function of both mesh selection effects (S) and other aspects of gear construction and use (V_1), so that $V = V_1 x S$. Changes in V as a function only of S are considered here.

Real situations are usually more complicated. Fish of different size have different spatial distributions (geographically or vertically in the water column) which results in them having different "availability" (A) to the gear. Also, fisheries tend to concentrate on fish of medium size, as small ones are unmarketable and large ones often do not occur in dense enough concentrations for economic fishing. Indeed, many factors influence the behaviour of fishermen, and all changes in the way fishermen fish can be looked upon as having some effect on the relative availability of particular sections of the fish population. Thus, catchability is a function of both availability and vulnerability, i.e.,

$$C' = A \times V$$

In the usual fish stock assessment and yield projection procedures, catchability enters the calculations through the partial recruitment (PR) vector. The most catchable age group is arbitrarily assigned a PR of 1.0, and catchabilities at other ages are scaled to this value. Yield projections concern only calculations of yield at different fishing mortalities (F), usually assuming that PR will not change from its present pattern. The relationship of fishing mortality to fishing effort (f) is not usually addressed explicitly. However, the relationship between F and f is a function of catchability, usually referred to as the catchability coefficient, q, so that:

$$F = qf$$

where f is a measure of fishing effort, such as days or hours fished, by a standard vessel. Thus, q is the fraction of the population caught by a standard unit of fishing effort. If catchability does not change, then F varies proportionally with fishing effort.

A change in mesh size changes the vulnerability, and thus the catchability, of the size and age groups of fish which are within the selection spans[1] of the mesh sizes involved. Thus, for these size and age groups, the relationship between F and f is changed, and so too is this relationship for the population as a whole. For those age groups outside of the selection spans of the meshes involved, V is not changed. Thus, C' is not changed and F is proportional to f for these age groups.

In some fisheries, availability may decrease at older age groups. Thus, although fully vulnerable to the gear, catchability of these age groups is less than at some younger age. In other words, PR in these fisheries is dome-shaped (i.e., is highest for intermediate ages). When mesh size is increased in such a fishery, V is reduced for those age groups within the selection span of the new mesh size and, as a result, the product V x A may become less than 1.0 at all ages. To retain the conventional definition of PR for yield calculations, it is necessary to rescale the catchabilities at age for the new mesh size to 1.0 at the age(s) with the greatest catchability. Introduction of this scaling factor (k) does, however, change the relationship between F and f in calculations with this new PR. This becomes:

$$F = q/k \ f$$

1. Selection span is the range of lengths over which selection acts, i.e., between the lengths for which selection is between zero and 100%. Selection range is the range between 25% and 75% selection lengths.

When k is greater than 1.0, a greater effort, f, is required to produce a given fishing mortality, F. The present analysis is primarily concerned with evaluation of management strategies concerning f. Thus, accurate measurement of the scaling factor, k, is critically important. Clay (1979a) has dealt with this problem of dome-shaped PR in his analysis of the effects of mesh size change on yields of silver hake. He chose not to rescale PR to 1.0 but made compensatory adjustments in F.

One of the most important limitations of the analysis described here is that the changes in fishermen's behaviour, which will almost certainly occur in response to a change in mesh size, are not considered. It is commonly speculated that fishermen will redirect their fishing effort towards older age groups by changing fishing practices. In other words, there will be an increase in A of older ages (and a corresponding decrease in younger ages). In this case, the scaling factor, k, will tend to be an over-estimate and F/f will be under-estimated. It can also be argued that an increase in mesh size might increase gear efficiency (i.e., that A for all ages would increase); a number of mesh selection experiments have given results suggesting that this might be so. Whether this would have any significance over the range of mesh sizes discussed here is not known. Neither of these criticisms can be addressed quantitatively. In stock assessments, the first criticism is sometimes addressed by assuming a flat-topped PR for yield-per-recruit (Y/R) and catch projection calculations. This procedure is not followed here. Qualitatively, the bias these factors could produce would result in overestimation of the f required to take specified catches at a larger mesh size. In other words, the effectiveness of a mesh size increase as a way to utilize excess fishing capacity would be less than calculated. A more serious danger would arise, in practical application of these results, from biases which caused under-estimation of effectiveness of a mesh size increase. In this circumstance, the ability of the fleet to catch fish could inadvertently be reduced to an unacceptable level. It is a reassurance, then, that the biases which might be expected are towards over-estimation of impacts.

Selection Data

Most of the information on trawl mesh selection was collected during active research programmes on gear selectivity conducted in the 1950s and 1960s. Much of the Northwest Atlantic data are summarized by the International Commission for Northwest Atlantic Fisheries (ICNAF, 1963) and that for the North Atlantic area as a whole by Holden (1971). More recently Clay (1979b), in reporting some new Canadian data, provided generalized relationships of retention lengths in relation to mesh size for as many species as adequacy of historical data would allow. Recent USA selectivity experiments were reported by Smolowitz (1983) and Icelandic experiments by Thorsteinsson (1980). While cod and haddock are among the species for which most data are available, data for pollock are very scarce. Not only is the number of reported experiments for pollock few (Clay, 1979b; Hylen, 1968; Smolowitz, 1983), the data collected during these experiments were scanty. Selection data for Northwest Atlantic flatfish species are also scarce.

Mesh selection data are most commonly expressed as a selection factor (SF) for a particular species, calculated as:

$$SF = \frac{\text{Length at which 50\% are retained in codend (i.e., } \ell_{50})}{\text{Average mesh size of codend}}$$

and a selection range (r). The selection ogive describes the relationship between the probability of retention of a fish by a particular mesh size and its length. Selection at length, $S(\ell)$, can be calculated from the equation:

$$S(\ell) = 1/(1 + \exp(\alpha [1 - \ell/\ell_{50}]))$$

where α is a parameter defining the shape of the ogive. The α parameter can be estimated using the formula:

$$\alpha = 2 \ln(3) \ell_{50}/r$$

Selectivity of a trawl is influenced by a variety of factors in addition to mesh size and, as a result, there is substantial variability in selection factors calculated from different experiments (Table 1). Clay (1979b) summarized all cod and haddock selection data provided by Holden (1971) by fitting regressions of the form:

$$\ell_{50} = a + (b \times \text{mesh size})$$

and his equations (Table 1) were used for these species. For the range of mesh sizes relevant to this study (130-165 mm) these equations gave selection factors of 3.68-3.82 for cod and 3.41-3.46 for haddock. Observations of selection at mesh sizes above 140 mm are scant for both cod and haddock, however. Thus the subsequent calculations conducted use ℓ_{50} values which in part lie outside the range of reliable observational data. For pollock, selection factors of 3.26 and 3.33 (Smolowitz, 1983) and 3.79 (Hylen, 1968) were obtained for mesh sizes in the range 136-138 mm (Table 1). Ignoring Clay's (1979b) value which was for a much smaller mesh size, these data give a mean SF = 3.5, not greatly different from comparable values obtained for cod and haddock, and this value was used.

Historically, little attention has been paid to selection range data and, in particular, the variation of selection range with other factors such as mesh size. Holden (1971) did provide a list of most of the selection range data which have been collected for cod and haddock. When the range is considered as a function of mesh size (Figs. 2 and 3), a positive relationship is evident. The shape parameter, α, calculated from these data using the equation given above, does not appear to be related to mesh size, however (Figs. 2 and 3). Average values of α were 11.6 for cod (number of observations, n = 96) and 11.5 for haddock (n = 106). For pollock, Hylen's (1968) data gave α = 12.9, but his data for cod and haddock gave values of α of 12.0 and 14.3 respectively. Thus, α for pollock cannot be considered as being different from that for cod and haddock based on Hylen's data. In any case, the selection ogives given by α = 11 and α = 13 are similar (Fig. 4). Thus, the value α = 12 was adopted for all three species.

The selection range data of Holden (1971) for cod have also been analysed by Clay (1979c) with rather different results. Clay determined the GM regression between r and m. The predicted r from Clay's regression for the range of m considered here varies from 1.35 to 2.00 times that predicted from α = 12, i.e., Clay's results give α = 9 to α = 6 for mesh sizes of 130 mm to 165 mm. This divergence indicates the scope for different interpretations provided by the variance of the data.

The scant data for flatfish (Table 2) indicate that the selection factor is 2.3 for American plaice and yellowtail flounder. That for witch flounder is 2.15 if the high value from Clay's (1979b) 60 mm experiment is excluded on the basis that the author considers it unreliable, and is 2.45 if this value is included. The values of the selection factors, and their similarity among species, are in conformity with Clay's (1979b) contention that a single relationship between mesh size and retention length for all North Atlantic flatfish, i.e., including Northeastern Atlantic species, provides an adequate basis for analysing the potential effects of mesh regulations on these species. Thus Clay's flatfish equation (Table 2) was accepted for use here.

The selection range data for American plaice and yellowtail flounder (Table 2) give mean values of the shape parameter of $\alpha = 12$ and $\alpha = 13$ respectively. Thus $\alpha = 12$ was used for flatfish as well as for the gadoids. For witch flounder the only data on which to judge the validity of the assumption of $\alpha = 12$ is that of Templeman (1963). Values of $\alpha = 5$, 10 and 11 can be estimated for his three experiments based on his Figure 7. These are sufficiently close to $\alpha = 12$ to justify use of that value for present purposes.

Clay et al. (1984) derive an equation describing the relationship between mesh size and selection range for American plaice, based on the data in Holden (1971), which implies that α for this species is approximately 18. It appears, however, that this relationship is based on data for European and American plaice combined (as is the "American plaice" relationship between mesh size and ℓ_{50} in Clay (1979b)). While SF for the two species is the same, and hence the relationship between m and ℓ_{50} is not greatly affected by data combination, their relationships between m and r are different. For European plaice, $\alpha = 26$, double that for American plaice, i.e., the selection ogive is much steeper. There are sufficient data in Holden (1971) to test the assumption that α is constant for European plaice, as already demonstrated for cod and haddock (Figs. 2 and 3). The correlation coefficient, $R = 0.365$ (19 observations), between α and m for European plaice is not significant. Furthermore, there are three observations for m >100 mm and these have α values of 17, 19 and 26. The 6 observations of r in Table 2 for American plaice for m = 99-131 give values of 10-14 for α. Thus, while most of the experiments for European plaice were conducted with smaller mesh sizes than were those for American plaice, they give a clear indication that α for the two species is different.

The percentage selection at length for each mesh size for each species, as used in subsequent calculations, is shown in Table 3.

Mesh Size Data

The International Observer Programme (IOP) currently provides the only routinely collected data on mesh sizes in use by the Scotia-Fundy groundfish fleet. The IOP data are from the large trawler (greater than 100') fleet only. Observed vessels (which took 10-15% of the catch by this fleet sector in 1984-86) are prevented by the observer from using undersized gear which possibly introduces some bias among sampled vessels in relation to the overall population being sampled. Mesh sizes recorded are "nominal"; although roughly checked using a ruler, they are not measured using an approved guage. Thus, the IOP programme provides a rough estimate of mesh size in use by the large trawler fleet, but there are no data concerning the inshore fleet (less than 100').

The mean observed mesh size (mm) in use by year is as follows:

	Year									
	79	80	81	82	83	84	85	86	87	88
Mesh	123	123	127	131	135	136	136	136	141	141

The regulatory mesh size increase to 130 mm implemented about 1982, as described in Calculation Methods below, is reflected in these data, mean mesh size in use increasing from about 125 mm in 1979-81 to about 135 mm in 1983-86. These data indicate that mesh size in use in 1984-86 was close to the regulated minimum size of 130 mm. It can only be assumed that unsampled vessels were also using meshes of approximately the minimum regulatory size.

Calculation Methods

Four specific questions were examined in relation to the stocks of cod in Div. 4VsW, Div. 4X, and Div. 5Z; haddock in Div. 4VW, Div. 4X, and Div. 5Z; and pollock in Div. 4VWX and Subarea 5 (Fig. 1):

1. Assuming that the catch in the 1988 management plan will be taken, how much additional fishing effort can be utilized by increasing mesh size on 1 January 1988?

2. Given that the 1988 allocations produce fishing mortalities in excess of $F_{0.1}$, how do effort levels, catches and fishing mortalities vary in subsequent years under strategies of a) maintaining catch allocations at 1988 levels and b) fishing at $F_{0.1}$?

3. What are the long term $F_{0.1}$ yields associated with each mesh size?

4. What are the expected size compositions of the catch for each mesh size?

The analysis required to provide answers to these questions was organized into the following stages:

1. Consistency checks on the input data.

2. Estimation of input parameters: size and age compositions, partial recruitments, the scaling factor (k) for the relation between F and effort, and weights-at-age corresponding to each mesh size. An answer to the fourth question is obtained as an adjunct to these calculations.

3. Yield-per-recruit calculations. These provide answers to the third question.

4. Catch projections: a) recalculation of catch projections for 1988 to provide the answer to the first question, and b) long term projections at constant catch and at $F_{0.1}$ to determine the answer to the second question.

Consistency Checks

A number of checks were made to help ensure that no errors were made in processing the input data. These included tests for the consistency of:

1. Trawl length frequencies.

2. Partial F's for the "other gears" for the various mesh sizes.

3. Catch weight calculated from the product of numbers and mean weight-at-age.

4. Partial recruitment patterns used in the assessments and those used in this study.

Input Parameters

The most recent assessments of the current status of these stocks (those conducted in 1987) were accepted as the basis for this analysis. The most recent complete year of fishing data included in these stock assessments is 1986. Data for the three years 1984-86 were chosen to characterize current stock and fishery conditions. Trawl mesh size regulations were most recently changed about the beginning of 1982 when the elimination of differentials based on materials effectively produced an approximate 10% increase in the required mesh size. As 1982, and perhaps 1983, were years in which the fleet was adjusting fishing patterns in response to this change, years prior to 1984 were omitted from the analysis. Thus, the estimated size and age compositions of catches in 1984-86 were assumed to represent the compositions typical for 130 mm mesh nets. In actuality, stock assessments are based on estimates of size and age composition of landings, not catches. Discards (by weight) from large trawlers observed through the IOP in 1984-86 were about 1% for pollock, 2% for cod, and 5.5% for haddock. These estimates include discards for reasons other than the capture of small, unmarketable fish, e.g., fish dumped because of trip limit or by-catch limit over-runs. No observations are available for inshore trawlers. Available data are in conformity with the view based on anecdotal information from the fishery that use of 130 mm mesh does not usually result in capture of significant quantities of small, unmarketable fish of these species. Thus, size and age compositions of landings should closely approximate those of catches.

Three mesh sizes greater than 130 mm - 140 mm (5½ inches), 152 mm (6 inches), and 165 mm (6½ inches) - were chosen arbitrarily to provide point estimates over the range of mesh sizes of potential interest. Results for intermediate mesh sizes can be obtained by interpolation.

It was assumed that a mesh size change would apply to all gears included under the present regulations. Thus all trawlers and seiners were treated where possible as one category, the one directly affected by changes in mesh size, and all vessels using other gears as a second category, affected only indirectly. For convenience, the affected group is referred to below always as trawlers, consistent with the regulatory definition, even though seiners are included. In the cases of Div. 4VsW cod and Div. 4VW haddock, seiners have been grouped with longliners in recent stock assessments and it was not possible to include them with trawlers for this analysis. These catches by seiners were small and the overall conclusions of the analysis are not affected.

Size Compositions - The calculations were predicated on the assumption that fishing patterns will not change in response to a change in mesh size. From this it follows that the effects of the change in mesh on assessment parameters could be estimated from historical data by determining the effects of mesh selection on catch composition. In a fishery consisting exclusively of trawlers the composition (numbers-at-length) of the catch after a change in mesh selection is given by:

$$c_m(\ell) = c(\ell) \times (S_m/S_{130})$$

where S_m is the selection-at-length for mesh size m, $c(\ell)$ is the original numbers-at-length in the catch using a mesh with selection-at-length S_{130}, and $c_m(\ell)$ is the numbers-at-length that would result from fishing in the same way and at the same level of fishing effort but using the new mesh. In cases where there were significant catches by other gears, size compositions were calculated separately for trawls and other gears, and the adjustment for the change in mesh selection was applied to the trawl component only.

In answering question 4, size compositions calculated for trawlers for each mesh size for the years 1984, 1985 and 1986 were taken as the expected size compositions for that mesh size. Catch compositions of the other gears were also taken as the values in these years. These provided estimates of the immediate effect of mesh size change on the size compositions of catches. Given the many factors which will affect long-term catch compositions - recruitment variations, fishing mortality levels, growth rate changes, fishing pattern changes - calculation of theoretical long-term size compositions was not justified.

Age Compositions - The catches-at-length derived for trawlers at each new mesh size were converted to catches-at-age using the appropriate age-length keys following the usual practices in stock assessments. A comparison of the new catches-at-age of trawlers with population numbers-at-age (from assessments) provided an estimate of the new partial recruitment to trawl gear implied by the change in mesh size. Where other gears took significant catches, the overall fishery PR was taken as the weighted mean of the PR's for trawl and other gears (see below).

The new catches-at-age calculated for larger mesh sizes corresponded to what would have been caught using the level of fishing effort actually applied in 1984-86. In the present context, fishing effort of trawlers is to be allowed to increase. In most instances, the controlling factor in this increase is the catch tonnage allocation. As allocations usually reflect historical catch shares, an appropriate weighting of trawl and other gear catches in the determination of Fs and PRs was one which provided the historical ratio of catch allocations. Thus, for use in some subsequent calculations, trawler catch numbers in each year were adjusted upwards to give the same catch weight for this component of the fishery.

It is conceivable that catches-at-age adjusted in this way could exceed population numbers-at-age. Clearly, the historical ratio of catch allocations could not provide a satisfactory basis for weighting between gears in these cases, and other bases for prognosis would be required. For the data sets examined in this study, the problem occurred only for older ages in the haddock stocks, but were not so severe as to require a change in the basis for adjusting catches-at-age.

Mean Weights-at-Age - Weights-at-age in the trawler catches were derived at the stage of the calculations at which age-length keys were applied to the catches at length to obtain catches-at-age for each mesh size, as in stock assessment calculations. These were combined to derive fishery weights-at-age in the same way as for the catches-at-age.

Fishing Mortalities - The overall fishing mortality-at-age in each year, 1984-86, was obtained using the beginning of year population numbers from the most recent assessment and the catches corresponding to each mesh size. Fishing mortalities were given by an approximate solution to Baranov's catch equation:

$$C(s) = N(s)F(s)[1-\exp(-M-F(s))]/(M+F(s))$$

$$= \bar{N}(s)F(s)$$

where s is time or age along a cohort, $C(s)$ is the catch for the interval [s,s+1], $N(s)$ is the size of the population (beginning of year numbers) at time s, $\bar{N}(s)$ is the mean population, M is the (assumed constant) instantaneous rate of natural mortality, and $F(s)$ is the average instantaneous rate of fishing mortality for the interval [s,s+1]. In particular, given any pair of [C(s), N(s), F(s)] the remaining value can be determined. In the case where C(s) and N(s) are known, an iterative calculation is required to determine F(s). In order to minimize the calculation effort, a simple approximation was used. To obtain an approximate solution formula, recall the cohort formula for numbers in terms of catch:

$$N(s) = N(s+1)\exp(M) + C(s)\exp(0.5M)$$

and the definition:

$$F(s) = \ln(N(s)/N(s+1)) - M$$

These can be combined to yield the desired approximation:

$$F(s) = \ln(N(s)/[N(s)\exp(-M) - C(s)\exp(-0.5M)]) - M$$

The accuracy of this approximation is shown in the following table:

F	
input	approx.
0.100	0.100
0.200	0.201
0.300	0.302
0.400	0.404
0.500	0.507
0.600	0.610

for M=0.2 and N(s)=50,000. Thus the approximate formula is adequate for most practical purposes. Indeed, if the seasonal pattern of catches is such that most of the catch is taken near the middle of the year, this approximation is more realistic than Baranov's equation.

The new fishing mortalities were calculated independently for each of the three years. The results of these hypothetical "experiments" were treated as three independent replicates.

Partial Recruitment and Scaling Factor - It was necessary to determine individual historical partial recruitment patterns (before introduction of a mesh change) for the two gear types (trawls and others). These are not usually provided in the stock assessments, in which only the overall fishery partial recruitment pattern is of interest. It is usually assumed that fishing mortality patterns, particularly those associated with a single gear, can be described by a separable model; that is, the pattern of fishing mortalities over time and age is the product of a year effect (a fishing mortality) and an age effect (a recruitment pattern). In the present analysis, estimates of the average partial recruitment patterns for each gear were obtained from a separable model for the partial fishing mortality produced by that gear. The form of the model is given by:

$$F(a,y) = F^*(y)R(a)$$

where F(a,y) is the partial fishing mortality by age, a, and year, y. The parameters of the model are F*(y), the "fully-recruited" fishing mortality in each year, and R(a), the average partial recruitment pattern. Values of the parameters were estimated using weighted linear regression on the log scale. No attempt was made to correct for bias on retransformation to the linear scale. Residual weights were given by the catch numbers at age. This weighting was chosen to give a zero weight to cases where the catch was estimated to be zero, and to give a low weight to cases where catch was small. Listings of the APL programmes used for these calculations are provided in Appendix 2.

Each parameter in this model represented, on average, less than three observations. In order to reduce the number of parameters, a two-stage procedure was adopted. Based on a preliminary fit using one parameter for each age, a range of fully-recruited ages was determined. Then a second fit was obtained with the fully-recruited ages pooled. The resulting partial recruitment pattern represented an average for the three years. Because only three years could be included in the average, the resulting partial recruitment patterns showed considerable irregularity. No effort was made to smooth the patterns, as this would have introduced another element of subjectivity.

In some cases, partial recruitment patterns for the trawl component were dome-shaped. Most assessments assume a flat-topped partial recruitment pattern. This occurs because catches of older fish are often dominated by catches in other gears, and there is a consequent "flattening-out" of the PR pattern for the fishery as a whole. For the ages which were considered fully-recruited to the other gears, the assessment fishing mortalities used in the analysis were largely determined by the input assumption of a flat-topped partial recruitment pattern for the overall fishery. As a result, little reliance can be place on these mortality estimates. This should, however, cause little difficulty in calculations relating to the overall characteristics of the fishery, as it affected only a small part of the overall population and catches.

For mesh sizes other than 130 mm, the scaling factor (k) and average partial recruitment patterns were estimated using the formula:

$$R_{m_1}(a) = (1/k)\ [S_{m_1}(a)/S_{m_0}(a)]\ R_{m_0}(a)$$

where k is the scaling factor used to maintain the proportionality between F and effort under the change in mesh, $S_m(a)$ is the selection-at-age for mesh size m, $R_m(a)$ is the partial recruitment pattern over age, and subscripts 1 and 0 indicate new and old mesh size respectively. It should be noted that, provided the ratios of selection-at-age approach one at older ages, k will be unity when R_m is asymptotic. For dome-shaped partial recruitments, however, k must be chosen so that the new partial recruitment achieves a maximum value of one.

The estimation proceeded in two stages. First, the average ratio of selection patterns for the period 1984-86 was estimated from the formula:

$$\frac{S_{m_1}(a)}{S_{m_0}(a)} = \frac{F^*_{m_0} \; F_{m_1}(a)}{F^*_{m_1} \; F_{m_0}(a)}$$

This calculation was performed using the same separable model as was used to generate the partial recruitment pattern for 130 mm mesh. The residual weights were taken to be the catch corresponding to the new mesh size. This model generates flat-topped patterns for the selection ratio at age. As in the calculation of partial recruitments, a two stage procedure was used to determine the range of ages for which the ratio was taken to be unity. As the mesh size increases, the number of ages for which the ratio can be considered to be one (i.e., fully-selected by the larger mesh) is reduced. Thus the estimates became increasingly dependent on ages which were poorly represented in the trawl catches.

The final partial recruitment pattern for the new mesh and the associated scaling factor, k, were obtained by normalizing the product of the selection-at-age ratios with the partial recruitment for 130 mm mesh.

Yield-Per-Recruit Calculations

Yield-per-recruit analyses were conducted using the three-year average partial recruitments and weights-at-age for both gears and each of the mesh sizes considered. The results were used to obtain estimates of the long-term yield and yield-per-unit-effort.

It should be noted that the calculations used here were intended to reflect the effects of a change in mesh, and thus should not be compared with yield-per-recruit calculations presented elsewhere. In particular, the use of non-smoothed partial recruitment patterns tends to over-estimate fully-recruited fishing mortalities, although the actual mortalities experienced by the population (i.e., the product of the fully-recruited F and the partial recruitment) are the same.

Reference Fishing Mortalities - Estimation of reference levels of fishing mortality such as $F_{0.1}$ and F_{max} require an average partial recruitment pattern and weights-at-age for the population as a whole. An overall partial recruitment pattern for the fishery was obtained by weighting trawl and other gears' partial recruitments according to the average fully-recruited fishing mortalities for 1984-86, using the formula:

$$R(a) = [F_T^* R_T(a) + F_O^* R_O(a)]/F^* \qquad (1)$$

where F_T^* and F_O^* are the average 1984-86 fully-recruited fishing mortalities for the trawl and other gears respectively, and the partial recruitments are those discussed above. This calculation assumes that future effort levels will be similar to those generated for each of the mesh sizes in the 1984-86 period.

Estimates for $F_{0.1}$ and F_{max} were obtained in the usual way. It is important to note that values of $F_{0.1}$ used for CAFSAC projections are based on long term historical average values. The value calculated using data for any given year will vary around this average. In order to provide a consistent reference point in the present analysis, $F_{0.1}$ values for the regulated mesh size of 130 mm were used.

Associated Yields - Formula (1) also determines the contributions of each gear to the overall fishery fully-recruited F. Thus the yield to each component can be determined using the formula:

$$Y_i = \sum_a w_i(a)\bar{N}(a)F_i$$

where Y_i is the yield obtained by the i-th gear category, $w_i(a)$ is the weight-at-age for catches by the i-th gear, and $\bar{N}(a)$ is the mean numbers in the population.

Estimates of the long-term yield for each mesh size were obtained from the product of the yield-per-recruit and long-term geometric mean recruitment.

Fishing Mortality and Effort - Fully-recruited fishing mortalities should not be used to compare across mesh sizes in the case of a dome-shaped partial recruitment pattern, as they do not reflect the effect of changes in the distribution of fishing mortalities over ages. For purposes of comparison, average F's including the ages which are important in the fishery (for example, calculated from age 6+/5+ numbers) provide a clearer indication of the effect on the population.

The effort required from each gear component was obtained from the relation between F and effort:

$$f = k/qF^*$$

For purposes of comparison, the ratio of yield to effort was calculated from the formula:

$$Y/f = (q/k)\ Y/F^*$$

where k is the scaling factor discussed above and q is chosen so that the yield-per-unit-effort is one at $F_{0.1}$ and a mesh size of 130 mm.

Catch Projections

The assessments for each stock provide estimates of the population at the beginning of 1988. The projections for 1988 were recalculated using the allocations for the trawl and other gears defined in the 1988 Groundfish Management Plan. The allocations were used to determine the fishing mortality exerted by each component.

Fishing Mortalities - The Baranov catch equation can be extended to situations in which the catch is given in terms of gear components:

$$C(a) = C_T(a) + C_O(a)$$

$$= \overline{N}(a)\ [R_T(a)F_T + R_O(a)F_O]$$

where C_i is the catch-at-age for the i-th gear component and $\overline{N}(a)$ is the mean population. The second equality is a consequence of the relationships:

$$C_T(a) = \overline{N}(a)R_T(a)F_T$$

$$C_O(a) = \overline{N}(a)R_O(a)F_O$$

These formulae provide the basis for the usual definitions of fishable biomass, B_T, and the yield, Y_T, to the trawl component:

$$B_T = \sum_a w(a)\overline{N}(a)R_T(a)$$

$$Y_T = F_T^* \sum_a w(a)\overline{N}(a)R_T(a)$$

where w is the weight-at-age. Given the allocations to the two gear components, an iterative procedure was used to determine the corresponding fishing mortalities which would be required to produce these yields.

Effort - Fishable biomass and yield to a gear component are related by the fully-recruited fishing mortality. Using the proportionality between F and effort, it follows that

$$f_T = (k/q)F_T = (k/q)\ (Y_T/B_T)$$

where q is taken as 1.0. This formula was used to obtain estimates for the effort that would be required to harvest the 1988 allocations. It should again be noted that, depending on the age structure of the population, there is a theoretical possibility that the fishable biomass for the trawl component might be less than the allocation. In this case it would not be possible to solve the equation relating fishing mortality to yield for the trawl component.

Recruitment - Recruitment values for projections were taken as the long-term geometric mean values given in the most recent stock assessment. Projections for one year are not sensitive to this value, but those for five years become progressively dependent on this assumption. Thus, five year projections can be taken as giving only the most general of guidance as to the possible course of events.

Reliability of Calculations

The proposed analysis raises a number of concerns over the reliability of the results. Chief among these are:

1. The choice of mesh selection parameters, ℓ_{50} and α.

2. The procedure used to estimate partial recruitments and the scaling factor, k, which is a key element in estimates of the additional effort that might be expended.

3. The adequacy of the assessment data sets, particularly the degree to which parameter estimates based on three years of data can be considered useful.

The effect of the choice of mesh selection parameters on the reliability of the results was examined by performing the calculations using data for cod in Div. 4VsW for different values of the mesh selection parameters. The selectivity studies for cod reported by Thorsteinsson (1980) and Smolowitz (1983) gave ℓ_{50} estimates which were lower in most cases then those given by Clay's (1979b) regression line, which was based on earlier data (Table 1). Thus, for comparison with the selection parameters used in the main analysis (case A), alternative calculations were conducted based on ℓ_{50} estimates from a line for which the slope was adjusted by x0.9 from that of Clay (case B). This value was selected as it gave a line which fit reasonably well the more recent values. Also, Clay (1979c) obtained much lower estimates of the shape parameter, α, (and hence higher estimates of selection range) by using an analysis procedure different from that used here. Thus the impact of reducing α by half was examined (case C). In summary, the three sets of mesh selection parameters chosen to examine the effects of errors in selection parameters were as follows:

Case	α	ℓ_{50}
A	12	-87.62 + 4.35 m
B	12	-87.62 + 3.92 m
C	6	-87.62 + 4.35 m

Average partial recruitment patterns for trawlers were estimated using the separable model using 1984-86 data for Div. 4VsW cod for mesh sizes of 140, 152, and 165 mm. The partial fishing mortalities for each age in 1984, 1985 and 1986 for each mesh size are compared among cases in Table 4. Partial recruitment patterns derived for 130 mm mesh trawls and for other gears are not influenced by selection parameters. The partial F's labelled "observed" are derived directly from the stock assessment data for each year, whereas the "predicted" are based on fully-recruited F in each year and average partial PR. Average PR patterns, fully-recruited F's and effort scaling factors are compared among cases in Table 5. In summary (Table 6), case B (reduced ℓ_{50}) reduced F slightly and k substantially compared to case A for an overall reduction in estimated fishing effort required to take the same catches with larger mesh sizes. Case C (increased selection range) reduced F moderately, but k is similar to Case A. Overall, fishing effort required is reduced to levels intermediate between cases A and B.

The key results of the calculations which depend on the partial recruitment determinations are, for the purposes of this investigation, the yield values obtained from the yield-per-recruit analysis and the fishing effort levels for 1988 from the catch projections. The yield-per-recruit is highest for case A for all mesh sizes at both $F_{0.1}$ and F_{max} (Table 7), and lowest for case C. Projected 1988 fishing effort required to take the catch allocation in that year is highest for case A (Table 8), and lowest for case B.

Case A corresponds to the parameters used for cod stocks in the main analysis. The scientific grounds for chosing these particular values are weak, due primarily to lack of experimental data for the larger mesh sizes. Cases B and C represent the likely alternative interpretations of the available data. The above results indicate that alternatives B and C result in prediction of a lower impact from a change in mesh size then from case A. Thus the mesh selection parameters chosen for this study are likely conservative in that the impacts of a mesh size increase may be overestimated.

The remaining issues were examined using a form a cross-validation, i.e., by performing the calculations using subsets of the full data set, again using Div. 4VsW cod as a test stock. Because the three years, 1984-86, were treated as independent replications in the determination of the key parameters, the most convenient approach was to replace data for one of these years with the data for one of the two remaining years. This gave a total of seven different mixtures of the three years. For comparison, the analysis was also conducted using the usual stock assessment technique of averaging across years to determine average partial recruitment patterns. The mesh selection parameters used for this analysis were α=12 as in the main analysis but ℓ_{50} was derived from the equation ℓ_{50}=-87.62+4.53 m.

Average partial recruitment patterns were estimated using 1984, 1985 and 1986 data for trawls of each mesh size and for other gears using both the separable model and the conventional averaging approach (Table 9). The partial fishing mortalities for each age and year calculated from the average PR's which resulted from the two methods are compared to those derived directly from the stock assessment data in Table 10 (refered to as predicted and observed, respectively). The results using the two methods did not differ greatly. However, the choice of weighting in the separable model resulted in better agreement between the observed and predicted partial F's at partly recruited ages than for the results obtained by averaging.

Additional partial recruitment estimates were obtained using the separable model and the six possible combinations of two years' data from 1984-86. This provided a total of eight combinations of years and methods. The output from each in terms of fully-recruited F, scaling factor and fishing effort index is summarized in

Table 11. Yield-per-recruit analysis was conducted using all eight parameter sets. Fishing mortalities and yields at $F_{0.1}$ and F_{max} are summarized in Table 12. Catch projections were made assuming that each gear type would catch its 1988 allocations, and using the beginning of year numbers for 1988 from the projections in the most recent assessment. Results in terms of fishing mortalities and trawl fishing effort are given in Table 13.

The effects of the variability in the input parameters on the estimates of yield at $F_{0.1}$ and F_{max} are minor (Table 12). The fishing effort estimates for each mesh size are also very similar (Table 13), although the results show greater variability for the larger mesh sizes. The two cases which give double weight to the data for 1984 show a reduced impact of the change in mesh size. This occurred because the selection at age pattern achieved its maximum at much younger ages than for the other mixtures, i.e., because the fish were larger at a given age than in 1985 or 1986. The Div. 4VsW cod stock has shown a long-term trend in declining size (and weight) at age, and there have been changes in both the seasonal pattern of landings and in the participation of some gear types (Sinclair and Annand, 1986; Sinclair and Smith, 1987). Uncertainties associated with such changes in the stock and its fishery appear to outway the differences that might arise in key output variables from using either of the two methods considered here to estimate partial recruitment parameters. Nonetheless, the variability associated with the estimates for a particular mesh size was small in relation to the differences resulting from a change in mesh size. Thus the effects which are being measured (i.e., mesh size effects) are larger than the uncertainties resulting from the data and methods. Thus the cross validation study suggests that the data and methods are adequate, and the results of the study can be used as the basis for management decisions, although their reliability decreases toward larger mesh sizes.

Results

The analysis of the impacts of a mesh size increase required extensive calculations for each of seven stocks. Output from the calculations has been summarised in eight standard tabulations for each stock. These tables are in Appendix 1, and are refered to in the following text only when necessary to point out some unique feature of the results. The key results are summarised from the appendix tables as text tables. Not all of the eight tabulations could be produced for every stock, and in some cases tabulations are duplicated to illustrate two parameter options. The standard tabulations are as follows:

1. Size compositions of adjusted catches - shows results of adjusting trawl length-frequencies for use of larger mesh sizes and then adjusting numbers caught to correspond to those required to give the catch weight observed in each year for each of the years 1984, 1985 and 1986, in comparison to observed length-frequencies of trawlers using 130 mm mesh. Observed length-frequencies of the non-trawler component are also shown.

2. Cumulative length-frequencies - illustrates for each year and mesh size (and for non-trawl gears) the percentage of fish in the catch at or below each length group.

3. Age compositions and weights-at-age of adjusted catches - illustrates the impact the adjustment of length-frequencies for higher mesh sizes had on age compositions and weights-at-age.

4. Annual and partial fishing mortalities by gear component - gives the estimates of annual F from the most recent stock assessment, these F's partitioned by gear, and the equivalent F's for larger mesh sizes based on the adjusted age compositions of catches but assuming the same population numbers in each year as were given by the assessment.

5. Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model - is self explanatory.

6. Results of yield-per-recruit analysis by mesh size - using 1984-86 estimates of PR and weights-at-age from tabulation 3, and M = 0.20 in all cases as in stock assessments. Note that this assumes that the ratio of mortality at age generated by trawl and other gears (and not catch allocations) remain constant at the 1984-86 values. Results of these Y/R analyses differ from those used in stock assessments as the latter are based on presumed long-term values of PR and weights-at-age.

7. Catch projections for 1988 by mesh size - are based on PR's by gear (from tabulation 5), weights-at-age by gear (from tabulation 3), population numbers at the beginning of 1988 from the stock assessment, and gear sector catch allocations in the 1988

Groundfish Management Plan. Projected catch weight and F by age group are tabulated.

8. Summary of projections - gives five year projections of catches, population sizes, F's, and relative fishing efforts for each mesh size for two scenarios, A) assuming constant TAC and allocations over the period at the levels in the 1988 Groundfish Management Plan and B) the TAC and allocations in the Groundfish Management Plan for 1988, but TAC at the $F_{0.1}$ level and allocations constant at the 1988 ratio in subsequent years.

A. Cod in Div. 4VsW (Appendix Tables A-1 - A-8)

There is a significant fishery for Div. 4VsW cod conducted using gears other than trawls, the most important of which is longline. Seiners took 2-3000 t in 1984-85 but less then 1000 t in 1986. These catches were included in the non-trawler catches in the present calculations to conform with historical precedent in stock assessment. Input data for the analysis for this stock were obtained from the assessment of Sinclair and Smith (1987).

Size Compositions - Trawl catches were dominated by fish of 45-70 cm, while other gears caught fish mainly in the 50-75 cm range, in 1984-86. Cumulative length-frequencies (up to 54-56 cm length group) observed, and calculated for larger mesh sizes, on average for 1984-86 were as follows:

Mesh	3 cm Length Groups (midpoint shown)						
Size (mm)	37	40	43	46	49	52	55
130	-	1	4	11	22	36	51
140	-	1	3	7	15	27	42
152	-	1	2	4	10	19	31
165	-	-	1	3	7	14	23
Other gears	-	-	1	3	7	13	21

The fish caught with a 130 mm mesh would have been virtually all larger than a minimum fish size of 16 inches (41 cm), had one been in effect in these years. However, about 15% of fish in the catch were smaller than the current USA regulation of 19 inches (48 cm). This percentage would have been reduced had larger mesh been used, e.g., to about 4% with 165 mm.

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size as follows:

	Mesh Size (mm)			
	130	140	152	165
Y/R (kg) at $F_{0.1}$	0.586	0.604	0.625	0.649
Increase from Y/R at 130 mm	-	3%	7%	11%

Long-term geometric mean recruitment at age 1 is 91 million fish (Sinclair and Smith, 1987), so increases in absolute yield amount to 1600 t, 3500 t, and 5700 t for mesh sizes of 140, 152, and 165 mm respectively.

While fishing mortalities, when fishing at $F_{0.1}$, increase on older age groups with increase in mesh size, they remain moderate, e.g., age 9+ F with 165 mm mesh is 0.24. Fishing mortality on the mature part of the population (approximated by age 5+) decreases slightly from 0.17 to 0.15 with increase in mesh size from 130 mm to 165 mm.

Catch and Fishing Effort Projections - If TAC's and allocations are kept constant at 1988 levels, population biomass is projected to increase and F to decline over time. This strategy is projected to result in F's falling to about the $F_{0.1}$ level by 1991-1992, i.e., in about 5 years. If fishing is at the $F_{0.1}$ level in 1989 and beyond, but allocation ratios are kept constant, yields drop to 29-32,000 t in 1989 but increase to 38,000 t (the 1988 level) or greater by 1991-1992.

If the index of fishing effort is set to 1.0 for 130 mm mesh size in 1988, relative effort for trawlers in other years and for other mesh sizes is as follows in the case of constant TAC:

Mesh	Year				
Size (mm)	1988	1989	1990	1991	1992
130	1.00	0.99	0.92	0.83	0.75
140	1.13	1.11	1.04	0.92	0.83
152	1.36	1.33	1.25	1.10	0.96
165	1.75	1.70	1.58	1.39	1.20

In the case where F is at the $F_{0.1}$ level for 1989 and beyond, relative effort is as follows:

Mesh	Year				
Size (mm)	1988	1989	1990	1991	1992
130	1.00	0.74	0.75	0.75	0.75
140	1.13	0.85	0.85	0.86	0.86
152	1.36	1.07	1.08	1.08	1.08
165	1.75	1.38	1.40	1.40	1.40

Thus, if 140 mm mesh nets were used in 1988 13% more effort could be utilized, and for 152 mm and 165 mm meshes 36% and 75% more respectively could be utilized. In subsequent years, effort would need to be lower irrespective of mesh size in use, to bring F down to the $F_{0.1}$ level. However, at mesh sizes greater than 140 mm, long-term effort could be as high or higher than it is in 1988 when using 130 mm mesh nets. In other words, the effort reduction which is required to reduce F to $F_{0.1}$ at the present mesh size could be negated by an increase in mesh size to 152 mm. At mesh sizes larger than 152 mm effort over and above that used in 1988 with 130 mm mesh size could be utilized. Clearly, maintaining a constant TAC provides for greater effort utilization in the short-term than does an immediate move to $F_{0.1}$ management in 1989.

B. Cod in Div. 4X (Appendix Tables B-1 - B-8)

There is a significant fishery for Div. 4X cod conducted using gears other than trawls, the most important of which is longline. Thus non-trawler and trawler catches are treated separately in the analysis. Input data for the analysis of this stock were obtained from the assessment of Campana and Simon (1987).

Size Compositions - Length-frequencies of trawler and non-trawler catches were fairly similar in 1984-86, both being dominated by fish of about 45-70 cm. The non-trawler component had a higher proportion of larger fish in catches in all years, but in 1986 also had a higher proportion of fish in the 40-50 cm range than did trawl catches.

Cumulative length-frequencies (up to 54-56 cm length group) observed, and calculated for larger mesh sizes, on average for 1984-86 were as follows:

Mesh Size (mm)	3 cm Length Groups (midpoint shown)						
	37	40	43	46	49	52	55
130	1	4	8	16	27	37	49
140	1	2	5	10	18	27	38
152	-	1	3	6	11	17	26
165	-	1	2	4	7	11	18
Other gears	-	2	7	15	25	36	46

Over 95% of the fish caught with a 130 mm mesh would have been as large or larger than a minimum fish size of 16 inches (41 cm), had one been in effect in these years. However, about 20% of fish in the catch were smaller than the current USA regulation of 19 inches (48 cm). This percentage would have been reduced had larger mesh been used, e.g., to about 5% with 165 mm. In contrast to Div. 4VsW cod, a mesh size of 140 mm or larger would have caused trawl catches to contain fewer small fish than non-trawl catches.

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size as follows:

	Mesh Size (mm)			
	130	140	152	165
Y/R (kg) at $F_{0.1}$	1.098	1.123	1.155	1.190
Increase from Y/R at 130 mm	-	2%	5%	8%

Long-term geometric mean recruitment at age 1 is about 19 million fish (Campana and Simon, 1987), so implied increases in absolute yield are 500 t, 1100 t, and 1700 t for mesh sizes of 140, 152, and 165 mm respectively. Fishing mortality on mature age groups (age 5+) when fishing at $F_{0.1}$ varies between 0.17 and 0.18 depending on mesh size.

Catch and Fishing Effort Projections - If TAC's and allocations are kept constant at 1988 levels, population biomass is projected to increase and F to decline over time. This strategy is projected to result in F's falling to about the $F_{0.1}$ level by 1993-94, i.e., in about 6 yrs. If fishing is reduced to the $F_{0.1}$ level in 1989 and beyond, but allocation ratios are kept constant, yields drop to about 7000 t in 1989, returning to the 14000 t level by 1992.

If the index of fishing effort is set to 1.0 for 130 mm mesh size in 1988, relative effort for trawlers in other years and for other mesh sizes is as follows in the case of constant TAC:

Mesh Size (mm)	Year				
	1988	1989	1990	1991	1992
130	1.00	0.89	0.80	0.71	0.65
140	1.08	0.96	0.85	0.74	0.66
152	1.23	1.08	0.93	0.81	0.71
165	1.45	1.24	1.07	0.89	0.77

In the case where F is at the $F_{0.1}$ level for 1989 and beyond, relative effort is as follows:

Mesh Size (mm)	Year 1988	1989	1990	1991	1992
130	1.00	0.43	0.46	0.50	0.52
140	1.08	0.47	0.50	0.52	0.55
152	1.23	0.53	0.55	0.58	0.61
165	1.45	0.61	0.64	0.65	0.67

Thus effort utilization in 1988 could be increased by 8%-45% if mesh size was increased to 140-165 mm. In subsequent years, effort would need to be reduced, irrespective of mesh size in use, to bring F down to the $F_{0.1}$ level. Even at a mesh size of 165 mm and constant catch, effort would have to be reduced by 1990-91 to the level required in 1988 with 130 mm mesh. If F is reduced to $F_{0.1}$ in 1989, the implied effort reduction is more than 50%.

C. Cod in Div. 5Z (Appendix Tables C-1 - C-8)

The Canadian cod fishery on Georges Bank is concentrated in the June to October period, particularly that by otter trawlers, and has been restricted to the Canadian side of the international maritime boundary line since October 1984. In 1985-86 longliners took approximately 25% of the catch and greater proportions in earlier years. Otter trawlers also predominate in the substantially larger USA fishery, the second most important gear being gillnets. Catches by the USA are less concentrated seasonally than Canadian catches and have been restricted to the USA side of the boundary line since 1984. Input data for the analysis of this stock were obtained from the assessment of Hunt (1987).

Size Compositions - Sampling data for 1986 only were available in suitable form for this analysis. In 1986 Canadian trawlers caught fish which were mainly 50-75 cm in length. The "non-trawler" sector catch, which is in fact largely USA caught fish, contained rather larger fish. USA catches contain a gillnet component and trawlers were subject to a 140 mm mesh regulation, but the differences in size compositions likely also reflect the differences in seasonality of the fishery and areas fished. An increase in trawl mesh size to 165 mm would have resulted in the proportions of small fish in the catches of both sectors being about the same.

Cumulative length-frequencies (up to 54-56 cm length group) observed, and calculated for larger mesh sizes, for 1986 were as follows:

Mesh Size (mm)	3 cm Length Groups (midpoint shown) 37	40	43	46	49	52	55
130	-	1	2	4	7	12	19
140	-	-	1	2	4	8	14
152	-	-	1	1	2	5	8
165	-	-	-	1	1	3	5
Other gears	-	-	-	-	1	2	5

The fish caught with a 130 mm mesh would have been virtually all larger than a minimum fish size of 16 inches (41 cm), had one been in effect in 1986. Also, very few were smaller than the current USA regulation of 19 inches (48 cm).

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size as follows:

	Mesh Size (mm) 130	140	152	165
Y/R (kg) at $F_{0.1}$	1.723	1.732	1.745	1.759
Increase from Y/R at 130 mm	-	1%	1%	2%

Thus there is essentially no change in Y/R brought about by a change in mesh size used by Canadian trawlers. This results in part from the fact that this gear sector accounts for a small proportion of the total catch in 1986 (23%).

Catch and Fishing Effort Projections - Projections for 1988 are based on the Canadian quota in the Groundfish Management Plan of 12500 t (8645 t mobile gear, 3855 t fixed gear) and an assumed USA catch of 20000 t, which is approximately the mean of 1985-86 catches. Thus the total 1988 catch was assumed to be 32500 t (Canadian trawlers = 8645 t, "non-trawlers" = 23855 t).

Projections beyond 1988 assuming an $F_{0.1}$ catch level are considered of little value as F could not be reduced to the $F_{0.1}$ level without elimination of the Canadian fishery, substantial restriction of the USA fishery, or both. Projections based on a constant catch may, however, approximate reality closely enough to provide guidance on mesh size effects. If TAC's and allocations are kept constant after 1988, population biomass is projected to increase and F decline over time. Fishing mortalities would fall below F_{max} after 1990. Differences in stock size and F with mesh size are small.

