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## Introduction

At the meeting of the Working Group on Greenland cod at Copenhagen in February 1966 considerable progress was made in assembling the basic data on catch, effort and size and age composition, and in making some estimates of the effect of possible regulatory measures - specifically increases in mesh size and closure of Division 1B (Store Hellefiske Bank) to fishing. However time did not permit the full discussion and computation of the various effects, and the present paper describes the results of some of the calculations carried out since the Copenhagen meeting. Since it has not been possible to discuss these results with the members of the working group this report does not appear in its present form as part of the working group's report. It must be emphasized, however, that this paper is based almost entirely on material presented to and compiled by the working group, and on discussions during the group's meeting.

## Length Compositions

The working group produced two sets of length composition figures from trawlers, the best estimates of the landings from the commercial trawlers and of the catches by research trawlers. These agreed well for the larger fish, but the research-ship samples contained substantially more small fish, even though the gear and mesh size were those normally used commercially. The simplest explanation is that these small fish found in the research-ship catches but not in the commercial landings are discarded at sea, and it is known from direct reports from the commercial trawlers that large quantities of fish are, at least on some occasions, discarded. However the quantity discarded, as estimated from the two length compositions, is in terms of the quantity landed (48% by numbers, or 10% by weight), which may be higher than the actual discard rate. The discards can be estimated for each division

separately, giving rates of discards (as percentages of the numbers landed) ranging from 80% in division 1B to 16% in 1E, the rates in 1C, D and F being 52%, 30% and 49% respectively.

The discards may be overestimated through bias in the estimates either of catches or landings. The commercial trawlers may in fact catch fewer very small fish (of the size that would be discarded) than the research vessels because they tend to avoid areas where such valueless fish are most frequent, and concentrate on the areas where the commercially valuable sizes predominate, i.e. the figures in the working group report may give a correct picture of the size composition of the landings, but overestimate the quantity of very small fish which are caught and then discarded. Alternatively, the composition of the landings could be biassed. In the absence of comprehensive data from all types and nationalities of trawlers the working group had to analyse all trawlers together, so that the result is biassed towards those classes of trawlers from which most samples were obtained - that is particularly English and German vessels landing fish on ice. The previous report (Beverton and Hodder, 1962, Figure 4.3) showed that there were considerable differences between the sizes of fish taken by trawlers of different nationalities, with the English, and particularly German, trawlers landing bigger fish. Little up-to-date information is available on the landings of the other countries to show whether these differences still exist in the recent landings, but it is likely that they do. It is known (A. Meyer, personal communication) that the German factory ships which fillet and freeze their catch at sea can use fish that are smaller than is acceptable for the market for fish on ice, so that the size composition of the German fresh fish landings is not typical of the retained catch of the German fleet as a whole. Thus it is possible that the tables of trawl-caught landings in the report underestimate the proportion of small fish in the trawl landings.

With all the uncertainties it is not worth attempting to obtain a single best estimate of the size compositions of trawl catches, landings, and discards, and accordingly four alternative hypotheses were used:

(A) That the working group's estimate of the trawl landings is also the trawl catches, and that there are no discards. This is certainly unrealistic,

and gives the least favourable estimate of the effect of any measure to protect the small fish.

(B) That the trawl landings are as for (A), but the commercial catches are the same as the research catches, i.e. the discards are 48% by number.

(C) That the trawl landings are as for (A), and that the discards are 20% by numbers, these being the smaller fish among those estimated as discarded in (B). This is possibly the most realistic hypothesis.

(D) That the commercial trawl landings have the same length composition as the research catches, i.e. there are no discards, and the recent tendency for commercial markets to accept small fish has been taken to the extreme.

The length compositions of the landings by trawlers and liners, and of the discards by trawlers under hypotheses (B) and (C), are given in Table 1.

Mesh Assessments

These have been made by the same method as in previous reports, using a selection factor of 3.3, and a selection range (25%-75% point) of 10 cm. In estimating the loss due to natural mortality between the times of release and of reaching the retention size of the new larger mesh, it has been assumed that M = 0.3, and that successive meshes from 110 mm up to 170 mm would delay the onset of fishing mortality by 0.1, 0.2, 0.3, 0.5, 0.8 and 1.0 years respectively.