If the index of fishing effort is set to 1.0 for 130 mm mesh size in 1988, relative effort for Canadian trawlers in other years and for other mesh sizes is as follows, given that TAC's and allocations remain constant:

Mesh Size (mm)	Year 1988	1989	1990	1991	1992
130	1.00	0.85	0.82	0.75	0.69
140	1.07	0.88	0.85	0.76	0.70'
152	1.25	0.98	0.94	0.83	0.76
165	2.07	1.61	1.45	1.30	1.14

Thus, in 1988, Canadian trawler effort could be increased by roughly 10-100% if mesh size was increased to 140-165mm. If catches did not increase in subsequent years effort would need to be reduced substantially, but it is more realistic to anticipate that USA catches (and perhaps Canadian quotas) will increase if stock size increases.

D. Haddock in Div. 4VW (Appendix Tables D-1 - D-5)

Canadian catches of haddock in Div. 4VW are taken mainly by otter trawlers (80-85% of the catch in 1984-86). Seiners have taken a few hundred tons in recent years. These are included in the non-trawler catches in the present calculations to conform with historical precedent in stock assessment. The bulk of the non-trawler catch is by long-liners. There are also small quantities of Div. 4VW haddock taken as bycatch in foreign small mesh fisheries. These are predominantly juvenile fish of ages 1 and 2, and are included in catch age compositions in current calculations. They are not included in length composition data presented here. Input data for the analysis for this stock were obtained from the assessment of Zwanenburg and Fanning (1987).

Size Compositions - Trawler catches in 1984-86 were composed mainly of fish 40-50 cm in length. Non-trawler catches contained rather larger fish. With mesh sizes up to 165 mm, trawler catches still tend to contain smaller fish than Canadian non-trawler catches.

Cumulative length-frequencies (up to 54-55 cm length group) observed, and calculated for larger mesh sizes, on average for 1984-86 were as follows:

Mesh Size (mm)	2 cm Length Groups (lower cm shown) 34	36	38	40	42	44	46	48	50	52	54
130	1	5	14	31	50	68	80	88	92	95	96
140	1	4	12	26	44	60	73	82	88	92	94
152	1	4	11	23	39	54	67	76	82	87	91
165	1	3	10	22	36	50	62	71	77	82	87
Other gears	-	1	2	8	19	34	49	63	73	82	88

About 25-30% of the fish caught with a 130 mm mesh would have been smaller than a minimum fish size of 16 inches (41 cm), had one been in effect in these years. However, 80% were smaller than the current USA regulation of 19 inches (48 cm). This percentage would have been reduced had larger mesh been used, but would still have exceeded 60% had 165 mm mesh been used. This reflects the predominance of small fish in the population in 1984-86.

Fishing Mortalities and Partial Recruitment - The stock assessment (Zwanenburg and Fanning, 1987) indicates that F in 1984-86 was extremely high on ages 5+. As a result it is not possible to calculate catch numbers at age which would have corresponded to the use of larger mesh sizes as there were insufficient fish in the population at the appropriate age groups to support the same catch at larger meshes. Partial recruitment patterns were calculated from the separable model by forcing full recruitment to trawlers to be at age 8+. This provides an approximation to PR at each mesh size for Y/R purposes.

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size as follows:

	Mesh Size (mm) 130	140	152	165
Y/R (kg) at $F_{0.1}$	0.423	0.435	0.448	0.466
Increase from Y/R at 130 mm	-	3%	6%	10%

Geometric mean recruitment at age 1 in the last 10 years (1977-86) has been 21 million fish (from Zwanenburg and Fanning, 1987). This period was chosen to avoid uncertainties stemming from possible bycatches in the silver hake/squid small mesh gear fisheries prior to extended jurisdiction. Implied increases in absolute yield are 250 t, 500 t and 900 t for mesh sizes of 140, 152 and 165 mm respectively.

Catch and Fishing Effort Projections - The poor condition of this stock has resulted in implementation of a variety of regulatory measures to minimize mortality, including restriction of catches to bycatch only in 1987 and 1988. It is, therefore, not appropriate to examine potential for increased effort directed towards this stock in the short-term.

Increase in mesh size will allow increased effort for other stocks in the area and hence increased bycatch effort. Div. 4VsW cod is the primary species in the area and, as already noted, effort could be increased by 13%, 36% and 75% for mesh size in use in 1988 of 140, 152 and 165 mm respectively. However, because this bycatch effort is applied using a larger mesh size it is less efficient at generating mortality of haddock. Based on the formula $F = (q/k)f$, and the estimates of k for Div. 4VW haddock of 1.34 for 140 mm nets and 1.56 for larger nets (Table D-4), it can be calculated that the net result is still a decrease in mortality of haddock except at 165 mm mesh (e.g., at 140 mm mesh $F = q. 1.13/1.34$, giving an F which is 0.84 of the F at 130 mm mesh). Given the method used to calculate k for Div. 4VW haddock, which required imposition of a flat-topped PR, these k values are likely to be under-estimates. The bycatch effort is also a function of fisheries for species other than cod, particularly pollock, and the increase in effort for increase in mesh size is less for pollock than for cod. Thus, bycatch mortality for haddock will almost certainly decrease with increase in mesh size.

The Y/R calculations can be used to give an indication of changes in fishing effort in the long-term resulting from changes in mesh size. Although Y/R calculations assume a constant ratio of fishing mortality between gears rather than a constant ratio of catch, Y/R results provide the only inferences which can be made in the absence of projections. Long-term trawler effort, fishing at $F_{0.1}$ for various mesh sizes relative to that for 130 mm mesh nets, is:

Mesh Size (mm)	Effort relative to 130 mm
140	1.49
152	1.80
165	1.93

Thus, once stock recovery is effected, an increase in trawler effort for haddock of roughly 50-100% would be possible with increase in mesh size to 140-165 mm.

E. Haddock in Div. 4X (Appendix Tables E-1 - E-8)

There is a significant fishery for Div. 4X haddock conducted using gears other than trawls, the most important of which is longline. Thus non-trawler and trawler catches are treated separately in the analysis. Input data for the analysis for this stock were obtained from the assessment of O'Boyle and Wallace (1987).

Size Compositions - Length-frequencies of trawler catches in 1984-86 were dominated by fish of 40-55 cm, while those of non-trawlers were rather larger at 45-60 cm. An increase in trawl mesh size to 165 mm in those years would have resulted in trawl catches having a similar proportion of small fish as non-trawl catches.

Cumulative length-frequencies (up to 54-55 cm length group) observed, and calculated for larger mesh sizes, on average for 1984-86 were as follows:

Mesh	2 cm Length Groups (lower cm shown)										
Size (mm)	34	36	38	40	42	44	46	48	50	52	54
130	3	6	12	18	27	38	50	61	71	79	86
140	2	5	9	14	21	30	41	52	63	73	81
152	2	4	7	11	16	24	33	43	54	65	74
165	2	4	6	10	14	21	28	37	47	57	67
Other gears	-	-	1	2	6	13	23	34	45	57	67

About 15-20% of the fish caught with 130 mm mesh would have been smaller than a minimum fish size of 16 inches (41 cm), had one been in effect in those years. However, 50% were smaller than the current USA regulation of 19 inches (48 cm). Had a mesh size as large as 165 mm been in use, 30% would still have been smaller than 19 inches. As in the case of Div. 4VW haddock, this reflects the predominance of small fish in the population in 1984-86.

Fishing Mortalities and Partial Recruitment - As a result of the high F's recently experienced by this stock (O'Boyle and Wallace, 1987), the calculation of hypothetical F's at larger mesh sizes cannot be accomplished for all ages in all years, as the stock numbers at age are lower than the hypothetical catch at age. This problem relates mainly to 1984 however (Table E-4) and the calculations of PR can still be completed (Table E-5).

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size as follows:

	Mesh Size (mm)			
	130	140	152	165
Y/R (kg) at $F_{0.1}$	0.529	0.540	0.553	0.559
Increase from Y/R at 130 mm	-	2%	5%	6%

Long-term geometric mean recruitment at age 1 is about 29 million fish (O'Boyle and Wallace, 1987), so implied increases in absolute yield are 300 t, 700 t, and 900 t for mesh sizes of 140, 152, and 165 mm respectively. Fishing mortality on mature age groups (age 5+) when fishing at $F_{0.1}$ is about 0.20 at all mesh sizes.

Catch and Fishing Effort Projections - If TAC's and allocations are kept constant at 1988 levels, population biomass is projected to increase and F to decline over time, but F's would not reach $F_{0.1}$ levels for about 10 years for any of the mesh sizes. If F is reduced to the $F_{0.1}$ level in 1989 and beyond, but allocation ratios are kept constant, yields drop to 8,000 t (at 130 mm) - 6,000 t (at 165 mm), returning to 12,000 t by 1993-94.

If the index of fishing effort is set at 1.0 for 130 mm mesh size in 1988, relative effort for trawlers in other years and for other mesh sizes is as follows in the case of constant TAC:

Mesh Size	Year				
	1988	1989	1990	1991	1992
130	1.00	0.99	1.00	0.97	0.89
140	1.18	1.14	1.15	1.12	1.02
152	1.58	1.41	1.41	1.39	1.29
165	3.33	2.87	2.67	2.51	2.35

In the case where F is at the $F_{0.1}$ level for 1989 and beyond, relative effort is as follows:

Mesh Size (mm)	Year				
	1988	1989	1990	1991	1992
130	1.00	0.62	0.65	0.65	0.65
140	1.18	0.69	0.71	0.72	0.72
152	1.58	0.80	0.82	0.82	0.83
165	3.33	1.27	1.25	1.22	1.22

Thus, effort utilization in 1988 could be increased by about 20% if 140 mm was used and by about 60% with 152 mesh. The estimated increase for 165 mm mesh is greater than 200% but the small number of older fish in the present population makes the calculation, at this mesh size in particular, prone to the vagaries of sampling error. In subsequent years, effort would need to be reduced, irrespective of mesh size in use. With constant TAC, effort would decline towards the $F_{0.1}$ level very slowly. If F is reduced to $F_{0.1}$ in 1989, the implied effort reduction is 40-60% depending on mesh size.

F. Haddock in Div. 5Z (Appendix Tables F-1 - F-7)

The Canadian haddock fishery on Georges Bank is concentrated in the June to October period and, after 1984, was restricted to the Canadian side of the international boundary line. The fishery is conducted largely by otter trawlers (80% in 1985-86), but the trawl fishery was unusually small in 1984 and there are insufficient data to calculate the effects of a mesh size change on trawl catches in that year. The USA fishery, which is also primarily by trawls, is spread more evenly throughout the year and, after 1984, has been restricted to the USA side of the boundary line. The present analysis includes the Canadian trawl fishery as the "trawler" component affected by mesh size changes. The "non-trawler" component includes Canadian catches by gears other than trawls and USA catches by all gears (mainly trawls). Input data for the analysis for this stock were obtained from the assessment of Gavaris (1987).

Size Compositions - Canadian trawl catches were of fish mainly between 40 and 50 cm in 1985 and 45 and 55 cm in 1986. In contrast catches by USA trawlers and other gears were between 50 and 70 cm. While USA trawlers have been subject to a regulation mesh size of 140 mm from 1983, the substantial difference in size composition of catches between Canadian and USA trawl fisheries must reflect size-based differences in haddock availability resulting from the different spatial and seasonal distributions of the two fisheries. It is clear that an increase in trawl mesh size, even to 165 mm, would not have brought Canadian trawl catches close to the size composition of those of USA trawl catches. (Violation of assumptions about use of regulation mesh size and insignificance of discarding could also explain differences in size compositions.)

Cumulative length-frequencies (up to 54-55 cm length group) observed, and calculated for larger mesh sizes, on average for 1985-86 were as follows:

Mesh Size (mm)	2 cm Length Groups (lower cm shown) 34	36	38	40	42	44	46	48	50	52	54
130	-	1	5	14	25	40	53	65	75	84	89
140	-	1	4	13	23	36	48	60	70	80	86
152	-	1	4	9	18	29	40	51	61	71	79
165	-	1	3	9	16	25	35	44	54	63	72
Other gears	-	-	-	-	1	1	3	5	10	15	21

Of the fish caught with 130 mm mesh, 10-15% would have been smaller than a minimum fish size of 16 inches (41 cm), had one been in effect in those years. However, 55% were smaller than the current USA regulation of 19 inches (48 cm). Had a mesh size as large as 165 mm been in use, 35-40% would still have been smaller than 19 inches. As for the other haddock stocks, this reflects the predominance of small fish available to the Canadian fishery in 1985-86.

Fishing Mortalities and Partial Recruitment - Exploitation rate of Georges Bank haddock has been high and year class strength highly variable. As a result there is a tendency for the fishery to concentrate on good year classes and for PR to vary accordingly. The two years of available data reflect this phenomenon, the Canadian trawl fishery in particular concentrating on the 1983 year class (Table F-4). Rather than average these years' data to give what might prove to be a seriously biased estimate of average PR with current mesh sizes, it was decided to treat each year as an alternative estimate of PR and conduct Y/R and projection calculations for each.

Yield-Per-Recruit - Two Y/R analyses were conducted, one using 1985 and the other using 1986 PR's. The Y/R at $F_{0.1}$ (for recruitment at age 1) varied with mesh size and PR option as follows:

	Mesh Size (mm) 130	140	152	165
1985 PR option				
Y/R (kg) at $F_{0.1}$	0.746	0.762	0.782	0.801
Increase from Y/R at 130 mm	-	2%	5%	7%
1986 PR option				
Y/R (kg) at $F_{0.1}$	0.778	0.792	0.809	0.825
Increase from Y/R at 130 mm	-	2%	4%	6%

Long-term geometric mean recruitment at age 1 (subsequent to 1964) is about 5 million fish (from Gavaris, 1987), so implied differences and increases in yield are not large - all less than 300 t. The low total yield estimate of about 4000 t reflects the low recruitment in most years since the 1963 year class. Use of the geometric mean is particularly conservative in this case, however. Arithmetic mean recruitment is about 17 million fish, and long-term yield at this recruitment is about 12000 t. The different PR options make little difference to the results.

Catch and Fishing Effort Projections - The 1988 Canadian quota for Subarea 5 haddock in the Groundfish Management Plan is 8300 t. While this quota includes fish reported from Div. 5Y, most of the catch can be expected to come from the stock assessment unit, Div. 5Z. USA catches are not regulated but might be expected to be at about the 1985-86 level (mean = 3800 t). The 1987 USA catch appears to have been less than this and recent Canadian catches have been substantially less than 8300 t. Nonetheless, the projected 1988 catch for present purposes is taken as 12100 t because the 1985 year class is of above average strength. This catch generates an F in 1988 comparable to that calculated for 1985-86, and there seems little reason to assume F will decrease when stock size is increasing. Based on allocations in the Canadian plan, Canadian otter trawl catch in 1988 is expected to be 7527 t and other sectors are therefore expected to catch 4573 t.

Regardless of mesh size or PR option, the 1985 year class dominates the 1988 catch, accounting for 8000-10000 t. The 1986 PR option is the more likely to apply in 1988 as population age structure is similar in the two years. In this option, age 3+ F is 0.55 with 130 mm mesh and increases to 0.75 with 165 mesh. This is double the $F_{0.1}$ level at 130 mm and closer to 2.5 x $F_{0.1}$ at 165 mm, although in both cases F is below F_{max}. Thus, there would be some immediate worsening of the over-exploitation already allowed under the management plans of the two countries if Canada allowed the same catch to be taken with increased mesh size. The increase in fishing effort of Canadian otter trawlers allowed in 1988 by increase in mesh size is as follows (1986 PR option):

Mesh Size (mm)	Fishing Effort Relative to 130 mm Nets
130	1.00
140	1.20
152	1.63
165	2.66

Projections beyond 1988 are not presented because neither of the two scenarios - constant catch and $F_{0.1}$ - are applicable for this stock. A catch of 12000 t is not possible after 1989 given presently projected stock size, and fishing at $F_{0.1}$ is not a practical option given the present USA fishing plan.

G. Pollock in Div. 4VWX + Subarea 5 (Appendix Tables G-1 - G-8)

This stock assessment and management unit includes the fishery in USA, as well as in Canadian waters. The present analysis includes the Canadian trawl fishery as the "trawler" component affected by mesh size changes. The "non-trawler" component includes Canadian catches by gears other than trawls and USA catches by all gears (mainly trawls and gillnets). Input data for the analysis for this stock were obtained from the assessment of Annand et al. (1987).

Size Compositions - Length-frequencies of Canadian trawl catches were dominated by fish of 55-70 cm in 1984-86. Cumulative length-frequencies (up to 54-56 cm length group) observed, and calculated for larger mesh sizes, on average for 1984-86 were as follows:

Mesh Size (mm)	3 cm Length Groups (midpoint shown) 37	40	43	46	49	52	55
130	-	-	1	2	6	14	24
140	-	-	-	2	4	11	21
152	-	-	-	1	3	8	17
165	-	-	-	1	2	5	12
Other gears	not calculated						

Virtually no fish taken with 130 mm would have been smaller than a minimum fish size of 16 inches (41 cm), had one been in effect in those years, and very few were smaller than the current USA regulation of 19 inches (48 cm).

Yield-Per-Recruit - The Y/R at $F_{0.1}$ (for recruitment at age 2) for each mesh size is as follows:

	Mesh Size (mm) 130	140	152	165
Y/R (kg) at $F_{0.1}$	1.147	1.153	1.162	1.173
Increase from Y/R at 130 mm	-	1%	1%	2%

These differences are too small to be considered meaningful and it is concluded that a mesh size change for the Canadian trawler fleet, over the range considered, will have no significant impact on Y/R. Fishing mortality at $F_{0.1}$ also does not change much with change in mesh size. One reason why the impact of a mesh change is small is that the gear sector affected accounts for only about half the catch.

Catch and Fishing Effort Projections - The Canadian Groundfish Management Plan for 1988 sets a Canadian quota of 43000 t, which is approximately the projected $F_{0.1}$ catch level. This takes no account of USA catches which averaged 20000 t in 1984-86. An arbitrary catch of 17000 t is assigned here to the USA, for a total expected 1988 catch of 60000 t, to allow illustrative calculations to be conducted.

If total catch and shares are kept constant at 1988 levels, population biomass is projected to decrease and F to increase over time. A reduction in F to $F_{0.1}$ in 1989 would require a reduction in catch to about 36000 t (and if USA fishermen continue to catch, say, 17000 t, would require a reduction in Canadian quota to about 19000 t). Population biomass is projected to stabilize under this scenario. Continuation of present practice of ignoring the USA catch would result in a 1989 catch of about 53000 t (36000 t to Canada, 17000 t to USA) and is thus similar in impact to the constant TAC option. Current population biomass is above the long-term average, however, and declines of the scale of those projected in the constant TAC option are not necessarily a cause for concern.

If the index of fishing effort is set at 1.0 for 130 mm mesh size in 1988, relative effort for trawlers in other years and for other mesh sizes is as follows in the case of constant TAC:

Mesh Size (mm)	Year 1988	1989	1990	1991	1992
130	1.00	1.15	1.25	1.41	1.66
140	1.04	1.21	1.32	1.49	1.74
152	1.14	1.34	1.48	1.67	1.95
165	1.31	1.58	1.76	2.01	2.35

In the case where F is at the $F_{0.1}$ level for 1989 and beyond, relative effort is as follows:

Mesh Size (mm)	Year 1988	1989	1990	1991	1992
130	1.00	0.64	0.62	0.61	0.61
140	1.04	0.66	0.64	0.64	0.63
152	1.14	0.72	0.70	0.69	0.69
165	1.31	0.84	0.81	0.81	0.80

Thus, if mesh sizes up to 165 mm were used in 1988, effort could be increased by up to 31%. The longer-term projection at $F_{0.1}$ assumes a constant allocation ratio which, in this case, assumes that USA catches will be reduced as TAC is reduced. This seems, at this juncture, to be an unlikely scenario and a move to $F_{0.1}$ management could involve a greater reduction in effort utilization by Canadian trawlers than shown here. Policies on TAC levels and allocation over the next few years appear to have a relatively greater potential to impact on effort levels than do mesh size changes.

H. Other Species

In the Scotia-Fundy Region, cod, haddock and pollock far outweigh in importance other groundfish species which are subject to the present 130 mm mesh regulation. The most important of these secondary species are cusk, white hake, wolffishes and the flatfishes (American plaice, yellowtail flounder and witch flounder). Collectively, recent annual landings of these species are only about 20,000 t (average for 1982-86), and much of that total is taken as incidental catch in fisheries directed towards the major gadoids. White hake has recently been the most important secondary species (Table 14) with landings of about 6000 t, followed by American plaice and cusk.

Most white hake and cusk are landed by vessels other than trawlers and seiners (Table 14), and thus total landings would not be greatly affected by mesh regulation changes. (The 32% trawler share of the white hake catch is greatly influenced by high landings recorded for 1986 only, the share in earlier years being close to 15%.) About two-thirds of the wolffish landings might be affected, but quantities are small. The most important impact of a mesh change would be on the flatfish fisheries which are conducted almost exclusively by trawlers and seiners. Effects on witch flounder and American plaice fisheries would have most importance to seiners, while trawlers are more dependent on American plaice and yellowtail flounder.

Although there are trawl selection data for flatfishes, there are no quantitative population models for these species which would allow calculation of mesh change impacts, as done for the major gadoids. Some comments can be made on the immediate effects of a mesh size increase on catches and landings, however. A distinction is made here between catches and landings as discarding of small fish is a persistent feature of plaice and yellowtail fisheries. In the 1984-87 period the IOP observed the following discard rates (by weight) for flatfishes on large otter trawlers using regulation 130 mm mesh in Div. 4VWX + Subarea 5:

American plaice	11%
Yellowtail flounder	20%
Witch flounder	4%

As indicated in the Mesh Selection section, Clay's (1979b) general flatfish equation for the relationship between mesh size and ℓ_{50} is considered adequate for all three of these flatfish species. Thus, in all cases the ℓ_{50} for each codend mesh size is as follows:

Mesh size (mm)	ℓ_{50} (cm)	ℓ_{50} (inches)
130	29.6	11.6
140	31.7	12.5
152	34.2	13.5
165	36.9	14.5

American plaice - An estimate from the IOP of the length-frequency of plaice caught by large otter trawlers using regulation 130 mm mesh in Div. 4VWX + Subarea 5 in 1984-87 (Fig. 5A) provides a basis for comment on immediate impacts of a mesh size change. This length-frequency of unculled catches is based on over 23,000 length measurements.

The IOP also sampled discarded and kept portions of plaice catches but much less extensively (3400 and 1100 length measurements respectively). The shore sampling programme provides more extensive measurements of landed (i.e. kept) plaice. In 1984-86 24 samples (5100 measurements) of trawler landings, mainly from large trawlers fishing Subdiv. 4Vs, and in 1984-87 13 samples (4,000 measurements) of seiner landings, mainly from Subdiv. 4Vn, were collected.

Taking the IOP unculled length frequency as indicative of fishery catches using 130 mm mesh allows expected catch length-frequencies at larger mesh sizes to be calculated (Fig. 5A). Length-frequencies of kept catch (from IOP) and of landings (from shore samples) for trawlers compare most closely with the expected catch length-frequency using 165 mm mesh (Fig. 5B). Indeed, they are composed of rather larger fish than predicted for a 165 mm mesh. In the case of seiners, landings were most similar in length-frequency to that expected for a 140 mm mesh (Fig. 5C).

From these results it would seem that an increase in mesh size to 140 mm is unlikely to affect the landings (either in size composition or quantity) of either seiners or trawlers and, in the case of trawlers, any increase in mesh size in the range considered here is unlikely to affect their landings. Discards would be reduced. The immediate impact on seiners of using meshes larger than 130 mm is estimated to be as follows:

	Mesh size (mm)		
	140	152	165
Change in landings per unit effort-weight	0	-12%	-25%
Change in landings per unit effort-numbers	0	-21%	-41%
Change in mean weight of landed fish	0	+12%	+27%

The IOP unculled length-frequency results from an amalgamation of data from both directed and bycatch catches from all over the Scotian Shelf and Georges Bank. It is unlikely that the populations fished by these observed vessels had the same size structure as those subject to the main directed fisheries by trawlers in Subdiv. 4Vs and seiners in Subdiv. 4Vn. As the length-frequency of catches is a function of both size composition of the fished population and mesh selection, the differences between length- frequencies of landings and IOP unculled catches cannot be attributed entirely to discarding. This will have introduced some bias to the results reported above.

Witch flounder - In contrast to American plaice, there is no evidence of significant discarding of witch flounder. Thus landings size compositions can be taken as approximations to catch size compositions. For witch, length-frequencies of trawler catches from IOP (6,200 measurements), and of trawler landings (14 samples, 3300 measurements) and seiner landings (25 samples, 7,700 measurements) from shore samples, in 1984-87 were fairly similar (Fig. 6A). Shore samples from trawlers were mainly from large vessels fishing Subdiv. 4Vs and those from seiners were from small vessels fishing Subdiv. 4Vn.

Witch flounder catches are mainly composed of fish which are sufficiently large to be outside the selection range of 130 mm mesh (25-75% selection occurs in the range 27-32 cm). Taking the seiner landings length-frequency as a worst-case scenario, as it contained a higher proportion of small fish than the trawler length-frequencies, the immediate impact of using larger meshes is estimated to be as follows (Fig. 6B):

	Mesh size (mm)		
	140	152	165
Change in landings per unit effort-weight	-3%	-9%	-19%
Change in landings per unit effort-numbers	-6%	-15%	-29%
Change in mean weight of landed fish	+3%	+7%	+14%

Thus, an increase in mesh size to 140 mm is unlikely to noticably affect the witch fishery, but increases to 152 mm or above would likely reduce catch rate by 10% or more. The effects on trawlers would be less.

Yellowtail flounder - The yellowtail flounder fishery is conducted almost exclusively by trawlers and, as indicated above, discarding is a feature of this fishery, approximately 20% of the catch weight being discarded in 1984-87 according to IOP data. Discards (based on 2600 measurements) include about 50% of the fish caught at 34 cm and occur over much of the size range caught (Fig. 7A). Samples of kept fish from the IOP (300 measurements) are similar in length-compositions to shore samples of landings (26 samples, 5500 measurements) (Fig. 7B). (Shore samples are almost all from vessels fishing in Subdiv. 4Vs.) Unculled catches are much more extensively sampled by the IOP (24,000 measurements). Taking these as representative of trawler catches using 130 mm mesh, the immediate impact of using larger meshes can be calculated (Fig. 7C). The expected size composition of the catch using 140 mm mesh is closely similar to that of landings based on shore samples (Fig. 7D). Thus, an increase to this mesh size would tend to eliminate discards but not affect landings. For larger meshes, the immediate impact is estimated to be as follows:

	Mesh size (mm)		
	140	152	165
Change in landings per unit effort-weight	0	-17%	-38%
Change in landings per unit effort-numbers	0	-21%	-44%
Change in mean weight of landed fish	0	+5%	+10%

Summary of Results

Size of fish in trawler catches - Cumulative length-frequencies for each species were calculated by weighting those for each stock by numbers landed by trawlers. Results for each species and mesh size were:

Species	Mesh Size (mm)	3 cm Length Groups (midpoint shown) 37	40	43	46	49	52	54
Cod	130	-	2	5	11	22	35	49
	140	-	1	3	7	15	26	40
	152	-	1	2	4	10	18	29
	165	-	-	1	3	7	13	21
Pollock	130	-	-	1	2	6	14	24
	140	-	-	-	2	4	11	21
	152	-	-	-	1	3	8	17
	165	-	-	-	1	2	5	12

Species	Mesh Size (mm)	2 cm Length Groups (lower cm shown) 38	40	42	44	46	48	50	52	54
Haddock	130	12	24	39	54	66	75	82	88	91
	140	10	20	33	46	58	68	77	84	88
	152	9	17	28	40	51	61	69	77	83
	165	8	16	26	37	46	55	63	71	78

In the cases of cod and pollock, very few fish were landed by trawlers in 1984-86 which were smaller than 16 inches (41 cm). In contrast, about 20% of the haddock landed were smaller than this. Very few pollock landed were smaller than 19 inches (48 cm), but about 15% of cod landed were smaller than this. About 5% of the cod landed would have been smaller than 48 cm had a mesh size of 165 mm been in use. The Div. 4VsW cod stock has the greatest influence on these results as over 75% of cod landed by trawlers were from this stock. About 65% of the haddock landings were of fish smaller than 48 cm and, even had 165 mm mesh been in use, this would still have been about 45%. Landings from the Div. 4VW haddock stock, which accounted for half the total, were composed of smaller fish than those from the other stocks. Div. 5Z landings composed 10% of the total.

Yield-per-recruit - Increases in mesh size are calculated to provide modest increases in long-term yield based on yield-per-recruit calculations. Changes in Y/R for each mesh size for each stock relative to that using 130 mm mesh nets are as follows:

Stock	Mesh Size (mm) 130	140	152	165
4VsW cod	1.00	1.03	1.07	1.11
4X cod	1.00	1.02	1.05	1.08
5Z cod	1.00	1.01	1.01	1.02
4VW haddock	1.00	1.03	1.06	1.10
4X haddock	1.00	1.02	1.05	1.06
5Z haddock[1]	1.00	1.02	1.04	1.06
4VWX+5 pollock	1.00	1.01	1.01	1.02

1 = 1986 PR option

These calculated increases in yield are small, almost all being 10% or less over the whole range of mesh sizes considered.

Catch and fishing effort projections - An increase in mesh size results in larger fish being caught, hence fewer are required to make up the catch allocations for trawlers. Thus, in the present calculations, use of larger mesh causes F on the population as a whole to decrease. However, F is redistributed, that on young fish being reduced and that on older fish being increased. The F on ages 5+ for each mesh size and stock in 1988 assuming trawler allocations are taken, and the age 5+ F at the reference levels of $F_{0.1}$ and F_{max}, are as follows:

Stock	1988 Age 5+ F with Mesh Size (mm) of: 130	140	152	165	Approx. Age 5+ F at: $F_{0.1}$	F_{max}
4VsW cod	.26	.27	.27	.26	.16	.30
4X cod	.40	.41	.43	.45	.17	.31
5Z cod	.50	.51	.53	.59	.22	.41
4VW haddock	--	--	--	--	.18	.37
4X haddock	.40	.42	.45	.46	.21	--[1]
5Z haddock	.51	.53	.57	.66	.26	.74
4VWX+5 pollock	.47	.48	.49	.50	.29	.56

1 = Y/R curve at 165 mm asymptotic

Ages 5+ are chose to illustrate the results because fish of these ages are fully or very largely recruited to 130 mm mesh nets and also approximate the reproductively mature stock. Age 5 is also the age above which F tends to increase with increase in mesh size (although this age varies from age 3 for Div. 5Z cod to age 7 for Div. 4VsW cod). The age 5+ F's at the reference F levels vary with mesh size within each stock but not greatly. At $F_{0.1}$ the range for any stock does not exceed 0.02. At F_{max} the range is greater but does not exceed 0.06 except for haddock in Div. 5Z (range = 0.20) and in Div. 4X where the Y/R curve at 165 mm is asymptotic. Thus, only the mean value is given as a basis for comparison. Comparisons between 1988 F levels and long term Y/R reference F's can only be of a general nature in any case as the age structures of the populations for which they are calculated are different.

It is clear, however, that F's permitted under the present management plan (i.e., using 130 mm mesh) for all these stocks are above $F_{0.1}$. An increase in mesh size would increase F on ages 5+ in all but Div. 4VsW cod, where the increase is on ages 7+. The increases are modest (6-18%) except for Div. 5Z haddock for which it is about 30%.

If mesh size had been increased in January 1988, but TAC's and allocations set for 1988 were unchanged, additional fishing effort relative to that required using the present 130 mm mesh would be as follows for the major cod, haddock and pollock stocks (Fig. 8):

Stock	Mesh Size (mm) 130	140	152	165
4VsW cod	1.00	1.13	1.36	1.75
4X cod	1.00	1.08	1.23	1.45
5Z cod	1.00	1.07	1.25	2.07
4VW haddock*	1.00	(1.49)	(1.80)	(1.93)
4X haddock	1.00	1.18	1.58	3.33
5Z haddock	1.00	1.20	1.63	2.66
4VWX+5 pollock	1.00	1.04	1.14	1.31
Mean	1.00	1.12	1.37	2.10

* - No directed fishing allowed-excluded from means.

Roughly 10% more effort would be required if 140 mm mesh was in use, about 40% with 152 mm mesh, and about 100% with 165 mm mesh. The means would be more precisely estimated if the ratios for each stock could be weighted by the amount of effort directed towards it. The substantial extent to which these fisheries are mixed complicates this weighting but, in any case, adoption of this refinement might give an impression of accuracy which is unmerited. Thus, it is not attempted.

Five year projections were not possible for Div. 4VW and Div. 5Z haddock. Of the remaining five stocks, a constant catch at the 1988 level results in a gradual decrease in F over time for four stocks. Maintaining a constant catch for pollock results in increasing F and effort, which is inconsistent with the prevailing management strategy. Thus, for illustrative purposes, it is assumed that effort for pollock will be kept constant, i.e., that catch will be gradually decreased. For the five stocks, projections to 1992 assuming a constant catch strategy (constant effort for pollock) indicate that trends in effort relative to that for 130 mm nets in 1988, on average, will be as follows:

Mesh Size (mm)	Year 1988	1989	1990	1991	1992
130	1.00	.94	.91	.85	.80
140	1.10	1.03	.99	.92	.85
152	1.31	1.19	1.13	1.05	.97
165	1.98	1.75	1.62	1.48	1.35

Since catch is held constant, relative catch rates are the inverse of relative efforts. As five year projections assuming fishing at $F_{0.1}$ after 1988 are considered unrealistic for Div. 5Z cod and pollock (and were not possible for Div. 4VW and Div. 5Z haddock), no summary is presented for this option.

Discussion

Fleet Capacity Utilization

The Scotia-Fundy groundfish fleet can presently exert two to four times the fishing effort required to exploit the available resource at $F_{0.1}$. Thus, regulatory measures which require that more fishing effort be exerted to fish at $F_{0.1}$ result in greater utilization of the fleet's potential to exert effort, i.e., of its capacity. In recent years about 60% of the fishing effort exerted in this fishery has been by trawlers (unpublished data). Thus, an increase in trawler mesh size could have a significant effect in relation to the overall fleet over-capacity problem.

An increase in mesh size reduces the vulnerability of small fish, causing the yield to be taken from larger fish of older age groups. As a result the $F_{0.1}$ reference level of fishing mortality increases. Thus, more fishing effort is required to fish at the $F_{0.1}$ level. In addition, when partial recruitment is dome-shaped a mesh increase causes the fishery to concentrate on age groups which are less available to the gear, reducing efficiency (by 1/k). Thus, more fishing effort is required to generate a unit of mortality, as well as more units of mortality being required to fish at $F_{0.1}$.

It is not possible to say how much additional fishing effort could be exerted by trawlers without making assumptions about allocations between trawlers and other gears (and about USA catches for some stocks). For the five year projections in this report a constant ratio between catch allocations to the major gear types most closely reflects the current practice of allocating based on recent catch history. Thus it was assumed that the ratios between catch allocations in the projection period would remain at the average values for 1984-86. The projections for 1989-92 (Appendix Tables 8B) indicate, based on this allocation assumption, that roughly 10% more trawler effort would be required to fish at $F_{0.1}$ with 140 mm mesh size, 25% more with 152 mm mesh and 60% with 165 mm mesh, than with the present 130 mm mesh when fishing at $F_{0.1}$.

Although the prevailing management strategy is to fish at the $F_{0.1}$ level, stock assessments indicate that, despite increasingly restrictive regulatory measures, fishing mortality in the 1980's has, on average, been about twice $F_{0.1}$. When this project was initiated, the 1988 Groundfish Management Plan had not been finalized. Although it was known that many TAC's for gadoids in Div. 4VWX + Subarea 5 would be set above the level corresponding to $F_{0.1}$, the extent to which this would be so was not known. The present calculations indicate that the plan allows for continued utilization of fishing effort at a level twice that required for fishing at $F_{0.1}$. Thus, the industry suggestion of maintaining catches at current levels while increasing mesh size would allow for more fleet capacity being used than has been the case in recent years. The increases in effort required to take the 1988 trawler allocations are about 10%, 40% and 100% for mesh sizes of 140, 152 and 165 mm, respectively. Licensed capacity has been estimated to be about double utilized capacity (unpublished data). There is a higher utilization of trawler capacity than for that of other gears, however, although separate estimates are not available. Thus, it would seem that an increase in mesh size to 152-165 mm would allow for full utilization of inshore trawler capacity in 1988 and indeed could possibly result in allocations not being taken. The fleet of large trawlers, which exerted about 50% of the trawler effort in 1984-86 while fishing under company-based enterprise catch allocations, has the capacity to take its allocations in the Region with any of the mesh sizes considered if it chose to do so. Management of the capacity of this fleet sector, however, is in principle largely the concern of the enterprise, rather than DFO, under the enterprise allocation scheme.

This information about potential impacts of a mesh size increase in 1988 is not particularly helpful unless put in the context of a longer term strategy. Five year projections were conducted to provide guidance on how a mesh size increase could best be incorporated in a plan to reduce exploitation of the resource to the $F_{0.1}$ level. Average recruitment is assumed in these projections, but actual recruitment for each individual stock will vary around these average values. Thus, the specific results are not reliable beyond the first two, possibly three years. Such projections provide only general insights into what might happen under different policy options, such as maintaining constant catch. Whatever strategy was adopted would, of course, be subject to the annual stock assessment review and management planning process and would be modified as necessary.

Four of the five stocks for which projections could be conducted increased in abundance over time under a constant catch regime. Thus F and fishing effort decreased regardless of mesh size. The decrease in F was gradual, however, and had not declined to the $F_{0.1}$ level in the five year period. These calculations suggest that maintaining constant catch, combined with a substantial increase in mesh size, could provide a practical method of "buying-time" to deal more directly with the problem of fleet overcapacity, while still moving closer to the target $F_{0.1}$ mortality levels.

The second set of projections conducted (i.e., fishing at $F_{0.1}$ in 1989) were conceived under the expectation that the 1988 Groundfish Management Plan would require fishing effort in 1988 to be reduced to a level intermediate between recent and $F_{0.1}$ levels, and hence that the projections would represent a two-step reduction in effort to $F_{0.1}$ (in contrast to the many step option of constant catch). Since the 1988 effort allowed under the plan is similar to recent levels, these projections amount to a one-step reduction to the $F_{0.1}$ effort level in 1989. This reduction would, therefore, follow the mesh size increase which allowed effort additional to recent high levels. Such a sequence of events would not contribute to a rational solution of the overcapacity problem. If an immediate transition to $F_{0.1}$ fishing is desired, the most direct strategy would be to increase mesh size co-incident with catch reductions. If mesh size was increased to 165 mm, for example, while catch was reduced to that corresponding to $F_{0.1}$, trawlers could continue to utilize about the same amount of fishing effort. Note, however, that both catches (for the whole fleet) and catch rates (of trawlers) would be halved in the first year, which would cause drastic disruption in both the catching and processing sectors.

Clearly, to gain any degree of industry acceptance, reduction of exploitation rate to the $F_{0.1}$ level will have to be phased over several years. While maintenance of constant catch may prove to be too slow, or be judged too risky, a stepwise reduction in catch combined with an initial increase in mesh size, may offer a practical approach. Capacity utilization would increase initially, then decline gradually. Catch rates of trawlers would go down with mesh size increase but total catch would be largely maintained.

Choice of Mesh Size

There are a number of factors relevant to the choice of mesh size, should it be decided to implement an increase. Firstly, the calculations for large mesh sizes are less reliable than for those close to the present size. There are few mesh selection experiments for mesh sizes greater than 140 mm. Thus, the selection parameters used here in part lie outside the range of reliable observational data. At larger mesh sizes, the results become increasingly sensitive also to small errors and biases in other input data, such as input fishing mortalities on older ages in the assessment results. The increased sensitivity results from fishing effort required in 1988 increasing exponentially with increase in mesh size (Fig. 8). These observations might encourage a fishery manager to decide on a small increase in mesh size, but another factor to be taken into account is the expected changes in fishermen's behaviour in response to a mesh size increase (see Mesh Selection - Theory section). Such changes in fishing practices will tend to compensate for the effects of a mesh size increase, i.e., would tend to cause the effects on catch rates and hence effort utilization to be less than calculated.

Industry experience in Canada and elsewhere indicates that an increase in mesh size to 140 mm should cause no practical difficulties. This is the same percentage increase as that imposed in 1982 when the differentials for mesh materials were discontinued and most vessels had to increase mesh size from 120 mm to 130 mm. There is no evidence that the 1982 increase created significant hardship. In addition, the USA industry has functioned without disruption using 140 mm mesh nets since 1983. Furthermore, the average mesh size used in Scotian-Shelf fisheries by those Canadian large trawlers which carried observers increased to 140 mm in 1987. Thus, this fleet sector appears to be adopting 140 mm mesh without the necessity of regulation. There also appears to be some reasonable assurance that an increase to as large a mesh size as 152 mm should not be seriously disruptive. Supporting evidence is provided by the Icelandic fishery, which also depends heavily on cod and to lesser extents on haddock and pollock. Mesh size used by trawlers has been regulated at 155 mm (approx. 6 1/8 inches) since 1977. Danish seiners are permitted to use 135 mm (Elisson, 1985). The basis for this differential is not known, but an Icelandic selection experiment with 166 mm mesh indicated that seiners had a higher selection factor for cod than did trawlers (Thorsteinsson, 1980).

In summary, it is clear that an increase in regulation mesh size to 140 mm would cause little disruption to the fishery, but would also have little, if any, discernable impact on the fleet overcapacity problem. At the other end of the scale, there must be serious reservations about implementation of a 165 mm mesh size as the impacts are poorly estimated. The present results, combined with the Icelandic experience, suggest that an increase in mesh size to 150-155 mm would be feasible. A change of this magnitude should produce a clear reduction in the overcapacity of the trawler sector.

Long-Term Yields

Yield-per-recruit calculations indicate that there will be increases in long-term yield over the entire range of mesh sizes considered and for all stocks, but almost all of the projected increases are less than 10%. Density-dependent changes in growth rate could negate these calculated increases. If, however, fishing patterns changed in response to a mesh size increase so that older fish became more fully-recruited to the gear, the increase in yield-per-recruit would be underestimated. Furthermore, allocation policies among gear types (which have different PR patterns) will influence long-term yield-per-recruit (Sinclair, 1986). The present calculations conform to the current practice of assuming a constant ratio of F's between gear types (in contrast to the short-term projections which assumed constant catch allocation ratios). Despite these qualifications, the calculations provide reassurance that an increase in mesh size is not likely to result in significant long-term losses in yield while, at the same time, providing no clear evidence of any prospective yield benefits.

Size of Fish in Catches

Fish processing plant operators prefer to utilize large groundfish, presumably for economic reasons, and this is reflected in the general tendency for buyers to offer higher prices to fishermen for larger fish. Nonetheless, fishermen tend to land all sizes caught if they can be sold profitably. An increase in mesh size, by increasing the size of fish caught should increase the size of fish landed (as discarding is insignificant). This should result in an increase in price received by fishermen per unit of weight landed.

Assessment of the economic impact of an increase in sizes caught is beyond the scope of this study. The impact on the regulatory regime can be addressed, however. In recent years both

Canadian and USA regulatory authorities have favoured the introduction of minimum fish size regulations, in addition to mesh regulation. The minimum fish sizes chosen presumably reflect the views of these agencies on the size range within which landed fish should lie for "optimal" utilization of the resource. Motivation, particularly in the case of the USA, has stemmed from conservation needs (minimizing the catch of juvenile fish) but, at least in the Canadian case, also reflects economic considerations. Be that as it may, introduction of minimum fish size regulations makes size composition of catches a relevant regulatory issue.

Fishermen could meet the requirements of minimum fish size regulations by changing their behaviour, i.e., by fishing only at times and in areas where large fish occur. It must be anticipated, however, that a more likely response will be to continue previous behaviour and to discard fish smaller than the minimum size, as necessary, to meet regulatory requirements. Thus, the importance of appropriate mesh size regulations is not reduced by the introduction of minimum fish size regulations. Indeed, the minimum regulated fish size provides a guide as to the suitability of particular mesh sizes. Nonetheless, as mesh selection occurs over a range of sizes, there are no hard and fast rules for judging the compatibility between fish size and mesh size regulations. One criterion which could be adopted is that the mesh size be set which results in the lower end of the selection range (i.e., the 25% selection length) being at or above the minimum landed fish size. Under average conditions this will result in relatively few fish being caught which are too small to be landed.

Various minimum fish sizes are of interest to the Canadian fishing industry in relation to regional cod, haddock and pollock fisheries. Canadian federal authorities implemented a minimum retainable fish size of 41 cm (16 inches) effective April 1988, while the Province of Nova Scotia has had a restriction on the buying, selling and transporting of fish less than 17 inches (43 cm) since 1986, for these species. The USA implemented minimum fish size restrictions of 17 inches for cod and haddock in 1977. These restrictions were extended to imported cod and haddock in September 1986 and imported pollock in October 1987, thus causing some impact on the Canadian industry. Also in October 1987 the specified minimum size was increased to 19 inches, consistent with regulations applying to USA domestic fishermen. The USA is currently considering an increase in minimum size to 21 inches (53 cm) for cod. The percentage retention at each of these lengths, calculated from the mesh selection parameters used here, for mesh sizes between 130 and 165 mm is as follows:

	Fish Length		Percentage Retained by Mesh Size (mm) of:			
Species	cm	inches (approx.)	130	140	152	165
Cod	41	16	15	7	3	1
	43	17	23	11	5	2
	48	19	51	28	12	5
	53	21	79	55	29	13
Pollock	41	16	23	12	6	3
	43	17	34	19	9	4
	48	19	66	44	24	12
Haddock	41	16	29	15	7	3
	43	17	41	22	11	5
	48	19	73	50	27	13

The stepped lines in the "percentage retained" columns separate entries above and below 25% retention. This indicates, for example, that a 130 mm mesh size and a 16 inch minimum size could be considered compatible for cod, but barely so for pollock and haddock, for which a 140 mm mesh would be preferable (particularly for haddock). With regard to a 19 inch minimum fish size, a mesh size of 152 mm would be required for cod but this mesh size would be borderline for pollock and haddock.

While the above table is of some interest from a regulatory viewpoint, it is the size composition of the catch which concerns the industry. Size of fish in catches is a function not only of gear selection, but also of the size structure of the population being fished. The average impact on catch size compositions of a mesh size increase has been calculated here based on the 1984-86 population size structures (see Summary - size of fish in trawler catches section). In the case of cod, 2% of the numbers landed in 1984-86 were 40 cm (39-41 cm) or less, and thus less than 16 inches. At larger mesh sizes, this percentage would have been about 1%. However, 11% of the landings were below 19 inches using 130 mm mesh. For pollock, virtually no fish 40 cm or less were taken despite the fact that about 20% of 40 cm pollock are retained by 130 mm trawls. Only 2% were 46 cm or less (i.e., less than 19 inches). This may be a function of large fish dominating the population structure and the fishery concentrating on these in 1984-86 (or possibly it is a function of poor selection data for pollock). Haddock catch size structure is quite different from the other species, about 25% being 40.5 cm (40-41 cm) or less. An increase in mesh size to 165 mm would have reduced that to 16%. The high percentage of small haddock calculated to occur using 165 mm mesh is remarkable, give that fish of 40.5 cm are only 3% retained by this mesh. Certainly, the numbers of large fish in the haddock populations have been reduced to a very low level and, even though only a small percentage of fish of 40.5 cm are retained, these small fish can account for a high proportion of the catch. Assuming that the high proportion of small fish was not a result of illegal use of small mesh gear, it is clear that mesh size regulation alone is not enough to prevent the exploitation of small fish and that reduction in exploitation rate is also essential.

The haddock and pollock data for 1984-86 illustrate the importance of population size structure, as well as mesh size, on the size of fish in catches. Population size structure is a function of exploitation history (e.g., a high F will result in few large fish being left in the population) and of recent recruitment (e.g., a good year class will result in a large proportion of the population being of small fish). Recruitment of a large year class can establish a trend in size structure which persists over several years as the year class passes through the population. The 1963 year class of haddock on Georges Bank, for example, dominated fished population (and catch) size structure from 1965 to 1972. There are also seasonal and area variations in the availability to the fishery of different size groups in the population, e.g., as a result of concentration of large fish on spawning grounds during the spawning season. There is, as a result, substantial variation in the size of fish in that part of the population available to be caught, both spatially and temporally. Haddock data provide a useful insight to temporal and spatial variability in size composition of catches. Div. 4VW catches in 1984 contained 43% of fish 40.5 cm and less (Table D-2), while in Div. 5Z in 1986 fish of these sizes comprised only 1% of catches (Table F-2). Even within these areas, the percentage of these sized fish declined from 43% to 23% over 2 years in Div. 4VW and from 26% to 1% in one year in Div. 5Z.

Thus, catches with the same mesh size in different areas, seasons and years will vary substantially in size composition and the data presented here in the form of annual averages for a period of only three years certainly will not reflect the range of variation which will be encountered. Such variations are of great practical import in the application of minimum fish size regulations. Nonetheless, an increase in mesh size will result in fewer small fish being caught, and hence in a smaller proportion of the total catch being of small fish on average. It might also be expected to smooth out temporal and spatial variations to some degree. Two factors come into play in this regard. Selection range increases with mesh size and growth rate decreases with age causing more overlap in size between adjacent year classes. Thus there are more year classes within the selection range, each of which recruits more gradually to the gear. It may be argued, however, that, with dome-shaped partial recruitment patterns, the size range of fish available to the gear may be so reduced that variability is actually increased. Thus, in practice, the impact of a mesh size increase on variability in size composition of catches is unpredictable.

Potential Impacts on Flatfish Species

Among other species, flatfish, particularly American plaice, are most important to large mesh bottom trawl fisheries and witch flounder and American plaice to seine net fisheries. As a generalization, flatfish less than 12-13 inches are not desirable to the industry and most fish less than this size are culled from catches and discarded. As about 75% of fish which are this size (32 cm) are retained by 130 mm mesh nets (Table 3), quite high discards could be expected when using this mesh size. The occurrence of substantial discards holds true for American plaice and yellowtail flounder. In contrast, discards of small witch flounder are low as these are not available to the gear, even when small-mesh nets are used. If the 12-13 inch (32 cm) cull size is thought of as an unofficial minimum landed size regulation, a compatable mesh size would be one that was greater than 152 mm (Table 3).

Based on the fish sizes in 1984-86 catches, an increase in mesh size to 140 mm would reduce discards but would have only a marginal impact on landings-per-unit-effort and on sizes of fish landed. Increases to 152 mm and 165 mm would result in an immediate drop in landings-per-unit-effort (on average) of about 10% and 25% respectively. Mean weight of fish in the landings would increase by about 10% and 20% respectively. Thus, to make the same landings, fishing effort could be increased by about 10% and 33% when using 152 mm and 165 mm mesh nets. Flatfish catch allocations have not been restrictive, however, so more fishing effort could be used even when fishing with 130 mm mesh nets.

Conclusions

The proposal to increase mesh size was put forward as a way to ameliorate temporarily the groundfish fleet overcapacity problem in the Scotia-Fundy Region. The proposal has been evaluated in that context, and this report provides analytical results which are intended to be useful to fishery managers in evaluating this proposal in relation to other measures which might serve the same purpose.

As trawlers exert about 60% of the fishing effort in the mesh-regulated groundfish fishery, i.e., that for cod, haddock, pollock and flatfishes, a mesh size increase has the potential to substantially influence overall fleet capacity utilization. However, since current fleet capacity is more than twice that required, a large increase in mesh size would be needed to make a significant contribution to a (temporary) solution.

There is no basis to suggest, at least from yield-per-recruit calculations, that significant increases in long-term yields will result from a mesh size increase. Nonetheless, the potential for discarding introduced with adoption of minimum landed fish size regulations would be reduced. There could also be less need to dump fish to meet trip limits because reduced catch-per-tow will allow more control over quantities caught. Size and trip limits had little impact in the base years used here (1984-86), and potential discarding has not been taken into account in the yield-per-recruit calculations. To the extent that a mesh size increase averts such prospective problems, it will safeguard long-term yields. Yield-per-recruit calculations also take no account of recruitment variability and, in the case of haddock stocks, spawning stock sizes may be approaching levels at which recruitment prospects are adversely affected. Haddock catches contain a high proportion of small fish, reflecting heavy over-exploitation. Increase in mesh size would reduce trawler efficiency for haddock more than for other species (Fig. 8), thus serving as a conservation measure which could protect long-term yield prospects. It would also help to reduce the number of instances where haddock by-catch restrictions hinder efforts to catch other species. In summary, yield related arguements for a mesh size increase concern conservation rather than augmentation.

Increase in the size of fish landed as a result of a mesh size increase would increase the value of the catch. A premium of 30-100% may be paid for fish of larger grades. As the catch per time fishing will be lower, particularly in the short-term, the cost of catching the same tonnage of fish will, however, increase. Fixed costs will not change but variable costs, e.g., fuel and gear, will. Labour costs will also increase to take the same total catch tonnage because value per ton will increase, and fishermen are paid on a share basis (but these extra labour costs must be completely offset by increased price paid for the landings). Whether or not vessels will operate more profitably depends on whether the owner's share of the increased value of landings is sufficient to offset the increased variable costs.

An increase in mesh size would make a contribution to the short-term reduction of fleet over-capacity without reduction in the number of participating vessels, and hence without reducing the number of fishermen employed. It also requires these fishermen to spend more time at sea to catch the same quantity of fish. The total wage earned would be somewhat higher due to increased value per ton landed, but the hourly wage may well be lower. If a fisherman had to give up employment opportunities in another fishery or another industry because of the additional time spent to make the catch, his annual wage from all sources could be lower. This could also apply if the individual was required to spend more time working and less time collecting unemployment insurance.

Perceived equality of opportunity between trawler and longline fishermen, who compose the bulk of the "other gear" sector, is another relevant issue. A longstanding complaint of longline fishermen is that trawlers "intercept" small fish before they become available to longline gear. Reduction in the selection of small fish by trawlers will move trawler selection closer to that by longliners, thus in some part addressing this complaint.

Practicality and costs of enforcement of mesh regulations are also relevant to evaluation of the merits of alternative actions. Mesh regulations have been in force for many years and costs should not greatly differ as a result of the particular size of mesh which is being enforced. A change in mesh size would no doubt heighten enforcement needs during a transition phase. In addition, reduced catch rates could increase the incentive to cheat, requiring more enforcement to maintain the same level of compliance with a larger mesh size than a smaller one in the longer-term. Of more importance, however, is whether the present level of enforcement is indeed providing a satisfactory level of compliance. If not, then adequate enforcement of a larger mesh size could prove to have substantial incremental costs.

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Table 1. Mesh selection parameters for cod, haddock and pollock. (m - mesh size in mm, "cc" - covered codend experiment, "at" - alternate tow experiment.)

Species	Selection Factor	Selection Range (mm)	Mesh Size (mm)	Source
Cod	-87.62+4.35 m		66-168	Clay (1979b)
	4.28		90	Clay (1979b)
	3.75	(see Fig. 2)	66-168	Holden (1971)
	3.68	92	136	Hylen (1968)
	3.33	~90	105	Smolowitz (1983)
	3.41	~90	135 (cc)	Smolowitz (1983)
	3.80	~90	135 (at)	Smolowitz (1983)
	2.97		132	Thorsteinsson (1980)
	3.03		140	Thorsteinsson (1980)
	3.03		151	Thorsteinsson (1980)
	3.24		166	Thorsteinsson (1980)
Haddock	-28.49+3.63 m		57-178	Clay (1979b)
	3.34		60	Clay (1979b)
	3.29		70	Clay (1979b)
	3.78		90	Clay (1979b)
	4.00		120	Clay (1979b)
	3.38	(see Fig. 3)	57-178	Holden (1971)
	3.44	72	136	Hylen (1968)
	3.17		107	Smolowitz (1983)
	3.04		138 (cc)	Smolowitz (1983)
	3.47		138 (at)	Smolowitz (1983)
	3.00		132	Thorsteinsson (1980)
	2.79		151	Thorsteinsson (1980)
	3.24		166	Thorsteinsson (1980)
Pollock	4.22		90	Clay (1979b)
	3.79	88	136	Hylen (1968)
	3.26		138 (cc)	Smolowitz (1983)
	3.33		138 (at)	Smolowitz (1983)

Table 2. Mesh selection parameters for flatfish.

Species	Selection Factor	Selection Range (mm)	Mesh Size (mm)	Source
American plaice	2.33	40	109	Holden (1971)
	2.41	47	114	Holden (1971)
	2.20	52	123	Holden (1971)
	2.42	-	60	Clay (1979b)
	2.31	-	70	Clay (1979b)
	2.50	-	120	Clay (1979b)
	2.33	-	66	Templeman (1963)
	2.26	-	102	Templeman (1963)
	2.24	-	112	Templeman (1963)
	2.35	36	99	Smolowitz (1983)
	2.25	60	131	Smolowitz (1983)
	2.41	70	131	Smolowitz (1983)
	2.0-2.5	-	112-125	McCracken (1963)
Yellowtail flounder	2.29[1]	31[1]	114	Holden (1971)
	2.15[1]	77	127	Holden (1971)
	2.29	50	129	Holden (1971)
	2.79	40	129	Holden (1971)
	2.34	85	145	Holden (1971)
	2.28	-	145	Holden (1971)
	2.16	30	102	Smolowitz (1983)
	2.18	60	133	Smolowitz (1983)
	2.29	60	133	Smolowitz (1983)
Witch flounder	3.67	-	60	Clay (1979b)
	2.08	-	120	Clay (1979b)
	2.21	-	99	Templeman (1963)
	1.83	-	112	Templeman (1963)
	2.48	-	117	Templeman (1963)
Flatfish - all species	22.91+2.10 m	-	60-145	Clay (1979b)

1 - Corrected based on original report by Strzyzewski (1966).

Table 3. Proportion of fish retained at each length with different mesh sizes for cod, haddock, pollock and flatfish. (Length groupings are 3 cm for cod and pollock -- midpoints shown, 2 cm for haddock -- lower lengths shown and 1 cm for flatfish.)

COD

Length Group (cm)	Mesh (mm) 130	140	152	165
25	0.00	0.00	0.00	0.00
28	0.01	0.00	0.00	0.00
31	0.01	0.01	0.00	0.00
34	0.03	0.02	0.01	0.00
37	0.06	0.03	0.01	0.01
40	0.12	0.06	0.03	0.01
43	0.23	0.11	0.05	0.02
46	0.39	0.20	0.09	0.04
49	0.58	0.33	0.15	0.06
52	0.74	0.49	0.25	0.11
55	0.86	0.66	0.38	0.18
58	0.93	0.79	0.53	0.28
61	0.97	0.88	0.68	0.41
64	0.98	0.94	0.80	0.55
67	0.99	0.97	0.88	0.68
70	1.00	0.98	0.93	0.79
73	1.00	0.99	0.96	0.87
76	1.00	1.00	0.98	0.92
79	1.00	1.00	0.99	0.95
82	1.00	1.00	0.99	0.97
85	1.00	1.00	1.00	0.99
88	1.00	1.00	1.00	0.99
91	1.00	1.00	1.00	1.00
94	1.00	1.00	1.00	1.00

POLLOCK

Length Group (cm)	Mesh (mm) 130	140	152	165
25	0.00	0.00	0.00	0.00
28	0.01	0.01	0.00	0.00
31	0.02	0.01	0.01	0.00
34	0.05	0.02	0.01	0.01
37	0.10	0.05	0.03	0.01
40	0.19	0.10	0.05	0.02
43	0.34	0.19	0.09	0.04
46	0.53	0.32	0.16	0.08
49	0.72	0.50	0.28	0.14
52	0.85	0.68	0.43	0.23
55	0.92	0.81	0.60	0.36
58	0.96	0.90	0.75	0.51
61	0.98	0.95	0.85	0.66
64	0.99	0.98	0.92	0.79
67	1.00	0.99	0.96	0.87
70	1.00	0.99	0.98	0.93
73	1.00	1.00	0.99	0.96
76	1.00	1.00	0.99	0.98
79	1.00	1.00	1.00	0.99
82	1.00	1.00	1.00	0.99
85	1.00	1.00	1.00	1.00
88	1.00	1.00	1.00	1.00

HADDOCK

Length Group (cm)	Mesh (mm) 130	140	152	165
24	0.00	0.00	0.00	0.00
26	0.01	0.00	0.00	0.00
28	0.01	0.01	0.00	0.00
30	0.02	0.01	0.01	0.00
32	0.04	0.02	0.01	0.01
34	0.07	0.03	0.02	0.01
36	0.11	0.05	0.03	0.01
38	0.17	0.09	0.04	0.02
40	0.26	0.13	0.06	0.03
42	0.38	0.20	0.10	0.04
44	0.51	0.30	0.14	0.07
46	0.64	0.41	0.21	0.10
48	0.76	0.53	0.29	0.14
50	0.84	0.65	0.40	0.20
52	0.90	0.76	0.51	0.28
54	0.94	0.84	0.62	0.37
56	0.96	0.89	0.72	0.47
58	0.98	0.93	0.80	0.58
60	0.99	0.96	0.87	0.67
62	0.99	0.97	0.91	0.76
64	1.00	0.98	0.94	0.83
66	1.00	0.99	0.96	0.88
68	1.00	0.99	0.98	0.92
70	1.00	1.00	0.98	0.94
72	1.00	1.00	0.99	0.96
74	1.00	1.00	0.99	0.98
76	1.00	1.00	1.00	0.98
78	1.00	1.00	1.00	0.99
80	1.00	1.00	1.00	0.99
82	1.00	1.00	1.00	1.00
84	1.00	1.00	1.00	1.00

FLATFISH

Length Group (cm)	Mesh (mm) 130	140	152	165
24	0.09	0.05	0.03	0.01
25	0.13	0.07	0.04	0.02
26	0.19	0.10	0.05	0.03
27	0.26	0.14	0.07	0.04
28	0.34	0.20	0.10	0.05
29	0.44	0.27	0.14	0.07
30	0.54	0.35	0.19	0.09
31	0.64	0.43	0.24	0.13
32	0.73	0.53	0.32	0.17
33	0.80	0.62	0.40	0.22
34	0.86	0.71	0.48	0.28
35	0.90	0.78	0.57	0.35
36	0.93	0.84	0.65	0.42
37	0.95	0.88	0.73	0.50
38	0.97	0.92	0.79	0.59
39	0.98	0.94	0.84	0.66
40	0.99	0.96	0.88	0.73
41	0.99	0.97	0.92	0.79
42	0.99	0.98	0.94	0.84
43	1.00	0.99	0.96	0.88
44	1.00	0.99	0.97	0.91
45	1.00	0.99	0.98	0.93
46	1.00	1.00	0.98	0.95
47	1.00	1.00	0.99	0.96
48	1.00	1.00	0.99	0.97
49	1.00	1.00	0.99	0.98
50	1.00	1.00	1.00	0.99
51	1.00	1.00	1.00	0.99
52	1.00	1.00	1.00	0.99
53	1.00	1.00	1.00	0.99
54	1.00	1.00	1.00	1.00

Table 4. Div. 4VsW cod: fishing mortality patterns for trawl mesh sizes of 140, 152 and 165 mm under the three choices of mesh selection parameters described in the text.

Trawl partial recruitment for 140 mm mesh.

Case: A

"Observed" Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.004	0.002	0.001
4	0.060	0.032	0.069
5	0.221	0.141	0.205
6	0.339	0.356	0.307
7	0.345	0.403	0.330
8	0.274	0.309	0.287
9	0.197	0.345	0.209
10	0.200	0.210	0.180
11	0.133	0.254	0.165
12	0.158	0.257	0.084
13	0.053	0.095	0.055
14	0.058	0.033	0.135
15	0.000	0.024	0.026

Predicted Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.003	0.002	0.003
4	0.059	0.050	0.056
5	0.201	0.170	0.189
6	0.354	0.300	0.333
7	0.397	0.337	0.373
8	0.320	0.272	0.301
9	0.286	0.243	0.269
10	0.220	0.187	0.207
11	0.211	0.179	0.198
12	0.230	0.195	0.216
13	0.068	0.058	0.064
14	0.071	0.060	0.067
15	0.028	0.023	0.026

Case: B

"Observed" Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.004	0.002	0.001
4	0.072	0.038	0.079
5	0.243	0.158	0.229
6	0.335	0.364	0.317
7	0.322	0.387	0.311
8	0.249	0.292	0.273
9	0.182	0.320	0.196
10	0.182	0.196	0.166
11	0.120	0.236	0.155
12	0.142	0.246	0.079
13	0.048	0.086	0.049
14	0.053	0.031	0.119
15	0.000	0.022	0.023

Predicted Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.003	0.003	0.003
4	0.069	0.060	0.066
5	0.221	0.191	0.211
6	0.355	0.307	0.339
7	0.378	0.327	0.360
8	0.301	0.261	0.287
9	0.257	0.222	0.245
10	0.197	0.171	0.188
11	0.189	0.164	0.180
12	0.206	0.179	0.197
13	0.061	0.053	0.059
14	0.064	0.055	0.061
15	0.025	0.021	0.024

Case: C

"Observed" Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.006	0.002	0.002
4	0.078	0.043	0.091
5	0.235	0.157	0.235
6	0.324	0.353	0.312
7	0.321	0.382	0.306
8	0.258	0.295	0.271
9	0.188	0.329	0.195
10	0.190	0.203	0.166
11	0.129	0.249	0.153
12	0.154	0.250	0.078
13	0.052	0.094	0.053
14	0.057	0.033	0.124
15	0.000	0.023	0.025

Predicted Partial F's

Age	1984	1985	1986
1	0.000	0.000	0.000
2	0.000	0.000	0.000
3	0.004	0.004	0.004
4	0.076	0.067	0.075
5	0.216	0.190	0.212
6	0.341	0.299	0.335
7	0.362	0.318	0.356
8	0.295	0.259	0.290
9	0.256	0.224	0.251
10	0.208	0.183	0.205
11	0.200	0.175	0.196
12	0.218	0.191	0.214
13	0.065	0.057	0.064
14	0.067	0.059	0.066
15	0.026	0.023	0.026

Table 4. (Continued).

Trawl partial recruitment for 152 mm mesh.

Case: A B C

"Observed" Partial F's

Age	A 1984	A 1985	A 1986	B 1984	B 1985	B 1986	C 1984	C 1985	C 1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.002	0.001	0.001	0.002	0.001	0.001	0.005	0.002	0.002
4	0.036	0.019	0.043	0.049	0.025	0.052	0.068	0.037	0.081
5	0.170	0.104	0.150	0.217	0.133	0.187	0.214	0.142	0.214
6	0.335	0.328	0.275	0.347	0.359	0.304	0.318	0.338	0.299
7	0.397	0.435	0.372	0.355	0.413	0.343	0.337	0.389	0.318
8	0.343	0.354	0.331	0.281	0.315	0.297	0.287	0.312	0.286
9	0.239	0.417	0.249	0.202	0.354	0.219	0.209	0.363	0.211
10	0.253	0.253	0.219	0.205	0.215	0.190	0.218	0.227	0.185
11	0.175	0.312	0.187	0.137	0.259	0.172	0.153	0.286	0.162
12	0.209	0.287	0.095	0.162	0.262	0.089	0.187	0.267	0.086
13	0.068	0.121	0.072	0.054	0.096	0.057	0.063	0.113	0.064
14	0.075	0.042	0.186	0.060	0.034	0.143	0.069	0.040	0.150
15	0.000	0.030	0.033	0.000	0.024	0.026	0.000	0.028	0.031

Predicted Partial F's

Age	A 1984	A 1985	A 1986	B 1984	B 1985	B 1986	C 1984	C 1985	C 1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.002	0.001	0.001	0.002	0.001	0.001	0.003	0.003	0.003
4	0.037	0.030	0.033	0.048	0.039	0.043	0.067	0.058	0.065
5	0.155	0.125	0.138	0.194	0.161	0.176	0.198	0.171	0.193
6	0.341	0.275	0.305	0.364	0.301	0.330	0.332	0.286	0.322
7	0.460	0.370	0.411	0.418	0.346	0.378	0.379	0.326	0.368
8	0.391	0.315	0.350	0.354	0.293	0.321	0.320	0.276	0.311
9	0.348	0.280	0.311	0.302	0.250	0.274	0.284	0.244	0.276
10	0.294	0.237	0.263	0.232	0.192	0.210	0.226	0.195	0.220
11	0.282	0.227	0.252	0.223	0.184	0.202	0.244	0.210	0.237
12	0.308	0.248	0.275	0.243	0.201	0.220	0.266	0.229	0.258
13	0.092	0.074	0.082	0.072	0.060	0.065	0.079	0.068	0.077
14	0.095	0.077	0.085	0.075	0.062	0.068	0.082	0.071	0.080
15	0.037	0.030	0.033	0.029	0.024	0.026	0.032	0.028	0.031

Table 4. (Continued).

Trawl partial recruitment for 165 mm mesh.

Case: **A** **B** **C**

"Observed" Partial F's

Age	A 1984	A 1985	A 1986	B 1984	B 1985	B 1986	C 1984	C 1985	C 1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.001	0.001	0.001	0.001	0.000	0.000	0.004	0.002	0.002
4	0.023	0.012	0.029	0.030	0.015	0.033	0.060	0.033	0.074
5	0.118	0.073	0.107	0.172	0.102	0.141	0.195	0.129	0.198
6	0.298	0.277	0.231	0.345	0.336	0.277	0.306	0.320	0.285
7	0.434	0.441	0.394	0.401	0.441	0.381	0.347	0.389	0.324
8	0.439	0.406	0.381	0.339	0.353	0.335	0.315	0.326	0.299
9	0.304	0.524	0.303	0.237	0.413	0.252	0.232	0.397	0.227
10	0.335	0.323	0.278	0.249	0.249	0.223	0.251	0.256	0.206
11	0.250	0.427	0.207	0.171	0.305	0.191	0.186	0.335	0.170
12	0.307	0.334	0.112	0.204	0.286	0.098	0.235	0.289	0.096
13	0.097	0.172	0.105	0.067	0.117	0.071	0.078	0.143	0.080
14	0.105	0.058	0.272	0.073	0.041	0.185	0.086	0.049	0.181
15	0.000	0.040	0.048	0.000	0.029	0.032	0.000	0.035	0.038

Predicted Partial F's

Age	A 1984	A 1985	A 1986	B 1984	B 1985	B 1986	C 1984	C 1985	C 1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.001	0.001	0.001	0.001	0.001	0.001	0.003	0.003	0.003
4	0.024	0.019	0.021	0.030	0.024	0.026	0.060	0.051	0.059
5	0.112	0.086	0.097	0.154	0.122	0.134	0.183	0.155	0.177
6	0.300	0.231	0.260	0.354	0.281	0.307	0.319	0.271	0.309
7	0.497	0.383	0.432	0.474	0.376	0.411	0.387	0.329	0.375
8	0.477	0.368	0.415	0.397	0.314	0.344	0.342	0.290	0.331
9	0.445	0.343	0.387	0.354	0.280	0.306	0.313	0.265	0.303
10	0.427	0.329	0.371	0.294	0.233	0.255	0.257	0.219	0.249
11	0.409	0.316	0.356	0.282	0.223	0.244	0.251	0.213	0.243
12	0.447	0.344	0.388	0.308	0.244	0.267	0.334	0.283	0.323
13	0.133	0.102	0.115	0.091	0.072	0.079	0.099	0.084	0.096
14	0.138	0.106	0.120	0.095	0.075	0.082	0.103	0.087	0.100
15	0.054	0.041	0.047	0.037	0.029	0.032	0.040	0.034	0.039

Table 5. Div. 4VsW cod: partial recruitment patterns, fully-recruited fishing mortalities and effort scaling factors for trawls of various mesh sizes under the three choices of mesh selection parameters described in the text.

Case: **A**

Trawl Average Partial Recruitment

Age	Mesh (mm) 130	140	152	165
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.014	0.007	0.003	0.002
4	0.250	0.149	0.080	0.048
5	0.674	0.505	0.337	0.224
6	1.000	0.891	0.742	0.602
7	1.000	1.000	1.000	1.000
8	0.797	0.807	0.851	0.959
9	0.680	0.721	0.757	0.896
10	0.522	0.554	0.640	0.858
11	0.501	0.531	0.614	0.823
12	0.546	0.580	0.670	0.898
13	0.162	0.172	0.199	0.267
14	0.169	0.179	0.207	0.277
15	0.066	0.070	0.080	0.108

Trawl Fully-Recruited F

Year	Mesh (mm) 130	140	152	165
84	0.344	0.397	0.460	0.497
85	0.307	0.337	0.370	0.383
86	0.343	0.373	0.411	0.432

Trawl Effort Scale Factors

	Mesh (mm) 130	140	152	165
Factor	1.000	1.061	1.226	1.644

Case: **B**

Trawl Average Partial Recruitment

Age	Mesh (mm) 130	140	152	165
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.014	0.008	0.004	0.002
4	0.250	0.184	0.114	0.063
5	0.674	0.584	0.465	0.325
6	1.000	0.940	0.872	0.747
7	1.000	1.000	1.000	1.000
8	0.797	0.797	0.848	0.837
9	0.680	0.680	0.723	0.745
10	0.522	0.522	0.556	0.620
11	0.501	0.501	0.533	0.594
12	0.546	0.546	0.581	0.649
13	0.162	0.162	0.173	0.193
14	0.169	0.169	0.180	0.200
15	0.066	0.066	0.070	0.078

Trawl Fully-Recruited F

Year	Mesh (mm) 130	140	152	165
84	0.344	0.378	0.418	0.474
85	0.307	0.327	0.346	0.376
86	0.343	0.360	0.378	0.411

Trawl Effort Scale Factors

	Mesh (mm) 130	140	152	165
Factor	1.000	1.000	1.064	1.187

Case: **C**

Trawl Average Partial Recruitment

Age	Mesh (mm) 130	140	152	165
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.014	0.011	0.009	0.008
4	0.250	0.210	0.177	0.156
5	0.674	0.597	0.524	0.473
6	1.000	0.941	0.877	0.824
7	1.000	1.000	1.000	1.000
8	0.797	0.816	0.846	0.884
9	0.680	0.706	0.750	0.808
10	0.522	0.575	0.597	0.665
11	0.501	0.551	0.643	0.648
12	0.546	0.601	0.702	0.862
13	0.162	0.179	0.209	0.256
14	0.169	0.186	0.217	0.266
15	0.066	0.072	0.084	0.104

Trawl Fully-Recruited F

Year	Mesh (mm) 130	140	152	165
84	0.344	0.362	0.379	0.387
85	0.307	0.318	0.326	0.329
86	0.343	0.356	0.368	0.375

Trawl Effort Scale Factors

	Mesh (mm) 130	140	152	165
Factor	1.000	1.101	1.285	1.577

Table 6. Div. 4VsW cod: summary of partial recruitment parameter estimation in terms of average trawl fully-recruited fishing mortality (F), effort scaling factor (k) and estimated fishing effort (f) required to take 1984-86 trawl catches for the three choices of mesh selection parameters described in the text.

	Trawl Fully-Recruited F (ave. 84-86)				Scaling Factor (k)				Trawl Fishing Effort Index (f=kF)			
	Mesh (mm)				Mesh (mm)				Mesh (mm)			
Case	130	140	152	165	130	140	152	165	130	140	152	165
A	.33	.37	.41	.44	1.00	1.06	1.23	1.64	.33	.39	.51	.72
B	.33	.36	.38	.42	1.00	1.00	1.06	1.19	.33	.36	.41	.50
C	.33	.35	.36	.36	1.00	1.10	1.29	1.58	.33	.38	.46	.57

Table 7. Div. 4VsW cod: results of yield-per-recruit analyses for fishing mortality, yield and yield-per-effort values for the trawl component (normalized to unity at 130 mm mesh) at $F_{0.1}$ and F_{max} using input data for the three sets of mesh selection parameters described in the text.

A. $F_{0.1}$

Mesh Size	Case	Fishing Mortality Full	5+	7+	9+	Yield	Yield/ Effort
130	A	.212	.166	.188	.186	.586	1.000
	B	.212	.166	.188	.186	.587	1.000
	C	.212	.166	.188	.186	.587	1.000
140	A	.228	.167	.203	.200	.604	0.910
	B	.221	.169	.198	.194	.597	0.964
	C	.225	.166	.196	.195	.598	0.912
152	A	.248	.162	.218	.214	.625	0.789
	B	.230	.168	.209	.202	.610	0.903
	C	.239	.163	.200	.201	.607	0.804
165	A	.279	.153	.228	.235	.649	0.661
	B	.248	.164	.220	.215	.627	0.802
	C	.261	.159	.203	.207	.616	0.688

B. F_{max}

Mesh Size	Case	Fishing Mortality Full	5+	7+	9+	Yield	Yield/ Effort
130	A	.400	.299	.350	.332	.632	1.000
	B	.400	.299	.350	.332	.632	1.000
	C	.400	.299	.350	.332	.632	1.000
140	A	.453	.310	.403	.380	.651	0.857
	B	.431	.313	.385	.359	.642	0.928
	C	.431	.302	.372	.356	.642	0.884
152	A	.523	.305	.460	.436	.678	0.695
	B	.472	.318	.427	.397	.658	0.827
	C	.464	.294	.383	.372	.653	0.765
165	A	.617	.286	.496	.508	.708	0.541
	B	.535	.314	.478	.448	.681	0.691
	C	.510	.285	.389	.387	.664	0.641

Table 8. Div. 4VsW cod: results of catch projections for fishing mortality and fishing effort of the trawl component in 1988 assuming that allocations are caught, using input data for the three sets of mesh selection parameters described in the text.

Mesh Size	Case	Fishing Mortality				Trawl Effort
		Full	5+	7+	9+	
130	A	.290	.262	.236	.212	.248
	B	.290	.262	.236	.212	.248
	C	.290	.262	.236	.212	.248
140	A	.306	.268	.252	.228	.280
	B	.302	.267	.244	.218	.259
	C	.294	.263	.245	.226	.277
152	A	.318	.269	.275	.255	.337
	B	.309	.271	.260	.229	.283
	C	.295	.262	.256	.241	.324
165	A	.307	.260	.302	.301	.434
	B	.323	.271	.274	.254	.332
	C	.292	.259	.265	.253	.393

Table 9. Div. 4VsW cod: average partial recruitment patterns, fully-recruited fishing mortalities and effort scaling factors for trawls of each mesh size and for other gears derived from the separable model and by conventional averaging methods using 1984, 1985 and 1986 data.

Separable Model / Averaging

Trawl Average Partial Recruitment

Separable Model

Age	Mesh (mm) 130	140	152	165
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.014	0.007	0.004	0.002
4	0.250	0.143	0.080	0.049
5	0.674	0.475	0.308	0.195
6	1.000	0.860	0.697	0.518
7	1.000	1.000	1.000	0.914
8	0.797	0.817	0.889	0.943
9	0.680	0.746	0.924	0.914
10	0.522	0.573	0.710	0.956
11	0.501	0.550	0.680	0.917
12	0.546	0.600	0.742	1.000
13	0.162	0.178	0.221	0.297
14	0.169	0.185	0.229	0.309
15	0.066	0.072	0.089	0.120

Averaging

Age	Mesh (mm) 130	140	152	165
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.012	0.007	0.004	0.003
4	0.252	0.156	0.088	0.055
5	0.699	0.529	0.344	0.286
6	1.000	1.000	0.773	0.709
7	1.000	1.000	1.000	1.000
8	0.783	0.864	1.000	1.000
9	0.657	0.739	0.798	1.000
10	0.516	0.589	0.680	1.000
11	0.481	0.546	0.633	0.785
12	0.435	0.482	0.544	0.667
13	0.172	0.203	0.255	0.448
14	0.196	0.240	0.304	0.514
15	0.043	0.050	0.062	0.092

Trawl Fully-Recruited F

Separable Model

Year	Mesh (mm) 130	140	152	165
84	0.344	0.404	0.463	0.527
85	0.307	0.342	0.372	0.406
86	0.343	0.381	0.418	0.467

Averaging

Year	Mesh (mm) 130	140	152	165
84	0.315	0.344	0.389	0.452
85	0.367	0.379	0.402	0.422
86	0.307	0.318	0.359	0.387

Trawl Effort Scale Factors

Separable Model

	Mesh (mm) 130	140	152	165
factor	1.000	1.098	1.359	1.831

Averaging

	Mesh (mm) 130	140	152	165
factor	1.000	1.150	1.359	2.004

Table 9. (Continued).

Other Gears' Average Partial Recruitment

Age	PR
1	0.000
2	0.000
3	0.003
4	0.046
5	0.108
6	0.180
7	0.291
8	0.325
9	0.456
10	0.499
11	0.668
12	1.000
13	1.000
14	1.000
15	1.000

Age	PR
1	0.000
2	0.000
3	0.003
4	0.053
5	0.127
6	0.212
7	0.328
8	0.353
9	0.443
10	0.526
11	0.684
12	1.000
13	1.000
14	1.000
15	1.000

Other Gears' Fully-Recruited F

	1984	1985	1986
F	0.360	0.335	0.276

	1984	1985	1986
F	0.224	0.382	0.291

Table 10. Div. 4VsW cod: observed and predicted fishing mortality patterns for trawls of various mesh sizes and for other gears derived from the separable model and by conventional averaging methods using 1984, 1985 and 1986 data.

A. 130 mm mesh

	Observed Partial F's			Separable Model: Predicted Partial F's			Averaging: Predicted Partial F's		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.007	0.003	0.002	0.004	0.005	0.004	0.005	0.004	0.005
4	0.089	0.050	0.104	0.079	0.093	0.077	0.086	0.077	0.086
5	0.252	0.171	0.255	0.220	0.257	0.215	0.232	0.207	0.231
6	0.324	0.362	0.321	0.315	0.367	0.307	0.344	0.307	0.343
7	0.305	0.372	0.293	0.315	0.367	0.307	0.344	0.307	0.343
8	0.235	0.280	0.258	0.246	0.288	0.241	0.274	0.245	0.273
9	0.173	0.304	0.182	0.207	0.241	0.202	0.234	0.209	0.233
10	0.171	0.187	0.152	0.162	0.190	0.159	0.179	0.161	0.179
11	0.113	0.226	0.145	0.151	0.177	0.148	0.172	0.154	0.172
12	0.133	0.237	0.073	0.137	0.160	0.134	0.188	0.168	0.187
13	0.045	0.082	0.046	0.054	0.063	0.053	0.056	0.050	0.056
14	0.050	0.029	0.107	0.062	0.072	0.060	0.058	0.052	0.058
15	0.000	0.021	0.022	0.013	0.016	0.013	0.023	0.020	0.022

B. 140 mm mesh

	Observed Partial F's			Separable Model: Predicted Partial F's			Averaging: Predicted Partial F's		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.004	0.002	0.001	0.003	0.002	0.003	0.002	0.003	0.002
4	0.058	0.031	0.069	0.058	0.049	0.054	0.054	0.059	0.049
5	0.210	0.134	0.198	0.192	0.162	0.181	0.182	0.200	0.168
6	0.336	0.349	0.300	0.348	0.294	0.327	0.344	0.379	0.318
7	0.353	0.408	0.335	0.404	0.342	0.381	0.344	0.379	0.318
8	0.286	0.317	0.294	0.330	0.279	0.311	0.298	0.327	0.275
9	0.205	0.359	0.214	0.302	0.255	0.284	0.255	0.280	0.235
10	0.210	0.218	0.185	0.232	0.196	0.218	0.203	0.223	0.187
11	0.141	0.265	0.167	0.222	0.188	0.209	0.188	0.207	0.173
12	0.168	0.262	0.085	0.242	0.205	0.228	0.166	0.182	0.153
13	0.056	0.100	0.058	0.072	0.061	0.068	0.070	0.077	0.064
14	0.062	0.035	0.143	0.075	0.063	0.071	0.083	0.091	0.076
15	0.000	0.025	0.027	0.029	0.025	0.027	0.017	0.019	0.016

Table 10. (Continued).

C. **152 mm mesh**

	Observed Partial F's			Separable Model: Predicted Partial F's			Averaging: Predicted Partial F's		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.002	0.001	0.001	0.002	0.001	0.002	0.001	0.002	0.001
4	0.035	0.019	0.045	0.037	0.030	0.033	0.034	0.035	0.031
5	0.153	0.096	0.143	0.143	0.115	0.129	0.134	0.138	0.123
6	0.319	0.310	0.261	0.323	0.259	0.292	0.301	0.311	0.278
7	0.406	0.434	0.374	0.463	0.372	0.418	0.389	0.402	0.359
8	0.371	0.370	0.343	0.411	0.330	0.371	0.389	0.402	0.359
9	0.258	0.449	0.261	0.428	0.343	0.386	0.310	0.321	0.286
10	0.277	0.274	0.232	0.329	0.264	0.297	0.264	0.273	0.244
11	0.197	0.347	0.190	0.315	0.253	0.284	0.246	0.254	0.227
12	0.237	0.301	0.098	0.344	0.276	0.310	0.211	0.219	0.195
13	0.077	0.136	0.082	0.102	0.082	0.092	0.099	0.102	0.091
14	0.084	0.047	0.208	0.106	0.085	0.096	0.118	0.122	0.109
15	0.000	0.033	0.037	0.041	0.033	0.037	0.024	0.025	0.022

D. **165 mm mesh**

	Observed Partial F's			Predicted Partial F's			Predicted Partial F's		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.002	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4	0.023	0.013	0.032	0.026	0.020	0.023	0.025	0.023	0.021
5	0.106	0.068	0.104	0.103	0.079	0.091	0.130	0.121	0.111
6	0.271	0.252	0.215	0.273	0.210	0.242	0.321	0.299	0.275
7	0.428	0.425	0.383	0.482	0.371	0.427	0.452	0.422	0.387
8	0.477	0.419	0.391	0.497	0.383	0.440	0.452	0.422	0.387
9	0.336	0.574	0.322	0.482	0.371	0.426	0.452	0.422	0.387
10	0.377	0.362	0.307	0.504	0.388	0.446	0.452	0.422	0.387
11	0.297	0.503	0.212	0.483	0.372	0.428	0.355	0.331	0.304
12	0.374	0.360	0.124	0.527	0.406	0.467	0.302	0.281	0.258
13	0.116	0.208	0.125	0.157	0.121	0.139	0.203	0.189	0.173
14	0.125	0.068	0.319	0.163	0.125	0.144	0.232	0.217	0.199
15	0.000	0.047	0.057	0.063	0.049	0.056	0.042	0.039	0.036

Table 10. (Continued).

E. Other Gears

	Observed Partial F's			Separable Model Predicted Partial F's			Averaging Predicted Partial F's		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
4	0.014	0.011	0.020	0.017	0.016	0.013	0.012	0.020	0.015
5	0.046	0.032	0.027	0.039	0.036	0.030	0.029	0.049	0.037
6	0.078	0.068	0.032	0.065	0.060	0.050	0.047	0.081	0.062
7	0.106	0.116	0.060	0.105	0.097	0.080	0.073	0.125	0.095
8	0.094	0.119	0.095	0.117	0.109	0.090	0.079	0.135	0.102
9	0.089	0.131	0.171	0.164	0.153	0.126	0.099	0.169	0.129
10	0.124	0.127	0.201	0.180	0.167	0.138	0.118	0.201	0.153
11	0.145	0.262	0.209	0.241	0.224	0.184	0.153	0.261	0.199
12	0.252	0.251	0.280	0.360	0.335	0.276	0.224	0.382	0.291
13	0.207	0.807	0.308	0.360	0.335	0.276	0.224	0.382	0.291
14	0.156	0.189	0.245	0.360	0.335	0.276	0.224	0.382	0.291
15	0.282	0.280	0.329	0.360	0.335	0.276	0.224	0.382	0.291

Table 11. Div. 4VsW cod: average fully-recruited F for trawls, scaling factor, and trawl fishing effort index for each mesh size for each of the eight combinations of data and methods used to calculate partial recruitments.

	Trawl Fully-Recruited F (ave. 84-86)				Scaling Factor (k)				Trawl Fishing Effort Index (f=kF)			
Year	Mesh (mm)				Mesh (mm)				Mesh (mm)			
Mix	130	140	152	165	130	140	152	165	130	140	152	165
1 2 3	0.33	0.38	0.42	0.47	1.00	1.10	1.36	1.83	0.33	0.41	0.57	0.85
1 2 3*	0.33	0.35	0.38	0.42	1.00	1.15	1.36	2.00	0.33	0.40	0.52	0.84
1 1 2	0.34	0.38	0.43	0.45	1.00	1.00	1.03	1.24	0.34	0.38	0.45	0.56
1 1 3	0.32	0.36	0.43	0.43	1.00	1.00	1.00	1.27	0.32	0.36	0.43	0.55
1 2 2	0.36	0.40	0.45	0.53	1.00	1.10	1.31	1.61	0.36	0.44	0.59	0.86
2 2 3	0.34	0.38	0.42	0.48	1.00	1.10	1.35	1.75	0.34	0.42	0.56	0.84
1 3 3	0.31	0.36	0.44	0.42	1.00	1.10	1.25	2.03	0.31	0.40	0.55	0.85
2 3 3	0.32	0.37	0.40	0.40	1.00	1.10	1.37	2.07	0.32	0.40	0.55	0.84

* - PRs determined by averaging

Table 12. Div. 4VsW cod: results of yield-per-recruit analyses for fishing mortality and yield at $F_{0.1}$ and F_{max} for PR's obtained from the separable model using input data for different mixtures of the years 1984-86 and from conventional averaging methods.

A. $F_{0.1}$

Mesh Size	Year Mix	Fishing Mortality Full	5+	7+	9+	Yield
130	1 2 3	0.237	0.167	0.189	0.189	0.590
	1 2 3*	0.217	0.173	0.192	0.185	0.588
	1 1 2	0.217	0.172	0.187	0.176	0.586
	1 1 3	0.220	0.167	0.177	0.172	0.586
	1 2 2	0.242	0.173	0.201	0.193	0.589
	2 2 3	0.239	0.165	0.196	0.197	0.594
	1 3 3	0.209	0.164	0.179	0.180	0.589
	2 3 3	0.206	0.162	0.186	0.189	0.594
140	1 2 3	0.250	0.168	0.209	0.203	0.606
	1 2 3*	0.227	0.172	0.204	0.198	0.607
	1 1 2	0.236	0.172	0.201	0.184	0.605
	1 1 3	0.229	0.167	0.192	0.181	0.606
	1 2 2	0.257	0.170	0.216	0.207	0.606
	2 2 3	0.255	0.163	0.211	0.212	0.612
	1 3 3	0.215	0.162	0.197	0.193	0.608
	2 3 3	0.212	0.159	0.202	0.201	0.612
152	1 2 3	0.274	0.167	0.230	0.223	0.627
	1 2 3*	0.239	0.165	0.222	0.213	0.632
	1 1 2	0.259	0.169	0.219	0.196	0.630
	1 1 3	0.246	0.163	0.212	0.192	0.631
	1 2 2	0.283	0.163	0.230	0.232	0.631
	2 2 3	0.278	0.156	0.224	0.235	0.635
	1 3 3	0.240	0.157	0.219	0.212	0.632
	2 3 3	0.229	0.153	0.216	0.225	0.636
165	1 2 3	0.267	0.164	0.252	0.245	0.655
	1 2 3*	0.243	0.159	0.226	0.236	0.658
	1 1 2	0.256	0.161	0.233	0.213	0.658
	1 1 3	0.254	0.155	0.225	0.209	0.658
	1 2 2	0.331	0.153	0.235	0.251	0.660
	2 2 3	0.330	0.147	0.229	0.250	0.663
	1 3 3	0.246	0.147	0.221	0.227	0.660
	2 3 3	0.271	0.144	0.221	0.238	0.662

* - PRs determined by averaging

Table 12. (Continued).

B. F_{max}

Mesh Size	Year Mix	Fishing Mortality Full	5+	7+	9+	Yield
130	1 2 3	0.452	0.303	0.354	0.339	0.633
	1 2 3*	0.411	0.316	0.361	0.332	0.630
	1 1 2	0.414	0.317	0.357	0.311	0.630
	1 1 3	0.414	0.307	0.329	0.300	0.628
	1 2 2	0.464	0.314	0.385	0.353	0.633
	2 2 3	0.461	0.300	0.374	0.362	0.638
	1 3 3	0.387	0.294	0.324	0.313	0.629
	2 3 3	0.386	0.289	0.340	0.334	0.635
140	1 2 3	0.498	0.311	0.417	0.388	0.654
	1 2 3*	0.449	0.320	0.403	0.375	0.652
	1 1 2	0.472	0.326	0.406	0.345	0.652
	1 1 3	0.453	0.313	0.377	0.332	0.651
	1 2 2	0.521	0.317	0.440	0.405	0.656
	2 2 3	0.517	0.300	0.425	0.416	0.661
	1 3 3	0.418	0.296	0.379	0.356	0.652
	2 3 3	0.418	0.289	0.393	0.379	0.657
152	1 2 3	0.574	0.309	0.486	0.456	0.681
	1 2 3*	0.499	0.307	0.463	0.430	0.683
	1 1 2	0.545	0.323	0.474	0.391	0.681
	1 1 3	0.512	0.310	0.448	0.374	0.681
	1 2 2	0.607	0.305	0.492	0.492	0.686
	2 2 3	0.599	0.289	0.476	0.502	0.690
	1 3 3	0.491	0.286	0.445	0.421	0.681
	2 3 3	0.474	0.278	0.440	0.455	0.685
165	1 2 3	0.576	0.299	0.548	0.538	0.715
	1 2 3*	0.518	0.293	0.473	0.495	0.713
	1 1 2	0.556	0.304	0.517	0.446	0.713
	1 1 3	0.546	0.291	0.489	0.429	0.712
	1 2 2	0.734	0.281	0.509	0.553	0.719
	2 2 3	0.736	0.270	0.494	0.552	0.722
	1 3 3	0.518	0.266	0.456	0.460	0.713
	2 3 3	0.576	0.259	0.458	0.491	0.716

* - PRs determined by averaging

Table 13. Div. 4VsW cod: results of catch projections for fishing mortality and fishing effort of trawlers in 1988 assuming that allocations are caught, based on partial recruitment parameters estimated using different mixtures of data and methods for the years 1984-86 as discussed in the text.

Mesh Size	Year Mix	Fishing Mortality Full	5+	7+	9+	Trawl Effort
130	1 2 3	0.290	0.262	0.236	0.214	0.248
	1 2 3*	0.293	0.262	0.230	0.205	0.249
	1 1 2	0.307	0.267	0.222	0.199	0.257
	1 1 3	0.286	0.252	0.215	0.196	0.243
	1 2 2	0.309	0.276	0.243	0.217	0.260
	2 2 3	0.301	0.273	0.249	0.225	0.257
	1 3 3	0.274	0.249	0.223	0.200	0.240
	2 3 3	0.286	0.260	0.236	0.211	0.252
140	1 2 3	0.307	0.267	0.257	0.235	0.290
	1 2 3*	0.292	0.269	0.249	0.221	0.285
	1 1 2	0.325	0.273	0.234	0.207	0.275
	1 1 3	0.308	0.260	0.230	0.205	0.265
	1 2 2	0.316	0.279	0.266	0.234	0.293
	2 2 3	0.315	0.275	0.269	0.244	0.297
	1 3 3	0.293	0.256	0.252	0.218	0.284
	2 3 3	0.302	0.265	0.264	0.228	0.293
152	1 2 3	0.344	0.264	0.287	0.269	0.362
	1 2 3*	0.304	0.266	0.282	0.245	0.347
	1 1 2	0.344	0.273	0.252	0.219	0.303
	1 1 3	0.340	0.264	0.250	0.219	0.297
	1 2 2	0.351	0.272	0.290	0.267	0.359
	2 2 3	0.351	0.269	0.296	0.279	0.367
	1 3 3	0.326	0.256	0.297	0.246	0.351
	2 3 3	0.311	0.261	0.286	0.265	0.379
165	1 2 3	0.417	0.252	0.312	0.331	0.495
	1 2 3*	0.310	0.254	0.290	0.289	0.478
	1 1 2	0.330	0.263	0.281	0.239	0.348
	1 1 3	0.320	0.256	0.285	0.242	0.350
	1 2 2	0.426	0.258	0.314	0.309	0.480
	2 2 3	0.434	0.255	0.316	0.310	0.512
	1 3 3	0.326	0.247	0.299	0.294	0.535
	2 3 3	0.363	0.249	0.305	0.308	0.543

* - PRs determined by averaging

Table 14. Average catches of secondary groundfish species in 1982-86 by gear type in Div. 4VWX + Subarea 5. (OT = otter trawl, DS = Danish and Scottish seine, LL+HL = longline and handline.)