Closure of Division 1B

The original Danish proposal only mentioned closure of the area to trawling. The fishery in 1B is however roughly equally divided between trawl and line (mainly dory vessel) fishing, and, as Tables 4 and 5 of the working group's report show, small fish (under 50 cm) are at least as abundant in the line-catches as in the trawl-catches; for both gears these small fish are most abundant in the landings from Division 1B, though they occur in smaller numbers in the landings from all divisions of Subarea 1. Thus the closure of 1B and the diversion of the effort to other areas should reduce the proportion of small fish caught, and thus benefit the catches in the long term; this benefit should apply for closure either to trawling or line fishing or both.

There is however the possibility that in practice, if the area is closed to only one gear, say trawl, then it will become more attractive to the line fishermen, not only because of possible increase in the stocks, but also due to elimination of direct interference from trawlers; thus the line fishery in 1B may increase if the division is closed to trawling, so that the calculations below, based on the assumption that a closure will cause no change in the pattern of fishing other than a redistribution of Division 1B's present trawling effort, are likely to overestimate the effect of such closure to a single gear.

Some of the general problems involved in assessing the effect of closure of a particular area have been set out in the working group report (e.g. the estimation of the size composition of the catches, the movements of the fish, and the redistribution of the fishing effort). The report concluded that the study of the effect of the redistributed effort could be simplified without serious error by assuming that it remained at West Greenland, any overestimate of the effort at Greenland (and hence underestimate of the catch per unit effort) being balanced by an underestimate of the effort elsewhere. The redistribution would result in a reduction in the total landings, the two estimates used being reductions of 5% and 15% of the landings at present taken in 1B.

The estimated catches immediately after the redistribution are given in Tables 2A and 2B for the two assumed values of the loss in redistributing. This shows the reduction in both weight and numbers landed, following closure to either trawl or line, and also the reduction in the numbers discarded (assuming no change in the proportion discarded in each length group) if 1B were closed to trawling. For instance if the division were closed to trawling, and discards were 20% by numbers (hypothesis C), then if there were a 5% loss to the trawlers in redistributing, the numbers landed would be reduced by 4.9 million fish and the numbers discarded by 5.9 million. Ultimately a proportion E of these would be caught, so that the long-term catches, in numbers, would be greater than the landings immediately after closure by a proportion $\frac{E \times 10.8}{N_K}$, where $N_K$ = numbers caught immediately after

closure, in millions. The increase in weight caught might not be the same, because the changed distribution of fishing might change the average size of fish caught outside 1B; however, as explained in the working group report, the average size may be assumed, as a first approximation, to remain unchanged (the smallest fish would not be affected, the medium fish would increase, due to better immigration from 1B, while the larger fish would also benefit from the better immigration, but would be reduced by the heavier fishing outside 1B). Thus the gross long-term change in weight might also be given by $Q = \frac{E \times N_R}{N_K}$, where $N_R$ is the immediate reduction in numbers caught following closure of 1B to trawling (10.8 million in the example above). The net long-term effect G, would, as when assessing the effect of mesh change, be given by

$$(1 + G) = (1 + Q)(1 - L)$$

where L = immediate loss, = 0.05 or $0.15 \times \frac{W_B}{W_T}$, where

$W_B$ = landings from 1B by regulated gear

$W_T$ = total landings by that gear.

In this formula there is no correction for loss due to natural mortality, analogous to that in the assessment of mesh change for the mortality of small fish during the period between being released and growing to the size at which they will be retained by the larger mesh. The effect of closure of an area is not so easy to assess - fewer fish are caught, but there is not a discrete group of particular fish which can be considered as being 'released', whose fate can be followed. Certainly the small fish (and in fact fish of all sizes) at present liable to be caught in Division 1B would be reduced by natural mortality before they had moved to other divisions and become liable to capture; however the fish already present in the other divisions would be exposed to a greater fishing intensity (because of the diverted effort), and hence a bigger proportion would be caught. That is, instead of writing