A. Tonnage (mt) of Catch

Species	Gear Type				Total
	OT	DS	LL+HL	Other	
Cusk	35	-	3467	134	3636
White hake	1885	77	3376	491	5829
Wolffishes	1351	12	524	78	1965
American plaice	3267	915	892	52	5126
Witch flounder	767	1126	34	37	1964
Yellowtail flounder	1605	191	63	23	1882

B. Percentage of Species Catch

Species	Gear Type				Total
	OT	DS	LL+HL	Other	
Cusk	1	-	95	4	100
White hake	32	1	58	9	100
Wolffishes	69	1	26	4	100
American plaice	64	18	17	1	100
Witch flounder	39	57	2	2	100
Yellowtail flounder	85	10	4	1	100

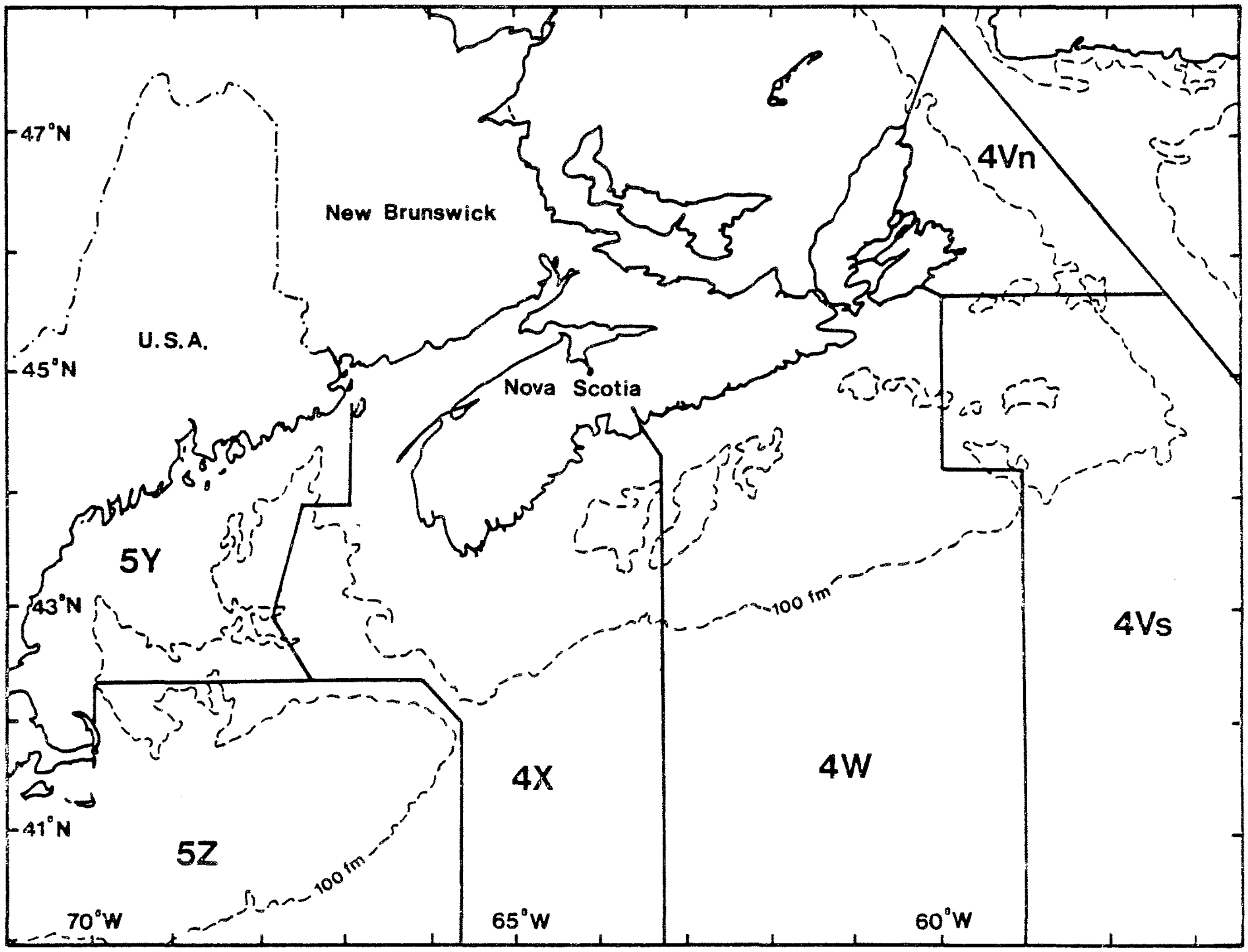
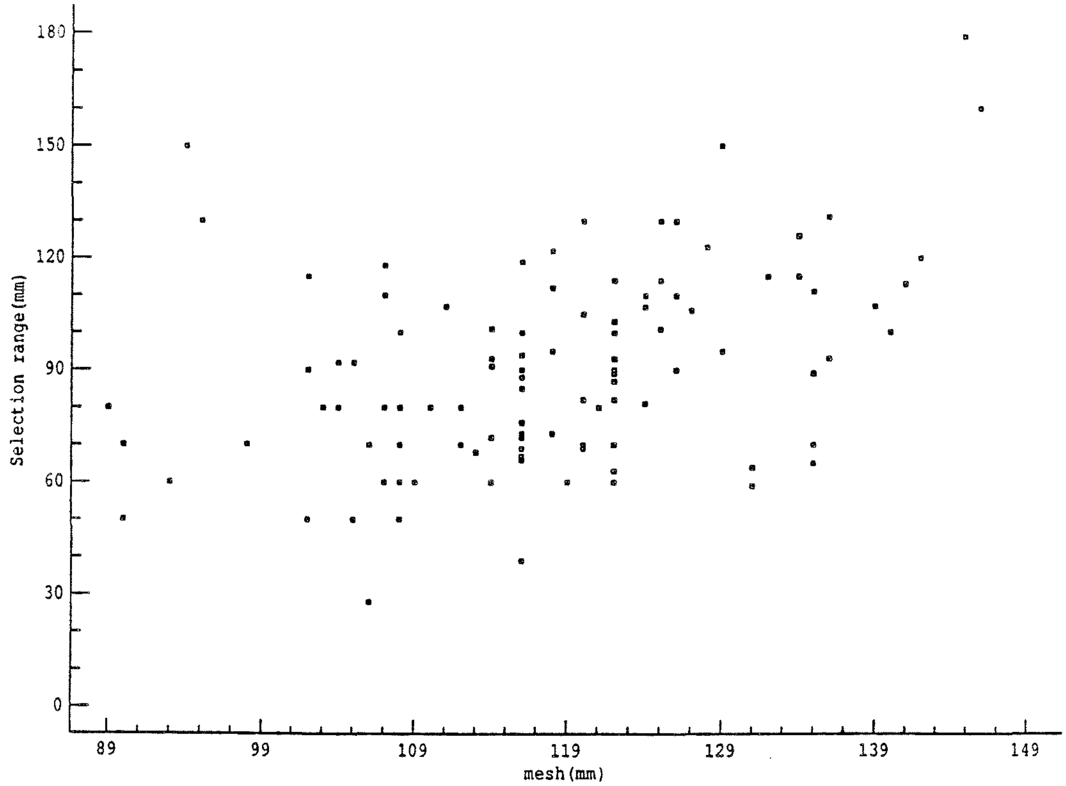


Figure 1. NAFO statistical divisions in the Scotia-Fundy Region.



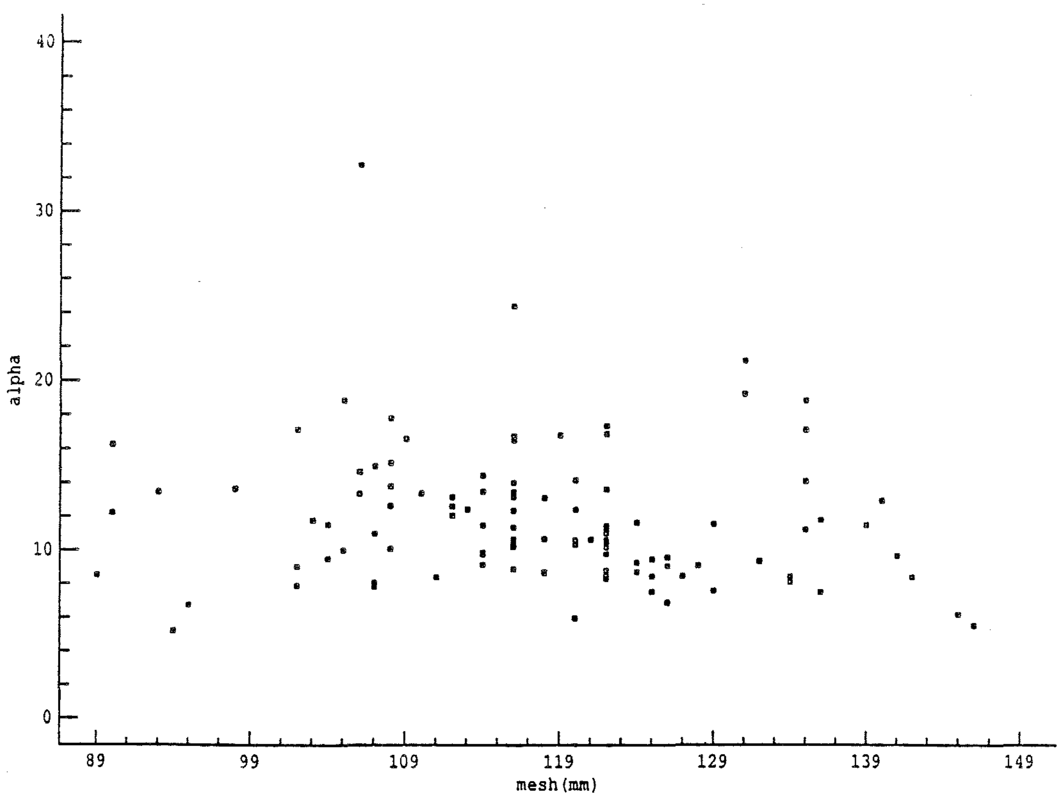


Figure 2. Selection range and selection ogive shape parameter in relation to mesh size for cod data from Holden (1971).

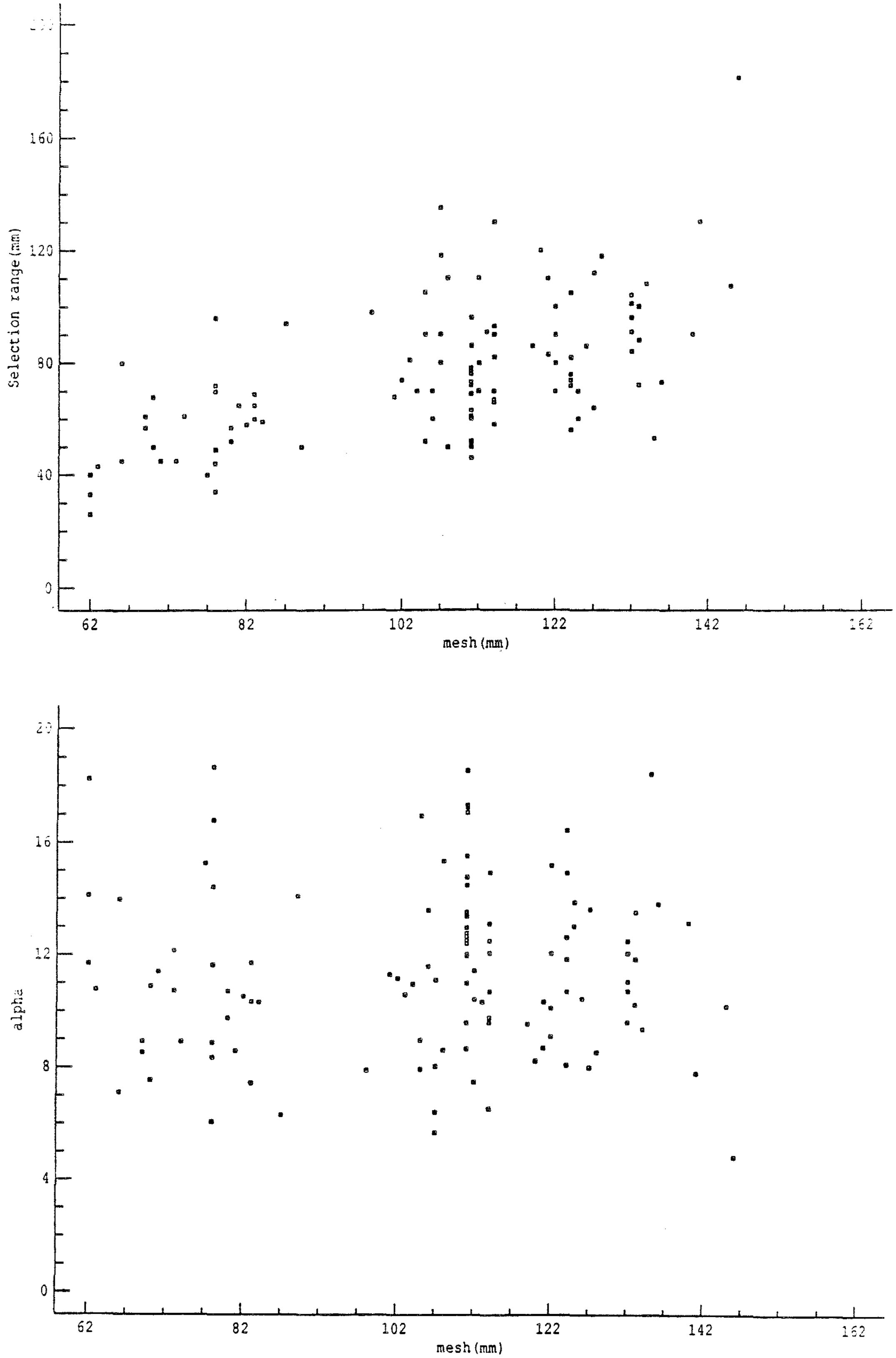


Figure 3. Selection range and selection ogive shape parameter in relation to mesh size for haddock data from Holden (1971).

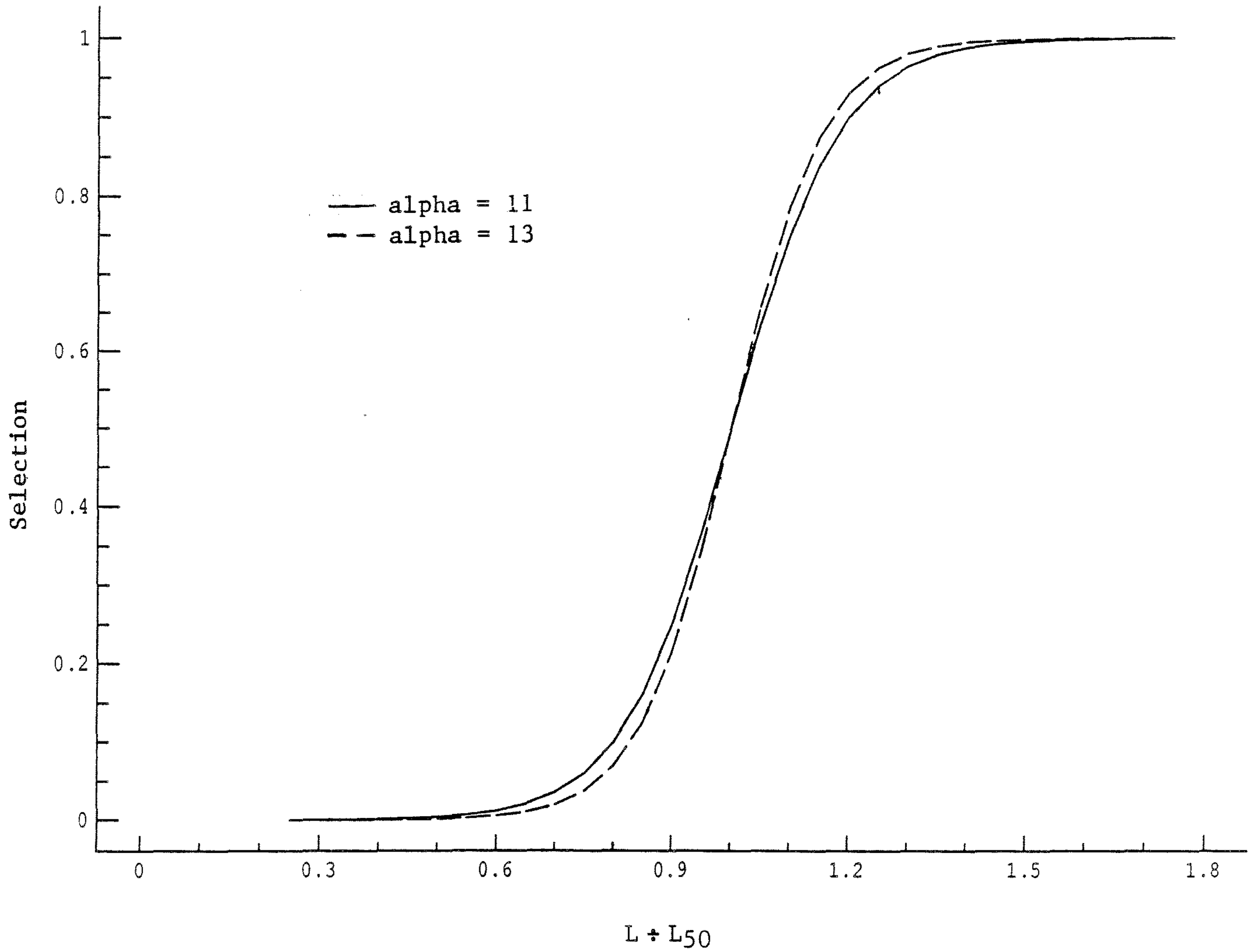


Figure 4. Comparison of mesh selection ogives with shape parameter values of $\alpha = 11$ and $\alpha = 13$.

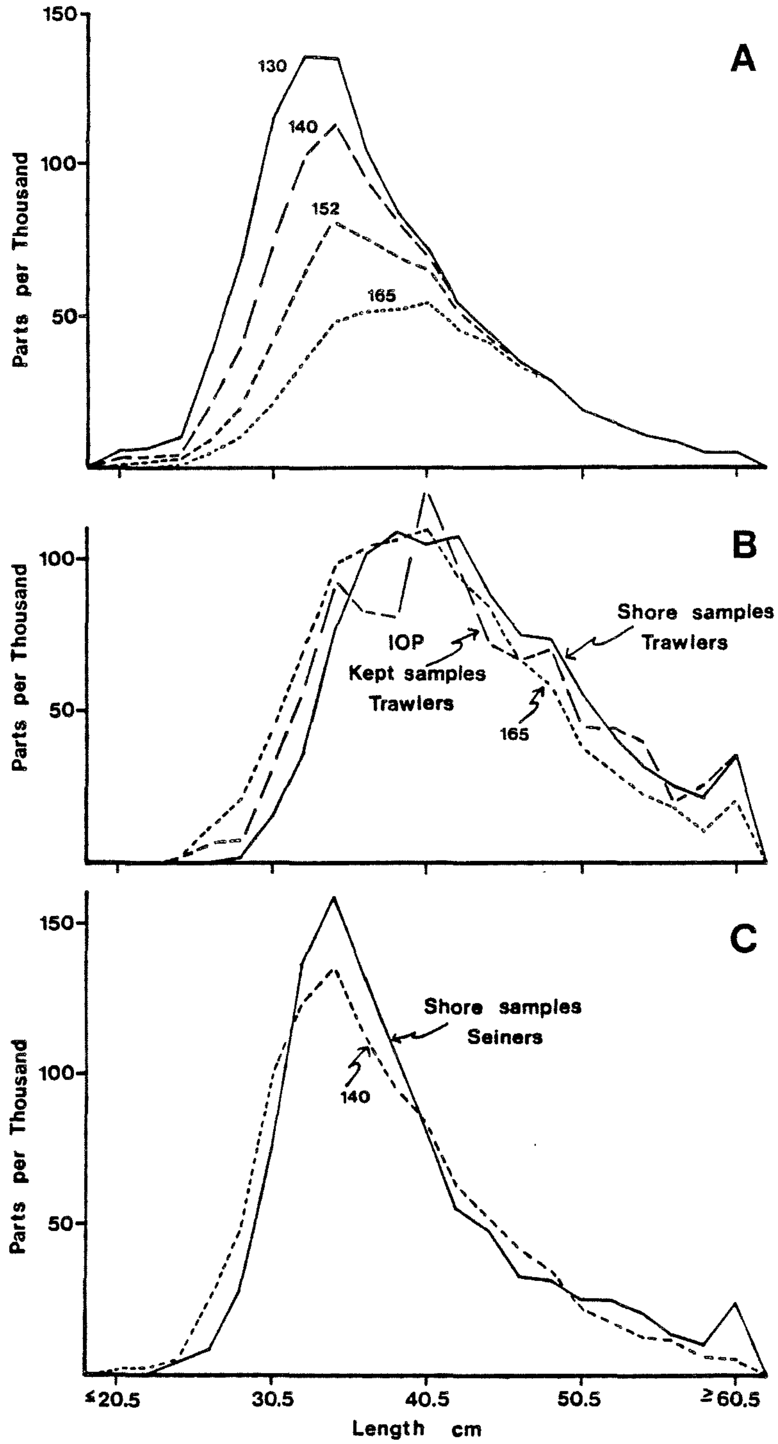


Figure 5. American plaice: A) IOP unculled trawler catch length-frequency for 130 mm mesh and adjusted for larger mesh sizes, B) trawler kept and landed length-frequencies compared to that expected for 165 mm mesh and C) seiner landed length-frequency compared to that expected for 140 mm mesh.

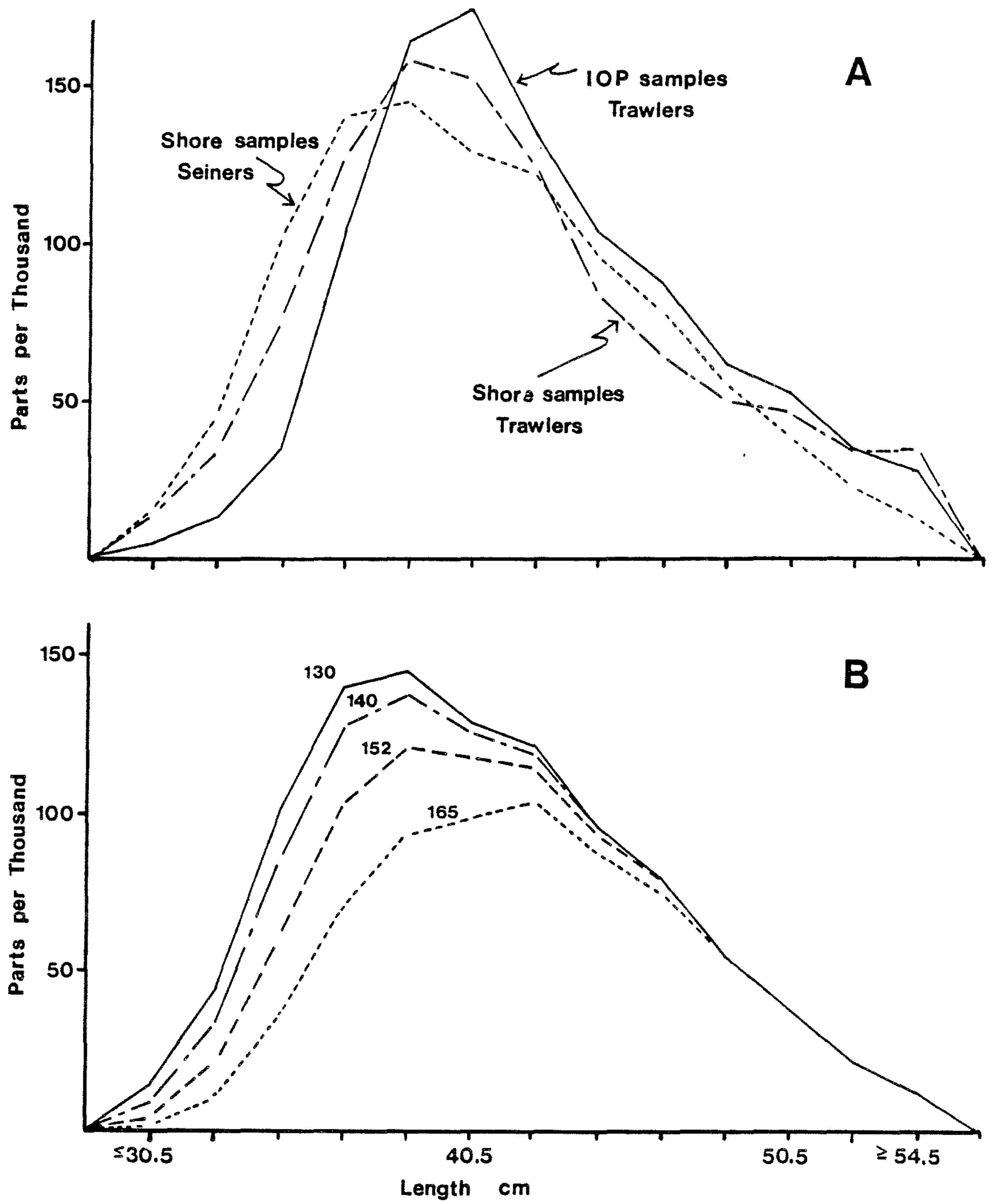


Figure 6. Witch flounder: A) length-frequencies of landings by trawlers and seiners and IOP unculled trawler catch length-frequency and B) seiner landings length-frequency adjusted for larger mesh sizes.

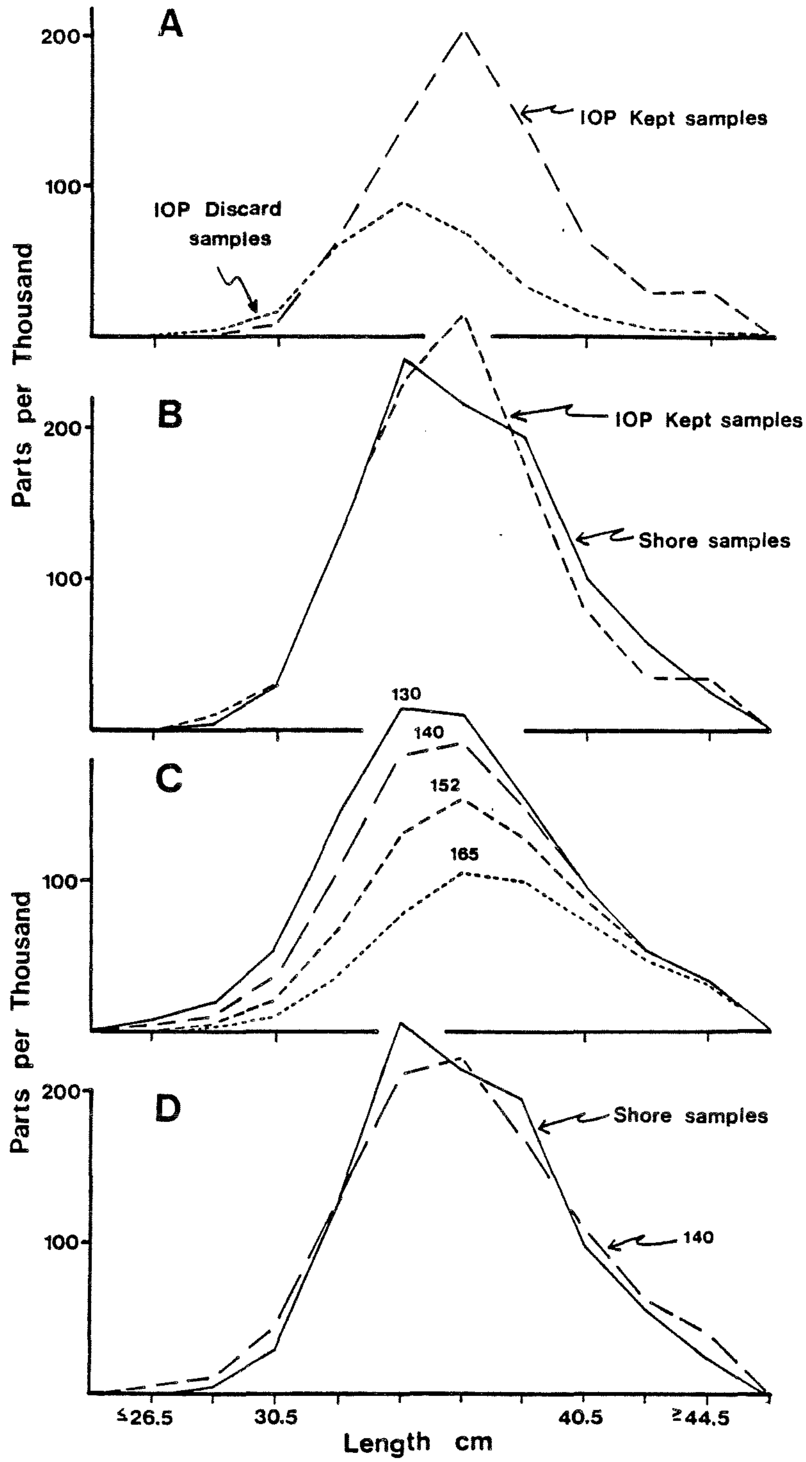


Figure 7. Yellowtail flounder: trawler length-frequencies A) from IOP for kept and discarded catch portions, B) for IOP kept and shore samples, C) for IOP unculled catch samples (labelled 130) and those expected at larger mesh sizes and D) from shore samples in comparison with that expected at 140 mm mesh.

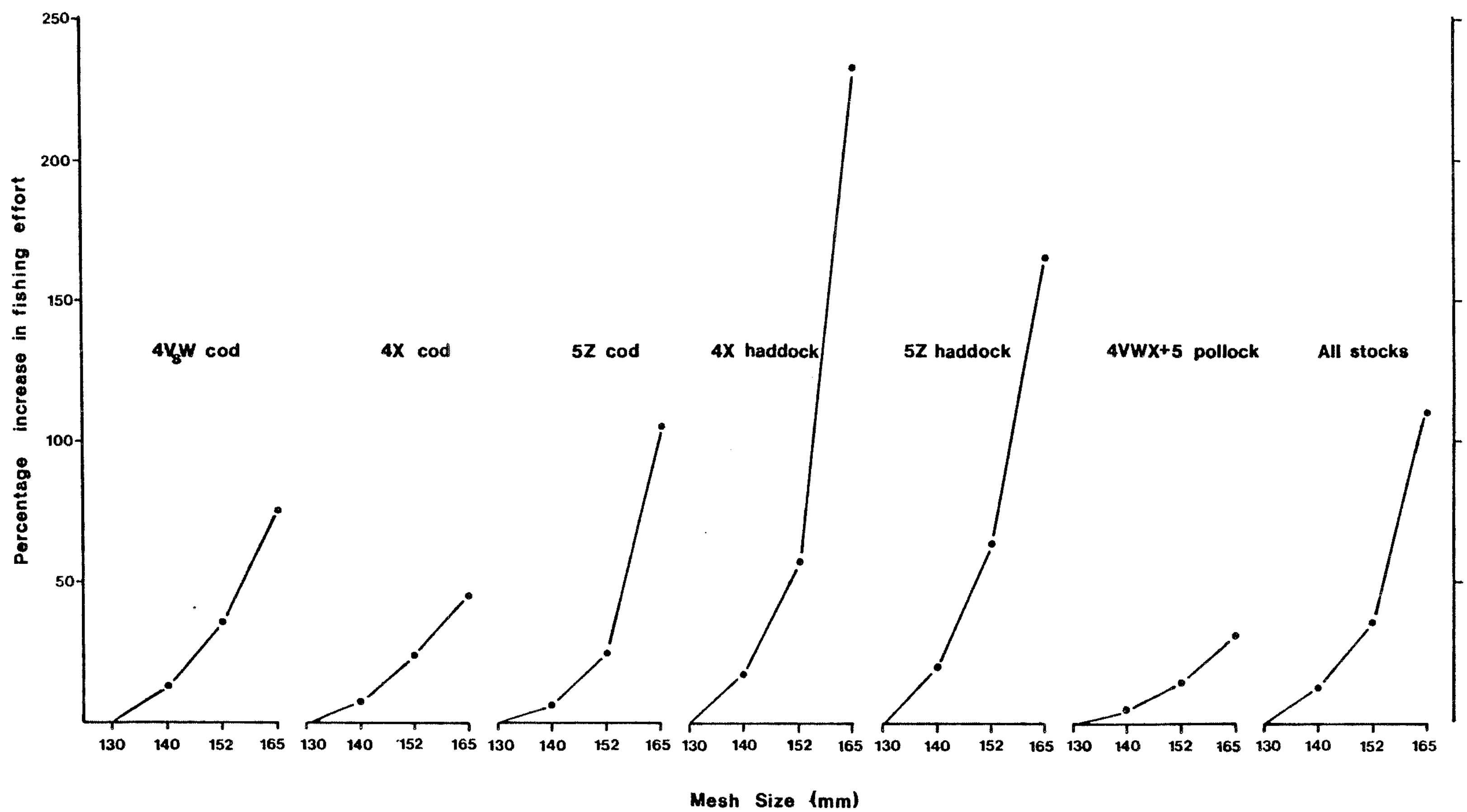


Figure 8. Percentage increase in fishing effort required to take 1988 trawler catch allocations for the cod, haddock and pollock stocks in Div. 4VWX and Subarea 5 with increase in mesh size, and the average for all stocks. (No estimate made for 4VW haddock.)

Appendix 1. Results of intermediate and final calculations for each stock describing potential effects of mesh size increases.

Table A-1. Div. 4VsW cod: Size compositions of adjusted catches. (Length shown is midpoint of 3 cm group.)

Non-trawler nos.-at-length (000's)

Length (cm)	Year 1984	1985	1986[1]
34	0	0	0
37	0	1	2
40	4	8	11
43	21	29	28
46	52	49	75
49	94	84	148
52	155	149	198
55	183	217	251
58	201	273	273
61	205	274	282
64	196	266	263
67	177	225	274
70	193	201	216
73	154	166	197
76	126	142	164
79	106	128	136
82	77	98	145
85	62	110	110
88	56	72	106
91	57	86	85
94	36	79	87
97	37	49	62
100	35	49	54
103	27	35	36
106	11	30	31
109	8	21	20
112	9	9	16
115	5	3	7
118	3	2	5
121	1	2	2
124	3	3	1
127	2	1	3
130	1	2	2
133	1	1	1
136	0	0	1
139	0	0	0
142	0	1	0
145	0	0	0
Total	2298	2865	3292

1984 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
28	0	0	0	0
31	0	0	0	0
34	1	0	0	0
37	2	1	1	1
40	87	48	27	18
43	495	273	153	98
46	1605	943	525	325
49	2771	1840	1071	654
52	3157	2446	1568	974
55	3362	3014	2228	1467
58	3025	3020	2602	1893
61	2537	2711	2669	2210
64	1902	2114	2302	2188
67	1414	1605	1865	2001
70	1024	1176	1423	1675
73	654	757	939	1181
76	387	450	566	743
79	280	324	408	546
82	149	174	223	306
85	116	135	173	237
88	67	78	99	138
91	42	49	62	87
94	28	33	42	58
97	21	24	32	45
100	19	22	29	41
103	7	9	11	16
106	4	5	6	8
109	4	5	7	9
112	3	3	4	5
115	2	2	3	4
118	1	1	1	2
121	2	3	3	5
124	0	0	0	1
127	0	0	0	0
130	1	1	1	2
133	0	0	0	0
136	0	0	1	1
139	0	0	0	0
Total	23169	21266	19044	16939

1985 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
28	0	0	0	0
31	0	0	0	0
34	2	1	1	1
37	13	7	4	3
40	88	47	26	17
43	448	242	133	85
46	1060	610	335	207
49	1870	1217	698	428
52	2502	1903	1206	755
55	3029	2664	1945	1290
58	3095	3033	2580	1886
61	2957	3106	3026	2523
64	2179	2382	2567	2456
67	1460	1631	1877	2025
70	1002	1130	1350	1590
73	578	656	801	1004
76	351	399	493	640
79	252	288	358	477
82	124	142	176	238
85	91	104	130	177
88	66	75	94	129
91	51	58	73	100
94	45	51	64	89
97	19	21	27	37
100	17	20	25	34
103	13	15	19	26
106	9	11	14	19
109	4	4	6	8
112	3	3	4	5
115	2	2	3	4
118	1	2	2	3
121	2	2	3	4
124	1	1	1	2
127	0	0	0	1
130	0	0	0	0
133	0	0	0	0
136	0	0	0	0
139	0	0	0	0
Total	21334	19827	18041	16263

1986 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
28	3	2	2	1
31	9	6	4	4
34	27	16	11	8
37	137	81	51	37
40	482	279	169	117
43	1092	635	373	250
46	1964	1218	724	478
49	3176	2231	1397	921
52	3898	3191	2202	1479
55	3449	3254	2578	1832
58	2633	2759	2536	1982
61	2251	2512	2622	2320
64	1555	1807	2082	2106
67	1096	1295	1586	1809
70	659	787	1000	1243
73	402	485	635	846
76	240	291	385	533
79	155	191	258	370
82	94	116	157	228
85	49	60	81	117
88	47	57	78	116
91	31	38	51	74
94	19	23	31	46
97	13	15	21	31
100	10	13	18	26
103	4	4	6	8
106	3	3	4	6
109	0	1	1	1
112	0	0	0	1
115	1	2	3	4
118	0	0	0	0
121	0	0	0	1
124	0	0	0	0
127	0	0	0	0
130	0	0	0	0
133	0	0	0	0
0	0	0	0	0
0	0	0	0	0
Total	23499	21372	19066	16995

1 = Longline numbers only. No samples available for remainder of "other gear" category.

Table A-2. Div. 4VsW cod: Cumulative length frequencies. (Length shown is midpoint of 3 cm group.)

Year	130 mm mesh length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.03	0.09	0.21	0.35	0.50
1985	0.00	0.00	0.00	0.03	0.08	0.16	0.28	0.42
1986	0.00	0.01	0.03	0.07	0.16	0.29	0.46	0.61
Mean	0.00	0.00	0.01	0.04	0.11	0.22	0.36	0.51

Year	140 mm mesh length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.02	0.06	0.15	0.26	0.40
1985	0.00	0.00	0.00	0.01	0.05	0.11	0.20	0.34
1986	0.00	0.00	0.02	0.05	0.10	0.21	0.36	0.51
Mean	0.00	0.00	0.01	0.03	0.07	0.15	0.27	0.42

Year	152 mm mesh length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.01	0.04	0.09	0.18	0.29
1985	0.00	0.00	0.00	0.01	0.03	0.07	0.13	0.24
1986	0.00	0.00	0.01	0.03	0.07	0.14	0.26	0.39
Mean	0.00	0.00	0.01	0.02	0.04	0.10	0.19	0.31

Year	165 mm mesh length group(cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.01	0.03	0.06	0.12	0.21
1985	0.00	0.00	0.00	0.01	0.02	0.05	0.09	0.17
1986	0.00	0.00	0.01	0.02	0.05	0.11	0.19	0.30
Mean	0.00	0.00	0.00	0.01	0.03	0.07	0.14	0.23

Year	Other Gears length group(cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.01	0.03	0.07	0.14	0.22
1985	0.00	0.00	0.00	0.01	0.03	0.06	0.11	0.19
1986	0.00	0.00	0.00	0.01	0.04	0.08	0.14	0.22
Mean	0.00	0.00	0.00	0.01	0.03	0.07	0.13	0.21

Table A-3. Div. 4VsW cod: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other gears 1984	Other gears 1985	Other gears 1986
1	0	0	0	0	0	0	0	0	0
2	2	4	2	0	1	2	2	3	0
3	378	154	121	330	120	94	48	34	27
4	6034	2323	4121	5204	1908	3463	830	415	658
5	9434	8353	7506	7976	7040	6786	1458	1313	720
6	6141	7782	9026	4950	6553	8210	1191	1229	816
7	4192	3922	3527	3113	2991	2926	1079	931	601
8	1318	2224	1518	941	1562	1109	377	662	409
9	579	978	1105	383	683	570	196	295	535
10	297	427	437	172	254	189	125	173	248
11	156	274	282	68	127	115	88	147	167
12	63	168	106	22	82	22	41	86	84
13	34	65	65	6	6	8	28	59	57
14	17	19	11	4	3	3	13	16	8
15	2	16	19	0	1	1	2	15	18
1+	28647	26709	27846	23170	21329	23498	5477	5380	4348

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	-	-	-	-	-	-	-	-	-	-
2	0.56	0.63	0.29	-	0.35	0.26	0.56	0.75	0.73	0.49
3	0.72	0.70	0.68	0.73	0.66	0.69	0.68	0.83	0.64	0.70
4	1.00	1.04	0.96	1.00	1.03	0.94	1.02	1.07	1.05	1.00
5	1.42	1.46	1.27	1.43	1.45	1.25	1.35	1.51	1.43	1.38
6	1.91	1.98	1.68	1.94	1.96	1.65	1.80	2.07	2.03	1.86
7	2.49	2.49	2.42	2.52	2.49	2.32	2.40	2.48	2.92	2.47
8	3.44	3.17	2.77	3.36	3.01	2.55	3.63	3.56	3.37	3.13
9	3.78	3.93	3.70	3.63	3.71	3.06	4.08	4.44	4.38	3.80
10	4.96	5.10	5.02	4.68	4.52	3.80	5.35	5.95	5.95	5.03
11	6.84	6.37	5.29	6.19	5.50	2.91	7.35	7.12	6.94	6.17
12	8.10	6.12	6.84	7.72	4.09	4.53	8.30	8.04	7.44	7.02
13	8.94	9.93	10.05	10.52	11.39	8.03	8.60	9.78	10.35	9.64
14	10.23	11.17	9.42	10.12	14.12	5.63	10.26	10.72	11.08	10.27
15	16.39	10.82	11.98	-	12.32	8.84	16.39	10.71	12.19	13.06

Table A-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)									
	Total			Trawl			Other Gears		
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986
1	0	0	0	0	0	0	0	0	0
2	2	3	2	0	1	2	2	3	0
3	234	99	82	186	65	55	48	34	27
4	4395	1664	3000	3565	1249	2342	830	415	658
5	8562	7184	6307	7104	5871	5587	1458	1313	720
6	6329	7693	8710	5138	6465	7894	1191	1229	816
7	4530	4124	3839	3450	3193	3238	1079	931	601
8	1453	2359	1627	1076	1697	1218	377	662	409
9	627	1056	1181	431	760	646	196	295	535
10	323	456	468	198	283	220	125	173	248
11	168	288	297	80	141	130	88	147	167
12	67	174	109	26	88	25	41	86	84
13	35	66	67	7	7	10	28	59	57
14	18	19	12	5	3	4	13	16	8
15	2	16	19	0	1	1	2	15	18
1+	26743	25202	25720	21266	19822	21372	5477	5380	4348

Weight at age (kg)										
	Total			Trawl			Other Gears			Average
Age	1984	1985	1986	1984	1985	1986	1984	1985	1986	84-86
1	-	-	-	-	-	-	-	-	-	-
2	-	0.67	0.30	-	0.35	0.26	0.56	0.75	0.73	0.49
3	0.72	0.72	0.68	0.73	0.66	0.71	0.68	0.83	0.64	0.71
4	1.02	1.07	0.99	1.02	1.07	0.97	1.02	1.07	1.05	1.03
5	1.46	1.52	1.33	1.48	1.52	1.32	1.35	1.51	1.43	1.44
6	1.95	2.03	1.77	1.99	2.02	1.74	1.80	2.07	2.03	1.92
7	2.52	2.52	2.47	2.56	2.54	2.39	2.40	2.48	2.92	2.50
8	3.45	3.20	2.85	3.38	3.06	2.67	3.63	3.56	3.37	3.17
9	3.81	3.94	3.73	3.69	3.75	3.18	4.08	4.44	4.38	3.83
10	4.96	5.10	5.00	4.71	4.58	3.92	5.35	5.95	5.95	5.02
11	6.79	6.38	5.22	6.19	5.61	3.01	7.35	7.12	6.94	6.13
12	8.08	6.12	6.82	7.73	4.23	4.76	8.30	8.04	7.44	7.01
13	8.98	9.95	10.00	10.50	11.39	8.00	8.60	9.78	10.35	9.64
14	10.22	11.22	9.14	10.09	14.11	5.58	10.26	10.72	11.08	10.19
15	-	10.84	11.94	-	12.32	8.84	16.39	10.71	12.19	11.39

Table A-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	0	0	0	0	0	0	0	0	0
2	2	3	1	0	0	1	2	3	0
3	153	70	60	105	36	32	48	34	27
4	3005	1161	2143	2175	746	1485	830	415	658
5	7048	5734	4920	5591	4420	4200	1458	1313	720
6	6281	7266	8001	5090	6037	7185	1191	1229	816
7	4954	4323	4181	3874	3391	3580	1079	931	601
8	1679	2564	1783	1302	1902	1374	377	662	409
9	708	1182	1288	512	887	753	196	295	535
10	369	506	511	244	333	262	125	173	248
11	190	315	312	103	168	146	88	147	167
12	74	183	112	33	96	28	41	86	84
13	37	68	70	9	9	13	28	59	57
14	19	20	13	6	4	6	13	16	8
15	2	16	20	0	2	2	2	15	18
1+	24522	23410	23415	19044	18031	19067	5477	5380	4348

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	-	-	-	-	-	-	-	-	-	-
2	-	0.70	0.32	-	0.35	0.26	0.56	0.75	0.73	0.51
3	0.71	0.74	0.67	0.73	0.66	0.70	0.68	0.83	0.64	0.71
4	1.04	1.08	1.01	1.04	1.09	0.99	1.02	1.07	1.05	1.04
5	1.50	1.57	1.39	1.54	1.59	1.38	1.35	1.51	1.43	1.49
6	2.02	2.10	1.87	2.07	2.11	1.86	1.80	2.07	2.03	2.00
7	2.58	2.59	2.56	2.63	2.62	2.50	2.40	2.48	2.92	2.57
8	3.48	3.27	2.97	3.43	3.17	2.85	3.63	3.56	3.37	3.24
9	3.89	4.00	3.81	3.81	3.85	3.41	4.08	4.44	4.38	3.90
10	4.99	5.15	5.06	4.80	4.73	4.22	5.35	5.95	5.95	5.07
11	6.73	6.42	5.20	6.20	5.80	3.22	7.35	7.12	6.94	6.12
12	8.05	6.20	6.93	7.74	4.55	5.41	8.30	8.04	7.44	7.06
13	9.06	9.99	9.91	10.47	11.40	7.99	8.60	9.78	10.35	9.65
14	10.19	11.33	8.75	10.05	14.10	5.55	10.26	10.72	11.08	10.09
15	-	10.87	11.88	-	12.32	8.84	16.39	10.71	12.19	11.37

Table A-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	0	0	0	0	0	0	0	0	0
2	2	3	1	0	0	1	2	3	0
3	116	57	49	68	23	22	48	34	27
4	2190	886	1664	1360	470	1006	830	415	658
5	5454	4475	3787	3996	3162	3067	1458	1313	720
6	5799	6453	6983	4607	5224	6167	1191	1229	816
7	5240	4362	4352	4160	3430	3751	1079	931	601
8	1971	2791	1952	1594	2129	1543	377	662	409
9	827	1354	1426	631	1058	891	196	295	535
10	435	584	570	311	411	322	125	173	248
11	229	363	327	141	216	160	88	147	167
12	87	196	117	46	110	33	41	86	84
13	41	71	75	13	12	19	28	59	57
14	21	21	15	8	5	8	13	16	8
15	2	17	20	0	2	3	2	15	18
1+	22413	21633	21340	16936	16253	16992	5477	5380	4348

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	-	-	-	-	-	-	-	-	-	-
2	-	0.71	0.32	-	0.35	0.26	0.56	0.75	0.73	0.51
3	0.71	0.76	0.66	0.73	0.66	0.69	0.68	0.83	0.64	0.71
4	1.04	1.08	1.01	1.05	1.09	0.99	1.02	1.07	1.05	1.04
5	1.52	1.60	1.42	1.58	1.64	1.42	1.35	1.51	1.43	1.51
6	2.10	2.18	1.98	2.17	2.20	1.97	1.80	2.07	2.03	2.08
7	2.67	2.69	2.67	2.74	2.74	2.63	2.40	2.48	2.92	2.68
8	3.55	3.38	3.13	3.53	3.32	3.06	3.63	3.56	3.37	3.35
9	4.01	4.12	3.96	3.99	4.03	3.70	4.08	4.44	4.38	4.03
10	5.10	5.26	5.22	5.00	4.96	4.66	5.35	5.95	5.95	5.20
11	6.66	6.47	5.28	6.23	6.03	3.56	7.35	7.12	6.94	6.14
12	8.01	6.36	7.14	7.75	5.03	6.38	8.30	8.04	7.44	7.17
13	9.18	10.06	9.76	10.45	11.43	7.99	8.60	9.78	10.35	9.67
14	10.17	11.50	8.29	10.02	14.10	5.56	10.26	10.72	11.08	9.99
15	-	10.92	11.77	-	12.33	8.84	16.39	10.71	12.19	11.34