$$Q = \frac{E \times N_R}{N_K}$$

the more correct formula is

$$Q = \frac{E' \times N_R'}{N_K}$$

where $E < E'$ = new exploitation rate in the divisions other than 1B,

$$N_R' = N_R e^{-Mt} < N_R,$$

and t = average time for fish to move from 1B to the division open to fishing. The two corrections to E and $N_R$ act in opposite directions, so there may not be too much error involved in ignoring them. Another term should also be introduced for the change in yield from the fish already present outside 1B, following the increased intensity of fishing on these grounds. Again this is likely to be small for a heavily fished stock with a fishing effort around the flat part of the yield/effort curve, and as a first approximation it has been ignored.

Results

The results of the assessments of both mesh change and of closure of Division 1B to trawl or line or both are set out in Table 3. This is presented in four parts, A-D, corresponding to the possible hypotheses regarding the discard rate by trawlers. Each part is given in three sets of columns, corresponding to the range of possible values of E. Thus each set of three columns, giving the estimates of the long-term changes in catches by trawl, line, and total, corresponds to a possible state of affairs at West Greenland, and comparisons between the effects of different regulatory measures should be made for entries in the same column.

An examination of the table shows that nearly all the entries are positive, i.e. in most situations there will be some long-term gain to both gears from any of the conservation actions considered. The exceptions are: (a) when there are no discards - the catch by trawlers (and for large meshes, the total catch) would be reduced; (b) for moderate discards, a 170 mm mesh might cause loss to trawlers; and (c) if diversion from 1B caused a large initial loss, there might be a long-term loss to liners if the division was only closed to line fishing. This last situation is of course unaffected by discarding.

When there are no discards, the best mesh size, so far as total landings are concerned, is at least as large as 130 mm (for E = 0.5), and possibly as

great as 160 mm (E = 0.8), giving long-term gains of 1-2%; these gains are less than would be obtained from closure of 1B to line fishing, or all fishing, or, if the loss from redistribution was small, from closure to trawling. The gain from total closure might be as much as 5%. Trawl landings might benefit very slightly from a moderate increase in mesh size and the long-term effect (either gain or loss) would be very small (less than 1%) for mesh changes up to 130-140 mm. Losses would be appreciable for very large meshes. Trawl landings would decrease if division 1B were closed only to trawling, but would gain (up to 4%) from closure to liners only, or to both lines and trawl. Catches by liners would, as usual, benefit from any increase in trawl mesh, or from closure of 1B to trawls (which would give about the same benefit as a mesh size of ca 145 mm). They would be reduced by closure of 1B to liners.

If there are discards (hypotheses B and C), the likely benefits to all types of gear would be considerably larger, especially as a result of larger mesh sizes. The total landings would increase with increasing mesh size at least up to 150 mm, and probably up to 170 mm, where the benefit might be as much as 15%; closure of division 1B to either gear would give a benefit; closure to all gears would give about the same benefit (5-10%) as the use of a 130-150 mm meshes, and probably considerably less than from the use of a 170 mm mesh. Trawlers also would certainly benefit from the use of larger mesh sizes - up to probably 170 mm if the discard rate is high (up to 10% gain), but if the discard rate is low the gain to the trawlers (2-6%) might decrease for increases in mesh size beyond 140-150 mm. Landings from liners would benefit very greatly from the use of very large meshes (possibly up to 25% from a 170 mm mesh), and the benefit to liners of closure of 1B would be about the same as that from the use of a trawl mesh of about 130 mm.

Finally if discards are ignored, and assessments made of the effect on commercial catches (hypothesis D), the results show that the total catches would increase with increasing mesh size up to at least 150 mm, and probably 170 mm, with gains of probably around 5% for 170 mm. The total catch would also gain from closure of 1B to either trawl or line, the benefit from total closure being greater than from any mesh increase if the fishing rate is low,

but about the same as from a 170 mm mesh at the more probable fishing rates. Trawl catches would benefit from mesh increases, probably up to 130 mm (1-2% gain), and would receive about the same benefit from closure of 1B to trawling. They would receive greater benefit from closure to lines, or to both trawl and lines (ca 5% gain). Catches by line would gain from any increase in mesh size (up to 20% from a 170 mm mesh) and, to a smaller extent (about the same as from a 130 mm mesh) from closure of 1B to trawling.

From this it appears that the relative benefits of mesh increase and closure of division 1B depend on the situation, especially concerning discards. The biggest benefits occur if discarding is heavy; this occurs, to a varying extent, in all divisions, so that the wastage by discarding will not be eliminated by closure of particular divisions, even though, since the proportion discarded is greatest in 1B, the wastage can be reduced by closure. Discarding is most effectively reduced by using larger mesh sizes, even though the spread in the curves of both mesh selection and percentage discarded against length means that the problem is not quite the simple matter of using a mesh size that will release all potential discards, and retain all the rest. However a suitable mesh size will release most of the discards with not too great an initial loss of marketable fish; thus when discards are frequent the best regulatory measure is a larger mesh. When there are no discards a larger mesh involves initially some loss of small fish, and unless this loss is substantial, at least in terms of numbers, the long-term gain cannot be substantial; however it may sometimes be possible to divert fishing from areas of mainly small fish to areas of large fish, with little initial loss. Thus, when there are no discards, and especially when the fishing rate (i.e. E) is fairly low, then the most effective regulation may be by diversion from nursery grounds, e.g. by closing division 1B.

To some extent this analysis exaggerates the difference between the two regulatory measures; the method used for the assessment of the effects of increasing mesh sizes makes no allowance for any resulting change in the distribution of the fleet. Particularly when initial losses are high the trawlers will tend to move away from the small-fish grounds to other areas and

so make up at least part of their initial losses even before the released fish grow; this would indirectly achieve much the same effect as the direct closure of the nursery grounds.

The analysis so far has considered the two possible methods (closure and mesh increase) independently; it is quite possible that both could be introduced, either simultaneously or in succession. No precise assessments can be made of the double effect, because, as mentioned in the previous paragraph, mesh increase is likely to change the distribution of fishing, while the closure of one division is likely to change the size composition of the fish in the remaining, fished, divisions. However, to a first approximation the effect of a mesh change after closure of 1B will be given by carrying out an assessment on the present catches or landings from the other divisions, i.e. ignoring any change in size composition due to the closure. The results of these calculations showed that, with or without an allowance for discards, the long-term benefits to a fishery in which the size composition (and discard rate, if any) is that of the present fishery in divisions 1C to 1F are two-thirds of the benefits to a fishery in which the size composition (and discard rate, if any) is that of the catches in Subarea 1 as a whole (because of the smaller proportion of small fish outside 1B). This, especially when discards are high, still means that benefits could be substantial, and therefore there is a benefit from applying both conservation measures. For instance, taking the most likely present situation, with 20% discards and E = 0.7, the following are the estimated long-term effects.

| Conservation measure | Long-term gain, % | | |
|---|---|---|---|
| | Trawl | Line | Total |
| 150 mm mesh | 4.9 | 9.2 | 6.7 |
| Closure of 1B to all gears (assuming 5% loss) | 6.9 | 6.2 | 6.6 |
| Extra effect of 150 mm mesh after closure | 3.8 | 6.9 | 4.9 |
| Total effect of both closure and 150 mm mesh | 11.0 | 13.5 | 11.8 |

Summary

The calculations and discussions of the Working Group on Greenland Cod are continued and estimates made of the immediate and long-term effects of closure of Division 1B (Store Hellefiske Bank) to trawlers and liners, and of the use of larger trawl meshes. Various rates of discards, and ratios of fishing to total mortality are assumed. Under virtually all conditions there will be some gain to both gears through protection of the small fish, either by closure of Division 1B or the use of larger meshes, or both. The magnitude of the gain depends on the precise rate of discards, but this is probably at least moderately high (20% by numbers), in which case closure of 1B to all gears or the use of a 150 mm mesh would give a long-term gain of 6-7%, and both measures together would give a gain of around 12%.