Table A-4. Div. 4VsW cod: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

Mesh Size: 130 mm mesh				Mesh Size: 140 mm mesh				Mesh Size: 152 mm mesh				Mesh Size: 165 mm mesh			
	Total F's				Total F's				Total F's				Total F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	0.00	0.00	0.00	1	0.00	0.00	0.00	1	0.00	0.00	0.00	1	0.00	0.00	0.00
2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00
3	0.01	0.00	0.00	3	0.00	0.00	0.00	3	0.00	0.00	0.00	3	0.00	0.00	0.00
4	0.10	0.06	0.12	4	0.07	0.04	0.09	4	0.05	0.03	0.06	4	0.04	0.02	0.05
5	0.30	0.20	0.28	5	0.27	0.17	0.23	5	0.21	0.13	0.18	5	0.16	0.10	0.13
6	0.40	0.43	0.35	6	0.42	0.42	0.34	6	0/41	0.40	0.31	6	0.38	0.34	0.26
7	0.41	0.49	0.35	7	0.45	0.52	0.39	7	0.51	0.55	0.43	7	0.55	0.56	0.46
8	0.33	0.40	0.35	8	0.37	0.43	0.38	8	0.44	0.48	0.43	8	0.54	0.53	0.48
9	0.26	0.44	0.35	9	0.29	0.48	0.38	9	0.33	0.56	0.43	9	0.40	0.67	0.48
10	0.29	0.31	0.35	10	0.33	0.34	0.38	10	0.38	0.38	0.43	10	0.47	0.46	0.49
11	0.26	0.49	0.35	11	0.28	0.52	0.38	11	0.32	0.59	0.40	11	0.41	0.72	0.42
12	0.38	0.49	0.35	12	0.41	0.51	0.37	12	0.47	0.54	0.38	12	0.58	0.60	0.40
13	0.25	0.89	0.35	13	0.26	0.91	0.36	13	0.28	0.95	0.39	13	0.31	1.03	0.42
14	0.21	0.22	0.35	14	0.21	0.22	0.38	14	0.23	0.23	0.44	14	0.26	0.25	0.54
15	0.28	0.30	0.35	15	0.28	0.30	0.36	15	0.28	0.31	0.36	15	0.28	0.32	0.38
	Trawl Partial F's				Trawl Partial F's				Trawl Partial F's				Trawl Partial F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	0.00	0.00	0.00	1	0.00	0.00	0.00	1	0.00	0.00	0.00	1	0.00	0.00	0.00
2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00
3	0.01	0.00	0.00	3	0.00	0.00	0.00	3	0.00	0.00	0.00	3	0.00	0.00	0.00
4	0.09	0.05	0.10	4	0.06	0.03	0.07	4	0.04	0.02	0.04	4	0.02	0.01	0.03
5	0.25	0.17	0.25	5	0.22	0.14	0.20	5	0.17	0.10	0.15	5	0.12	0.07	0.11
6	0.32	0.36	0.32	6	0.34	0.36	0.31	6	0.34	0.33	0.27	6	0.30	0.28	0.23
7	0.30	0.37	0.29	7	0.34	0.40	0.33	7	0.40	0.44	0.37	7	0.43	0.44	0.39
8	0.23	0.28	0.26	8	0.27	0.31	0.29	8	0.34	0.35	0.33	8	0.44	0.41	0.38
9	0.17	0.30	0.18	9	0.20	0.35	0.21	9	0.24	0.42	0.25	9	0.30	0.52	0.30
10	0.17	0.19	0.15	10	0.20	0.21	0.18	10	0.25	0.25	0.22	10	0.33	0.32	0.28
11	0.11	0.23	0.14	11	0.13	0.25	0.16	11	0.17	0.31	0.19	11	0.25	0.43	0.21
12	0.13	0.24	0.07	12	0.16	0.26	0.08	12	0.21	0.29	0.10	12	0.31	0.33	0.11
13	0.04	0.08	0.05	13	0.05	0.09	0.05	13	0.07	0.12	0.07	13	0.10	0.17	0.10
14	0.05	0.03	0.11	14	0.06	0.03	0.14	14	0.07	0.04	0.19	14	0.10	0.06	0.27
15	0.00	0.02	0.02	15	0.00	0.02	0.03	15	0.00	0.03	0.03	15	0.00	0.04	0.05

Other Gears' Partial F's			
Age	1984	1985	1986
1	0.00	0.00	0.00
2	0.00	0.00	0.00
3	0.00	0.00	0.00
4	0.01	0.01	0.02
5	0.05	0.03	0.03
6	0.08	0.07	0.03
7	0.11	0.12	0.06
8	0.09	0.12	0.10
9	0.09	0.13	0.17
10	0.12	0.13	0.20
11	0.14	0.26	0.21
12	0.25	0.25	0.28
13	0.21	0.81	0.31
14	0.16	0.19	0.24
15	0.28	0.28	0.33

Table A-5. Div. 4VsW cod: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm) 130	140	152	165	Age	Other Gears
1	0.000	0.000	0.000	0.000	1	0.000
2	0.000	0.000	0.000	0.000	2	0.000
3	0.014	0.007	0.003	0.002	3	0.003
4	0.250	0.149	0.080	0.048	4	0.046
5	0.674	0.505	0.337	0.224	5	0.108
6	1.000	0.891	0.742	0.602	6	0.180
7	1.000	1.000	1.000	1.000	7	0.291
8	0.797	0.807	0.851	0.959	8	0.325
9	0.680	0.721	0.757	0.896	9	0.456
10	0.522	0.554	0.640	0.858	10	0.499
11	0.501	0.531	0.614	0.823	11	0.668
12	0.546	0.580	0.670	0.898	12	0.834
13	0.162	0.172	0.199	0.267	13	1.000
14	0.169	0.179	0.207	0.277	14	1.000
15	0.066	0.070	0.080	0.108	15	1.000

Fully-Recruited F

Year	Trawl Mesh Size (mm) 130	140	152	165	Year	Other Gears
1984	0.344	0.397	0.460	0.497	1984	0.360
1985	0.307	0.337	0.370	0.383	1985	0.335
1986	0.343	0.373	0.411	0.432	1986	0.276

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.06
152	1.23
165	1.64

Table A-6. Div. 4VsW cod: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.000	.000	.200		.100	.085	.097	.104	.430
2.0	.494	.000	.200		.200	.157	.178	.177	.578
3.0	.700	.012	.200	$F_{0.1}$---	.212	.166	.188	.186	.586
4.0	1.000	.217	.200		.300	.229	.263	.254	.623
5.0	1.383	.573	.200	F_{max}---	.400	.299	.350	.332	.632
6.0	1.857	.864	.200		.400	.300	.350	.332	.632
7.0	2.467	.943	.200		.500	.368	.439	.412	.628
8.0	3.127	.819	.200		.600	.435	.529	.492	.621
9.0	3.803	.827	.200		.700	.500	.621	.572	.614
10.0	5.027	.742	.200		.800	.564	.713	.652	.607
11.0	6.167	.847	.200		.900	.626	.806	.733	.600
12.0	7.020	1.000	.200		1.000	.687	.899	.813	.594
13.0	9.640	.837	.200		1.100	.747	.993	.894	.589
14.0	10.273	.842	.200		1.200	.806	1.088	.975	.585
15.0	13.064	.766	.200		1.300	.864	1.183	1.057	.581
16.0	13.064	.766	.200		1.400	.922	1.278	1.138	.577
					1.500	.978	1.373	1.220	.574

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.000	.000	.200		.100	.081	.098	.104	.427
2.0	.487	.000	.200		.200	.149	.180	.179	.583
3.0	.708	.007	.200	$F_{0.1}$---	.228	.167	.203	.200	.604
4.0	1.027	.145	.200		.300	.215	.266	.257	.636
5.0	1.436	.458	.200		.400	.278	.355	.337	.650
6.0	1.917	.800	.200	F_{max}---	.453	.310	.403	.380	.651
7.0	2.504	.957	.200		.500	.338	.446	.419	.651
8.0	3.166	.833	.200		.600	.397	.538	.502	.646
9.0	3.827	.855	.200		.700	.453	.632	.585	.641
10.0	5.019	.757	.200		.800	.507	.725	.668	.635
11.0	6.132	.852	.200		.900	.559	.820	.751	.630
12.0	7.010	1.000	.200		1.000	.610	.915	.835	.625
13.0	9.643	.800	.200		1.100	.660	1.010	.919	.620
14.0	10.194	.806	.200		1.200	.708	1.106	1.003	.617
15.0	11.391	.722	.200		1.300	.756	1.202	1.087	.613
16.0	11.391	.722	.200		1.400	.803	1.299	1.172	.610
					1.500	.849	1.395	1.257	.606

Table A-6. (Continued)

C: 152 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.000	.000	.200		.100	.075	.097	.103	.419
2.0	.505	.000	.200		.200	.134	.178	.177	.586
3.0	.711	.004	.200	$F_{0.1}$---	.248	.162	.218	.214	.625
4.0	1.042	.088	.200		.300	.191	.263	.255	.650
5.0	1.488	.319	.200		.400	.244	.350	.335	.672
6.0	2.000	.668	.200		.500	.294	.439	.417	.678
7.0	2.575	.928	.200	F_{max}---	.523	.305	.460	.436	.678
8.0	3.239	.836	.200		.600	.341	.529	.500	.677
9.0	3.899	.842	.200		.700	.386	.620	.583	.673
10.0	5.066	.780	.200		.800	.428	.712	.666	.669
11.0	6.117	.859	.200		.900	.469	.804	.749	.665
12.0	7.060	1.000	.200		1.000	.508	.896	.832	.661
13.0	9.650	.742	.200		1.100	.546	.988	.915	.658
14.0	10.090	.748	.200		1.200	.583	1.081	.998	.654
15.0	11.374	.652	.200		1.300	.618	1.175	1.082	.651
16.0	11.374	.652	.200		1.400	.653	1.268	1.165	.648
					1.500	.687	1.361	1.249	.645

D: 165 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.000	.000	.200		.100	.067	.092	.102	.405
2.0	.514	.000	.200		.200	.116	.167	.174	.583
3.0	.710	.003	.200	$F_{0.1}$---	.279	.153	.228	.235	.649
4.0	1.044	.055	.200		.300	.162	.244	.251	.660
5.0	1.514	.201	.200		.400	.205	.323	.331	.693
6.0	2.084	.486	.200		.500	.244	.403	.412	.705
7.0	2.677	.802	.200		.600	.280	.483	.494	.708
8.0	3.350	.792	.200	F_{max}---	.617	.286	.496	.508	.708
9.0	4.028	.814	.200		.700	.314	.563	.575	.708
10.0	5.195	.810	.200		.800	.346	.642	.657	.705
11.0	6.138	.869	.200		.900	.376	.722	.739	.702
12.0	7.169	1.000	.200		1.000	.405	.802	.820	.699
13.0	9.666	.664	.200		1.100	.433	.882	.901	.696
14.0	9.985	.671	.200		1.200	.459	.962	.982	.693
15.0	11.342	.559	.200		1.300	.485	1.042	1.063	.690
16.0	11.342	.559	.200		1.400	.510	1.122	1.144	.687
					1.500	.534	1.202	1.225	.684

Table A-7. Div. 4VsW cod: Catch projections for 1988 by mesh size.

	Population	130 mm		140 mm		152 mm		165 mm	
Age	Nos. ('000) 1988	Catch wt.	Fishing Mortalities	Catch wt.	Fishing Mortalities	Catch wt.	Fishing Mortalities	Catch wt.	Fishing Mortalities
1	91000	0	0.000	0	0.000	0	0.000	0	0.000
2	74054	1	0.000	1	0.000	1	0.000	1	0.000
3	61121	147	0.004	85	0.002	52	0.001	36	0.001
4	35087	2110	0.069	1467	0.046	945	0.029	647	0.020
5	26948	5664	0.183	4880	0.149	3764	0.109	2700	0.075
6	18953	7696	0.274	7624	0.261	7142	0.231	6120	0.186
7	12682	7178	0.290	7641	0.306	8133	0.318	8223	0.307
8	11745	7151	0.245	7661	0.260	8446	0.282	9296	0.302
9	4590	3238	0.235	3538	0.257	3864	0.275	4379	0.304
10	1976	1594	0.202	1717	0.219	1959	0.250	2381	0.301
11	1438	1524	0.222	1618	0.238	1791	0.267	2080	0.316
12	568	776	0.257	823	0.275	918	0.307	1084	0.361
13	367	548	0.186	563	0.192	591	0.202	636	0.219
14	138	226	0.188	232	0.194	243	0.204	260	0.221
15	84	147	0.162	149	0.165	152	0.169	157	0.177
Totals	340751	38000	-	38000	-	38000	-	38000	-
F5+	-	-	0.262	-	0.268	-	0.269	-	0.260

Table A-8A. Div. 4VsW cod: Summary of projections -- constant TAC and allocations.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	301203	319253	339952	359985	381182
5+ Population biomass:	186770	190179	211019	230737	251916
9+ Population biomass:	46298	65582	72985	77477	82522
5+ fishing mortality:	.262	.252	.232	.211	.193
7+ fishing mortality:	.236	.223	.201	.181	.164
9+ fishing mortality:	.212	.200	.181	.165	.149
Yield:	38000	38000	38000	38000	38000
Trawler fishable biomass:	121257	122904	131453	145951	160710
catch biomass:	30050	30050	30050	30050	30050
relative effort:	.248	.245	.229	.206	.187
Others' fishable biomass:	54465	61226	68437	77384	87150
catch biomass:	7950	7950	7950	7950	7950
relative effort:	.146	.130	.116	.103	.091

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	305573	324924	347224	369166	392080
5+ Population biomass:	190153	194384	216833	238458	261361
9+ Population biomass:	46185	64425	70263	73913	78975
5+ fishing mortality:	.268	.258	.238	.212	.192
7+ fishing mortality:	.252	.240	.217	.194	.173
9+ fishing mortality:	.228	.216	.196	.177	.158
Yield:	38000	38000	38000	38000	38000
Trawler fishable biomass:	114035	115777	123792	139021	155465
catch biomass:	30050	30050	30050	30050	30050
relative effort:	.280	.275	.258	.229	.205
Others' fishable biomass:	54249	60638	67573	76418	86382
catch biomass:	7950	7950	7950	7950	7950
relative effort:	.147	.131	.118	.104	.092

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	312730	333747	358236	382727	408282
5+ Population biomass:	195301	200923	225568	249739	275287
9+ Population biomass:	46606	63635	67906	70847	76557
5+ fishing mortality:	.269	.258	.238	.208	.186
7+ fishing mortality:	.275	.261	.238	.212	.186
9+ fishing mortality:	.255	.243	.221	.198	.174
Yield:	38000	38000	38000	38000	38000
Trawler fishable biomass:	109179	111295	119156	135003	154030
catch biomass:	30050	30050	30050	30050	30050
relative effort:	.337	.331	.309	.273	.239
Others' fishable biomass:	53990	59978	66645	75405	85678
catch biomass:	7950	7950	7950	7950	7950
relative effort:	.147	.133	.119	.105	.093

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	319261	342085	368800	396130	424826
5+ Population biomass:	201131	208503	235374	262385	291076
9+ Population biomass:	47531	63128	65972	68684	75522
5+ fishing mortality:	.260	.247	.228	.194	.172
7+ fishing mortality:	.302	.289	.265	.235	.203
9+ fishing mortality:	.301	.285	.261	.232	.201
Yield:	38000	38000	38000	38000	38000
Trawler fishable biomass:	113764	117442	126231	143096	166261
catch biomass:	30050	30050	30050	30050	30050
relative effort:	.434	.421	.391	.345	.297
Others' fishable biomass:	53684	59229	65627	74313	84960
catch biomass:	7950	7950	7950	7950	7950
relative effort:	.148	.134	.121	.107	.094

Table A-8B. Div. 4VsW cod: Summary of projections -- TAC and allocations for 1988, $F_{0.1}$ and constant allocation ratio in subsequent years.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	301203	319253	350149	376613	399595
5+ Population biomass:	186770	190179	221169	247332	270313
9+ Population biomass:	46298	65582	77079	85338	93107
5+ fishing mortality:	.262	.189	.187	.189	.190
7+ fishing mortality:	.236	.167	.162	.162	.162
9+ fishing mortality:	.212	.150	.146	.148	.147
Yield:	38000	29285	32704	36739	40178
Trawler fishable biomass:	121257	126113	139820	156586	170339
catch biomass:	30050	23162	25863	29055	31774
relative effort:	.248	.184	.185	.186	.187
Others' fishable biomass:	54465	62797	73342	84875	95876
catch biomass:	7950	6123	6841	7684	8404
relative effort:	.146	.098	.093	.091	.088

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	305573	324923	356660	384242	407760
5+ Population biomass:	190153	194384	226243	253516	277034
9+ Population biomass:	46185	64425	74270	81460	88660
5+ fishing mortality:	.268	.198	.196	.196	.198
7+ fishing mortality:	.252	.184	.178	.179	.179
9+ fishing mortality:	.228	.165	.161	.163	.162
Yield:	38000	29834	33224	37587	41464
Trawler fishable biomass:	114035	118716	131329	148260	163049
catch biomass:	30050	23590	26277	29730	32795
relative effort:	.280	.211	.212	.213	.213
Others' fishable biomass:	54249	62160	72229	83272	93789
catch biomass:	7950	6244	6946	7857	8669
relative effort:	.147	.100	.096	.094	.092

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	312730	333747	365966	394403	418631
5+ Population biomass:	195301	200924	233285	261406	285634
9+ Population biomass:	46606	63635	71446	77188	83796
5+ fishing mortality:	.269	.208	.206	.204	.207
7+ fishing mortality:	.275	.210	.206	.207	.207
9+ fishing mortality:	.255	.195	.191	.193	.193
Yield:	38000	31221	34561	39180	43673
Trawler fishable biomass:	109179	113746	125262	141802	157969
catch biomass:	30050	24692	27336	30977	34538
relative effort:	.337	.266	.268	.268	.268
Others' fishable biomass:	53990	61288	70488	80580	90180
catch biomass:	7950	6529	7225	8202	9135
relative effort:	.147	.107	.103	.102	.101

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	319261	342085	375919	406187	432560
5+ Population biomass:	201131	208503	242484	272437	298810
9+ Population biomass:	47531	63128	69566	74683	81563
5+ fishing mortality:	.260	.202	.203	.197	.201
7+ fishing mortality:	.302	.236	.235	.236	.236
9+ fishing mortality:	.301	.233	.231	.233	.233
Yield:	38000	31687	35363	40025	45063
Trawler fishable biomass:	113764	119964	132379	149471	168771
catch biomass:	30050	25062	27960	31647	35639
relative effort:	.434	.343	.347	.348	.347
Others' fishable biomass:	53684	60495	69158	78676	87915
catch biomass:	7950	6626	7403	8378	9424
relative effort:	.148	.110	.107	.106	.107

Table B-1. Div. 4X cod: Size compositions of adjusted catches. (Length shown is midpoint of 3 cm group.)

Non-trawler nos.-at-length (000's)

Length (cm)	Year 1984	1985	1986
25	0	0	0
28	0	0	0
31	0	0	0
34	1	2	0
37	6	5	28
40	34	62	74
43	134	96	138
46	288	147	353
49	315	195	385
52	403	224	358
55	382	227	260
58	409	217	210
61	351	209	192
64	271	197	146
67	208	172	118
70	116	126	108
73	131	110	78
76	119	86	76
79	91	64	50
82	88	46	57
85	61	43	42
88	40	35	47
91	44	26	48
94	38	18	32
97	44	19	17
100	26	20	18
103	14	12	15
106	14	8	11
109	11	8	10
112	7	7	5
115	13	8	3
118	44	9	7
121	0	0	2
124	0	0	2
127	0	0	1
130	0	0	0
133	0	0	1
136	0	0	0
139	0	0	1
142	0	0	0
Total	3703	2398	2893

1984 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
25	0	0	0	0
28	0	0	0	0
31	8	5	3	2
34	29	17	10	7
37	40	22	13	8
40	157	84	46	29
43	343	186	98	59
46	408	236	125	72
49	545	357	197	113
52	474	358	218	127
55	599	520	364	225
58	620	601	490	334
61	621	646	604	469
64	508	553	573	512
67	381	423	469	473
70	284	319	368	409
73	225	255	301	355
76	131	149	178	219
79	84	95	115	144
82	46	52	62	79
85	46	52	62	80
88	29	32	39	50
91	29	33	39	51
94	20	22	26	33
97	12	14	16	21
100	15	17	20	26
103	7	8	10	13
106	11	13	16	20
109	6	6	7	10
112	0	1	1	1
115	1	1	1	2
118	1	1	1	1
121	1	1	1	1
124	0	0	0	0
127	1	1	1	1
130	0	0	0	0
133	0	0	0	0
136	1	1	1	1
139	1	1	1	1
142	0	0	0	0
Total	5684	5082	4476	3948

1985 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
25	0	0	0	0
28	0	0	0	0
31	0	0	0	0
34	19	11	6	4
37	54	29	16	11
40	180	95	51	31
43	240	128	66	38
46	369	210	108	60
49	491	316	170	94
52	427	319	189	106
55	432	374	256	152
58	382	369	295	194
61	387	402	369	278
64	356	384	388	333
67	339	372	400	385
70	285	316	354	376
73	206	229	260	291
76	164	182	209	242
79	139	155	181	217
82	81	89	102	121
85	70	78	90	110
88	31	34	39	46
91	28	31	36	43
94	23	25	29	35
97	19	21	24	28
100	12	13	15	17
103	6	6	7	8
106	7	7	8	10
109	4	4	5	5
112	2	2	2	3
115	4	4	5	6
118	5	5	6	7
121	0	1	1	1
124	1	1	1	1
127	0	0	1	1
130	0	0	0	0
133	0	0	0	0
136	0	0	0	0
139	0	0	0	0
142	0	0	0	0
Total	4763	4212	3689	3254

1986 Trawler nos.-at-length (000's)

Length (cm)	mesh size (mm) 130	140	152	165
25	0	0	0	0
28	0	0	0	0
31	0	0	0	0
34	1	0	0	0
37	10	6	3	2
40	45	24	13	8
43	165	89	47	27
46	328	189	100	55
49	568	370	204	111
52	665	507	308	172
55	672	592	415	245
58	519	510	416	271
61	325	342	320	238
64	207	227	235	201
67	170	191	213	208
70	134	152	176	189
73	134	153	181	206
76	124	142	170	200
79	84	96	116	140
82	74	85	103	125
85	72	82	100	122
88	48	55	66	82
91	55	63	75	92
94	37	43	52	63
97	26	30	36	44
100	16	19	22	27
103	2	2	3	3
106	4	5	6	7
109	5	6	7	8
112	2	3	3	4
115	0	0	0	0
118	2	2	3	3
121	0	0	0	1
124	2	2	2	3
127	0	0	0	0
130	0	0	0	0
133	0	0	0	0
136	0	0	0	0
139	0	0	0	0
142	0	0	0	0
Total	4496	3987	3395	2857

Table B-2. Div. 4X cod: Cumulative length frequencies.
(Length shown is midpoint of 3 cm group.)

	130 mm mesh length group (cm)							
Year	34	37	40	43	46	49	52	55
1984	0.01	0.01	0.04	0.10	0.17	0.27	0.35	0.46
1985	0.00	0.02	0.05	0.10	0.18	0.28	0.37	0.46
1986	0.00	0.00	0.01	0.05	0.12	0.25	0.40	0.55
Mean	0.00	0.01	0.04	0.08	0.16	0.27	0.37	0.49

	140 mm mesh length group (cm)							
Year	34	37	40	43	46	49	52	55
1984	0.00	0.01	0.03	0.06	0.11	0.18	0.25	0.35
1985	0.00	0.01	0.03	0.06	0.11	0.19	0.26	0.35
1986	0.00	0.00	0.01	0.03	0.08	0.17	0.30	0.45
Mean	0.00	0.01	0.02	0.05	0.10	0.18	0.27	0.38

	152 mm mesh length group (cm)							
Year	34	37	40	43	46	49	52	55
1984	0.00	0.01	0.02	0.04	0.07	0.11	0.16	0.24
1985	0.00	0.01	0.02	0.04	0.07	0.11	0.16	0.23
1986	0.00	0.00	0.00	0.02	0.05	0.11	0.20	0.32
Mean	0.00	0.00	0.01	0.03	0.06	0.11	0.17	0.26

	165 mm mesh length group (cm)							
Year	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.01	0.03	0.05	0.07	0.11	0.16
1985	0.00	0.00	0.01	0.03	0.04	0.07	0.11	0.15
1986	0.00	0.00	0.00	0.01	0.03	0.07	0.13	0.22
Mean	0.00	0.00	0.01	0.02	0.04	0.07	0.11	0.18

	Other Gears length group (cm)							
Year	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.01	0.05	0.12	0.21	0.32	0.42
1985	0.00	0.00	0.03	0.07	0.13	0.21	0.31	0.40
1986	0.00	0.01	0.04	0.08	0.20	0.34	0.46	0.55
Mean	0.00	0.00	0.02	0.07	0.15	0.25	0.36	0.46

Table B-3. Div. 4X cod: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	39	0	0	38	0	1	1	0	0
2	808	888	147	765	718	97	42	170	50
3	2386	1597	3131	1971	1258	2244	414	338	887
4	3247	1489	2205	1623	885	1202	1625	603	1003
5	1847	2460	906	814	1154	390	1032	1306	516
6	924	1160	985	270	465	368	653	695	617
7	443	491	343	134	194	109	309	297	234
8	158	171	165	47	55	49	111	116	116
9	53	66	79	10	16	23	43	49	56
10	49	45	39	7	7	3	43	38	35
11	31	26	15	1	4	6	30	22	8
12	22	8	14	0	4	6	22	4	8
13	6	8	9	1	2	0	5	6	9
1+	10011	8407	8037	5681	4762	4498	4330	3644	3539

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.38	0.37	0.38	0.38	0.37	0.38	0.38	0.37	0.38	0.38
2	0.95	0.82	0.80	0.96	0.84	0.77	0.90	0.73	0.86	0.86
3	1.50	1.41	1.29	1.55	1.46	1.40	1.25	1.19	1.02	1.40
4	2.00	1.97	1.90	2.36	2.22	2.24	1.64	1.60	1.49	1.96
5	2.73	2.52	2.63	3.01	2.90	3.53	2.51	2.18	1.94	2.62
6	3.82	3.53	3.96	4.29	3.83	5.06	3.63	3.33	3.29	3.77
7	5.40	4.96	5.02	5.69	4.92	5.32	5.28	4.98	4.88	5.13
8	7.57	6.66	7.47	8.03	7.22	7.50	7.37	6.39	7.46	7.23
9	9.31	8.09	9.29	10.25	9.36	9.07	9.09	7.68	9.37	8.90
10	11.61	9.85	9.15	10.33	11.95	12.95	11.81	9.48	8.79	10.20
11	13.27	12.41	11.77	10.07	11.16	8.76	13.37	12.65	14.11	12.48
12	14.15	14.58	13.47	-	14.58	13.26	14.15	14.57	13.62	14.06
13	14.50	12.57	15.07	17.56	13.89	14.85	13.65	12.24	15.08	14.05

Table B-3. (Continued).

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	24	0	0	22	0	0	1	0	0
2	520	584	103	478	414	53	42	170	50
3	2000	1314	2599	1586	976	1712	414	338	887
4	3243	1458	2171	1619	854	1168	1625	603	1003
5	1883	2462	937	851	1156	421	1032	1306	516
6	954	1199	1026	300	504	409	653	695	617
7	457	511	357	149	214	122	309	297	234
8	164	174	172	53	58	56	111	116	116
9	54	67	82	11	17	26	43	49	56
10	50	45	39	8	7	4	43	38	35
11	31	26	16	1	4	7	30	22	8
12	22	8	15	0	4	7	22	4	8
13	6	8	9	1	2	0	5	6	9
1+	9408	7856	7525	5078	4212	3986	4330	3644	3539

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.38	0.37	0.37	0.38	0.37	0.38	0.38	0.37	0.38	0.37
2	0.98	0.83	0.81	0.99	0.87	0.77	0.90	0.73	0.86	0.87
3	1.59	1.48	1.32	1.68	1.58	1.48	1.25	1.19	1.02	1.46
4	2.05	2.03	1.95	2.46	2.33	2.35	1.64	1.60	1.49	2.01
5	2.79	2.60	2.70	3.13	3.07	3.63	2.51	2.18	1.94	2.70
6	3.85	3.56	4.04	4.34	3.88	5.17	3.63	3.33	3.29	3.82
7	5.42	4.96	5.06	5.73	4.93	5.40	5.28	4.98	4.88	5.15
8	7.59	6.70	7.47	8.04	7.30	7.51	7.37	6.39	7.46	7.25
9	9.34	8.12	9.28	10.30	9.40	9.07	9.09	7.68	9.37	8.91
10	11.58	9.89	9.20	10.32	12.07	12.94	11.81	9.48	8.79	10.23
11	13.26	12.41	11.60	10.07	11.16	8.76	13.37	12.65	14.11	12.42
12	-	14.59	13.45	-	14.61	13.25	14.15	14.57	13.62	14.02
13	14.56	12.58	15.07	17.56	13.89	14.85	13.65	12.24	15.08	14.07

Table B-3. (Continued).

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	15	0	0	14	0	0	1	0	0
2	311	391	78	269	221	28	42	170	50
3	1582	1011	2019	1168	673	1132	414	338	887
4	3162	1367	2055	1537	764	1052	1625	603	1003
5	1920	2445	970	887	1139	454	1032	1306	516
6	997	1240	1083	343	546	466	653	695	617
7	479	540	376	171	243	142	309	297	234
8	174	180	183	63	64	67	111	116	116
9	56	68	88	13	19	32	43	49	56
10	52	46	40	9	8	5	43	38	35
11	31	26	17	1	4	9	30	22	8
12	22	9	16	0	4	8	22	4	8
13	7	8	9	2	2	0	5	6	9
1+	8807	7332	6935	4477	3687	3396	4330	3644	3539

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.38	0.37	0.37	0.38	0.37	0.38	0.38	0.37	0.38	0.37
2	0.99	0.81	0.83	1.00	0.87	0.77	0.90	0.73	0.86	0.87
3	1.67	1.53	1.32	1.82	1.70	1.56	1.25	1.19	1.02	1.51
4	2.10	2.09	2.02	2.59	2.48	2.52	1.64	1.60	1.49	2.07
5	2.87	2.70	2.82	3.29	3.30	3.81	2.51	2.18	1.94	2.80
6	3.91	3.61	4.17	4.44	3.98	5.34	3.63	3.33	3.29	3.90
7	5.48	4.98	5.13	5.85	4.97	5.56	5.28	4.98	4.88	5.20
8	7.62	6.76	7.48	8.05	7.43	7.53	7.37	6.39	7.46	7.29
9	9.38	8.17	9.26	10.35	9.45	9.06	9.09	7.68	9.37	8.94
10	11.55	9.95	9.27	10.33	12.20	12.91	11.81	9.48	8.79	10.26
11	13.24	12.39	11.36	10.07	11.16	8.77	13.37	12.65	14.11	12.33
12	-	14.61	13.42	-	14.64	13.23	14.15	14.57	13.62	14.02
13	14.66	12.59	15.07	17.56	13.89	14.85	13.65	12.24	15.08	14.11

Table B-3. (Continued).

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	11	0	0	9	0	0	1	0	0
2	201	297	66	158	128	16	42	170	50
3	1232	776	1569	818	438	682	414	338	887
4	2972	1228	1858	1347	625	855	1625	603	1003
5	1937	2404	984	904	1098	468	1032	1306	516
6	1049	1266	1144	395	572	527	653	695	617
7	509	573	398	200	276	164	309	297	234
8	192	189	198	81	73	82	111	116	116
9	59	71	96	16	21	39	43	49	56
10	54	47	41	12	9	6	43	38	35
11	31	26	19	1	5	11	30	22	8
12	22	9	18	0	5	10	22	4	8
13	7	8	9	2	2	0	5	6	9
1+	8275	6896	6399	3944	3251	2859	4330	3644	3539

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.37	0.37	0.44	0.37	0.37	0.38	0.38	0.37	0.38	0.40
2	0.97	0.78	0.84	0.99	0.85	0.76	0.90	0.73	0.86	0.86
3	1.70	1.53	1.27	1.93	1.79	1.61	1.25	1.19	1.02	1.50
4	2.14	2.12	2.06	2.73	2.63	2.72	1.64	1.60	1.49	2.11
5	2.96	2.81	2.94	3.48	3.57	4.04	2.51	2.18	1.94	2.90
6	4.00	3.71	4.34	4.61	4.17	5.57	3.63	3.33	3.29	4.02
7	5.61	5.03	5.24	6.13	5.08	5.77	5.28	4.98	4.88	5.30
8	7.67	6.87	7.51	8.08	7.62	7.59	7.37	6.39	7.46	7.35
9	9.45	8.24	9.24	10.42	9.52	9.06	9.09	7.68	9.37	8.98
10	11.50	10.02	9.37	10.34	12.35	12.86	11.81	9.48	8.79	10.30
11	13.22	12.37	11.10	10.07	11.16	8.79	13.37	12.65	14.11	12.23
12	-	14.63	13.39	-	14.69	13.20	14.15	14.57	13.62	14.01
13	14.80	12.62	15.07	17.56	13.89	14.84	13.65	12.24	15.08	14.16

Table B-4. Div. 4X cod: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

Mesh Size: 130 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.07	0.05	0.02	0.06	0.04	0.01
3	0.39	0.18	0.25	0.32	0.14	0.18
4	0.41	0.45	0.40	0.20	0.27	0.22
5	0.53	0.63	0.56	0.24	0.29	0.24
6	0.58	0.78	0.56	0.17	0.31	0.21
7	0.63	0.72	0.56	0.19	0.28	0.18
8	0.56	0.54	0.56	0.17	0.17	0.17
9	0.40	0.48	0.53	0.07	0.12	0.15
10	0.45	0.73	0.58	0.06	0.11	0.05
11	0.55	0.46	0.54	0.02	0.07	0.23
12	0.81	0.27	0.49	-	0.12	0.20
13	0.59	0.75	0.56	0.13	0.15	0.01

Mesh Size: 140 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.04	0.03	0.01	0.04	0.02	0.01
3	0.32	0.15	0.20	0.25	0.11	0.13
4	0.41	0.44	0.40	0.20	0.26	0.21
5	0.55	0.63	0.58	0.25	0.30	0.26
6	0.61	0.82	0.59	0.19	0.35	0.23
7	0.66	0.76	0.59	0.22	0.32	0.20
8	0.59	0.55	0.59	0.19	0.19	0.19
9	0.41	0.49	0.56	0.08	0.13	0.18
10	0.46	0.74	0.59	0.07	0.12	0.06
11	0.55	0.46	0.58	0.02	0.07	0.27
12	0.81	0.28	0.53	-	0.13	0.24
13	0.60	0.76	0.56	0.14	0.15	0.01

Mesh Size: 152 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.02	0.01	0.02	0.01	0.00
3	0.24	0.11	0.15	0.18	0.07	0.09
4	0.40	0.41	0.37	0.19	0.23	0.19
5	0.56	0.62	0.61	0.26	0.29	0.29
6	0.65	0.87	0.64	0.22	0.38	0.27
7	0.71	0.83	0.63	0.25	0.37	0.24
8	0.64	0.58	0.65	0.23	0.21	0.24
9	0.43	0.50	0.61	0.10	0.14	0.22
10	0.48	0.75	0.61	0.08	0.13	0.07
11	0.55	0.47	0.66	0.02	0.08	0.34
12	0.81	0.29	0.59	-	0.14	0.30
13	0.63	0.77	0.56	0.16	0.16	0.02

Mesh Size: 165 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	0.00	0.00
2	0.02	0.02	0.01	0.01	0.01	0.00
3	0.18	0.08	0.12	0.12	0.05	0.05
4	0.37	0.36	0.33	0.17	0.18	0.15
5	0.57	0.61	0.62	0.27	0.28	0.30
6	0.69	0.90	0.69	0.26	0.40	0.32
7	0.77	0.91	0.68	0.30	0.44	0.28
8	0.73	0.62	0.72	0.31	0.24	0.30
9	0.46	0.53	0.68	0.12	0.16	0.28
10	0.51	0.78	0.64	0.11	0.15	0.09
11	0.56	0.48	0.78	0.03	0.09	0.44
12	0.81	0.31	0.69	-	0.16	0.38
13	0.68	0.80	0.57	0.20	0.18	0.02

Other Gears' Partial F's

Age	1984	1985	1986
1	0.00	0.00	0.00
2	0.00	0.01	0.01
3	0.07	0.04	0.07
4	0.20	0.18	0.18
5	0.30	0.33	0.32
6	0.41	0.47	0.35
7	0.44	0.43	0.38
8	0.39	0.37	0.40
9	0.33	0.36	0.37
10	0.39	0.62	0.53
11	0.53	0.39	0.30
12	0.81	0.15	0.28
13	0.46	0.60	0.55

Table B-5. Div. 4X cod: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm)				Age	Other Gears
	130	140	152	165		
1	0.005	0.003	0.002	0.001	1	0.000
2	0.172	0.095	0.046	0.022	2	0.013
3	0.839	0.596	0.358	0.193	3	0.115
4	0.875	0.797	0.643	0.447	4	0.358
5	1.000	0.970	0.888	0.751	5	0.586
6	1.000	1.000	1.000	1.000	6	0.756
7	0.884	0.884	0.884	0.884	7	0.777
8	0.669	0.669	0.669	0.669	8	0.710
9	0.500	0.500	0.500	0.500	9	0.659
10	0.291	0.291	0.291	0.291	10	0.923
11	0.527	0.527	0.527	0.527	11	1.000
12	0.725	0.725	0.725	0.725	12	1.000
13	0.447	0.447	0.447	0.447	13	1.000

Fully-Recruited F

Year	Trawl Mesh Size (mm)				Year	Other Gears
	130	140	152	165		
1984	0.291	0.318	0.369	0.454	1984	0.548
1985	0.250	0.262	0.286	0.326	1985	0.544
1986	0.219	0.233	0.261	0.307	1986	0.530

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.00
152	1.00
165	1.00

Table B-6. Div. 4X cod: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.376	.002	.200		.100	.090	.094	.103	.839
2.0	.859	.070	.200	$F_{0.1}$---	.196	.166	.168	.171	1.098
3.0	1.399	.379	.200		.200	.169	.171	.174	1.103
4.0	1.957	.573	.200		.300	.250	.250	.246	1.165
5.0	2.625	.787	.200	F_{max}---	.331	.276	.274	.268	1.168
6.0	3.769	.914	.200		.400	.332	.330	.318	1.159
7.0	5.125	.889	.200		.500	.415	.412	.389	1.132
8.0	7.233	.764	.200		.600	.497	.496	.460	1.100
9.0	8.896	.666	.200		.700	.579	.580	.529	1.071
10.0	10.205	.791	.200		.800	.660	.665	.597	1.045
11.0	12.484	.931	.200		.900	.741	.751	.665	1.022
12.0	14.064	1.000	.200		1.000	.822	.838	.732	1.003
13.0	14.047	.903	.200		1.100	.902	.926	.798	.986
14.0	14.047	.903	.200		1.200	.982	1.014	.864	.972
15.0	14.047	.903	.200		1.300	1.061	1.103	.930	.959
16.0	14.047	.903	.200		1.400	1.140	1.192	.996	.948
					1.500	1.219	1.281	1.061	.938

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.375	.001	.200		.100	.090	.094	.103	.845
2.0	.875	.045	.200		.200	.170	.171	.173	1.120
3.0	1.464	.303	.200	$F_{0.1}$---	.202	.171	.173	.175	1.123
4.0	2.011	.556	.200		.300	.251	.250	.245	1.192
5.0	2.696	.786	.200	F_{max}---	.350	.292	.290	.281	1.197
6.0	3.816	.922	.200		.400	.333	.331	.317	1.193
7.0	5.147	.895	.200		.500	.416	.414	.388	1.170
8.0	7.252	.767	.200		.600	.498	.497	.458	1.143
9.0	8.912	.667	.200		.700	.580	.582	.528	1.116
10.0	10.225	.784	.200		.800	.662	.668	.596	1.092
11.0	12.421	.927	.200		.900	.743	.755	.663	1.071
12.0	14.019	1.000	.200		1.000	.824	.842	.730	1.053
13.0	14.068	.898	.200		1.100	.904	.930	.797	1.037
14.0	14.068	.898	.200		1.200	.984	1.019	.863	1.023
15.0	14.068	.898	.200		1.300	1.063	1.109	.929	1.012
16.0	14.068	.898	.200		1.400	1.142	1.199	.994	1.001
					1.500	1.220	1.289	1.059	.992

Table B-6. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.372	.001	.200		.100	.090	.094	.102	.852
2.0	.874	.028	.200		.200	.169	.171	.173	1.141
3.0	1.508	.225	.200	$F_{0.1}$---	.210	.177	.179	.180	1.155
4.0	2.070	.511	.200		.300	.251	.251	.244	1.223
5.0	2.795	.771	.200	F_{max}---	.372	.310	.310	.295	1.233
6.0	3.898	.937	.200		.400	.333	.333	.315	1.232
7.0	5.198	.905	.200		.500	.415	.416	.386	1.215
8.0	7.288	.772	.200		.600	.497	.501	.456	1.190
9.0	8.936	.668	.200		.700	.578	.587	.525	1.166
10.0	10.256	.771	.200		.800	.659	.673	.593	1.143
11.0	12.331	.921	.200		.900	.739	.761	.661	1.124
12.0	14.015	1.000	.200		1.000	.818	.850	.728	1.106
13.0	14.106	.889	.200		1.100	.897	.939	.794	1.091
14.0	14.106	.889	.200		1.200	.976	1.029	.860	1.078
15.0	14.106	.889	.200		1.300	1.053	1.120	.926	1.066
16.0	14.106	.889	.200		1.400	1.131	1.211	.991	1.056
					1.500	1.208	1.302	1.057	1.046

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.396	.000	.200		.100	.089	.095	.102	.859
2.0	.864	.019	.200		.200	.168	.172	.171	1.162
3.0	1.503	.164	.200	$F_{0.1}$---	.219	.183	.187	.184	1.190
4.0	2.106	.442	.200		.300	.249	.253	.242	1.257
5.0	2.904	.733	.200	F_{max}---	.394	.325	.331	.309	1.273
6.0	4.016	.960	.200		.400	.330	.335	.313	1.273
7.0	5.296	.921	.200		.500	.410	.420	.383	1.261
8.0	7.350	.780	.200		.600	.490	.506	.453	1.240
9.0	8.976	.669	.200		.700	.569	.593	.521	1.217
10.0	10.295	.752	.200		.800	.646	.682	.589	1.195
11.0	12.229	.911	.200		.900	.724	.771	.656	1.175
12.0	14.010	1.000	.200		1.000	.800	.862	.723	1.158
13.0	14.164	.875	.200		1.100	.875	.953	.789	1.142
14.0	14.164	.875	.200		1.200	.950	1.045	.855	1.128
15.0	14.164	.875	.200		1.300	1.024	1.137	.921	1.115
16.0	14.164	.875	.200		1.400	1.097	1.230	.987	1.104
					1.500	1.170	1.323	1.052	1.094

Table B-7. Div. 4X cod: Catch projections for 1988 by mesh size.

Age	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
1	18752	4	.001	3	.000	2	.000	1	.000
2	15348	300	.026	208	.017	142	.012	107	.009
3	11997	2016	.145	1780	.122	1463	.098	1164	.078
4	5750	2126	.244	2169	.244	2149	.235	2021	.218
5	5816	3948	.349	4102	.356	4279	.361	4398	.361
6	2053	2356	.416	2429	.427	2558	.445	2757	.471
7	564	885	.410	905	.420	941	.436	995	.459
8	613	1210	.358	1233	.366	1273	.378	1330	.396
9	214	471	.318	479	.324	493	.333	511	.346
10	102	310	.397	313	.401	318	.407	324	.415
11	51	220	.455	222	.462	225	.472	229	.486
12	23	113	.479	114	.487	117	.501	120	.520
13	9	41	.446	41	.451	42	.460	43	.473
Totals	61292	14000	-	14000	-	14000	-	14000	-
F5+	-	-	.399	-	.409	-	.425	-	.447

Table B-8A. Div. 4X cod: Summary of projections -- constant TAC and allocations.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	82626	89958	97905	107032	116503
5+ Population biomass:	34360	35966	43218	51988	61126
9+ Population biomass:	4031	5724	5566	7523	12251
5+ fishing mortality:	.399	.349	.298	.254	.219
7+ fishing mortality:	.362	.308	.271	.228	.193
9+ fishing mortality:	.425	.363	.306	.271	.226
Yield:	14000	14000	14000	14000	14000
Trawler fishable biomass:	50501	56670	63243	71021	78251
catch biomass:	5995	5995	5995	5995	5995
relative effort:	.119	.106	.095	.084	.077
Others' fishable biomass:	20375	23942	28342	33517	39499
catch biomass:	8005	8005	8005	8005	8005
relative effort:	.393	.334	.282	.239	.203

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	84478	92233	100655	110265	120243
5+ Population biomass:	34896	36218	43806	53081	62755
9+ Population biomass:	4033	5691	5500	7387	12014
5+ fishing mortality:	.409	.357	.303	.256	.220
7+ fishing mortality:	.368	.313	.274	.229	.193
9+ fishing mortality:	.430	.367	.307	.271	.224
Yield:	14000	14000	14000	14000	14000
Trawler fishable biomass:	46467	52623	59566	67834	75519
catch biomass:	5995	5995	5995	5995	5995
relative effort:	.129	.114	.101	.088	.079
Others' fishable biomass:	20332	23891	28394	33791	40066
catch biomass:	8005	8005	8005	8005	8005
relative effort:	.394	.335	.282	.237	.200

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	86077	94299	103291	113482	124071
5+ Population biomass:	35696	36747	44806	54696	65014
9+ Population biomass:	4037	5637	5393	7162	11643
5+ fishing mortality:	.425	.370	.312	.261	.222
7+ fishing mortality:	.379	.321	.280	.232	.193
9+ fishing mortality:	.438	.374	.311	.272	.224
Yield:	14000	14000	14000	14000	14000
Trawler fishable biomass:	40951	46842	53886	62669	70860
catch biomass:	5995	5995	5995	5995	5995
relative effort:	.146	.128	.111	.096	.085
Others' fishable biomass:	20277	23823	28440	34089	40683
catch biomass:	8005	8005	8005	8005	8005
relative effort:	.395	.336	.281	.235	.197

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	87491	96112	105686	116498	127755
5+ Population biomass:	36672	37592	46188	56737	67752
9+ Population biomass:	4044	5565	5248	6856	11174
5+ fishing mortality:	.447	.389	.326	.269	.227
7+ fishing mortality:	.395	.332	.289	.237	.196
9+ fishing mortality:	.450	.383	.317	.275	.224
Yield:	14000	14000	14000	14000	14000
Trawler fishable biomass:	34951	40480	47123	56378	65094
catch biomass:	5995	5995	5995	5995	5995
relative effort:	.172	.148	.127	.106	.092
Others' fishable biomass:	20218	23753	28481	34375	41270
catch biomass:	8005	8005	8005	8005	8005
relative effort:	.396	.337	.281	.233	.194

Table B-8B. Div. 4X cod: Summary of projections -- TAC and allocations for 1988, $F_{0.1}$ and constant allocation ratio in subsequent years.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	82626	89958	106413	122221	135896
5+ Population biomass:	34360	35966	50337	65940	79680
9+ Population biomass:	4031	5724	6553	10096	18063
5+ fishing mortality:	.399	.167	.167	.166	.167
7+ fishing mortality:	.361	.147	.151	.149	.147
9+ fishing mortality:	.425	.173	.170	.176	.170
Yield:	14000	7162	9366	11588	13621
Trawler fishable biomass:	50501	60174	72941	84834	93386
catch biomass:	5995	3067	4012	4963	5832
relative effort:	.119	.051	.055	.059	.062
Others' fishable biomass:	20375	25764	34327	43141	51688
catch biomass:	8005	4095	5354	6625	7789
relative effort:	.393	.159	.156	.154	.151

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	84478	92232	109002	125004	138789
5+ Population biomass:	34896	36218	50981	66828	80651
9+ Population biomass:	4033	5691	6476	9902	17646
5+ fishing mortality:	.409	.173	.173	.172	.173
7+ fishing mortality:	.368	.151	.156	.154	.151
9+ fishing mortality:	.430	.177	.175	.181	.175
Yield:	14000	7263	9532	11809	13900
Trawler fishable biomass:	46466	55960	68860	81006	89708
catch biomass:	5995	3110	4083	5057	5954
relative effort:	.129	.056	.059	.062	.066
Others' fishable biomass:	20332	25701	34268	43114	51668
catch biomass:	8005	4153	5450	6752	7947
relative effort:	.394	.162	.159	.157	.154

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	86077	94299	111520	127843	141796
5+ Population biomass:	35696	36747	52085	68285	82254
9+ Population biomass:	4037	5637	6365	9627	17116
5+ fishing mortality:	.425	.181	.181	.181	.181
7+ fishing mortality:	.379	.157	.162	.160	.157
9+ fishing mortality:	.438	.183	.180	.188	.181
Yield:	14000	7358	9694	12075	14217
Trawler fishable biomass:	40952	49968	62666	75109	84039
catch biomass:	5995	3151	4150	5170	6087
relative effort:	.146	.063	.066	.069	.072
Others' fishable biomass:	20277	25630	34219	43108	51659
catch biomass:	8005	4207	5544	6905	8130
relative effort:	.395	.164	.162	.160	.157

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	87491	96111	113880	130664	144917
5+ Population biomass:	36672	37591	53611	70288	84544
9+ Population biomass:	4044	5565	6223	9289	16570
5+ fishing mortality:	.447	.192	.191	.190	.190
7+ fishing mortality:	.395	.164	.169	.168	.164
9+ fishing mortality:	.450	.189	.186	.194	.188
Yield:	14000	7417	9813	12308	14540
Trawler fishable biomass:	34951	43396	55376	68179	77454
catch biomass:	5995	3176	4203	5270	6225
relative effort:	.172	.073	.076	.077	.080
Others' fishable biomass:	20218	25571	34207	43165	51719
catch biomass:	8005	4241	5610	7039	8315
relative effort:	.396	.166	.164	.163	.161

Table C-1. Div. 5Z cod: Size compositions of adjusted catches. (Length shown is midpoint of 3 cm group.)