## Reference

Beverton, R. J. H. & Hodder, V. M., 1962. Report of working group of scientists on fishery assessment in relation to regulation problems. ICNAF Supplement to Annual Proceedings, Vol. 11, Halifax, N.S., Canada, 1962.

Table 1. Present catches and landings of cod, in thousands of fish, from Division 1B and other divisions of Subarea 1

| | Division 1B | | | | Other divisions | | | | Total | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Trawl | | | Line | Trawl | | | Line | Trawl | | | Line |
| | Landings | Discards Hyp. B | Discards Hyp. C | Landings | Landings | Discards Hyp. B | Discards Hyp. C | Landings | Landings | Discards Hyp. B | Discards Hyp. C | Landings |
| < 24 | | | | | | 18 | 18 | | | 18 | 18 | |
| 24-32 | | 105 | 105 | 22 | | 296 | 296 | 8 | | 401 | 401 | 30 |
| 33-41 | 36 | 2 940 | 2 940 | 987 | 216 | 2 373 | 2 373 | 286 | 252 | 5 313 | 5 313 | 1 273 |
| 42-50 | 2 743 | 8 823 | 4 890 | 5 038 | 2 807 | 8 072 | 4 474 | 1 169 | 5 555 | 16 895 | 9 364 | 6 207 |
| 51-59 | 6 353 | 4 358 | - | 6 185 | 8 365 | 9 380 | - | 3 645 | 14 718 | 13 738 | | 9 830 |
| 60-68 | 5 246 | - | - | 5 025 | 16 820 | - | - | 626 723 | 22 066 | | | 11 748 |
| 69-77 | 3 546 | - | - | 3 036 | 16 039 | - | - | 7 779 | 19 585 | | | 10 815 |
| 78-86 | 1 520 | - | - | 1 822 | 7 534 | - | - | 5 758 | 9 054 | | | 7 580 |
| 87-95 | 669 | - | - | 838 | 2 805 | - | - | 2 322 | 3 474 | | | 3 160 |
| 96-104 | 119 | - | - | 292 | 562 | - | - | 486 | 681 | | | 778 |
| 105+ | 17 | - | - | 128 | 77 | - | - | 165 | 94 | | | 293 |
| Total | 20 254 | 16 226 | 7 935 | 23 373 | 55 225 | 20 139 | 7 161 | 28 341 | 75 479 | 36 365 | 15 096 | 51 714 |
| Weight | 50 665 | | | 56 125 | 173 225 | | | 99 959 | 223 890 | | | 156 084 |

Table 2. Catches and landings of cod in Subarea 1 immediately after closure of Division 1B

| Length (cm) | Numbers (thousands) | | | | Change | | | |
|---|---|---|---|---|---|---|---|---|
| | Trawl | | | Line | Trawl | | | Line |
| | Landings | Discards Hyp. B | Discards Hyp. C | | Landings | Discards Hyp. B | Discards Hyp. C | |
| | | A. Assuming a 5% loss of catch to diverted ships | | | | | | |
| < 24 | | 23 | 23 | | | 5 | 5 | |
| 24-32 | | 378 | 378 | 12 | | -23 | -23 | -18 |
| 33-41 | 276 | 3,032 | 3,032 | 439 | 24 | -2,281 | -2,281 | -834 |
| 42-50 | 3,587 | 10,315 | 5,717 | 1,793 | -1,968 | -6,580 | -3,647 | -4,414 |
| 51-59 | 10,690 | 11,987 | | 5,589 | -4,028 | -1,751 | | -4,241 |
| 60-68 | 21,494 | | | 10,309 | -572 | | | -1,439 |
| 69-77 | 20,496 | | | 11,928 | 911 | | | 1,113 |
| 78-86 | 9,628 | | | 8,829 | 574 | | | 1,249 |
| 87-95 | 3,585 | | | 3,561 | 111 | | | 401 |
| 96-104 | 768 | | | 745 | 37 | | | -33 |
| 105+ | 98 | | | 253 | 4 | | | -40 |
| Total | 70,572 | 25,735 | 9,150 | 43,458 | -4,907 | -10,630 | -5,946 | -8,256 |
| Weight (tons) | 221,364 | | | 153,277 | -2,525 | | | -2,806 |
| | | B. Assuming a 15% loss of catch to diverted ships | | | | | | |
| < 24 | | 22 | 22 | | | 4 | 4 | |
| 24-32 | | 370 | 370 | 12 | | -31 | -31 | -18 |
| 33-41 | 276 | 2,963 | 2,963 | 422 | 18 | -2,350 | -2,350 | -851 |
| 42-50 | 3,505 | 10,079 | 5,586 | 1,727 | -2,050 | -6,816 | -3,778 | -4,480 |
| 51-59 | 10,445 | 11,712 | | 5,384 | -4,273 | -2,026 | | -4,446 |
| 60-68 | 21,001 | | | 9,931 | -1,065 | | | -1,817 |
| 69-77 | 20,026 | | | 11,491 | 441 | | | 676 |
| 78-86 | 9,407 | | | 8,506 | 353 | | | 926 |
| 87-95 | 3,502 | | | 3,430 | 28 | | | 270 |
| 96-104 | 702 | | | 718 | 21 | | | -60 |
| 105+ | 96 | | | 244 | 2 | | | -49 |
| Total | 68,954 | 25,146 | 8,941 | 41,865 | -6,525 | -11,219 | -6,155 | -9,849 |
| Weight (tons) | 216,290 | | | 147,665 | -7,600 | | | -8,419 |

Table 3. Estimated immediate and long-term changes in landings from Subarea 1 (as percentages of present landings) following mesh changes, or closure of Division 1B to fishing

| | Long-term changes | | | | | | | | | Imm. loss (%) | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | E = 0.5 | | | E = 0.7 | | | E = 0.8 | | | | |
| | Trawl | Line | Total | Trawl | Line | Total | Trawl | Line | Total | Reg. Gear | Total |
| HYPOTHESIS A (no discards) | | | | | | | | | | | |
| Mesh change | | | | | | | | | | | |
| To 110 mm | 0 | 0.1 | 0 | 0 | 0.2 | 0 | 0 | 0.2 | 0 | 0.1 | 0.1 |
| " 120 mm | -0.1 | 0.4 | 0.1 | 0.1 | 0.6 | 0.3 | 0.1 | 0.6 | 0.3 | 0.5 | 0.3 |
| " 130 mm | -0.4 | 0.9 | 0.2 | 0 | 1.2 | 0.5 | 0.2 | 1.4 | 0.7 | 1.2 | 0.7 |
| " 140 mm | -0.8 | 1.5 | 0.1 | -0.2 | 2.2 | 0.7 | 0.1 | 2.5 | 1.0 | 2.3 | 1.4 |
| " 150 mm | -1.8 | 2.5 | -0.1 | -0.9 | 3.4 | 0.9 | -0.4 | 3.9 | 1.3 | 4.2 | 2.5 |
| " 160 mm | -3.5 | 3.9 | -0.5 | -2.1 | 5.4 | 1.0 | -1.4 | 6.2 | 1.7 | 7.2 | 4.2 |
| " 170 mm | -6.7 | 5.8 | -1.6 | -4.6 | 8.1 | 0.5 | -3.6 | 9.3 | 1.6 | 11.8 | 7.0 |
| Closure of Division 1B, assuming a redistribution loss of 5% | | | | | | | | | | | |
| Closure to trawl | 0.3 | 1.5 | 0.7 | 0.8 | 2.1 | 1.4 | 1.2 | 2.4 | 1.7 | 1.1 | 0.7 |
| Closure to line | 2.5 | 0.7 | 1.7 | 3.5 | 1.7 | 2.7 | 4.0 | 2.1 | 3.2 | 1.8 | 0.7 |
| Total closure | 2.8 | 2.1 | 2.5 | 4.4 | 3.7 | 4.1 | 5.2 | 4.5 | 4.9 | 1.4 | 1.4 |
| Closure of Division 1B, assuming a redistribution loss of 15% | | | | | | | | | | | |
| Closure to trawl | -1.5 | 2.0 | -0.1 | -0.7 | 2.8 | 0.7 | -0.3 | 3.2 | 1.1 | 3.4 | 2.0 |
| Closure to line | 3.0 | -2.6 | 0.7 | 4.2 | -1.4 | 1.9 | 4.8 | -0.9 | 2.5 | 5.4 | 2.2 |
| Total closure | 1.3 | -0.7 | 0.5 | 3.2 | 1.2 | 2.4 | 4.2 | 2.2 | 3.4 | 4.2 | 4.2 |
| HYPOTHESIS B (Discards = differences between research and commercial (= 46% by number)) | | | | | | | | | | | |
| Mesh change | | | | | | | | | | | |
| To 110 mm | 1.1 | 1.3 | 1.2 | 1.6 | 1.8 | 1.8 | 1.9 | 2.0 | 1.9 | 0.2 | 0.1 |
| " 130 mm | 3.5 | 4.8 | 4.1 | 5.4 | 6.7 | 6.0 | 6.4 | 7.7 | 7.0 | 1.2 | 0.7 |