Non-trawler nos.-at-length (000's)				1986 Trawler nos.-at-length (000's)				
Length (cm)	Year 1984	1985	1986	Length (cm)	mesh size (mm) 130	140	152	165
31	*****	*****	0	31	0	0	0	0
34	*****	*****	0	34	1	1	0	0
37	*****	*****	0	37	3	2	1	1
40	*****	*****	0	40	12	6	3	2
43	*****	*****	0	43	18	9	4	3
46	*****	*****	29	46	31	17	8	5
49	*****	*****	28	49	66	39	20	11
52	*****	*****	82	52	97	68	38	22
55	*****	*****	189	55	120	97	63	38
58	*****	*****	244	58	135	122	93	62
61	*****	*****	313	61	194	188	163	125
64	*****	*****	531	64	284	287	274	240
67	*****	*****	770	67	291	300	306	301
70	*****	*****	727	70	199	208	220	238
73	*****	*****	627	73	122	128	139	159
76	*****	*****	503	76	45	48	52	63
79	*****	*****	284	79	34	36	40	50
82	*****	*****	206	82	39	41	46	57
85	*****	*****	287	85	38	41	45	57
88	*****	*****	371	88	23	24	27	34
91	*****	*****	319	91	33	35	39	49
94	*****	*****	293	94	30	32	36	45
97	*****	*****	231	97	10	11	12	15
100	*****	*****	147	100	5	6	6	8
103	*****	*****	106	103	1	1	1	2
106	*****	*****	38	106	1	1	1	1
109	*****	*****	11	109	1	1	1	1
112	*****	*****	5	112	0	0	0	1
115	*****	*****	12	115	0	0	0	0
118	*****	*****	1	118	0	0	1	1
121	*****	*****	0	121	0	0	0	0
124	*****	*****	0	124	0	0	0	0
127	*****	*****	0	127	0	0	0	0
Total	*****	*****	6354	Total	1833	1749	1639	1591

Table C-2. Div. 5Z cod: Cumulative length frequencies. (Length shown is midpoint of 3 cm group.)

Year	130 mm mesh length group (cm) 34	37	40	43	46	49	52	55
1984	*****	*****	*****	*****	*****	*****	*****	*****
1985	*****	*****	*****	*****	*****	*****	*****	*****
1986	0.00	0.00	0.01	0.02	0.04	0.07	0.12	0.19
Mean	0.00	0.00	0.01	0.02	0.04	0.07	0.12	0.19

Year	140 mm mesh length group (cm) 34	37	40	43	46	49	52	55
1984	*****	*****	*****	*****	*****	*****	*****	*****
1985	*****	*****	*****	*****	*****	*****	*****	*****
1986	0.00	0.00	0.00	0.01	0.02	0.04	0.08	0.14
Mean	0.00	0.00	0.00	0.01	0.02	0.04	0.08	0.14

Year	152 mm mesh length group (cm) 34	37	40	43	46	49	52	55
1984	*****	*****	*****	*****	*****	*****	*****	*****
1985	*****	*****	*****	*****	*****	*****	*****	*****
1986	0.00	0.00	0.00	0.01	0.01	0.02	0.05	0.08
Mean	0.00	0.00	0.00	0.01	0.01	0.02	0.05	0.08

Year	165 mm mesh length group(cm) 34	37	40	43	46	49	52	55
1984	*****	*****	*****	*****	*****	*****	*****	*****
1985	*****	*****	*****	*****	*****	*****	*****	*****
1986	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05
Mean	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05

Year	Other Gears length group (cm) 34	37	40	43	46	49	52	55
1984	*****	*****	*****	*****	*****	*****	*****	*****
1985	*****	*****	*****	*****	*****	*****	*****	*****
1986	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05
Mean	0.00	0.00	0.00	0.00	0.00	0.01	0.02	0.05

Table C-3. Div. 5Z cod: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	*****	157	*****	*****	19	*****	*****	138
2	*****	*****	1323	*****	*****	215	*****	*****	1108
3	*****	*****	4554	*****	*****	1106	*****	*****	3448
4	*****	*****	800	*****	*****	230	*****	*****	570
5	*****	*****	484	*****	*****	92	*****	*****	392
6	*****	*****	632	*****	*****	139	*****	*****	492
7	*****	*****	88	*****	*****	19	*****	*****	69
8	*****	*****	73	*****	*****	9	*****	*****	63
9	*****	*****	47	*****	*****	4	*****	*****	43
10	*****	*****	30	*****	*****	3	*****	*****	27
1+	*****	*****	8187	*****	*****	1835	*****	*****	6352

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	*****	0.72	*****	*****	0.72	*****	*****	0.72	0.72
2	*****	*****	1.57	*****	*****	1.56	***-*	*****	1.58	1.57
3	*****	*****	2.88	*****	*****	2.87	*****	*****	2.88	2.88
4	*****	*****	3.94	*****	*****	3.82	*****	*****	3.99	3.94
5	*****	*****	5.62	*****	*****	5.27	*****	*****	5.71	5.62
6	*****	*****	7.21	*****	*****	6.66	*****	*****	7.36	7.21
7	*****	*****	8.62	*****	*****	7.84	*****	*****	8.83	8.62
8	*****	*****	9.51	*****	*****	8.65	*****	*****	9.64	9.51
9	*****	*****	10.00	*****	*****	7.93	*****	*****	10.20	10.00
10	*****	*****	8.94	*****	*****	8.94	*****	*****	8.94	8.94

Table C-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	*****	147	*****	*****	9	*****	*****	138
2	*****	*****	1259	*****	*****	150	*****	*****	1108
3	*****	*****	4523	*****	*****	1075	*****	*****	3448
4	*****	*****	807	*****	*****	237	*****	*****	570
5	*****	*****	488	*****	*****	96	*****	*****	392
6	*****	*****	638	*****	*****	146	*****	*****	492
7	*****	*****	89	*****	*****	20	*****	*****	69
8	*****	*****	73	*****	*****	10	*****	*****	63
9	*****	*****	48	*****	*****	4	*****	*****	43
10	*****	*****	30	*****	*****	3	*****	*****	27
1+	*****	*****	8100	*****	*****	1749	*****	*****	6352

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	*****	0.72	*****	*****	0.72	*****	*****	0.72	0.72
2	*****	*****	1.58	*****	*****	1.62	*****	*****	1.58	1.58
3	*****	*****	2.89	*****	*****	2.93	*****	*****	2.88	2.89
4	*****	*****	3.95	*****	*****	3.86	*****	*****	3.99	3.95
5	*****	*****	5.63	*****	*****	5.32	*****	*****	5.71	5.63
6	*****	*****	7.21	*****	*****	6.69	*****	*****	7.36	7.21
7	*****	*****	8.61	*****	*****	7.85	*****	*****	8.83	8.61
8	*****	*****	9.51	*****	*****	8.64	*****	*****	9.64	9.51
9	*****	*****	9.99	*****	*****	7.91	*****	*****	10.20	9.99
10	*****	*****	8.93	*****	*****	8.89	*****	*****	8.94	8.93

Table C-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	*****	143	*****	*****	5	*****	*****	138
2	*****	*****	1197	*****	*****	89	*****	*****	1108
3	*****	*****	4446	*****	*****	997	*****	*****	3448
4	*****	*****	816	*****	*****	246	*****	*****	570
5	*****	*****	494	*****	*****	102	*****	*****	392
6	*****	*****	652	*****	*****	159	*****	*****	492
7	*****	*****	91	*****	*****	22	*****	*****	69
8	*****	*****	74	*****	*****	11	*****	*****	63
9	*****	*****	48	*****	*****	5	*****	*****	43
10	*****	*****	30	*****	*****	3	*****	*****	27
1+	*****	*****	7990	*****	*****	1639	*****	*****	6352

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	*****	0.72	*****	*****	0.72	*****	*****	0.72	0.72
2	*****	*****	1.58	*****	*****	1.67	*****	*****	1.58	1.58
3	*****	*****	2.91	*****	*****	3.02	*****	*****	2.88	2.91
4	*****	*****	3.97	*****	*****	3.91	*****	*****	3.99	3.97
5	*****	*****	5.65	*****	*****	5.43	*****	*****	5.71	5.65
6	*****	*****	7.22	*****	*****	6.76	*****	*****	7.36	7.22
7	*****	*****	8.59	*****	*****	7.85	*****	*****	8.83	8.59
8	*****	*****	9.50	*****	*****	8.66	*****	*****	9.64	9.50
9	*****	*****	9.97	*****	*****	7.96	*****	*****	10.20	9.97
10	*****	*****	8.93	*****	*****	8.89	*****	*****	8.94	8.93

Table C-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	*****	138	*****	*****	0	*****	*****	138
2	*****	*****	1158	*****	*****	50	*****	*****	1108
3	*****	*****	4380	*****	*****	932	*****	*****	3448
4	*****	*****	818	*****	*****	248	*****	*****	570
5	*****	*****	519	*****	*****	127	*****	*****	392
6	*****	*****	661	*****	*****	168	*****	*****	492
7	*****	*****	105	*****	*****	36	*****	*****	69
8	*****	*****	74	*****	*****	11	*****	*****	63
9	*****	*****	58	*****	*****	15	*****	*****	43
10	*****	*****	27	*****	*****	0	*****	*****	27
1+	*****	*****	7938	*****	*****	1586	*****	*****	6352

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	*****	0.72	*****	*****	0.85	*****	*****	0.72	0.72
2	*****	*****	1.58	*****	*****	1.59	*****	*****	1.58	1.58
3	*****	*****	2.90	*****	*****	2.96	*****	*****	2.88	2.90
4	*****	*****	3.93	*****	*****	3.79	*****	*****	3.99	3.93
5	*****	*****	5.62	*****	*****	5.35	*****	*****	5.71	5.62
6	*****	*****	7.15	*****	*****	6.52	*****	*****	7.36	7.15
7	*****	*****	8.47	*****	*****	7.77	*****	*****	8.83	8.47
8	*****	*****	9.70	*****	*****	10.08	*****	*****	9.64	9.70
9	*****	*****	9.67	*****	*****	8.10	*****	*****	10.20	9.67
10	*****	*****	8.95	*****	*****	13.51	*****	*****	8.94	8.95

Table C-4. Div. 5Z cod: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

Mesh Size: 130 mm mesh				Mesh Size: 140 mm mesh				Mesh Size: 152 mm mesh				Mesh Size: 165 mm mesh			
	Total F's				Total F's				Total F's				Total F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	******	******	0.01	1	******	******	0.00	1	******	******	0.00	1	******	******	0.00
2	******	******	0.24	2	******	******	0.24	2	******	******	0.22	2	******	******	0.22
3	******	******	0.71	3	******	******	0.71	3	******	******	0.69	3	******	******	0.66
4	******	******	0.71	4	******	******	0.72	4	******	******	0.74	4	******	******	0.74
5	******	******	0.71	5	******	******	0.72	5	******	******	0.74	5	******	******	0.76
6	******	******	0.71	6	******	******	0.72	6	******	******	0.75	6	******	******	0.79
7	******	******	0.71	7	******	******	0.72	7	******	******	0.76	7	******	******	0.81
8	******	******	0.72	8	******	******	0.72	8	******	******	0.73	8	******	******	0.77
9	******	******	0.71	9	******	******	0.73	9	******	******	0.73	9	******	******	0.76
10	******	******	0.71	10	******	******	0.73	10	******	******	0.73	10	******	******	0.76
	Trawl Partial F's				Trawl Partial F's				Trawl Partial F's				Trawl Partial F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	******	******	0.00	1	******	******	0.00	1	******	******	0.00	1	******	******	0.00
2	******	******	0.04	2	******	******	0.03	2	******	******	0.02	2	******	******	0.01
3	******	******	0.17	3	******	******	0.17	3	******	******	0.15	3	******	******	0.14
4	******	******	0.21	4	******	******	0.21	4	******	******	0.22	4	******	******	0.22
5	******	******	0.14	5	******	******	0.14	5	******	******	0.15	5	******	******	0.19
6	******	******	0.16	6	******	******	0.17	6	******	******	0.18	6	******	******	0.20
7	******	******	0.15	7	******	******	0.16	7	******	******	0.19	7	******	******	0.28
8	******	******	0.09	8	******	******	0.10	8	******	******	0.11	8	******	******	0.11
9	******	******	0.06	9	******	******	0.07	9	******	******	0.08	9	******	******	0.19
10	******	******	0.06	10	******	******	0.07	10	******	******	0.07	10	******	******	0.00

Other Gears' Partial F's			
Age	1984	1985	1986
1	******	******	0.00
2	******	******	0.20
3	******	******	0.54
4	******	******	0.51
5	******	******	0.58
6	******	******	0.56
7	******	******	0.56
8	******	******	0.62
9	******	******	0.65
10	******	******	0.65

Table C-5. Div. 5Z cod: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm) 130	140	152	165
1	.003	.001	.001	.000
2	.192	.131	.075	.033
3	.845	.777	.698	.493
4	1.000	1.000	1.000	.790
5	.662	.662	.686	.658
6	.767	.767	.836	.710
7	.749	.749	.818	1.000
8	.446	.446	.487	.596
9	.308	.308	.336	.411
10	.298	.298	.325	.397

Age	Other Gears
1	.007
2	.318
3	.843
4	.794
5	.902
6	.868
7	.871
8	1.000
9	1.000
10	1.000

Fully Recruited F

Year	Trawl Mesh Size (mm) 130	140	152	165
1984	-	-	-	-
1985	-	-	-	-
1986	.205	.215	.222	.284

Year	Other Gears
1984	-
1985	-
1986	.641

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.00
152	1.09
165	1.34

Table C-6. Div. 5Z cod: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.723	.007	.200		.100	.103	.107	.115	1.244
2.0	1.573	.332	.200		.200	.197	.199	.202	1.683
3.0	2.877	.974	.200	$F_{0.1}$---	.218	.214	.216	.218	1.723
4.0	3.944	.974	.200		.300	.293	.294	.293	1.828
5.0	5.623	.974	.200		.400	.390	.391	.386	1.861
6.0	7.208	.974	.200	F_{max}---	.409	.399	.400	.395	1.861
7.0	8.618	.972	.200		.500	.487	.488	.481	1.849
8.0	9.512	1.000	.200		.600	.585	.586	.576	1.821
9.0	9.996	.961	.200		.700	.682	.684	.672	1.787
10.0	8.937	.958	.200		.800	.780	.781	.768	1.754
11.0	8.937	.958	.200		.900	.877	.879	.864	1.722
12.0	8.937	.958	.200		1.000	.975	.977	.960	1.693
13.0	8.937	.958	.200		1.100	1.072	1.074	1.056	1.667
14.0	8.937	.958	.200		1.200	1.169	1.172	1.153	1.643
15.0	8.937	.958	.200		1.300	1.267	1.269	1.249	1.621
16.0	8.937	.958	.200		1.400	1.364	1.366	1.345	1.601
					1.500	1.462	1.463	1.441	1.582

B: 140 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.723	.006	.200		.100	.103	.107	.115	1.246
2.0	1.581	.314	.200		.200	.197	.199	.201	1.688
3.0	2.893	.960	.200	$F_{0.1}$---	.220	.216	.218	.219	1.732
4.0	3.952	.982	.200		.300	.294	.294	.292	1.836
5.0	5.631	.978	.200		.400	.391	.391	.386	1.871
6.0	7.209	.979	.200	F_{max}---	.414	.405	.405	.399	1.872
7.0	8.613	.976	.200		.500	.489	.489	.480	1.861
8.0	9.506	1.000	.200		.600	.587	.587	.575	1.834
9.0	9.987	.960	.200		.700	.685	.685	.671	1.802
10.0	8.933	.957	.200		.800	.782	.783	.767	1.770
11.0	8.933	.957	.200		.900	.880	.881	.863	1.739
12.0	8.933	.957	.200		1.000	.978	.979	.959	1.710
13.0	8.933	.957	.200		1.100	1.076	1.077	1.055	1.684
14.0	8.933	.957	.200		1.200	1.174	1.175	1.151	1.661
15.0	8.933	.957	.200		1.300	1.271	1.273	1.247	1.639
16.0	8.933	.957	.200		1.400	1.369	1.371	1.342	1.619
					1.500	1.467	1.469	1.438	1.601

Table C-6. (Continued)

C: 152 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.723	.006	.200		.100	.103	.107	.114	1.247
2.0	1.582	.294	.200		.200	.198	.199	.200	1.694
3.0	2.913	.928	.200	$F_{0.1}$---	.223	.220	.221	.221	1.745
4.0	3.967	.975	.200		.300	.295	.295	.291	1.847
5.0	5.650	.975	.200		.400	.392	.393	.384	1.886
6.0	7.216	.991	.200	F_{max}---	.422	.414	.415	.405	1.887
7.0	8.594	.987	.200		.500	.490	.491	.478	1.878
8.0	9.495	1.000	.200		.600	.588	.590	.573	1.853
9.0	9.968	.955	.200		.700	.686	.689	.668	1.822
10.0	8.932	.952	.200		.800	.784	.789	.763	1.791
11.0	8.932	.952	.200		.900	.882	.888	.859	1.760
12.0	8.932	.952	.200		1.000	.980	.987	.954	1.732
13.0	8.932	.952	.200		1.100	1.077	1.086	1.050	1.707
14.0	8.932	.952	.200		1.200	1.175	1.185	1.145	1.683
15.0	8.932	.952	.200		1.300	1.272	1.284	1.241	1.662
16.0	8.932	.952	.200		1.400	1.369	1.383	1.336	1.642
					1.500	1.467	1.482	1.432	1.624

D: 165 (mm) mesh

Input data				Results					
AGE	WEIGHT	PR	M		F full	F 5+	F 7+	F 9+	Total Yield
1.0	.723	.005	.200		.100	.098	.104	.109	1.212
2.0	1.576	.253	.200		.200	.187	.194	.190	1.672
3.0	2.898	.808	.200	$F_{0.1}$---	.239	.222	.230	.223	1.759
4.0	3.932	.871	.200		.300	.278	.288	.275	1.840
5.0	5.618	.908	.200		.400	.369	.384	.362	1.891
6.0	7.150	.900	.200	F_{max}---	.459	.423	.442	.414	1.895
7.0	8.470	1.000	.200		.500	.461	.482	.450	1.892
8.0	9.703	.962	.200		.600	.552	.581	.539	1.873
9.0	9.666	.900	.200		.700	.643	.681	.629	1.846
10.0	8.952	.895	.200		.800	.733	.781	.718	1.817
11.0	8.952	.895	.200		.900	.824	.881	.808	1.788
12.0	8.952	.895	.200		1.000	.914	.982	.898	1.761
13.0	8.952	.895	.200		1.100	1.004	1.082	.988	1.735
14.0	8.952	.895	.200		1.200	1.095	1.183	1.078	1.712
15.0	8.952	.895	.200		1.300	1.185	1.284	1.168	1.691
16.0	8.952	.895	.200		1.400	1.275	1.385	1.258	1.671
					1.500	1.366	1.485	1.348	1.653

Table C-7. Div. 5Z cod: Catch projections for 1988 by mesh size.

AGE	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
1	20900	47	.003	43	.003	42	.003	40	.003
2	17040	3779	.169	3614	.160	3419	.150	3281	.144
3	19800	20654	.506	20708	.503	20703	.497	20423	.493
4	1710	2462	.511	2511	.523	2570	.536	2595	.551
5	1639	3298	.499	3343	.507	3423	.520	3605	.562
6	289	749	.503	759	.512	786	.535	804	.561
7	174	537	.501	544	.509	561	.533	632	.640
8	228	782	.504	787	.509	802	.522	904	.587
9	32	111	.480	111	.483	113	.492	119	.537
10	26	81	.478	81	.481	82	.490	97	.534
11	0	0	.478	0	.481	0	.490	0	.534
12	0	0	.478	0	.481	0	.490	0	.534
13	0	0	.478	0	.481	0	.490	0	.534
14	0	0	.478	0	.481	0	.490	0	.534
15	0	0	.478	0	.481	0	.490	0	.534
16	0	0	.478	0	.481	0	.490	0	.534
Totals	61838	32500	-	32500	-	32500	-	32500	-
F5+	-	-	.501	-	.508	-	.527	-	.585

Table C-8. Div. 5Z cod: Summary of projections -- constant TAC and allocations.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	121145	128453	137533	146237	154915
3+ Population biomass:	79225	86513	95585	104279	112950
5+ Population biomass:	15520	14041	37037	43646	50442
3+ fishing mortality:	.504	.459	.412	.375	.344
5+ fishing mortality:	.501	.454	.407	.372	.340
7+ fishing mortality:	.498	.447	.397	.367	.332
Yield:	32500	32500	32500	32500	32500
Trawler fishable biomass:	50036	58973	60716	67127	72645
catch biomass:	8645	8645	8645	8645	8645
relative effort:	.173	.147	.142	.129	.119
Others' fishable biomass:	55946	60400	68957	75708	82624
catch biomass:	23855	23855	23855	23855	23855
relative effort:	.426	.395	.346	.315	.289

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	121607	129141	138501	147524	156538
3+ Population biomass:	79563	87068	96421	105435	114442
5+ Population biomass:	15531	13921	36933	43800	50898
3+ fishing mortality:	.514	.463	.414	.375	.343
5+ fishing mortality:	.508	.456	.408	.372	.339
7+ fishing mortality:	.503	.448	.396	.365	.329
Yield:	32500	32500	32500	32500	32500
Trawler fishable biomass:	46845	56939	58902	65473	71188
catch biomass:	8645	8645	8645	8645	8645
relative effort:	.185	.152	.147	.132	.121
Others' fishable biomass:	55962	60611	69368	76379	83563
catch biomass:	23855	23855	23855	23855	23855
relative effort:	.426	.394	.344	.312	.285

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	122075	129916	139640	149069	158496
3+ Population biomass:	80011	87821	97537	106957	116378
5+ Population biomass:	15556	13733	36901	44091	51537
3+ fishing mortality:	.528	.467	.416	.375	.342
5+ fishing mortality:	.527	.467	.416	.377	.343
7+ fishing mortality:	.516	.453	.399	.367	.329
Yield:	32500	32500	32500	32500	32500
Trawler fishable biomass:	43726	55377	58036	65505	71770
catch biomass:	8645	8645	8645	8645	8645
relative effort:	.216	.170	.163	.144	.131
Others' fishable biomass:	55989	60873	69888	77217	84740
catch biomass:	23855	23855	23855	23855	23855
relative effort:	.426	.392	.341	.309	.282

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	121570	129068	138616	147885	157074
3+ Population biomass:	79599	87064	96605	105865	115049
5+ Population biomass:	15502	13126	35968	42902	50188
3+ fishing mortality:	.562	.480	.429	.386	.351
5+ fishing mortality:	.585	.498	.454	.394	.369
7+ fishing mortality:	.576	.493	.433	.401	.355
Yield:	32500	32500	32500	32500	32500
Trawler fishable biomass:	32225	41404	45893	51205	58647
catch biomass:	8645	8645	8645	8645	8645
relative effort:	.358	.279	.251	.225	.197
Others' fishable biomass:	55835	60590	69450	76691	84145
catch biomass:	23855	23855	23855	23855	23855
relative effort:	.427	.394	.343	.311	.283

Table D-1. Div. 4VW haddock: Size compositions of adjusted catches. (Length shown is lower of 2 cm group.)

Non-trawler nos.-at-length (000's) Length (cm)	Year 1984	1985	1986
34	2	0	0
36	10	6	1
38	15	11	11
40	44	28	69
42	70	57	132
44	77	100	163
46	90	135	140
48	107	121	99
50	93	100	53
52	75	78	43
54	80	56	25
56	48	47	13
58	35	26	7
60	29	17	6
62	13	7	4
64	6	4	1
66	4	2	0
68	2	2	0
70	2	2	0
72	0	0	0
74	0	0	0
76	0	0	0
78	0	0	0
80	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
0	0	0	0
Total	802	799	767

1984 Trawler nos.-at-length (000's) Length (cm)	mesh size (mm) 130	140	152	165
30	2	2	1	1
32	27	22	19	17
34	162	127	105	95
36	535	411	332	293
38	1131	868	688	593
40	1298	1016	799	676
42	1125	924	731	608
44	888	787	640	529
46	618	603	518	430
48	538	581	541	463
50	306	364	373	334
52	218	280	319	307
54	172	235	295	309
56	129	183	250	288
58	75	109	159	200
60	43	63	97	133
62	29	44	69	101
64	21	31	51	78
66	13	20	33	52
68	8	12	20	33
70	7	11	18	30
72	3	4	6	11
74	1	2	3	5
76	1	1	1	2
78	0	0	0	0
80	0	0	1	1
82	0	0	0	0
84	0	0	0	0
86	0	0	1	1
Total	7350	6700	6070	5590

1985 Trawler nos.-at-length (000's) Length (cm)	mesh size (mm) 130	140	152	165
30	0	0	0	0
32	2	2	2	2
34	35	28	23	22
36	226	174	144	130
38	877	676	547	481
40	1942	1529	1226	1051
42	2410	1990	1610	1360
44	2036	1814	1509	1266
46	1507	1478	1299	1098
48	958	1041	990	858
50	491	586	615	559
52	336	435	505	491
54	215	295	377	400
56	161	229	320	373
58	111	162	241	308
60	69	104	161	224
62	51	77	125	186
64	41	62	103	162
66	24	37	62	101
68	16	24	41	69
70	9	14	23	40
72	5	7	12	21
74	4	7	12	20
76	1	2	3	5
78	0	1	1	2
80	1	2	3	5
82	0	0	1	1
84	0	0	0	0
86	0	0	0	0
Total	11528	10776	9955	9235

1986 Trawler nos.-at-length (000's) Length (cm)	mesh size (mm) 130	140	152	165
30	2	1	1	1
32	5	4	4	4
34	45	37	33	33
36	220	177	158	155
38	969	779	680	650
40	2306	1892	1632	1523
42	3343	2862	2470	2252
44	3373	3109	2753	2488
46	2316	2353	2203	2009
48	1170	1313	1327	1239
50	666	823	919	901
52	319	425	524	549
54	177	250	339	387
56	101	148	218	272
58	66	99	155	212
60	48	73	120	179
62	20	31	53	84
64	21	34	60	102
66	13	20	36	64
68	3	5	10	17
70	4	6	10	18
72	1	2	3	6
74	1	1	2	3
76	0	0	1	1
78	0	0	0	0
80	0	0	0	0
82	0	0	0	0
84	0	0	0	0
86	0	0	0	0
Total	15189	14444	13711	13149

Table D-2. Div. 4VW haddock: Cumulative length frequencies. (Length shown is lower of 2 cm group.)

Year	130 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	0.03	0.10	0.25	0.43	0.58	0.70	0.79	0.86	0.90	0.93	0.96
1985	0.00	0.02	0.10	0.27	0.48	0.65	0.78	0.87	0.91	0.94	0.96
1986	0.00	0.02	0.08	0.23	0.45	0.68	0.83	0.91	0.95	0.97	0.98
Mean	0.01	0.05	0.14	0.31	0.50	0.68	0.80	0.88	0.92	0.95	0.96

Year	140 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	0.02	0.08	0.21	0.37	0.50	0.62	0.71	0.80	0.85	0.89	0.93
1985	0.00	0.02	0.08	0.22	0.41	0.58	0.71	0.81	0.86	0.91	0.93
1986	0.00	0.02	0.07	0.20	0.40	0.61	0.78	0.87	0.92	0.95	0.97
Mean	0.01	0.04	0.12	0.26	0.44	0.60	0.73	0.82	0.88	0.92	0.94

Year	152 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	0.02	0.08	0.19	0.32	0.44	0.55	0.63	0.72	0.78	0.83	0.88
1985	0.00	0.02	0.07	0.20	0.36	0.51	0.64	0.74	0.80	0.85	0.89
1986	0.00	0.01	0.06	0.18	0.36	0.56	0.72	0.82	0.89	0.93	0.95
Mean	0.01	0.04	0.11	0.23	0.39	0.54	0.67	0.76	0.82	0.87	0.91

Year	165 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	0.02	0.07	0.18	0.30	0.41	0.50	0.58	0.66	0.72	0.78	0.83
1985	0.00	0.02	0.07	0.18	0.33	0.47	0.59	0.68	0.74	0.79	0.84
1986	0.00	0.01	0.06	0.18	0.35	0.54	0.69	0.79	0.86	0.90	0.93
Mean	0.01	0.03	0.10	0.22	0.36	0.50	0.62	0.71	0.77	0.82	0.87

Year	Other Gears										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	0.00	0.02	0.03	0.09	0.18	0.27	0.38	0.52	0.63	0.73	0.83
1985	0.00	0.01	0.02	0.06	0.13	0.25	0.42	0.57	0.70	0.80	0.87
1986	0.00	0.00	0.02	0.11	0.28	0.49	0.67	0.80	0.87	0.93	0.96
Mean	0.00	0.01	0.02	0.08	0.19	0.34	0.49	0.63	0.73	0.82	0.88

Table D-3. Div. 4VW haddock: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	10	133	12	0	0	0	10	133	12
2	360	69	50	36	0	9	324	69	41
3	1514	411	1257	1416	195	1044	99	216	213
4	4158	8006	9770	3524	7233	8577	634	773	1193
5	2225	4162	5747	1659	3341	4861	566	821	886
6	821	881	738	459	565	607	362	316	131
7	410	232	98	176	155	79	233	77	19
8	90	47	12	54	44	8	36	3	4
9	30	14	2	21	9	1	9	5	1
10	5	2	2	3	2	1	2	0	1
11	2	1	1	2	1	1	1	0	0
1+	9624	13958	17689	7349	11545	15189	2275	2413	2500

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.09	0.12	0.10	-	-	-	0.09	0.12	0.10	0.12
2	0.26	0.20	0.27	0.36	-	0.40	0.25	0.20	0.24	0.25
3	0.58	0.46	0.62	0.56	0.55	0.64	0.86	0.38	0.51	0.58
4	0.74	0.70	0.81	0.73	0.69	0.80	0.81	0.74	0.85	0.76
5	1.04	0.99	1.05	1.01	0.96	1.04	1.10	1.10	1.11	1.03
6	1.46	1.43	1.57	1.41	1.37	1.54	1.53	1.54	1.71	1.48
7	1.79	1.93	2.42	1.85	1.92	2.47	1.75	1.94	2.20	1.92
8	2.15	2.35	2.28	2.05	2.34	2.25	2.31	2.53	2.33	2.23
9	2.66	2.96	2.58	2.70	3.00	2.58	2.59	2.91	2.58	2.75
10	3.24	2.20	3.76	3.27	2.20	3.76	3.19	2.44	3.75	3.12
11	3.18	5.59	4.47	3.25	5.58	4.47	2.98	5.61	4.47	4.05

Table D-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	10	133	12	0	0	0	10	133	12
2	353	69	48	28	0	8	324	69	41
3	1208	371	1087	1109	156	874	99	216	213
4	3605	6864	8866	2971	6091	7673	634	773	1193
5	2240	4315	5855	1674	3494	4969	566	821	886
6	921	1054	915	559	737	785	362	316	131
7	478	305	139	244	229	120	233	77	19
8	110	69	16	75	66	12	36	3	4
9	40	19	3	31	13	2	9	5	1
10	6	3	3	5	3	2	2	0	1
11	3	1	1	2	1	1	1	0	0
1+	8974	13203	16945	6700	10790	14445	2275	2413	2500

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.09	0.12	0.10	-	-	-	0.09	0.12	0.10	0.12
2	0.26	0.20	0.27	0.36	-	0.40	0.25	0.20	0.24	0.25
3	0.58	0.45	0.62	0.56	0.56	0.64	0.86	0.38	0.51	0.58
4	0.76	0.71	0.82	0.75	0.70	0.82	0.81	0.74	0.85	0.77
5	1.07	1.01	1.08	1.06	0.99	1.07	1.10	1.10	1.11	1.06
6	1.50	1.45	1.61	1.49	1.41	1.60	1.53	1.54	1.71	1.52
7	1.82	1.94	2.45	1.88	1.93	2.49	1.75	1.94	2.20	1.95
8	2.19	2.36	2.30	2.13	2.35	2.29	2.31	2.53	2.33	2.26
9	2.68	2.97	2.58	2.71	3.00	2.58	2.59	2.91	2.58	2.77
10	3.25	2.20	3.76	3.27	2.20	3.76	3.19	2.44	3.75	3.11
11	3.22	5.59	4.47	3.27	5.58	4.47	2.98	5.61	4.47	4.07

Table D-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	10	133	12	0	0	0	10	133	12
2	348	69	48	24	0	7	324	69	41
3	976	343	986	878	127	773	99	216	213
4	3069	5804	8046	2435	5032	6853	634	773	1193
5	2141	4203	5741	1575	3382	4855	566	821	886
6	1018	1254	1130	656	938	1000	362	316	131
7	567	427	214	334	350	195	233	77	19
8	140	111	22	104	108	18	36	3	4
9	57	28	4	48	23	3	9	5	1
10	9	5	4	8	5	4	2	0	1
11	5	2	2	4	2	2	1	0	0
1+	8341	12379	16211	6066	9966	13711	2275	2413	2500

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.09	0.12	0.10	-	-	-	0.09	0.12	0.10	0.12
2	0.26	0.20	0.26	0.36	-	0.40	0.25	0.20	0.24	0.25
3	0.59	0.45	0.62	0.56	0.56	0.64	0.86	0.38	0.51	0.58
4	0.77	0.71	0.83	0.76	0.71	0.83	0.81	0.74	0.85	0.78
5	1.11	1.04	1.11	1.11	1.03	1.11	1.10	1.10	1.11	1.09
6	1.56	1.49	1.68	1.58	1.47	1.68	1.53	1.54	1.71	1.57
7	1.87	1.96	2.49	1.94	1.97	2.52	1.75	1.94	2.20	2.01
8	2.27	2.38	2.37	2.25	2.38	2.38	2.31	2.53	2.33	2.32
9	2.72	2.99	2.58	2.74	3.00	2.58	2.59	2.91	2.58	2.80
10	3.26	2.22	3.76	3.27	2.22	3.76	3.19	2.44	3.75	3.11
11	3.27	5.59	4.47	3.32	5.58	4.47	2.98	5.61	4.47	4.13

Table D-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	10	133	12	0	0	0	10	133	12
2	346	69	48	21	0	7	324	69	41
3	842	327	951	743	112	738	99	216	213
4	2702	5070	7525	2068	4297	6332	634	773	1193
5	1979	3876	5463	1413	3055	4577	566	821	886
6	1062	1391	1288	700	1075	1157	362	316	131
7	645	568	315	412	491	296	233	77	19
8	175	172	30	139	169	26	36	3	4
9	79	44	6	70	39	5	9	5	1
10	14	8	8	13	7	7	2	0	1
11	7	4	4	6	3	3	1	0	0
1+	7859	11661	15650	5585	9249	13150	2275	2413	2500

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.09	0.12	0.10	-	-	-	0.09	0.12	0.10	0.12
2	0.26	0.20	0.27	0.36	-	0.40	0.25	0.20	0.24	0.25
3	0.59	0.44	0.61	0.55	0.55	0.64	0.86	0.38	0.51	0.58
4	0.77	0.71	0.83	0.76	0.71	0.83	0.81	0.74	0.85	0.78
5	1.13	1.06	1.13	1.14	1.05	1.13	1.10	1.10	1.11	1.10
6	1.61	1.54	1.75	1.66	1.54	1.75	1.53	1.54	1.71	1.63
7	1.92	2.01	2.56	2.02	2.03	2.58	1.75	1.94	2.20	2.09
8	2.37	2.44	2.49	2.39	2.44	2.52	2.31	2.53	2.33	2.41
9	2.79	3.00	2.58	2.82	3.01	2.58	2.59	2.91	2.58	2.85
10	3.27	2.26	3.76	3.28	2.25	3.76	3.19	2.44	3.75	3.14
11	3.39	5.58	4.47	3.43	5.58	4.47	2.98	5.61	4.47	4.25

Table D-4. Div. 4VW haddock: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm) 130	140	152	165
1	.000	.000	.000	.000
2	.001	.001	.000	.000
3	.043	.026	.020	.014
4	.310	.191	.149	.099
5	.537	.417	.369	.246
6	.640	.640	.640	.640
7	.745	.745	.745	.745
8	1.000	1.000	1.000	1.000
9	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000

Age	Other Gears
1	.025
2	.019
3	.027
4	.165
5	.501
6	1.000
7	1.000
8	1.000
9	1.000
10	1.000

Fully Recruited F

Year	Trawl Mesh Size (mm) 130	140	152	165
1984	1.304	1.675	1.745	2.197
1985	1.572	2.131	2.208	2.756
1986	1.575	2.174	2.395	3.288

Year	Other Gears
1984	.463
1985	.406
1986	.349

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.00
152	1.09
165	1.34

Table D-5. Div. 4VW haddock: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.117	.005	.200		.100	.085	.105	.119	.291
2.0	.254	.005	.200		.200	.154	.191	.209	.402
3.0	.579	.039	.200	$F_{0.1}$---	.239	.181	.225	.246	.423
4.0	.756	.279	.200		.300	.221	.278	.304	.444
5.0	1.026	.529	.200		.400	.284	.365	.402	.459
6.0	1.483	.717	.200		.500	.345	.451	.501	.463
7.0	1.918	.800	.200	F_{max}---	.515	.354	.464	.516	.463
8.0	2.226	1.000	.200		.600	.404	.536	.600	.461
9.0	2.753	1.000	.200		.700	.462	.619	.700	.458
10.0	3.121	1.000	.200		.800	.518	.702	.800	.454
11.0	4.051	1.000	.200		.900	.573	.783	.900	.450
12.0	4.051	1.000	.200		1.000	.628	.864	1.000	.446
13.0	4.051	1.000	.200		1.100	.681	.945	1.100	.442
14.0	4.051	1.000	.200		1.200	.735	1.025	1.200	.438
15.0	4.051	1.000	.200		1.300	.788	1.104	1.300	.434
16.0	4.051	1.000	.200		1.400	.840	1.183	1.400	.430
					1.500	.892	1.262	1.500	.427

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.117	.004	.200		.100	.082	.104	.119	.290
2.0	.252	.004	.200		.200	.148	.190	.209	.406
3.0	.580	.026	.200	$F_{0.1}$---	.251	.179	.234	.257	.435
4.0	.770	.187	.200		.300	.209	.277	.304	.453
5.0	1.055	.431	.200		.400	.267	.363	.402	.471
6.0	1.519	.701	.200		.500	.322	.448	.501	.478
7.0	1.952	.788	.200	F_{max}---	.581	.365	.516	.581	.479
8.0	2.256	1.000	.200		.600	.375	.532	.600	.479
9.0	2.766	1.000	.200		.700	.426	.615	.700	.478
10.0	3.106	1.000	.200		.800	.475	.696	.800	.475
11.0	4.069	1.000	.200		.900	.523	.777	.900	.472
12.0	4.069	1.000	.200		1.000	.569	.857	1.000	.468
13.0	4.069	1.000	.200		1.100	.615	.936	1.100	.465
14.0	4.069	1.000	.200		1.200	.660	1.015	1.200	.461
15.0	4.069	1.000	.200		1.300	.705	1.093	1.300	.458
16.0	4.069	1.000	.200		1.400	.749	1.171	1.400	.455
					1.500	.792	1.248	1.500	.452

Table D-5. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.117	.004	.200		.100	.081	.104	.119	.295
2.0	.251	.003	.200		.200	.145	.190	.209	.414
3.0	.579	.021	.200	$F_{0.1}$---	.258	.180	.240	.264	.448
4.0	.779	.151	.200		.300	.205	.277	.304	.464
5.0	1.085	.390	.200		.400	.261	.363	.402	.485
6.0	1.574	.698	.200		.500	.314	.448	.501	.493
7.0	2.012	.786	.200		.600	.364	.531	.600	.495
8.0	2.321	1.000	.200	F_{max}---	.621	.374	.549	.621	.495
9.0	2.797	1.000	.200		.700	.412	.614	.700	.495
10.0	3.106	1.000	.200		.800	.458	.695	.800	.493
11.0	4.127	1.000	.200		.900	.503	.776	.900	.490
12.0	4.127	1.000	.200		1.000	.547	.855	1.000	.487
13.0	4.127	1.000	.200		1.100	.590	.934	1.100	.484
14.0	4.127	1.000	.200		1.200	.631	1.013	1.200	.480
15.0	4.127	1.000	.200		1.300	.673	1.091	1.300	.477
16.0	4.127	1.000	.200		1.400	.713	1.169	1.400	.474
					1.500	.753	1.246	1.500	.471

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.117	.003	.200		.100	.078	.104	.119	.300
2.0	.250	.003	.200		.200	.138	.190	.209	.425
3.0	.577	.015	.200	$F_{0.1}$---	.267	.175	.247	.272	.466
4.0	.781	.107	.200		.300	.193	.276	.304	.479
5.0	1.104	.279	.200		.400	.243	.361	.402	.503
6.0	1.633	.686	.200		.500	.290	.446	.501	.513
7.0	2.089	.778	.200		.600	.334	.529	.600	.517
8.0	2.411	1.000	.200	F_{max}---	.689	.370	.602	.689	.518
9.0	2.853	1.000	.200		.700	.375	.611	.700	.518
10.0	3.139	1.000	.200		.800	.414	.691	.800	.517
11.0	4.247	1.000	.200		.900	.451	.771	.900	.516
12.0	4.247	1.000	.200		1.000	.487	.850	1.000	.513
13.0	4.247	1.000	.200		1.100	.522	.928	1.100	.511
14.0	4.247	1.000	.200		1.200	.555	1.006	1.200	.508
15.0	4.247	1.000	.200		1.300	.588	1.083	1.300	.505
16.0	4.247	1.000	.200		1.400	.620	1.160	1.400	.502
					1.500	.651	1.237	1.500	.499

Table E-1. Div. 4X haddock: Size compositions of adjusted catches. (Length shown is lower of 2 cm group.)

Non-trawler nos.-at-length (000's)				1984 Trawler nos.-at-length (000's)					1985 Trawler nos.-at-length (000's)					1986 Trawler nos.-at-length (000's)				
Length	Year			Length	mesh size (mm)				Length	mesh size (mm)				Length	mesh size (mm)			
(cm)	1984	1985	1986	(cm)	130	140	152	165	(cm)	130	140	152	165	(cm)	130	140	152	165
28	0	0	0	22	2	1	1	1	22	0	0	0	0	22	0	0	0	0
30	0	0	0	24	0	0	0	0	24	0	0	0	0	24	0	0	0	0
32	0	0	0	26	0	0	0	0	26	0	0	0	0	26	0	0	0	0
34	2	0	4	28	8	6	6	5	28	3	2	2	2	28	0	0	0	0
36	12	2	3	30	32	25	20	19	30	17	12	10	9	30	3	2	2	2
38	36	12	14	32	108	79	63	56	32	36	24	18	16	32	39	29	25	24
40	83	33	49	34	225	156	116	98	34	120	83	62	53	34	140	104	87	83
42	203	91	107	36	360	240	170	138	36	258	177	129	107	36	291	211	169	155
44	283	190	234	38	513	339	234	184	38	458	309	217	174	38	401	292	229	204
46	332	302	354	40	519	349	238	183	40	654	451	316	249	40	526	383	290	248
48	358	341	434	42	736	518	355	268	42	742	534	376	292	42	762	575	435	362
50	352	326	503	44	941	709	498	373	44	889	687	498	386	44	1065	854	656	538
52	412	297	480	46	1005	832	616	463	46	869	726	547	422	46	1167	1017	813	665
54	424	271	402	48	1028	941	751	579	48	861	788	635	498	48	1080	1035	892	746
56	398	258	336	50	956	946	820	656	50	832	835	740	608	50	829	872	825	722
58	344	185	206	52	816	873	840	720	52	712	769	751	657	52	589	666	696	652
60	294	154	154	54	698	782	819	760	54	577	660	706	667	54	462	551	631	641
62	183	116	103	56	520	603	683	694	56	436	518	604	630	56	306	383	479	537
64	138	68	69	58	429	514	624	697	58	292	357	441	501	58	159	203	266	323
66	93	53	49	60	280	341	431	518	60	197	246	319	393	60	151	196	273	361
68	60	30	24	62	195	238	310	399	62	142	177	235	307	62	61	80	114	160
70	38	22	15	64	107	131	174	234	64	99	124	168	229	64	27	36	54	80
72	25	12	6	66	70	86	116	162	66	33	41	56	79	66	17	22	33	52
74	9	4	6	68	36	44	59	84	68	34	42	58	83	68	11	15	23	37
76	8	2	3	70	29	36	50	74	70	14	17	23	35	70	8	11	16	25
78	1	0	0	72	8	10	13	19	72	10	12	17	24	72	3	4	7	11
80	0	1	0	74	4	5	7	10	74	2	2	3	5	74	4	5	8	13
82	0	0	0	76	4	4	5	7	76	1	1	1	2	76	1	1	1	2
84	0	0	0	78	0	0	0	0	78	0	0	0	0	78	0	0	0	0
86	0	0	0	80	0	0	0	0	80	2	2	3	4	80	1	1	1	2
0	0	0	0	82	0	0	1	1	82	0	0	0	0	82	1	1	1	3
Total	4088	2770	3555	Total	9629	8808	8020	7402	Total	8290	7596	6935	6432	Total	8104	7549	7026	6648

Table E-2. Div. 4X haddock: Cumulative length frequencies. (Length shown is lower of 2 cm group.)