| " 150 mm | 5.0 | 9.4 | 6.8 | 8.6 | 13.1 | 10.5 | 10.4 | 15.0 | 12.3 | 4.0 | 2.4 |
| " 170 mm | 3.8 | 16.1 | 8.2 | 9.6 | 22.6 | 14.2 | 12.5 | 25.8 | 17.2 | 11.6 | 6.8 |
| Closure of Division 1B, assuming a redistribution loss of 5% | | | | | | | | | | | |
| Closure to trawl | 3.5 | 4.7 | 4.0 | 5.3 | 6.6 | 5.9 | 6.4 | 7.5 | 6.9 | 1.1 | 0.7 |
| Closure to line | 2.5 | 0.7 | 1.7 | 3.5 | 1.7 | 2.7 | 4.0 | 2.1 | 3.2 | 1.8 | 0.7 |
| Total closure | 6.0 | 5.3 | 5.7 | 8.8 | 8.1 | 8.5 | 10.3 | 9.6 | 10.0 | 1.4 | 1.4 |
| Closure of Division 1B, assuming a redistribution loss of 15% | | | | | | | | | | | |
| Closure to trawl | 1.8 | 5.4 | 3.3 | 3.9 | 7.5 | 5.3 | 4.9 | 8.6 | 6.4 | 3.4 | 2.0 |
| Closure to line | 3.0 | -2.6 | 0.7 | 4.2 | -1.4 | 1.9 | 4.8 | -0.9 | 2.5 | 5.4 | 2.2 |
| Total closure | 4.6 | 2.6 | 3.8 | 7.8 | 5.8 | 7.0 | 9.4 | 7.4 | 8.6 | 4.2 | 4.2 |
| HYPOTHESIS C (Discards = 20% by numbers) | | | | | | | | | | | |
| Mesh change | | | | | | | | | | | |
| To 110 mm | 0.9 | 1.1 | 1.0 | 1.3 | 1.5 | 1.4 | 1.5 | 1.7 | 1.6 | 0.2 | 0.1 |
| " 130 mm | 2.4 | 3.7 | 2.9 | 3.9 | 5.1 | 4.4 | 4.6 | 5.9 | 5.1 | 1.2 | 0.7 |
| " 150 mm | 2.3 | 6.6 | 4.1 | 4.9 | 9.2 | 6.7 | 6.1 | 10.6 | 8.0 | 4.0 | 2.4 |
| " 170 mm | -0.7 | 11.1 | 3.5 | 3.3 | 15.6 | 7.6 | 5.3 | 17.8 | 9.7 | 11.6 | 6.8 |
| Closure of Division 1B, assuming a redistribution loss of 5% | | | | | | | | | | | |
| Closure to trawl | 2.1 | 3.3 | 2.5 | 3.5 | 4.6 | 3.9 | 4.1 | 5.3 | 4.6 | 1.1 | 0.7 |
| Closure to line | 2.5 | 0.7 | 1.7 | 3.5 | 1.7 | 2.7 | 4.0 | 2.1 | 3.2 | 1.8 | 0.7 |
| Total closure | 4.6 | 3.9 | 4.3 | 6.9 | 6.2 | 6.6 | 8.0 | 7.7 | 7.3 | 1.4 | 1.4 |
| Closure of Division 1B, assuming a redistribution loss of 15% | | | | | | | | | | | |
| Closure to trawl | 0.3 | 3.8 | 1.8 | 1.8 | 5.4 | 3.3 | 2.6 | 6.2 | 4.1 | 3.4 | 2.0 |
| Closure to line | 3.0 | -2.6 | 0.7 | 4.2 | -1.4 | 1.9 | 4.8 | -0.9 | 2.5 | 5.4 | 2.2 |
| Total closure | 3.1 | 1.1 | 2.3 | 5.7 | 3.7 | 4.9 | 7.0 | 6.2 | 5.0 | 4.2 | 4.2 |
| HYPOTHESIS D (Commercial landings equal to research-vessel catches) | | | | | | | | | | | |
| Mesh change | | | | | | | | | | | |