130 mm mesh — length group (cm)

Year	34	36	38	40	42	44	46	48	50	52	54
1984	0.04	0.08	0.13	0.18	0.26	0.36	0.46	0.57	0.67	0.75	0.83
1985	0.02	0.05	0.11	0.19	0.28	0.38	0.49	0.59	0.69	0.78	0.85
1986	0.02	0.06	0.11	0.17	0.27	0.40	0.54	0.68	0.78	0.85	0.91
Mean	0.03	0.06	0.12	0.18	0.27	0.38	0.50	0.61	0.71	0.79	0.86

140 mm mesh — length group (cm)

Year	34	36	38	40	42	44	46	48	50	52	54
1984	0.03	0.06	0.10	0.14	0.19	0.27	0.37	0.48	0.58	0.68	0.77
1985	0.02	0.04	0.08	0.14	0.21	0.30	0.40	0.50	0.61	0.71	0.80
1986	0.02	0.05	0.08	0.14	0.21	0.32	0.46	0.60	0.71	0.80	0.87
Mean	0.02	0.05	0.09	0.14	0.21	0.30	0.41	0.52	0.63	0.73	0.81

152 mm mesh — length group (cm)

Year	34	36	38	40	42	44	46	48	50	52	54
1984	0.03	0.05	0.08	0.11	0.15	0.21	0.29	0.38	0.48	0.59	0.69
1985	0.01	0.03	0.06	0.11	0.16	0.23	0.31	0.41	0.51	0.62	0.72
1986	0.02	0.04	0.07	0.11	0.18	0.27	0.39	0.51	0.63	0.73	0.82
Mean	0.02	0.04	0.07	0.11	0.16	0.24	0.33	0.43	0.54	0.65	0.74

165 mm mesh — length group (cm)

Year	34	36	38	40	42	44	46	48	50	52	54
1984	0.02	0.04	0.07	0.09	0.13	0.18	0.24	0.32	0.41	0.51	0.61
1985	0.01	0.03	0.06	0.09	0.14	0.20	0.27	0.34	0.44	0.54	0.64
1986	0.02	0.04	0.07	0.11	0.16	0.24	0.34	0.46	0.56	0.66	0.76
Mean	0.02	0.04	0.06	0.10	0.14	0.21	0.28	0.37	0.47	0.57	0.67

Other Gears — length group (cm)

Year	34	36	38	40	42	44	46	48	50	52	54
1984	0.00	0.00	0.01	0.03	0.08	0.15	0.23	0.32	0.41	0.51	0.61
1985	0.00	0.00	0.01	0.02	0.05	0.12	0.23	0.35	0.47	0.58	0.67
1986	0.00	0.00	0.01	0.02	0.05	0.12	0.22	0.34	0.48	0.61	0.73
Mean	0.00	0.00	0.01	0.02	0.06	0.13	0.23	0.34	0.45	0.57	0.67

Table E-3. Div. 4X haddock: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	2	0	0	2	0	0	0	0	0
2	683	199	291	683	198	291	10	0	0
3	1106	1953	1169	1031	1884	1148	89	73	22
4	4650	2258	4370	3510	1872	3456	1203	389	924
5	3466	4509	3911	2300	3189	2321	1214	1328	1603
6	2299	1461	1471	1373	849	728	959	614	749
7	927	463	246	480	227	80	461	237	166
8	340	133	115	157	35	62	190	97	54
9	104	53	40	46	28	6	60	25	34
10	75	17	28	30	5	8	46	11	20
11	37	6	9	10	0	2	29	6	7
12	20	1	4	7	1	0	13	0	4
13	5	1	2	0	0	0	5	1	2
14	3	0	0	0	0	0	3	0	0
15	3	0	0	0	0	0	3	0	0
16	0	0	0	0	0	0	0	0	0
1+	13720	11054	11657	9629	8288	8103	4285	2781	3585

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.25	-	-	0.25	-	-	-	-	-	0.25
2	0.53	0.55	0.52	0.52	0.55	0.52	-	0.69	-	0.53
3	0.79	0.79	0.73	0.76	0.78	0.73	0.93	1.01	0.76	0.77
4	1.08	1.05	1.05	1.05	1.03	1.03	1.09	1.12	1.11	1.06
5	1.43	1.39	1.40	1.39	1.40	1.36	1.45	1.37	1.46	1.41
6	1.97	1.95	1.88	1.89	1.98	1.80	2.02	1.89	1.93	1.94
7	2.32	2.46	2.48	2.27	2.39	2.51	2.30	2.53	2.46	2.38
8	2.75	2.89	2.63	2.56	3.01	2.36	2.81	2.86	2.92	2.76
9	3.15	3.32	3.36	3.00	3.25	3.59	3.19	3.46	3.36	3.24
10	3.48	3.11	3.55	3.20	3.06	3.58	3.57	3.31	3.52	3.44
11	4.03	3.86	2.99	3.67	3.13	3.45	3.89	4.16	2.92	3.83
12	4.13	4.66	3.11	4.00	4.30	-	4.21	-	3.11	3.98
13	3.33	5.70	4.41	3.74	-	-	3.58	5.70	4.41	3.87
14	4.11	-	-	5.92	-	-	4.47	-	-	4.11
15	4.33	-	-	-	-	-	4.33	-	-	4.33
16	-	-	-	-	-	-	-	-	-	4.33

Table E-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	1	0	0	1	0	0	0	0	0
2	469	145	211	469	144	211	10	0	0
3	837	1465	904	762	1396	883	89	73	22
4	4073	1960	3945	2933	1574	3031	1203	389	924
5	3408	4457	3961	2242	3137	2371	1214	1328	1603
6	2462	1597	1595	1536	985	852	959	614	749
7	1006	510	269	559	274	103	461	237	166
8	371	142	130	188	44	77	190	97	54
9	115	60	43	57	35	9	60	25	34
10	81	18	30	36	6	10	46	11	20
11	39	6	10	12	0	3	29	6	7
12	21	1	4	8	1	0	13	0	4
13	5	1	2	0	0	0	5	1	2
14	4	0	0	1	0	0	3	0	0
15	3	0	0	0	0	0	3	0	0
16	0	0	0	0	0	0	0	0	0
1+	12897	10363	11104	8806	7597	7550	4285	2781	3585

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.25	-	-	0.25	-	-	-	-	-	0.25
2	0.54	0.55	0.52	0.51	0.55	0.52	-	0.69	-	0.53
3	0.82	0.81	0.74	0.79	0.80	0.74	0.93	1.01	0.76	0.79
4	1.12	1.09	1.08	1.11	1.08	1.07	1.09	1.12	1.11	1.10
5	1.47	1.44	1.43	1.45	1.47	1.41	1.45	1.37	1.46	1.44
6	1.99	1.97	1.90	1.92	2.01	1.85	2.02	1.89	1.93	1.96
7	2.33	2.46	2.49	2.30	2.40	2.53	2.30	2.53	2.46	2.39
8	2.75	2.89	2.62	2.58	3.00	2.38	2.81	2.86	2.92	2.75
9	3.14	3.32	3.38	3.01	3.26	3.62	3.19	3.46	3.36	3.24
10	3.46	3.10	3.56	3.21	3.06	3.60	3.57	3.31	3.52	3.43
11	4.01	3.85	3.02	3.67	3.13	3.45	3.89	4.16	2.92	3.82
12	4.11	4.60	3.11	3.98	4.30	-	4.21	-	3.11	3.98
13	3.33	5.70	4.41	3.74	-	-	3.58	5.70	4.41	3.87
14	4.16	-	-	5.92	-	-	4.47	-	-	4.16
15	4.33	-	-	-	-	-	4.33	-	-	4.33
16	-	-	-	-	-	-	-	-	-	4.33

Table E-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	1	0	0	1	0	0	0	0	0
2	341	112	168	341	111	168	10	0	0
3	635	1087	720	560	1018	699	89	73	22
4	3455	1644	3478	2315	1258	2564	1203	389	924
5	3216	4267	3903	2050	2947	2313	1214	1328	1603
6	2617	1753	1750	1691	1141	1007	959	614	749
7	1117	581	309	670	345	143	461	237	166
8	421	158	153	238	60	100	190	97	54
9	135	72	47	77	47	13	60	25	34
10	93	20	35	48	8	15	46	11	20
11	44	7	11	17	1	4	29	6	7
12	24	1	4	11	1	0	13	0	4
13	6	1	2	1	0	0	5	1	2
14	4	0	0	1	0	0	3	0	0
15	3	0	0	0	0	0	3	0	0
16	0	0	0	0	0	0	0	0	0
1+	12110	9701	10579	8019	6935	7025	4285	2781	3585

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.25	-	-	0.25	-	-	-	-	-	0.25
2	0.54	0.54	0.51	0.51	0.55	0.51	-	0.69	-	0.53
3	0.84	0.83	0.74	0.81	0.81	0.73	0.93	1.01	0.76	0.80
4	1.16	1.12	1.11	1.16	1.12	1.11	1.09	1.12	1.11	1.13
5	1.51	1.49	1.46	1.51	1.55	1.46	1.45	1.37	1.46	1.49
6	2.02	2.01	1.93	1.98	2.07	1.92	2.02	1.89	1.93	1.99
7	2.37	2.48	2.51	2.36	2.44	2.56	2.30	2.53	2.46	2.42
8	2.75	2.91	2.62	2.62	3.01	2.45	2.81	2.86	2.92	2.76
9	3.14	3.33	3.41	3.04	3.29	3.66	3.19	3.46	3.36	3.24
10	3.44	3.10	3.58	3.23	3.06	3.63	3.57	3.31	3.52	3.43
11	3.98	3.83	3.07	3.67	3.13	3.45	3.89	4.16	2.92	3.80
12	4.09	4.52	3.11	3.96	4.30	-	4.21	-	3.11	3.97
13	3.35	5.70	4.41	3.74	-	-	3.58	5.70	4.41	3.86
14	4.27	-	-	5.92	-	-	4.47	-	-	4.27
15	4.33	-	-	-	-	-	4.33	-	-	4.33
16	-	-	-	-	-	-	-	-	-	4.33

Table E-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	1	0	0	1	0	0	0	0	0
2	281	97	156	281	96	156	10	0	0
3	518	875	637	443	806	616	89	73	22
4	2978	1406	3139	1838	1020	2225	1203	389	924
5	2955	3991	3749	1789	2671	2159	1214	1328	1603
6	2678	1863	1867	1752	1251	1124	959	614	749
7	1234	659	358	787	423	192	461	237	166
8	482	181	180	299	83	127	190	97	54
9	163	91	54	105	66	20	60	25	34
10	110	23	43	65	11	23	46	11	20
11	51	7	13	24	1	6	29	6	7
12	28	2	4	15	2	0	13	0	4
13	6	1	2	1	0	0	5	1	2
14	4	0	0	1	0	0	3	0	0
15	3	0	0	0	0	0	3	0	0
16	0	0	0	0	0	0	0	0	0
1+	11492	9197	10202	7401	6431	6648	4285	2781	3585

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	0.25	-	-	0.25	-	-	-	-	-	0.25
2	0.54	0.54	0.51	0.50	0.54	0.51	-	0.69	-	0.53
3	0.85	0.83	0.73	0.81	0.81	0.73	0.93	1.01	0.76	0.80
4	1.17	1.13	1.13	1.18	1.13	1.13	1.09	1.12	1.11	1.14
5	1.54	1.53	1.49	1.55	1.61	1.50	1.45	1.37	1.46	1.52
6	2.06	2.06	1.97	2.04	2.14	1.98	2.02	1.89	1.93	2.03
7	2.42	2.52	2.54	2.44	2.51	2.61	2.30	2.53	2.46	2.47
8	2.77	2.93	2.66	2.68	3.04	2.54	2.81	2.86	2.92	2.78
9	3.16	3.36	3.46	3.10	3.34	3.71	3.19	3.46	3.36	3.27
10	3.43	3.09	3.61	3.28	3.06	3.67	3.57	3.31	3.52	3.43
11	3.94	3.80	3.14	3.68	3.13	3.46	3.89	4.16	2.92	3.77
12	4.07	4.45	3.11	3.96	4.30	-	4.21	-	3.11	3.98
13	3.37	5.70	4.41	3.74	-	-	3.58	5.70	4.41	3.86
14	4.44	-	-	5.92	-	-	4.47	-	-	4.44
15	4.33	-	-	-	-	-	4.33	-	-	4.33
16	-	-	-	-	-	-	-	-	-	4.33

Table E-4. Div. 4X haddock: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

Mesh Size: 130 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	******	******
2	0.02	0.01	0.02	0.02	0.01	0.02
3	0.06	0.07	0.07	0.06	0.06	0.07
4	0.36	0.18	0.21	0.27	0.15	0.17
5	0.81	0.73	0.55	0.54	0.52	0.33
6	1.30	1.02	0.56	0.77	0.59	0.28
7	1.48	1.34	0.46	0.77	0.66	0.15
8	1.26	1.05	1.98	0.58	0.27	1.07
9	1.31	0.66	1.16	0.58	0.35	0.19
10	1.63	0.95	0.90	0.65	0.27	0.25
11	3.72	0.63	1.00	1.01	0.04	0.24
12	1.56	0.52	1.33	0.55	0.52	******
13	1.50	0.99	1.11	0.11	******	******
14	1.50	******	******	0.18	******	******
15	1.50	******	******	******	******	******
16	******	******	******	******	******	******

Mesh Size: 140 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	******	******
2	0.01	0.01	0.01	0.01	0.01	0.01
3	0.05	0.05	0.06	0.04	0.05	0.05
4	0.31	0.16	0.19	0.22	0.13	0.14
5	0.79	0.72	0.56	0.52	0.51	0.34
6	1.51	1.21	0.63	0.94	0.74	0.34
7	1.83	1.68	0.51	1.02	0.90	0.20
8	1.52	1.18	3.63	0.77	0.36	2.15
9	1.65	0.79	1.29	0.82	0.46	0.26
10	2.05	1.08	1.04	0.92	0.35	0.35
11	******	0.65	1.12	******	0.05	0.32
12	1.85	0.68	1.33	0.72	0.68	******
13	1.57	0.99	1.11	0.14	******	******
14	1.61	******	******	0.24	******	******
15	1.50	******	******	******	******	******
16	******	******	******	******	******	******

Mesh Size: 152 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	******	******
2	0.01	0.01	0.01	0.01	0.01	0.01
3	0.04	0.04	0.04	0.03	0.03	0.04
4	0.26	0.13	0.16	0.17	0.10	0.12
5	0.73	0.68	0.55	0.46	0.47	0.33
6	1.76	1.46	0.72	1.14	0.95	0.41
7	2.69	2.59	0.62	1.62	1.54	0.29
8	2.17	1.47	******	1.23	0.56	******
9	2.87	1.06	1.60	1.63	0.69	0.44
10	4.89	1.34	1.38	2.51	0.53	0.59
11	******	0.67	1.43	******	0.07	0.52
12	2.90	1.07	1.33	1.32	1.07	******
13	1.72	0.99	1.11	0.21	******	******
14	1.91	******	******	0.38	******	******
15	1.50	******	******	******	******	******
16	******	******	******	******	******	******

Mesh Size: 165 mm mesh

Age	Total F's 1984	Total F's 1985	Total F's 1986	Trawl Partial F's 1984	Trawl Partial F's 1985	Trawl Partial F's 1986
1	0.00	0.00	0.00	0.00	******	******
2	0.01	0.00	0.01	0.01	0.00	0.01
3	0.03	0.03	0.04	0.03	0.03	0.04
4	0.22	0.11	0.15	0.13	0.08	0.10
5	0.64	0.62	0.52	0.39	0.41	0.30
6	1.88	1.70	0.79	1.23	1.14	0.48
7	******	******	0.77	******	******	0.41
8	******	2.17	******	******	0.99	******
9	******	1.75	2.53	******	1.27	0.94
10	******	1.92	2.53	******	0.93	1.36
11	******	0.72	2.46	******	0.10	1.16
12	******	2.79	1.33	******	2.79	******
13	2.09	0.99	1.11	0.38	******	******
14	3.05	******	******	0.86	******	******
15	1.50	******	******	******	******	******
16	******	******	******	******	******	******

Other Gears' Partial F's

Age	1984	1985	1986
1	******	******	******
2	0.00	******	******
3	0.01	0.00	0.00
4	0.09	0.03	0.04
5	0.29	0.22	0.23
6	0.54	0.43	0.29
7	0.74	0.68	0.31
8	0.70	0.77	0.92
9	0.75	0.30	0.97
10	1.00	0.65	0.65
11	2.90	0.56	0.75
12	1.01	0.19	1.33
13	1.28	0.99	1.11
14	1.14	******	******
15	1.50	******	******
16	******	******	******

Table E-5. Div. 4X haddock: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm)			
	130	140	152	165
1	.000	.000	.000	.000
2	.029	.015	.007	.003
3	.124	.068	.031	.010
4	.372	.230	.112	.038
5	.861	.629	.355	.130
6	1.000	.906	.685	.324
7	1.000	1.000	.989	.465
8	1.000	1.000	1.000	.679
9	1.000	1.000	1.000	1.000
10	1.000	1.000	1.000	1.000
11	1.000	1.000	1.000	1.000
12	.831	.831	.831	.831
13	.163	.163	.163	.163
14	.264	.264	.264	.264
15	.000	.000	.000	.000
16	.000	.000	.000	.000

Age	Other Gears
1	.000
2	.000
3	.003
4	.052
5	.221
6	.364
7	.505
8	.613
9	.561
10	.679
11	1.000
12	1.000
13	1.000
14	1.000
15	1.000
16	1.000

Fully Recruited F

Year	Trawl Mesh Size (mm)			
	130	140	152	165
1984	.673	.891	1.421	3.252
1985	.524	.705	1.156	2.800
1986	.429	.599	1.014	2.561

Year	Other Gears
1984	1.498
1985	.980
1986	.910

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.00
152	1.00
165	1.00

Table E-6. Div. 4X haddock: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.247	.000	.200		.100	.071	.087	.101	.288
2.0	.533	.010	.200		.200	.127	.155	.172	.432
3.0	.771	.042	.200		.300	.181	.224	.245	.506
4.0	1.062	.155	.200	$F_{0.1}$---	.350	.207	.258	.282	.529
5.0	1.408	.429	.200		.400	.233	.293	.319	.547
6.0	1.938	.570	.200		.500	.284	.361	.393	.569
7.0	2.384	.666	.200		.600	.333	.429	.467	.581
8.0	2.761	.738	.200		.700	.381	.496	.540	.588
9.0	3.242	.703	.200		.800	.428	.564	.612	.591
10.0	3.441	.783	.200		.900	.474	.630	.683	.592
11.0	3.829	1.000	.200	F_{max}---	.964	.503	.673	.729	.593
12.0	3.980	.945	.200		1.000	.519	.697	.754	.592
13.0	3.867	.729	.200		1.100	.564	.764	.824	.592
14.0	4.109	.761	.200		1.200	.608	.830	.894	.590
15.0	4.333	.676	.200		1.300	.652	.896	.963	.588
16.0	4.330	.676	.200		1.400	.696	.963	1.032	.587
					1.500	.739	1.029	1.101	.585

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.247	.000	.200		.100	.071	.089	.101	.288
2.0	.534	.006	.200		.200	.126	.158	.173	.434
3.0	.794	.028	.200		.300	.179	.230	.247	.511
4.0	1.100	.122	.200	$F_{0.1}$---	.360	.210	.273	.293	.540
5.0	1.445	.381	.200		.400	.230	.302	.323	.554
6.0	1.957	.577	.200		.500	.279	.374	.400	.578
7.0	2.394	.700	.200		.600	.326	.445	.477	.592
8.0	2.753	.765	.200		.700	.372	.516	.553	.600
9.0	3.238	.733	.200		.800	.416	.586	.628	.605
10.0	3.433	.805	.200		.900	.459	.657	.702	.607
11.0	3.817	1.000	.200		1.000	.501	.727	.776	.608
12.0	3.976	.934	.200	F_{max}---	1.097	.541	.795	.847	.608
13.0	3.866	.671	.200		1.100	.542	.797	.850	.608
14.0	4.164	.711	.200		1.200	.583	.867	.923	.608
15.0	4.333	.607	.200		1.300	.623	.936	.995	.607
16.0	4.330	.607	.200		1.400	.663	1.006	1.068	.606
					1.500	.702	1.076	1.140	.604

Table E-6. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.247	.000	.200		.100	.069	.091	.101	.284
2.0	.533	.004	.200		.200	.122	.164	.174	.434
3.0	.805	.017	.200		.300	.172	.240	.251	.515
4.0	1.131	.083	.200	$F_{0.1}$---	.380	.209	.302	.314	.553
5.0	1.487	.290	.200		.400	.218	.317	.331	.561
6.0	1.990	.529	.200		.500	.262	.395	.412	.588
7.0	2.422	.754	.200		.600	.304	.472	.493	.604
8.0	2.758	.812	.200		.700	.343	.548	.575	.614
9.0	3.244	.787	.200		.800	.381	.625	.656	.620
10.0	3.426	.844	.200		.900	.417	.701	.736	.624
11.0	3.798	1.000	.200		1.000	.452	.776	.816	.627
12.0	3.971	.913	.200		1.100	.486	.852	.895	.628
13.0	3.863	.569	.200		1.200	.519	.927	.974	.629
14.0	4.269	.621	.200		1.300	.552	1.002	1.053	.629
15.0	4.333	.485	.200	F_{max}---	1.310	.555	1.010	1.061	.629
16.0	4.330	.485	.200		1.400	.583	1.078	1.131	.628
					1.500	.615	1.153	1.209	.628

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.247	.000	.200		.100	.057	.081	.101	.252
2.0	.529	.002	.200		.200	.097	.142	.175	.397
3.0	.804	.008	.200		.300	.134	.204	.256	.484
4.0	1.145	.042	.200		.400	.167	.264	.341	.538
5.0	1.518	.155	.200	F0.1---	.456	.185	.297	.391	.559
6.0	2.031	.336	.200		.500	.198	.322	.430	.572
7.0	2.468	.476	.200		.600	.226	.379	.520	.594
8.0	2.784	.661	.200		.700	.253	.433	.611	.610
9.0	3.274	.876	.200		.800	.277	.486	.702	.620
10.0	3.433	.909	.200		.900	.301	.538	.792	.628
11.0	3.775	1.000	.200		1.000	.324	.588	.882	.633
12.0	3.976	.879	.200		1.100	.345	.638	.972	.637
13.0	3.858	.399	.200		1.200	.367	.686	1.061	.640
14.0	4.444	.472	.200		1.300	.387	.734	1.150	.643
15.0	4.333	.282	.200		1.400	.407	.782	1.238	.644
16.0	4.330	.282	.200		1.500	.427	.829	1.326	.645
				Fmax---	2.000	.519	1.060	1.763	.647

Table E-7. Div. 4X haddock: Catch projections for 1988 by mesh size.

AGE	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
1	28461	0	.000	0	.000	0	.000	0	.000
2	16374	57	.007	35	.004	22	.003	17	.002
3	13260	282	.031	192	.021	123	.013	90	.010
4	10029	996	.110	813	.085	621	.063	506	.050
5	9923	3197	.292	3003	.264	2634	.221	2329	.189
6	9301	5119	.379	5381	.397	5548	.402	5665	.402
7	2267	1746	.431	1898	.476	2215	.574	2244	.570
8	828	782	.471	839	.516	963	.618	1153	.786
9	181	199	.452	215	.497	249	.599	361	1.027
10	8	10	.496	10	.541	12	.643	16	1.072
11	8	12	.614	13	.661	14	.763	18	1.193
12	0	0	.573	0	.612	0	.698	0	1.056
13	0	0	.410	0	.419	0	.439	0	.510
14	0	0	.435	0	.448	0	.478	0	.593
15	0	0	.370	0	.372	0	.375	0	.378
16	0	0	.370	0	.372	0	.375	0	.378
Totals	90640	12400	-	12400	-	12400	-	12400	-
F5+	-	-	.396	-	.420	-	.447	-	.460

Table E-8A. Div. 4X haddock: Summary of projections -- constant TAC and allocations.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	76977	80485	84050	88099	92371
5+ Population biomass:	40336	39592	38768	38079	42333
9+ Population biomass:	645	1726	3026	6537	6933
5+ fishing mortality:	.396	.392	.401	.392	.362
7+ fishing mortality:	.469	.443	.442	.434	.407
Yield:	12400	12400	12400	12400	12400
Trawler fishable biomass:	33451	33607	33215	34330	37472
catch biomass:	8180	8180	8180	8180	8180
relative effort:	.245	.243	.246	.238	.218
Others' fishable biomass:	11416	12809	13219	13201	14167
catch biomass:	4220	4220	4220	4220	4220
relative effort:	.370	.329	.319	.320	.298

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	78228	81961	85964	90566	95395
5+ Population biomass:	40887	40185	39617	39236	44056
9+ Population biomass:	644	1647	2784	5921	6295
5+ fishing mortality:	.420	.415	.424	.413	.380
7+ fishing mortality:	.514	.479	.478	.469	.437
Yield:	12400	12400	12400	12400	12400
Trawler fishable biomass:	28370	29435	29103	29883	32582
catch biomass:	8180	8180	8180	8180	8180
relative effort:	.288	.278	.281	.274	.251
Others' fishable biomass:	11348	12680	13107	13187	14287
catch biomass:	4220	4220	4220	4220	4220
relative effort:	.372	.333	.322	.320	.295

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	79452	83465	87895	93064	98520
5+ Population biomass:	41679	41138	40895	40883	46336
9+ Population biomass:	645	1489	2351	5034	5417
5+ fishing mortality:	.447	.438	.449	.435	.401
7+ fishing mortality:	.616	.550	.545	.535	.498
Yield:	12400	12400	12400	12400	12400
Trawler fishable biomass:	21081	23620	23632	24031	25956
catch biomass:	8180	8180	8180	8180	8180
relative effort:	.388	.346	.346	.340	.315
Others' fishable biomass:	11249	12523	12991	13193	14429
catch biomass:	4220	4220	4220	4220	4220
relative effort:	.375	.337	.325	.320	.292

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	80347	84643	89366	94955	100957
5+ Population biomass:	42503	42209	42255	42566	48556
9+ Population biomass:	650	1210	1845	4253	4531
5+ fishing mortality:	.460	.442	.451	.435	.402
7+ fishing mortality:	.829	.736	.678	.682	.647
Yield:	12400	12400	12400	12400	12400
Trawler fishable biomass:	10030	11648	12486	13315	14205
catch biomass:	8180	8180	8180	8180	8180
relative effort:	.816	.702	.655	.614	.576
Others' fishable biomass:	11182	12479	12992	13255	14572
catch biomass:	4220	4220	4220	4220	4220
relative effort:	.377	.338	.325	.318	.290

Table E-8B. Div. 4X haddock: Summary of projections -- TAC and allocations for 1988, $F_{0.1}$ and constant allocation ratio in subsequent years.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	76977	80485	88645	96054	102546
5+ Population biomass:	40336	39592	43195	45776	52269
9+ Population biomass:	645	1726	3567	8958	10889
5+ fishing mortality:	.396	.247	.257	.257	.259
7+ fishing mortality:	.469	.278	.282	.282	.287
Yield:	12400	8270	9327	10176	11305
Trawler fishable biomass:	33451	35536	38530	42129	46617
catch biomass:	8180	5454	6152	6712	7459
relative effort:	.245	.153	.160	.159	.160
Others' fishable biomass:	11416	13645	15861	17264	19233
catch biomass:	4220	2816	3175	3464	3846
relative effort:	.370	.206	.200	.201	.200

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	78228	81961	90733	98783	105861
5+ Population biomass:	40887	40185	44270	47272	54353
9+ Population biomass:	644	1647	3361	8501	10527
5+ fishing mortality:	.420	.252	.263	.263	.266
7+ fishing mortality:	.514	.291	.295	.295	.300
Yield:	12400	8049	9160	10048	11199
Trawler fishable biomass:	28370	31358	34461	37761	41780
catch biomass:	8180	5311	6044	6628	7388
relative effort:	.288	.169	.175	.176	.177
Others' fishable biomass:	11348	13588	15938	17505	19619
catch biomass:	4220	2738	3116	3420	3811
relative effort:	.372	.202	.195	.195	.194

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	79452	83465	93033	101828	109613
5+ Population biomass:	41679	41138	45956	49528	57314
9+ Population biomass:	645	1489	2980	7926	10161
5+ fishing mortality:	.447	.250	.264	.264	.267
7+ fishing mortality:	.616	.313	.316	.316	.320
Yield:	12400	7635	8888	9844	10972
Trawler fishable biomass:	21081	25540	29115	32128	35414
catch biomass:	8180	5038	5864	6495	7236
relative effort:	.388	.197	.201	.202	.204
Others' fishable biomass:	11249	13557	16147	17938	20233
catch biomass:	4220	2597	3025	3349	3736
relative effort:	.375	.192	.187	.187	.185

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	80347	84643	96036	106176	114737
5+ Population biomass:	42503	42209	48852	53681	62241
9+ Population biomass:	650	1210	2775	8214	10875
5+ fishing mortality:	.460	.199	.222	.235	.240
7+ fishing mortality:	.829	.329	.323	.344	.356
Yield:	12400	6167	7895	9408	10557
Trawler fishable biomass:	10030	13025	16958	20786	23231
catch biomass:	8180	4067	5206	6207	6965
relative effort:	.816	.312	.307	.299	.300
Others' fishable biomass:	11182	13850	17134	19354	21878
catch biomass:	4220	2101	2688	3201	3592
relative effort:	.377	.152	.157	.165	.164

Table F-1. Div. 5Z haddock: Size compositions of adjusted catches. (Length shown is lower of 2 cm group.)

Non-trawler nos.-at-length (000's)			
Length (cm)	Year 1984	1985	1986
28	*****	0	0
30	*****	0	0
32	*****	0	0
34	*****	0	0
36	*****	0	0
38	*****	2	0
40	*****	6	0
42	*****	14	1
44	*****	18	1
46	*****	24	37
48	*****	27	61
50	*****	26	188
52	*****	39	165
54	*****	50	177
56	*****	72	197
58	*****	107	102
60	*****	161	74
62	*****	174	124
64	*****	209	154
66	*****	236	125
68	*****	224	102
70	*****	227	103
72	*****	158	196
74	*****	105	81
76	*****	53	63
78	*****	30	35
80	*****	17	19
82	*****	7	5
84	*****	2	1
86	*****	2	0
Total	*****	1990	2011

1984 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
28	*****	*****	*****	*****
30	*****	*****	*****	*****
32	*****	*****	*****	*****
34	*****	*****	*****	*****
36	*****	*****	*****	*****
38	*****	*****	*****	*****
40	*****	*****	*****	*****
42	*****	*****	*****	*****
44	*****	*****	*****	*****
46	*****	*****	*****	*****
48	*****	*****	*****	*****
50	*****	*****	*****	*****
52	*****	*****	*****	*****
54	*****	*****	*****	*****
56	*****	*****	*****	*****
58	*****	*****	*****	*****
60	*****	*****	*****	*****
62	*****	*****	*****	*****
64	*****	*****	*****	*****
66	*****	*****	*****	*****
68	*****	*****	*****	*****
70	*****	*****	*****	*****
72	*****	*****	*****	*****
74	*****	*****	*****	*****
76	*****	*****	*****	*****
78	*****	*****	*****	*****
80	*****	*****	*****	*****
82	*****	*****	*****	*****
84	*****	*****	*****	*****
86	*****	*****	*****	*****
Total	*****	*****	*****	*****

1985 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
28	0	0	0	0
30	0	0	0	0
32	0	0	0	0
34	7	5	4	4
36	57	42	33	28
38	185	138	106	86
40	408	314	240	191
42	527	425	328	259
44	464	404	321	251
46	336	323	271	214
48	191	202	184	148
50	87	100	99	83
52	59	72	79	70
54	45	58	69	66
56	37	49	62	65
58	33	46	63	73
60	30	41	58	71
62	26	37	54	73
64	15	21	32	45
66	19	27	42	62
68	9	13	19	29
70	6	9	13	20
72	3	4	5	8
74	5	7	11	18
76	2	2	4	7
78	1	1	1	2
80	0	0	0	0
82	0	0	0	0
84	0	1	1	2
86	0	0	0	0
Total	2552	2341	2099	1875

1986 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
28	0	0	0	0
30	0	0	0	0
32	1	1	1	1
34	4	2	2	1
36	1	0	0	0
38	5	3	2	2
40	14	90	6	5
42	50	34	23	17
44	202	148	104	78
46	242	194	143	108
48	307	271	216	167
50	317	307	269	218
52	264	277	268	233
54	178	198	211	200
56	96	111	129	134
58	53	63	79	90
60	27	33	43	53
62	19	23	31	42
64	13	16	22	32
66	9	11	16	24
68	10	12	17	26
70	12	15	21	32
72	2	3	4	6
74	3	4	6	9
76	3	4	6	9
78	0	0	0	0
80	6	7	10	16
82	0	0	0	0
84	0	0	0	0
86	0	0	0	0
Total	1838	1827	1629	1503

Table F-2. Div. 5Z haddock: Cumulative length frequencies. (Length shown is lower of 2 cm group.)

Year	130 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1985	0.00	0.03	0.10	0.26	0.46	0.65	0.78	0.85	0.89	0.91	0.93
1986	0.00	0.00	0.01	0.01	0.04	0.15	0.28	0.45	0.62	0.77	0.86
Mean	0.00	0.01	0.05	0.14	0.25	0.40	0.53	0.65	0.75	0.84	0.89

Year	140 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1985	0.00	0.02	0.08	0.21	0.39	0.57	0.70	0.79	0.83	0.87	0.89
1986	0.00	0.00	0.00	0.05	0.07	0.15	0.26	0.41	0.57	0.73	0.83
Mean	0.00	0.01	0.04	0.13	0.23	0.36	0.48	0.60	0.70	0.80	0.86

Year	152 mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1985	0.00	0.02	0.07	0.18	0.34	0.49	0.62	0.71	0.76	0.79	0.83
1986	0.00	0.00	0.00	0.01	0.02	0.08	0.17	0.30	0.47	0.63	0.76
Mean	0.00	0.01	0.04	0.09	0.18	0.29	0.40	0.51	0.61	0.71	0.79

Year	165mm mesh										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1985	0.00	0.02	0.06	0.16	0.30	0.44	0.55	0.63	0.67	0.71	0.75
1986	0.00	0.00	0.00	0.01	0.02	0.07	0.14	0.25	0.40	0.55	0.69
Mean	0.00	0.01	0.03	0.09	0.16	0.25	0.35	0.44	0.54	0.63	0.72

Year	Other Gears										
	length group (cm)										
	34	36	38	40	42	44	46	48	50	52	54
1984	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****	*****
1985	0.00	0.00	0.00	0.00	0.01	0.02	0.03	0.05	0.06	0.08	0.10
1986	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.05	0.14	0.22	0.31
Mean	0.00	0.00	0.00	0.00	0.01	0.01	0.03	0.05	0.10	0.15	0.21

Table F-3. Div. 5Z haddock: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	0	6	*****	0	6	*****	0	0
2	*****	2334	46	*****	2006	38	*****	327	8
3	*****	571	2784	*****	293	1611	*****	278	1173
4	*****	225	211	*****	98	72	*****	127	139
5	*****	313	168	*****	66	41	*****	247	127
6	*****	176	161	*****	36	31	*****	140	130
7	*****	655	157	*****	32	13	*****	623	144
8	*****	90	272	*****	5	21	*****	85	251
9	*****	176	45	*****	16	5	*****	160	40
1+	*****	4541	3849	*****	2552	1838	*****	1989	2011

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	-	0.45	*****	-	0.45	*****	-	-	0.45
2	*****	0.98	0.95	*****	0.95	0.98	*****	1.16	0.83	0.97
3	*****	1.26	1.38	*****	1.25	1.44	*****	1.27	1.29	1.32
4	*****	1.91	1.84	*****	2.00	1.85	*****	1.84	1.83	1.87
5	*****	2.39	2.41	*****	1.93	2.59	*****	2.52	2.36	2.40
6	*****	2.86	2.86	*****	2.72	2.48	*****	2.89	2.95	2.86
7	*****	3.03	3.04	*****	3.10	3.19	*****	3.03	3.03	3.04
8	*****	3.53	3.54	*****	2.70	4.20	*****	3.58	3.49	3.53
9	*****	3.92	4.08	*****	3.92	4.08	*****	3.92	4.08	4.00

Table F-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	0	4	*****	0	4	*****	0	0
2	*****	2059	35	*****	1731	27	*****	327	8
3	*****	569	2680	*****	291	1508	*****	278	1173
4	*****	249	216	*****	121	77	*****	127	139
5	*****	325	176	*****	79	50	*****	247	127
6	*****	188	165	*****	48	35	*****	140	130
7	*****	667	160	*****	43	16	*****	623	144
8	*****	92	276	*****	7	26	*****	85	251
9	*****	182	47	*****	22	6	*****	160	40
1+	*****	4331	3759	*****	2342	1747	*****	1989	2011

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	-	0.45	*****	-	0.45	*****	-	-	0.45
2	*****	1.01	0.96	*****	0.98	1.00	*****	1.16	0.83	0.99
3	*****	1.29	1.40	*****	1.32	1.49	*****	1.27	1.29	1.35
4	*****	1.96	1.87	*****	2.10	1.93	*****	1.84	1.83	1.92
5	*****	2.41	2.43	*****	2.06	2.61	*****	2.52	2.36	2.42
6	*****	2.87	2.88	*****	2.79	2.61	*****	2.89	2.95	2.87
7	*****	3.03	3.04	*****	3.10	3.19	*****	3.03	3.03	3.04
8	*****	3.51	3.55	*****	2.67	4.19	*****	3.58	3.49	3.53
9	*****	3.92	4.08	*****	3.92	4.08	*****	3.92	4.08	4.00

Table F-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	0	3	*****	0	3	*****	0	0
2	*****	1742	27	*****	1415	19	*****	327	8
3	*****	549	2524	*****	271	1351	*****	278	1173
4	*****	278	223	*****	151	84	*****	127	139
5	*****	340	190	*****	93	64	*****	247	127
6	*****	207	173	*****	67	43	*****	140	130
7	*****	686	166	*****	62	22	*****	623	144
8	*****	94	287	*****	9	36	*****	85	251
9	*****	191	49	*****	31	8	*****	160	40
1+	*****	4088	3641	*****	2099	1630	*****	1989	2011

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	-	0.45	*****	-	0.45	*****	-	-	0.45
2	*****	1.03	0.96	*****	1.00	1.02	*****	1.16	0.83	1.00
3	*****	1.33	1.43	*****	1.40	1.54	*****	1.27	1.29	1.38
4	*****	2.05	1.91	*****	2.22	2.04	*****	1.84	1.83	1.98
5	*****	2.43	2.46	*****	2.22	2.66	*****	2.52	2.36	2.45
6	*****	2.89	2.91	*****	2.89	2.79	*****	2.89	2.95	2.90
7	*****	3.04	3.05	*****	3.12	3.21	*****	3.03	3.03	3.04
8	*****	3.49	3.57	*****	2.65	4.20	*****	3.58	3.49	3.53
9	*****	3.92	4.08	*****	3.92	4.08	*****	3.92	4.08	4.00

Table F-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
1	*****	0	2	*****	0	2	*****	0	0
2	*****	1465	22	*****	1137	14	*****	327	8
3	*****	513	2338	*****	235	1165	*****	278	1173
4	*****	298	228	*****	171	89	*****	127	139
5	*****	351	207	*****	104	80	*****	247	127
6	*****	228	184	*****	88	54	*****	140	130
7	*****	709	175	*****	85	31	*****	623	144
8	*****	95	305	*****	10	54	*****	85	251
9	*****	204	53	*****	44	13	*****	160	40
1+	*****	3863	3515	*****	1874	1503	*****	1989	2011

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
1	*****	-	0.45	*****	-	0.45	*****	-	-	0.45
2	*****	1.04	0.95	*****	1.00	1.02	*****	1.16	0.83	1.00
3	*****	1.36	1.44	*****	1.46	1.59	*****	1.27	1.29	1.40
4	*****	2.13	1.95	*****	2.34	2.14	*****	1.84	1.83	2.04
5	*****	2.47	2.51	*****	2.37	2.76	*****	2.52	2.36	2.49
6	*****	2.94	2.96	*****	3.02	2.99	*****	2.89	2.95	2.95
7	*****	3.04	3.07	*****	3.17	3.26	*****	3.03	3.03	3.06
8	*****	3.48	3.62	*****	2.68	4.24	*****	3.58	3.49	3.55
9	*****	3.92	4.08	*****	3.92	4.08	*****	3.92	4.08	4.00

Table F-4. Div. 5Z haddock: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

	Mesh Size: 130 mm mesh				Mesh Size: 140 mm mesh				Mesh Size: 152 mm mesh				Mesh Size: 165 mm mesh		
	Total F's				Total F's				Total F's				Total F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	******	0.00	0.00	1	******	0.00	0.00	1	******	0.00	0.00	1	******	0.00	0.00
2	******	0.22	0.05	2	******	0.20	0.04	2	******	0.16	0.03	2	******	0.13	0.02
3	******	0.67	0.46	3	******	0.66	0.43	3	******	0.63	0.40	3	******	0.57	0.37
4	******	0.39	0.56	4	******	0.44	0.57	4	******	0.50	0.60	4	******	0.55	0.62
5	******	0.52	0.56	5	******	0.55	0.60	5	******	0.58	0.66	5	******	0.60	0.75
6	******	0.33	0.56	6	******	0.36	0.58	6	******	0.40	0.61	6	******	0.46	0.67
7	******	0.61	0.56	7	******	0.63	0.57	7	******	0.65	0.60	7	******	0.68	0.65
8	******	0.50	0.56	8	******	0.51	0.57	8	******	0.53	0.60	8	******	0.54	0.65
9	******	0.50	0.57	9	******	0.53	0.59	9	******	0.56	0.63	9	******	0.61	0.70
	Trawl Partial F's				Trawl Partial F's				Trawl Partial F's				Trawl Partial F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
1	******	******	0.00	1	******	******	0.00	1	******	******	0.00	1	******	******	0.00
2	******	0.19	0.04	2	******	0.16	0.03	2	******	0.13	0.02	2	******	0.10	0.02
3	******	0.34	0.26	3	******	0.34	0.24	3	******	0.31	0.22	3	******	0.26	0.18
4	******	0.17	0.19	4	******	0.21	0.21	4	******	0.27	0.23	4	******	0.31	0.24
5	******	0.11	0.14	5	******	0.13	0.17	5	******	0.16	0.22	5	******	0.18	0.29
6	******	0.07	0.11	6	******	0.09	0.12	6	******	0.13	0.15	6	******	0.18	0.20
7	******	0.03	0.04	7	******	0.04	0.06	7	******	0.06	0.08	7	******	0.08	0.11
8	******	0.03	0.04	8	******	0.04	0.05	8	******	0.05	0.08	8	******	0.06	0.12
9	******	0.05	0.06	9	******	0.06	0.08	9	******	0.09	0.11	9	******	0.13	0.17

	Other Gears' Partial F's		
Age	1984	1985	1986
1	******	******	******
2	******	0.03	0.01
3	******	0.32	0.19
4	******	0.22	0.37
5	******	0.41	0.42
6	******	0.26	0.45
7	******	0.58	0.51
8	******	0.47	0.51
9	******	0.46	0.50

Table F-5A. Div. 5Z haddock: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model based on 1985 data.

Average Partial Recruitment

Age	Trawl Mesh Size (mm) 130	140	152	165
1	.000	.000	.000	.000
2	.563	.483	.424	.332
3	1.000	1.000	1.000	.837
4	.489	.626	.872	1.000
5	.321	.389	.512	.569
6	.196	.268	.412	.548
7	.086	.118	.182	.242
8	.081	.111	.171	.228
9	.134	.184	.283	.376

Age	Other Gears
1	.000
2	.062
3	.643
4	.432
5	.812
6	.523
7	1.000
8	1.000
9	1.000

Fully Recruited F

Year	Trawl Mesh Size (mm) 130	140	152	165
1984	-	-	-	-
1985	.342	.339	.311	.315
1986	-	-	-	-

Year	Other Gears
1984	.000
1985	.504
1986	.000

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.37
152	2.11
165	2.79

Table F-5B. Div. 5Z haddock: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model based on 1986 data.

Average Partial Recruitment

	Trawl Mesh Size (mm)			
Age	130	140	152	165
1	.001	.001	.000	.000
2	.156	.119	.089	.053
3	1.000	1.000	.948	.633
4	.722	.841	1.000	.839
5	.519	.683	1.000	1.000
6	.412	.543	.795	.685
7	.170	.224	.328	.393
8	.160	.211	.308	.389
9	.235	.309	.453	.571

Age	Other Gears
1	.000
2	.017
3	.376
4	.718
5	.826
6	.884
7	1.000
8	1.000
9	1.000

Fully Recruited F

	Trawl Mesh Size (mm)			
Year	130	140	152	165
1984	-	-	-	-
1985	-	-	-	-
1986	.264	.244	.228	.289

Year	Other Gears
1984	.000
1985	.000
1986	.510

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.32
152	1.93
165	2.43

Table F-6A. Div. 5Z haddock: Results of yield-per-recruit analysis by mesh size, 1985 PR option.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.452	.000	.200		.100	.081	.093	.103	.457
2.0	.967	.336	.200		.200	.150	.168	.177	.659
3.0	1.317	1.000	.200	$F_{0.1}$---	.290	.212	.238	.246	.746
4.0	1.872	.578	.200		.300	.219	.246	.254	.753
5.0	2.404	.779	.200		.400	.289	.325	.334	.797
6.0	2.860	.496	.200		.500	.359	.404	.415	.817
7.0	3.035	.801	.200		.600	.429	.484	.496	.825
8.0	3.533	.798	.200	F_{max}---	.695	.495	.560	.574	.826
9.0	4.000	.825	.200		.700	.499	.564	.578	.826
10.0	4.000	.825	.200		.800	.569	.644	.661	.825
11.0	4.000	.825	.200		.900	.640	.724	.743	.822
12.0	4.000	.825	.200		1.000	.712	.803	.825	.818
13.0	4.000	.825	.200		1.100	.784	.883	.908	.814
14.0	4.000	.825	.200		1.200	.857	.963	.991	.810
15.0	4.000	.825	.200		1.300	.930	1.043	1.073	.806
16.0	4.000	.825	.200		1.400	1.004	1.123	1.156	.802
					1.500	1.079	1.203	1.238	.799

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.451	.000	.200		.100	.084	.095	.106	.471
2.0	.986	.294	.200		.200	.156	.172	.182	.677
3.0	1.347	1.000	.200	F0.1---	.285	.218	.240	.250	.762
4.0	1.916	.648	.200		.300	.228	.252	.262	.772
5.0	2.418	.816	.200		.400	.301	.333	.345	.816
6.0	2.873	.534	.200		.500	.375	.415	.429	.836
7.0	3.038	.820	.200		.600	.448	.497	.513	.845
8.0	3.531	.817	.200		.700	.522	.578	.598	.847
9.0	4.000	.854	.200	Fmax---	.707	.527	.584	.604	.847
10.0	4.000	.854	.200		.800	.597	.660	.683	.846
11.0	4.000	.854	.200		.900	.672	.742	.768	.843
12.0	4.000	.854	.200		1.000	.747	.824	.854	.840
13.0	4.000	.854	.200		1.100	.824	.905	.939	.836
14.0	4.000	.854	.200		1.200	.900	.987	1.024	.832
15.0	4.000	.854	.200		1.300	.978	1.069	1.110	.829
16.0	4.000	.854	.200		1.400	1.056	1.150	1.195	.825
					1.500	1.135	1.232	1.281	.822

Table F-6A. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.449	.000	.200		.100	.091	.101	.113	.503
2.0	.996	.257	.200		.200	.170	.185	.197	.711
3.0	1.380	1.000	.200	$F_{0.1}$---	.269	.225	.245	.257	.782
4.0	1.978	.770	.200		.300	.250	.272	.285	.803
5.0	2.447	.895	.200		.400	.331	.360	.375	.845
6.0	2.903	.616	.200		.500	.412	.448	.467	.864
7.0	3.043	.882	.200		.600	.494	.535	.560	.871
8.0	3.533	.877	.200	F_{max}---	.685	.563	.610	.638	.873
9.0	4.000	.932	.200		.700	.576	.623	.653	.873
10.0	4.000	.932	.200		.800	.659	.711	.746	.871
11.0	4.000	.932	.200		.900	.743	.799	.839	.868
12.0	4.000	.932	.200		1.000	.827	.887	.932	.864
13.0	4.000	.932	.200		1.100	.912	.974	1.025	.860
14.0	4.000	.932	.200		1.200	.998	1.062	1.118	.856
15.0	4.000	.932	.200		1.300	1.085	1.150	1.211	.852
16.0	4.000	.932	.200		1.400	1.172	1.238	1.305	.848
					1.500	1.260	1.325	1.398	.845

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.446	.000	.200		.100	.096	.107	.119	.527
2.0	.995	.219	.200		.200	.182	.196	.209	.738
3.0	1.398	.944	.200	$F_{0.1}$---	.259	.232	.250	.265	.801
4.0	2.040	.856	.200		.300	.268	.288	.304	.830
5.0	2.493	.945	.200		.400	.355	.381	.402	.871
6.0	2.953	.700	.200		.500	.442	.474	.501	.889
7.0	3.056	.932	.200		.600	.530	.567	.600	.896
8.0	3.551	.925	.200	F_{max}---	.669	.590	.630	.669	.897
9.0	4.000	1.000	.200		.700	.618	.659	.700	.897
10.0	4.000	1.000	.200		.800	.707	.752	.800	.894
11.0	4.000	1.000	.200		.900	.797	.845	.900	.891
12.0	4.000	1.000	.200		1.000	.888	.937	1.000	.886
13.0	4.000	1.000	.200		1.100	.979	1.030	1.100	.882
14.0	4.000	1.000	.200		1.200	1.071	1.122	1.200	.877
15.0	4.000	1.000	.200		1.300	1.163	1.215	1.300	.872
16.0	4.000	1.000	.200		1.400	1.256	1.307	1.400	.868
					1.500	1.350	1.400	1.500	.864

Table F-6B. Div. 5Z haddock: Results of yield-per-recruit analysis by mesh size, 1986 PR option.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.452	.000	.200		.100	.104	.108	.119	.524
2.0	.967	.087	.200		.200	.198	.201	.209	.727
3.0	1.317	.797	.200	$F_{0.1}$---	.249	.245	.247	.255	.778
4.0	1.872	.974	.200		.300	.294	.296	.304	.812
5.0	2.404	.976	.200		.400	.391	.392	.402	.848
6.0	2.860	.979	.200		.500	.488	.488	.501	.864
7.0	3.035	.970	.200		.600	.586	.585	.600	.869
8.0	3.533	.965	.200	F_{max}---	.656	.640	.639	.656	.870
9.0	4.000	1.000	.200		.700	.683	.682	.700	.869
10.0	4.000	1.000	.200		.800	.781	.778	.800	.867
11.0	4.000	1.000	.200		.900	.878	.875	.900	.864
12.0	4.000	1.000	.200		1.000	.976	.972	1.000	.860
13.0	4.000	1.000	.200		1.100	1.074	1.069	1.100	.856
14.0	4.000	1.000	.200		1.200	1.171	1.165	1.200	.852
15.0	4.000	1.000	.200		1.300	1.269	1.262	1.300	.848
16.0	4.000	1.000	.200		1.400	1.366	1.359	1.400	.845
					1.500	1.464	1.455	1.500	.842

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.451	.000	.200		.100	.104	.108	.118	.526
2.0	.986	.064	.200		.200	.199	.199	.208	.734
3.0	1.347	.742	.200	$F_{0.1}$---	.256	.254	.252	.261	.792
4.0	1.916	.973	.200		.300	.297	.293	.303	.822
5.0	2.418	1.000	.200		.400	.396	.389	.401	.862
6.0	2.873	.992	.200		.500	.495	.484	.499	.880
7.0	3.038	.961	.200		.600	.595	.580	.598	.887
8.0	3.531	.955	.200		.700	.695	.676	.697	.889
9.0	4.000	.996	.200	F_{max}---	.706	.700	.681	.703	.889
10.0	4.000	.996	.200		.800	.795	.771	.797	.888
11.0	4.000	.996	.200		.900	.895	.867	.897	.886
12.0	4.000	.996	.200		1.000	.995	.963	.996	.883
13.0	4.000	.996	.200		1.100	1.095	1.058	1.096	.879
14.0	4.000	.996	.200		1.200	1.195	1.154	1.195	.876
15.0	4.000	.996	.200		1.300	1.296	1.250	1.295	.873
16.0	4.000	.996	.200		1.400	1.396	1.346	1.395	.870
					1.500	1.496	1.441	1.494	.866

Table F-6B. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.449	.000	.200		.100	.101	.103	.114	.514
2.0	.996	.045	.200		.200	.194	.188	.199	.730
3.0	1.380	.629	.200	$F_{0.1}$---	.275	.266	.255	.266	.809
4.0	1.978	.916	.200		.300	.289	.277	.288	.827
5.0	2.447	1.000	.200		.400	.387	.366	.380	.874
6.0	2.903	.974	.200		.500	.485	.456	.474	.897
7.0	3.043	.901	.200		.600	.584	.545	.567	.908
8.0	3.533	.894	.200		.700	.684	.635	.662	.912
9.0	4.000	.945	.200	F_{max}---	.797	.782	.723	.754	.913
10.0	4.000	.945	.200		.800	.784	.725	.756	.913
11.0	4.000	.945	.200		.900	.884	.814	.850	.913
12.0	4.000	.945	.200		1.000	.985	.904	.945	.911
13.0	4.000	.945	.200		1.100	1.085	.994	1.039	.908
14.0	4.000	.945	.200		1.200	1.186	1.083	1.134	.905
15.0	4.000	.945	.200		1.300	1.287	1.173	1.228	.903
16.0	4.000	.945	.200		1.400	1.388	1.263	1.323	.900
					1.500	1.488	1.352	1.417	.897

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
1.0	.446	.000	.200		.100	.099	.102	.114	.510
2.0	.995	.034	.200		.200	.190	.187	.200	.730
3.0	1.398	.528	.200	$F_{0.1}$---	.289	.273	.264	.280	.825
4.0	2.040	.857	.200		.300	.284	.274	.290	.833
5.0	2.493	1.000	.200		.400	.379	.361	.383	.885
6.0	2.953	.914	.200		.500	.476	.449	.476	.912
7.0	3.056	.878	.200		.600	.573	.536	.571	.926
8.0	3.551	.876	.200		.700	.671	.624	.666	.933
9.0	4.000	.951	.200		.800	.770	.711	.761	.936
10.0	4.000	.951	.200	F_{max}---	.873	.843	.775	.830	.936
11.0	4.000	.951	.200		.900	.870	.799	.856	.936
12.0	4.000	.951	.200		1.000	.969	.886	.951	.935
13.0	4.000	.951	.200		1.100	1.069	.973	1.046	.933
14.0	4.000	.951	.200		1.200	1.170	1.060	1.141	.931
15.0	4.000	.951	.200		1.300	1.270	1.147	1.236	.928
16.0	4.000	.951	.200		1.400	1.371	1.235	1.331	.925
					1.500	1.472	1.322	1.426	.922

Table F-7A. Div. 5Z haddock: Catch projections for 1988 by mesh size using 1985 PR option.

AGE	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
1	4709	0	.000	0	.000	0	.000	0	.000
2	535	107	.258	91	.210	77	.171	67	.148
3	17278	9709	.623	9615	.592	9433	.554	9175	.520
4	402	200	.341	226	.380	269	.444	318	.519
5	2180	1517	.387	1582	.403	1699	.431	1857	.467
6	128	71	.245	77	.266	89	.307	107	.371
7	102	83	.346	84	.354	88	.370	94	.398
8	98	92	.344	93	.351	96	.367	102	.392
9	287	321	.366	331	.380	350	.406	380	.450
10	0	0	.366	0	.380	0	.406	0	.450
11	0	0	.366	0	.380	0	.406	0	.450
12	0	0	.366	0	.380	0	.406	0	.450
13	0	0	.366	0	.380	0	.406	0	.450
14	0	0	.366	0	.380	0	.406	0	.450
15	0	0	.366	0	.380	0	.406	0	.450
16	0	0	.366	0	.380	0	.406	0	.450
Totals	25719	12100	-	12100	-	12100	-	12100	-
F3+	-	-	.371	-	.389	-	.421	-	.463

Table F-7B. Div. 5Z haddock: Catch projections for 1988 by mesh size using 1986 PR option.

AGE	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
1	4709	1	.000	0	.000	0	.000	0	.000
2	535	31	.069	24	.051	18	.037	15	.031
3	17278	8950	.558	8786	.523	8449	.478	8016	.437
4	402	308	.591	323	.610	347	.641	371	.673
5	2180	2017	.556	2150	.598	2419	.686	2740	.789
6	128	138	.538	145	.571	160	.642	171	.676
7	102	110	.490	112	.504	118	.533	129	.598
8	98	121	.486	124	.499	129	.527	141	.596
9	287	423	.516	435	.535	460	.576	517	.676
10	0	0	.516	0	.535	0	.576	0	.676
11	0	0	.516	0	.535	0	.576	0	.676
12	0	0	.516	0	.535	0	.576	0	.676
13	0	0	.516	0	.535	0	.576	0	.676
14	0	0	.516	0	.535	0	.576	0	.676
15	0	0	.516	0	.535	0	.576	0	.676
16	0	0	.516	0	.535	0	.576	0	.676
Totals	25719	12100	-	12100	-	12100	-	12100	-
F3+	-	-	.552	-	.586	-	.658	-	.746

Table G-1. Div. 4VWX & Subarea 5 pollock: Size compositions of adjusted catches. (Length shown is midpoint of 3 cm group.)

Non-trawler nos.-at-length (000's)			
Length (cm)	Year 1984	1985	1986
34	0	0	0
37	0	0	0
40	0	0	0
43	0	0	0
46	0	0	0
49	0	0	0
52	0	0	0
55	0	0	0
58	0	0	0
61	0	0	0
64	0	0	0
67	0	0	0
70	0	0	0
73	0	0	0
76	0	0	0
79	0	0	0
82	0	0	0
85	0	0	0
88	0	0	0
91	0	0	0
94	0	0	0
97	0	0	0
100	0	0	0
103	0	0	0
106	0	0	0
109	0	0	0
Total	0	0	0

1984 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
34	0	0	0	0
37	2	1	1	0
40	15	8	4	3
43	43	25	14	9
46	144	94	55	34
49	284	213	139	90
52	873	754	571	407
55	1622	1536	1331	1051
58	2062	2053	1960	1724
61	1868	1909	1946	1895
64	1220	1263	1339	1411
67	711	739	798	884
70	330	344	376	432
73	163	172	191	227
76	115	122	137	169
79	111	117	131	162
82	97	102	114	139
85	64	68	76	93
88	21	23	25	31
91	14	15	16	20
94	8	8	9	12
97	5	6	6	7
100	2	2	2	3
103	0	0	0	0
106	0	0	0	0
109	0	0	0	0
Total	9774	9574	9241	8803

1985 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
34	0	0	0	0
37	1	1	0	0
40	19	10	5	3
43	53	30	16	10
46	225	145	82	48
49	460	343	217	134
52	599	507	364	238
55	633	584	477	344
58	1095	1070	977	799
61	1944	1961	1934	1782
64	2086	2133	2190	2195
67	1535	1574	1644	1731
70	820	842	888	964
73	432	443	468	514
76	232	239	255	286
79	129	134	144	165
82	111	115	124	144
85	77	80	86	98
88	56	58	62	70
91	27	28	29	33
94	13	13	14	16
97	3	3	3	4
100	5	5	6	7
103	1	1	1	1
106	0	0	0	1
109	0	0	1	1
Total	10556	10319	9987	9588

1986 Trawler nos.-at-length (000's)				
Length (cm)	mesh size (mm) 130	140	152	165
34	2	1	1	0
37	7	4	2	1
40	25	13	7	4
43	46	27	14	8
46	171	109	61	35
49	421	308	188	110
52	748	624	438	276
55	1020	938	757	533
58	1214	1183	1071	858
61	1329	1338	1310	1185
64	1601	1641	1688	1685
67	1574	1627	1721	1830
70	965	1000	1068	1171
73	503	521	557	619
76	247	255	274	307
79	171	177	192	219
82	105	110	120	139
85	63	66	72	83
88	36	38	41	48
91	20	20	22	26
94	14	14	16	18
97	5	5	5	6
100	4	4	4	4
103	1	1	1	1
106	1	1	1	1
109	0	0	0	0
Total	10293	10025	9631	9167

Table G-2. Div. 4VWX & Subarea 5 pollock: Cumulative length frequencies. (Length shown is midpoint of 3 cm group.)

Year	130 mm mesh							
	length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.01	0.02	0.05	0.14	0.31
1985	0.00	0.00	0.00	0.01	0.03	0.07	0.13	0.19
1986	0.00	0.00	0.00	0.01	0.02	0.07	0.14	0.24
Mean	0.00	0.00	0.00	0.01	0.02	0.06	0.14	0.24

Year	140 mm mesh							
	length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.00	0.01	0.04	0.11	0.27
1985	0.00	0.00	0.00	0.00	0.02	0.05	0.10	0.16
1986	0.00	0.00	0.00	0.00	0.02	0.05	0.11	0.20
Mean	0.00	0.00	0.00	0.00	0.02	0.04	0.11	0.21

Year	152mm mesh							
	length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.00	0.01	0.02	0.08	0.23
1985	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.12
1986	0.00	0.00	0.00	0.00	0.01	0.03	0.07	0.15
Mean	0.00	0.00	0.00	0.00	0.01	0.03	0.08	0.17

Year	165 mm mesh							
	length group (cm)							
	34	37	40	43	46	49	52	55
1984	0.00	0.00	0.00	0.00	0.01	0.02	0.06	0.18
1985	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.08
1986	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.11
Mean	0.00	0.00	0.00	0.00	0.01	0.02	0.05	0.12

Table G-3. Div. 4VWX & Subarea 5 pollock: Age compositions and weights-at-age of adjusted catches.

A: 130 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
2	64	248	60	21	23	4	43	225	56
3	1188	2384	1291	620	448	268	568	1936	1023
4	5151	2737	6019	2701	1747	2057	2450	990	3962
5	9654	5648	4453	5596	2908	2559	4058	2740	1894
6	1247	7766	5234	427	4216	2454	820	3550	2780
7	206	1340	4510	54	760	2408	152	580	2102
8	372	206	494	130	97	248	242	109	246
9	327	233	139	134	100	42	193	133	97
10	193	343	268	63	159	77	130	184	191
11	60	130	266	11	55	111	49	75	155
2+	18462	21035	22734	9757	10512	10229	8705	10523	12505

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
2	1.03	0.70	0.80	1.45	0.94	0.83	0.82	0.67	0.80	0.77
3	1.47	1.04	1.19	1.65	1.53	1.33	1.27	0.92	1.15	1.18
4	2.16	1.94	1.85	2.27	1.93	1.87	2.03	1.98	1.84	1.98
5	2.64	2.77	2.59	2.60	2.64	2.30	2.70	2.91	2.97	2.66
6	3.51	3.25	3.40	3.73	3.03	3.02	3.40	3.52	3.74	3.33
7	5.15	3.78	3.84	5.14	3.30	3.34	5.15	4.41	4.42	3.87
8	5.75	5.17	4.84	5.90	4.30	3.87	5.68	5.95	5.81	5.22
9	5.99	6.38	6.26	5.85	6.00	5.53	6.09	6.66	6.58	6.17
10	6.52	6.35	6.83	6.21	5.87	5.88	6.67	6.76	7.20	6.55
11	7.52	6.67	6.70	7.60	6.07	5.92	7.50	7.10	7.25	6.80

Table G-3. (Continued)

B: 140 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
2	58	238	58	16	13	2	43	225	56
3	1064	2288	1218	496	352	195	568	1936	1023
4	5027	2541	5782	2577	1551	1821	2450	990	3962
5	9663	5597	4363	5605	2856	2470	4058	2740	1894
6	1264	7847	5272	444	4297	2492	820	3550	2780
7	209	1360	4585	57	780	2483	152	580	2102
8	379	209	503	137	100	257	242	109	246
9	335	236	141	142	104	44	193	133	97
10	197	349	272	67	165	80	130	184	191
11	61	132	271	12	57	116	49	75	155
2+	18258	20797	22465	9552	10275	9960	8705	10523	12505

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
2	1.01	0.69	0.80	1.55	0.95	0.84	0.82	0.67	0.80	0.76
3	1.48	1.02	1.19	1.72	1.59	1.39	1.27	0.92	1.15	1.17
4	2.17	1.99	1.87	2.31	2.00	1.93	2.03	1.98	1.84	2.00
5	2.65	2.79	2.62	2.62	2.68	2.34	2.70	2.91	2.97	2.68
6	3.52	3.26	3.41	3.73	3.04	3.04	3.40	3.52	3.74	3.34
7	5.14	3.77	3.84	5.13	3.30	3.34	5.15	4.41	4.42	3.87
8	5.75	5.17	4.82	5.89	4.31	3.88	5.68	5.95	5.81	5.21
9	5.98	6.37	6.25	5.83	5.99	5.53	6.09	6.66	6.58	6.16
10	6.51	6.34	6.81	6.20	5.86	5.88	6.67	6.76	7.20	6.54
11	7.52	6.66	6.68	7.57	6.06	5.91	7.50	7.10	7.25	6.78

Table G-3. (Continued)

C: 152 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
2	53	232	57	11	7	1	43	225	56
3	931	2182	1149	362	246	126	568	1936	1023
4	4791	2269	5437	2341	1279	1475	2450	990	3962
5	9618	5487	4170	5560	2747	2276	4058	2740	1894
6	1299	7940	5316	479	4390	2536	820	3550	2780
7	216	1392	4714	64	812	2612	152	580	2102
8	395	214	520	154	105	274	242	109	246
9	355	244	145	162	111	48	193	133	97
10	205	363	279	76	179	88	130	184	191
11	62	137	282	13	62	127	49	75	155
2+	17926	20461	22069	9221	9938	9564	8705	10523	12505

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
2	0.98	0.68	0.80	1.63	0.95	0.84	0.82	0.67	0.80	0.75
3	1.47	1.01	1.18	1.79	1.67	1.44	1.27	0.92	1.15	1.16
4	2.19	2.04	1.89	2.36	2.09	2.01	2.03	1.98	1.84	2.03
5	2.68	2.82	2.67	2.67	2.74	2.41	2.70	2.91	2.97	2.72
6	3.53	3.27	3.42	3.75	3.06	3.08	3.40	3.52	3.74	3.35
7	5.14	3.77	3.83	5.10	3.31	3.36	5.15	4.41	4.42	3.86
8	5.75	5.16	4.80	5.87	4.34	3.89	5.68	5.95	5.81	5.20
9	5.96	6.35	6.23	5.80	5.98	5.53	6.09	6.66	6.58	6.14
10	6.49	6.31	6.79	6.19	5.85	5.87	6.67	6.76	7.20	6.51
11	7.51	6.63	6.65	7.52	6.05	5.90	7.50	7.10	7.25	6.75

Table G-3. (Continued)

D: 165 mm mesh

Catch at age (nos., 000's)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986
2	49	229	57	7	4	1	43	225	56
3	823	2100	1100	255	163	77	568	1936	1023
4	4464	1996	5069	2014	1005	1108	2450	990	3962
5	9448	5301	3873	5390	2561	1980	4058	2740	1894
6	1352	7980	5330	532	4430	2550	820	3550	2780
7	230	1426	4873	78	846	2771	152	580	2102
8	429	223	543	187	114	298	242	109	246
9	395	260	152	202	128	55	193	133	97
10	223	392	294	93	208	103	130	184	191
11	66	147	304	17	72	148	49	75	155
2+	17480	20054	21596	8775	9531	9091	8705	10523	12505

Weight at age (kg)

Age	Total 1984	Total 1985	Total 1986	Trawl 1984	Trawl 1985	Trawl 1986	Other Gears 1984	Other Gears 1985	Other Gears 1986	Average 84-86
2	0.94	0.68	0.80	1.67	0.95	0.84	0.82	0.67	0.80	0.74
3	1.45	0.98	1.17	1.85	1.73	1.47	1.27	0.92	1.15	1.13
4	2.21	2.09	1.90	2.43	2.20	2.09	2.03	1.98	1.84	2.05
5	2.72	2.86	2.73	2.74	2.81	2.50	2.70	2.91	2.97	2.76
6	3.56	3.29	3.45	3.81	3.11	3.14	3.40	3.52	3.74	3.38
7	5.13	3.78	3.83	5.09	3.36	3.39	5.15	4.41	4.42	3.87
8	5.75	5.17	4.78	5.85	4.41	3.94	5.68	5.95	5.81	5.20
9	5.92	6.32	6.20	5.76	5.96	5.53	6.09	6.66	6.58	6.10
10	6.46	6.27	6.74	6.17	5.84	5.87	6.67	6.76	7.20	6.47
11	7.49	6.58	6.59	7.45	6.03	5.89	7.50	7.10	7.25	6.70

Table G-4. Div. 4VWX & Subarea 5 pollock: Annual fishing mortality for total fishery and partial annual fishing mortality for trawl and other gears, by mesh size.

Mesh Size: 130 mm mesh				Mesh Size: 140 mm mesh				Mesh Size: 152 mm mesh				Mesh Size: 165 mm mesh			
	Total F's				Total F's				Total F's				Total F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
2	0.00	0.02	0.01	2	0.00	0.01	0.01	2	0.00	0.01	0.01	2	0.00	0.01	0.01
3	0.04	0.06	0.11	3	0.04	0.06	0.10	3	0.03	0.06	0.09	3	0.03	0.06	0.09
4	0.15	0.13	0.22	4	0.15	0.12	0.21	4	0.14	0.11	0.20	4	0.13	0.09	0.18
5	0.27	0.25	0.32	5	0.27	0.24	0.32	5	0.27	0.24	0.30	5	0.27	0.23	0.27
6	0.27	0.37	0.38	6	0.28	0.37	0.38	6	0.29	0.38	0.39	6	0.30	0.38	0.39
7	0.20	0.53	0.38	7	0.21	0.54	0.39	7	0.22	0.56	0.40	7	0.23	0.58	0.42
8	0.21	0.32	0.38	8	0.22	0.33	0.39	8	0.23	0.34	0.40	8	0.25	0.36	0.43
9	0.18	0.20	0.38	9	0.18	0.21	0.38	9	0.19	0.21	0.40	9	0.22	0.23	0.42
10	0.39	0.29	0.38	10	0.40	0.29	0.38	10	0.42	0.31	0.40	10	0.47	0.34	0.42
11	0.26	0.50	0.38	11	0.26	0.51	0.39	11	0.27	0.54	0.41	11	0.29	0.59	0.45
	Trawl Partial F's				Trawl Partial F's				Trawl Partial F's				Trawl Partial F's		
Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986	Age	1984	1985	1986
2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00	2	0.00	0.00	0.00
3	0.02	0.01	0.02	3	0.02	0.01	0.02	3	0.01	0.01	0.01	3	0.01	0.00	0.01
4	0.08	0.08	0.08	4	0.08	0.07	0.07	4	0.07	0.06	0.05	4	0.06	0.05	0.04
5	0.16	0.13	0.19	5	0.16	0.12	0.18	5	0.16	0.12	0.16	5	0.15	0.11	0.14
6	0.09	0.20	0.18	6	0.10	0.20	0.18	6	0.11	0.21	0.18	6	0.12	0.21	0.19
7	0.05	0.30	0.20	7	0.06	0.31	0.21	7	0.06	0.33	0.22	7	0.08	0.34	0.24
8	0.08	0.15	0.19	8	0.08	0.16	0.20	8	0.09	0.17	0.21	8	0.11	0.18	0.23
9	0.07	0.09	0.11	9	0.08	0.09	0.12	9	0.09	0.10	0.13	9	0.11	0.11	0.15
10	0.13	0.13	0.11	10	0.14	0.14	0.11	10	0.16	0.15	0.13	10	0.20	0.18	0.15
11	0.05	0.21	0.16	11	0.05	0.22	0.17	11	0.06	0.24	0.18	11	0.07	0.29	0.22

Other Gears' Partial F's			
Age	1984	1985	1986
2	0.00	0.01	0.01
3	0.02	0.05	0.08
4	0.07	0.05	0.15
5	0.11	0.12	0.14
6	0.18	0.17	0.20
7	0.15	0.23	0.18
8	0.14	0.17	0.19
9	0.11	0.12	0.26
10	0.26	0.15	0.27
11	0.21	0.29	0.22

Table G-5. Div. 4VWX and Subarea 5 pollock: Average partial recruitment patterns, fully recruited fishing mortalities and trawl effort scaling factors from the separable model.

Average Partial Recruitment

Age	Trawl Mesh Size (mm) 130	140	152	165
2	.004	.003	.001	.001
3	.095	.069	.042	.027
4	.417	.356	.267	.203
5	.820	.755	.636	.556
6	1.000	1.000	.896	.884
7	1.000	1.000	1.000	1.000
8	.732	.732	.732	.856
9	.443	.443	.443	.518
10	.659	.659	.659	.771
11	.821	.821	.821	.961

Age	Other Gears
2	.046
3	.234
4	.433
5	.593
6	.805
7	1.000
8	1.000
9	1.000
10	1.000
11	1.000

Fully Recruited F

Year	Trawl Mesh Size (mm) 130	140	152	165
1984	.184	.202	.239	.265
1985	.188	.198	.221	.228
1986	.199	.208	.228	.229

Year	Other Gears
1984	.176
1985	.202
1986	.280

Trawl Effort Scaling Factor

Mesh Size (mm)	k
130	1.00
140	1.00
152	1.00
165	1.17

Table G-6. Div. 4VWX & Subarea 5 pollock: Results of yield-per-recruit analysis by mesh size.

A: 130 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
2.0	.772	.027	.200		.100	.111	.142	.193	.616
3.0	1.182	.169	.200		.200	.183	.216	.251	.937
4.0	1.981	.426	.200		.300	.257	.296	.313	1.102
5.0	2.665	.699	.200	$F_{0.1}$---	.346	.291	.334	.342	1.147
6.0	3.331	.896	.200		.400	.332	.380	.377	1.184
7.0	3.874	1.000	.200		.500	.407	.469	.443	1.222
8.0	5.219	.875	.200		.600	.482	.561	.511	1.237
9.0	6.173	.741	.200	F_{max}---	.694	.552	.650	.576	1.240
10.0	6.549	.841	.200		.700	.557	.655	.581	1.240
11.0	6.797	.917	.200		.800	.630	.752	.651	1.236
					.900	.703	.850	.722	1.230
					1.000	.774	.949	.794	1.221
					1.100	.845	1.048	.866	1.213
					1.200	.915	1.149	.938	1.204
					1.300	.985	1.250	1.010	1.195
					1.400	1.054	1.351	1.083	1.186
					1.500	1.123	1.453	1.155	1.178

B: 140 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
2.0	.760	.025	.200		.100	.111	.142	.192	.611
3.0	1.174	.155	.200		.200	.181	.215	.250	.933
4.0	2.004	.396	.200		.300	.254	.295	.311	1.101
5.0	2.684	.671	.200	$F_{0.1}$---	.353	.292	.339	.344	1.153
6.0	3.335	.899	.200		.400	.327	.379	.375	1.186
7.0	3.867	1.000	.200		.500	.401	.468	.440	1.227
8.0	5.210	.871	.200		.600	.474	.560	.508	1.244
9.0	6.162	.732	.200		.700	.547	.654	.576	1.249
10.0	6.537	.836	.200	F_{max}---	.720	.561	.673	.590	1.249
11.0	6.782	.914	.200		.800	.618	.750	.646	1.247
					.900	.688	.848	.716	1.241
					1.000	.758	.947	.787	1.234
					1.100	.826	1.046	.858	1.226
					1.200	.894	1.147	.929	1.218
					1.300	.961	1.248	1.001	1.210
					1.400	1.027	1.349	1.073	1.202
					1.500	1.094	1.451	1.144	1.194

Table G-6. (Continued)

C: 152 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
2.0	.747	.023	.200		.100	.108	.141	.191	.597
3.0	1.155	.136	.200		.200	.175	.214	.248	.920
4.0	2.031	.348	.200		.300	.244	.293	.308	1.093
5.0	2.718	.615	.200	$F_{0.1}$---	.369	.292	.351	.351	1.162
6.0	3.348	.852	.200		.400	.313	.377	.370	1.184
7.0	3.862	1.000	.200		.500	.383	.465	.435	1.231
8.0	5.201	.863	.200		.600	.451	.556	.501	1.252
9.0	6.140	.715	.200		.700	.518	.650	.568	1.260
10.0	6.512	.826	.200	F_{max}---	.769	.564	.716	.615	1.261
11.0	6.752	.909	.200		.800	.585	.746	.636	1.261
					.900	.650	.844	.704	1.257
					1.000	.714	.943	.774	1.252
					1.100	.777	1.042	.843	1.245
					1.200	.839	1.143	.913	1.238
					1.300	.901	1.244	.983	1.230
					1.400	.962	1.345	1.052	1.223
					1.500	1.023	1.447	1.122	1.215

D: 165 (mm) mesh

Input data				Results					
					F				Total
AGE	WEIGHT	PR	M		full	5+	7+	9+	Yield
2.0	.737	.023	.200		.100	.108	.144	.195	.606
3.0	1.131	.125	.200		.200	.174	.220	.255	.932
4.0	2.050	.313	.200		.300	.242	.301	.319	1.106
5.0	2.764	.574	.200	$F_{0.1}$---	.366	.287	.358	.363	1.173
6.0	3.377	.847	.200		.400	.310	.388	.385	1.198
7.0	3.868	1.000	.200		.500	.376	.478	.454	1.244
8.0	5.203	.925	.200		.600	.442	.572	.523	1.266
9.0	6.102	.748	.200		.700	.506	.667	.594	1.275
10.0	6.468	.880	.200	F_{max}---	.779	.556	.744	.651	1.276
11.0	6.700	.979	.200		.800	.568	.764	.666	1.276
					.900	.630	.863	.738	1.273
					1.000	.690	.963	.811	1.268
					1.100	.749	1.063	.884	1.261
					1.200	.808	1.163	.956	1.255
					1.300	.865	1.265	1.030	1.247
					1.400	.922	1.366	1.103	1.240
					1.500	.979	1.467	1.176	1.233

Table G-7. Div. 4VWX and Subarea 5 pollock: Catch projections for 1988 by mesh size.

AGE	Population Nos. ('000) 1988	130 mm Catch wt.	130 mm Fishing Mortalities	140 mm Catch wt.	140 mm Fishing Mortalities	152 mm Catch wt.	152 mm Fishing Mortalities	165 mm Catch wt.	165 mm Fishing Mortalities
2	38046	308	.012	290	.011	277	.011	268	.011
3	31091	2724	.082	2472	.075	2191	.068	1953	.062
4	21295	7881	.228	7526	.213	6970	.192	6243	.169
5	6922	5381	.391	5303	.379	5164	.361	4888	.330
6	12953	15052	.495	15357	.507	15324	.501	15337	.494
7	5965	8656	.538	8790	.550	9135	.582	9156	.578
8	5811	9938	.454	10082	.463	10457	.486	11146	.527
9	5007	8573	.362	8672	.368	8923	.382	9359	.408
10	549	1129	.430	1145	.439	1184	.460	1251	.497
11	155	358	.482	363	.492	376	.518	399	.564
12	0	0	.482	0	.492	0	.518	0	.564
Totals	127794	60000	-	60000	-	60000	-	60000	-
F5+	-	-	.471	-	.481	-	.492	-	.502

Table G-8A. Div. 4VWX & Subarea 5 pollock: Summary of projections -- constant TAC and allocations.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258881	241769	225755	208938	191821
5+ Population biomass:	150590	129564	114706	98717	82599
5+ fishing mortality:	.471	.547	.620	.731	.883
7+ fishing mortality:	.412	.484	.578	.658	.809
Yield:	60000	60000	60000	60000	60000
Trawler fishable biomass:	98850	86196	79060	70070	59776
catch biomass:	31175	31175	31175	31175	31175
relative effort:	.315	.362	.394	.445	.522
Others' fishable biomass:	129470	109822	92701	78538	64942
catch biomass:	28825	28825	28825	28825	28825
relative effort:	.223	.262	.311	.367	.444

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258726	242055	226499	210206	193703
5+ Population biomass:	150617	129621	115192	99700	84134
5+ fishing mortality:	.481	.563	.639	.752	.904
7+ fishing mortality:	.420	.497	.593	.672	.822
Yield:	60000	60000	60000	60000	60000
Trawler fishable biomass:	95270	81850	75123	66672	56922
catch biomass:	31175	31175	31175	31175	31175
relative effort:	.327	.381	.415	.468	.548
Others' fishable biomass:	129213	109393	92510	78780	65673
catch biomass:	28825	28825	28825	28825	28825
relative effort:	.223	.263	.312	.366	.439

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258416	242308	227445	211918	196337
5+ Population biomass:	150800	129938	116166	101421	86706
5+ fishing mortality:	.492	.589	.662	.775	.924
7+ fishing mortality:	.439	.523	.628	.707	.861
Yield:	60000	60000	60000	60000	60000
Trawler fishable biomass:	87037	74041	67060	59437	50775
catch biomass:	31175	31175	31175	31175	31175
relative effort:	.358	.421	.465	.525	.614
Others' fishable biomass:	128818	108754	92241	79195	66848
catch biomass:	28825	28825	28825	28825	28825
relative effort:	.224	.265	.312	.364	.431

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258179	242773	228898	214320	199937
5+ Population biomass:	151327	130836	118027	104198	90603
5+ fishing mortality:	.502	.616	.690	.798	.941
7+ fishing mortality:	.473	.573	.688	.771	.936
Yield:	60000	60000	60000	60000	60000
Trawler fishable biomass:	88106	73078	65772	57543	49205
catch biomass:	31175	31175	31175	31175	31175
relative effort:	.414	.499	.554	.634	.741
Others' fishable biomass:	128463	108303	92258	80083	68738
catch biomass:	28825	28825	28825	28825	28825
relative effort:	.224	.266	.312	.360	.419

Table G-8B. Div. 4VWX & Subarea 5 pollock: Summary of projections -- TAC and allocations for 1988, $F_{0.1}$ and constant allocation ratio in subsequent years.

130 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258881	241769	252120	257953	259202
5+ Population biomass:	150590	129564	138870	144561	145840
5+ fishing mortality:	.471	.304	.305	.311	.316
7+ fishing mortality:	.412	.269	.284	.279	.289
Yield:	60000	36429	38734	40489	41204
Trawler fishable biomass:	98850	94424	103476	109482	111932
catch biomass:	31175	18934	20120	21028	21404
relative effort:	.315	.201	.194	.192	.191
Others' fishable biomass:	129470	120309	122717	126440	127883
catch biomass:	28825	17494	18614	19462	19800
relative effort:	.223	.145	.152	.154	.155

140 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258726	242055	253102	259454	261069
5+ Population biomass:	150617	129622	139703	145921	147575
5+ fishing mortality:	.481	.309	.311	.318	.322
7+ fishing mortality:	.420	.273	.288	.284	.293
Yield:	60000	36129	38582	40558	41368
Trawler fishable biomass:	95270	89983	99234	105530	108127
catch biomass:	31175	18773	20058	21070	21492
relative effort:	.327	.209	.202	.200	.199
Others' fishable biomass:	129213	120098	122930	127063	128831
catch biomass:	28825	17356	18524	19488	19876
relative effort:	.223	.145	.151	.153	.154

152 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258416	242307	254497	261850	264372
5+ Population biomass:	150800	129938	141231	148453	151017
5+ fishing mortality:	.492	.318	.315	.322	.327
7+ fishing mortality:	.439	.282	.299	.293	.304
Yield:	60000	35638	38176	40409	41459
Trawler fishable biomass:	87037	81896	89987	96361	99361
catch biomass:	31175	18511	19842	20995	21551
relative effort:	.358	.226	.220	.218	.217
Others' fishable biomass:	128818	119843	123425	128391	130906
catch biomass:	28825	17126	18334	19414	19908
relative effort:	.224	.143	.149	.151	.152

165 mm mesh

Year:	1988	1989	1990	1991	1992
Total Population biomass:	258179	242773	256305	264640	268576
5+ Population biomass:	151327	130836	143532	151739	155707
5+ fishing mortality:	.502	.326	.322	.325	.330
7+ fishing mortality:	.473	.303	.321	.314	.326
Yield:	60000	35197	37960	40183	41581
Trawler fishable biomass:	88106	81371	90084	96004	99857
catch biomass:	31175	18296	19721	20876	21614
relative effort:	.414	.263	.256	.254	.253
Others' fishable biomass:	128463	119775	124103	130015	133653
catch biomass:	28825	16901	18238	19306	19967
relative effort:	.224	.141	.147	.148	.149

Appendix 2. Key APL functions used to estimate partial recruitment and selectivity patterns.

Appendix 2. Key APL functions used to estimate partial recruitment and selectivity patterns.

Descriptions of APL Variables

The following data dictionary provides a consistent framework for naming data objects used in the APL programs. Data for each stock were stored in an STSC Statgraphics APL structured file and read into the workspace as required. Four categories of data were used for each stock: sample data, input population data, analysis results, and other variables. Sample data are not used in the partial recruitment and selectivity calculations; thus these variables have been omitted from the following list.

Input Population Data

These items provide the basic data required for yield-per-recruit and projections. They are stored as arrays of rank 1, 2, or 3. The leading axis (if appropriate) is the mesh size, followed by any aspect variable (length or age), and then by the year. Thus a rank three array would be indexed as [mesh; age; year] or [mesh; length; year]. A rank two array could be indexed by [mesh; age], [mesh; length], [age; year], or [length; year]. This arrangement was chosen so that variables which do not depend on mesh size can be reshaped to conform with variables which do depend on the mesh size.

avwt - (Av)erage of the mean (w)eigh(t)s-at-age for the period 1984-86, for the combined catch. This variable is a rank 2 array with one row for each mesh size, and one column for each age.

trawlnl - (Trawl) catch (n)umbers-at-(l)ength, from the adjusted keys. This variable is a rank 3 array with one plane for each mesh size. The length category is given in the first plane. Each plane contains one column for each year.

trawlc - (Trawl) (c)atch numbers-at-age from the adjusted keys. This variable is a rank 3 array with one plane for each mesh size. Each plane contains one row for each age and one column for each year.

trawlavwt - (Trawl) (av)erage mean (w)eigh(t)s-at-age over the period 1984-86. This variable is a rank 2 array with one row for each mesh size and one column for each age.

cat - (Cat)ch at age for the period 1984-86, for all gears combined. This variable is a rank 3 array with one plane for each mesh size. Each plane contains one row for each age and one column for each year.

F - (F)ishing mortalities for 1984-86 based on the adjusted catches and the beginning of year population numbers from the most recent assessment. This variable is a rank 3 array with one plane for each mesh size. Each plane contains one row for each age and one column for each year.

othernl - (Other) gear's catch (n)umbers-at-(l)ength for 1984-86, weighted by numbers. This is not affected by mesh size. This variable is a rank 2 array whose first column gives the length group, followed by one column for each year.

mwt - (M)ean (w)eigh(t)s-at-age for the overall catch, 1984-86. This variable is a rank 3 array with one plane for each mesh size. Each plane contains one row for each age and one column for each year.

otherc - Non-trawl (other) (c)atch numbers-at-age for 1984-86. This variable does not depend on the mesh. It is a rank 2 array with one row for each age and one column for each year.

pop - (Pop)ulation beginning of year numbers-at-age from the most recent assessment, for years 1984-86. This variable is a rank 2 array with one row for each age and one column for each year.

pop88 - (Pop)ulation numbers-at-age for the beginning of 19(88) from the projection given in the most recent assessment. This variable is a vector with one element for each age.

trawlwt - (Trawl)er mean (w)eigh(t)s-at-age. This variable is a rank 3 array with one plane for each mesh size. Each plane contains one row for each age and one column for each year.

otherwt - (Other) gear's mean (w)eigh(t)s-at-age for each year, 1984-86. This variable does not depend on the mesh size. It is a rank 2 array with one row for each age and one column for each year.

otheravwt - (Other) gear's (av)erage mean (w)eigh(t)s-at-age for the period 1984-86. This variable does not depend on the mesh size. It is vector with one element for each age.

Other Variables

stockname -A character vector containing the name of the stock, in the form: "Div. 4VsW cod".

M - Natural mortality.

firstage - The first age used in the catch at age.

cmgrp - The length frequency grouping interval (cm).

contact - The name and phone number of the individual who prepared the data set.

sppcode - The species code (10=cod, 12=haddock, 16=pollock).

alloc88 - Canadian (alloc)ations for 19(88), in the form of a two element vector, with the first element containing the allocation for mobile gear in 1988, and the second the allocation for other gears.

cafsacF01 - (CAFSAC $F_{0.1}$) a scalar containing the agreed long-term average value for $F_{0.1}$ used by CAFSAC.

cafsacPR - (CAFSAC) (p)artial (r)ecruitment vector, as used in the catch projections from the most recent assessment.

pryrs - Mixture array used to select the years to be included in partial recruitment calculations. This variable is required for the sensitivity analysis. It is an array with 3 rows and one column for each scenario.

selparm - Vector containing the mesh selection parameters in the order: shape parameter, intercept, and slope.

projdisp - Control variable for catch projection output tables.

Analysis Results

These items contain intermediate results of the analyses. They use the same rank and shape conventions as for the input population data.

otheravpr - (Other) gear's (av)erage (p)artial (r)ecruitment for 1984-86 calculated from partial F's. This variable is a rank 3 array with one plane for each mesh size. Each plane is an array with one row for each age, and one column for each partial recruitment scenario.

F01 - ($F_{0.1}$) fishing mortality. This variable is a rank two array with one row for each mesh size, and one column for each partial recruitment scenario (i.e., domed or flat-topped).

pryrs - (P)artial (r)ecruitment (y)ea(rs), the sequence of the years 1984-86 used in the cross validation of partial recruitment parameter estimates. This variable is an array with three rows and one column for each mix of years.

trawlavpr - (Trawl) (av)erage (p)artial (r)ecruitment for 1984-86, calculated from partial F's for the trawl component. This variable is a rank 3 array with one plane for each mesh size. Each array has one row for each age and one column for each partial recruitment scenario.

trawlfrf - (Trawl) (f)ully-(r)ecruited (f)ishing mortality. This variable is a rank 3 array with one plane for each mesh size. Each plane has one row for each year and one column for each partial recruitment scenario.

otherfrf - (Other) gear's (f)ully-(r)ecruited (f)ishing mortality. This variable is a rank 3 array with one plane for each mesh size. Each plane has one row for each year and one column for each partial recruitment scenario.

Functions: TRAWLPR OTHERPR SEPM

```
    ∇ tn←opt TRAWLPR FILE;ALPHA;YC;TIT;P;i;trawlc;partf;z;avpr;q;frf;selr;wt
   ⍝ calculate trawler average partial recruitment & catchability
    tn←'R trawlc' SG∆FILEIT FILE
    trawlc←(⍴cat)↑trawlc
    partf←F×trawlc÷cat
    partf←partf[;;yrs] ⍝ shuffle cols for sensitivity study
    avpr←(4,⍴AG)⍴0 ⋄ q←4↑1 ⋄ frf← 4 3 ⍴0
    ∆TURNPAGE '/',wsid,'/TRAWLPR/',∆DAT,'/'
    i←1 ⍝ 130 mm mesh is special case
    ∆Q ⎕TCNL,⍞←'    ',stockname,': Trawl partial recruitment.'
    ∆Q '          option ',(⍕opt),' for ',mesh[i;],' mm mesh.',⎕TCNL
    wt←(0⌈trawlc[i;;])×partf[i;;]≥0
    P←(wt*0.5)SEPM partf[i;;]
    avpr[i;]←(⍴YR)↓P ⋄ frf[i;]←(⍴YR)↑P
  lp:i←i+1 ⍝ .................................the other mesh sizes
    ∆Q,'.bp',⎕TCNL
    ∆Q ⍞←'           Selection ratios for ',mesh[i;],' mm mesh.',⎕TCNL
    selr←partf[i;;]÷partf[1;;]
    wt←(0⌈trawlc[i;;])×partf[i;;]≥0
    P←(wt*0.5)SEPM selr
    avpr[i;]←avpr[1;]×(⍴YR)↓P
    q[i]←⌈/avpr[i;] ⍝ final normalization
    avpr[i;]←avpr[i;]÷q[i]
    frf[i;]←frf[1;]×q[i]×(⍴YR)↑P
    →(4>i)/lp ⍝ ...........................................................
    ⍞←'Update "trawlfrf", "trawlq", and "trawlavpr" (Y/N)?'
    ⍎((⍞←⎕INKEY)∊'Yy↑')/'tn←opt TRAWL∆S tn'
  ⍝ ................ the end
    ∇

    ∇ tn←opt OTHERPR FILE;wt;ALPHA;YC;TIT;P;otherc;partf;avpr;z;frf
   ⍝ calculate other gears' average partial recruitment
    tn←'R otherc' SG∆FILEIT FILE
    partf←F[1;;]×otherc÷cat[1;;]
    partf←partf[;yrs]
    ∆TURNPAGE '/',wsid,'/OTHERPR/',∆DAT,'/'
    ∆Q ⎕TCNL,⍞←'    ',stockname,': Other gears'' partial recruitment.'
    ∆Q '         option ',(⍕opt),⎕TCNL
    wt←(0⌈otherc)×partf≥0
    P←(wt*0.5)SEPM partf
    avpr←(⍴YR)↓P ⋄ frf←(⍴YR)↑P
    ⍞←'Update "otherfrf" and "otheravpr" (Y/N)?'
    ⍎((⍞←⎕INKEY)∊'Yy↑')/'tn←opt OTHER∆S tn'
    ∇
```

```
    ∇ B←WT SEPM RESP;CEF;WY;X;X0;WX;YCM;FA;ID;G;ag;yr;REF
  ⍝ weighted least-squares fit of separable model
   ∆Q 'Separable model:',⎕TCNL
   ∆Q '       response = (column effect)(row effect)',⎕TCNL
   ∆Q 'using weighted ln-ln regression.  Row effect is'
   ∆Q 'normalized to max. of 1. ',⎕TCNL
   ⍎(0=⎕NC 'AG')/'AG←⍳1↑⍴RESP'
   ⍎(0=⎕NC 'YR')/'YR←⍳1↓⍴RESP'
   ag←AG ⋄ yr←YR ⋄ WT←WT×RESP>0 ⍝ treat as missing
   ID←∨/WT≠0 ⍝ to eliminate rows with all wts = 0
   AG←ID/AG ⋄ WT←WT[ID/⍳1↑⍴WT;] ⋄ RESP←RESP[ID/⍳1↑⍴RESP;]
   FA←¯1↑AG ⍝ fully-recruited?
   YCM←((⍴RESP)⍴YR)-⍉(⌽⍴RESP)⍴AG
   ⍎(0=⎕NC 'YC')/'YC←⍳¯1++/⍴RESP' ⍝∆NUB,YCM
   WY←,(⍟((WT≠0)×RESP)+WT=0)×WT ⍝ weighted response
   ID←YR∘.=YR
   X0←ID[,(⍴RESP)⍴⍳⍴YR;]
   ID←AG∘.=AG
   X0←X0, 0 ¯1 ↓ID[,⍉(⌽⍴RESP)⍴⍳⍴AG;] ⍝ full model
   X←X0
  rgn:WX←X×⍉(⌽⍴X)⍴WT ⍝ weighted carrier
   B←WY⌹WX
   CEF←*(⍴YR)↑B ⍝ column effects
   REF←(*(¯1+⍴AG)↑(⍴YR)↓B),1 ⍝ row effects
   REF←REF÷ALPHA←⌈/REF ⍝ normalization
   AG←AG,1↓FA
   G←⍋AG
   REF←(REF,(⍴FA)⍴REF[AG⍳''⍴FA])[G] ⍝ fold in fully-recruited
   AG←AG[G]
   'Age effects: '
   6 0 8 3 ⍕AG,[1.5]REF
   FA←¯1 ∆ACCEPTIF '∧/X∊',(⍕0,AG),'  ⍝ fully-recruited ages (0 to exit)'
   →(0=FA)/out ⍝ otw., collapse X and regress
   X←X0[;(⍳⍴YR),(⍴YR)+((¯1↓AG)<''⍴FA)/⍳¯1+⍴AG]
   X←X,∨/X0[;(⍴YR)+((¯1↓AG)∊FA)/⍳¯1+⍴AG]
   X←X,X0[;(⍴YR)+((¯1↓AG)>¯1↑FA)/⍳¯1+⍴AG]
   AG←(~AG∊1↓FA)/AG
   →rgn
  out:
   CEF←ALPHA×CEF
   RESID←(⍴RESP)⍴WY-WX+.×B
   ∆Q SEPM∆out
  end:B←(⍴ag)⍴0 ⍝ assume for values that couldn't be estimated
   B[(ag∊AG)/⍳⍴ag]←REF
   B←CEF,B ⍝ return col., row effects
   AG←ag ⍝ restore global
    ∇
```