| To 110 mm | 0.9 | 1.1 | 1.0 | 1.3 | 1.5 | 1.4 | 1.5 | 1.7 | 1.6 | 0.2 | 0.1 |
| " 130 mm | 2.4 | 3.7 | 2.9 | 3.9 | 5.1 | 4.4 | 4.6 | 5.9 | 5.1 | 1.2 | 0.7 |
| " 150 mm | 2.3 | 6.6 | 4.1 | 4.9 | 9.2 | 6.7 | 6.1 | 10.6 | 8.0 | 4.0 | 2.4 |
| " 170 mm | -0.7 | 11.1 | 3.5 | 3.3 | 15.6 | 7.6 | 5.3 | 17.8 | 9.7 | 11.6 | 6.8 |
| Closure of Division 1B, assuming a redistribution loss of 5% | | | | | | | | | | | |
| Closure to trawl | 2.1 | 3.3 | 2.5 | 3.5 | 4.6 | 3.9 | 4.1 | 5.3 | 4.6 | 1.1 | 0.7 |
| Closure to line | 2.5 | 0.7 | 1.7 | 3.5 | 1.7 | 2.7 | 4.0 | 2.1 | 3.2 | 1.8 | 0.7 |
| Total closure | 4.6 | 3.9 | 4.3 | 6.9 | 6.2 | 6.6 | 8.0 | 7.7 | 7.3 | 1.4 | 1.4 |
| Closure of Division 1B, assuming a redistribution loss of 15% | | | | | | | | | | | |
| Closure to trawl | 0.3 | 3.8 | 1.8 | 1.8 | 5.4 | 3.3 | 2.6 | 6.2 | 4.1 | 3.4 | 2.0 |
| Closure to line | 3.0 | -2.6 | 0.7 | 4.2 | -1.4 | 1.9 | 4.8 | -0.9 | 2.5 | 5.4 | 2.2 |
| Total closure | 3.1 | 1.1 | 2.3 | 5.7 | 3.7 | 4.9 | 7.0 | 6.2 | 5.0 | 4.2 | 4.2 |

RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES.

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Corrigenda

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# Further notes on the effect of possible regulatory measures on catches of Greenland cod

By J. A. Gulland

In Table 2, under B, number landed by trawls of 33-41 cm fish, for 276 read 270.

In Table 3 of Res. Doc. 66-56, "Further notes on the effects of possible regulatory measures on catches of Greenland cod", the entries under Hypothesis D by mistake repeats the entries under Hypothesis C. The correct entries are given below

HYPOTHESIS D (Commercial landings equal to research-vessel catches)

| | Long-term Changes | | | | | | | | | Imm.Loss % | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | E = 0.5 | | | E = 0.7 | | | E = 0.8 | | | Reg. | |
| Mesh Change to | Trawl | Line | Total | Trawl | Line | Total | Trawl | Line | Total | Gear | Total |
| 110 mm | 0.2 | 1.0 | 0.5 | 0.6 | 1.4 | 0.9 | 0.8 | 1.6 | 1.1 | 0.8 | 0.5 |
| 130 mm | -0.2 | 4.0 | 1.4 | 1.3 | 5.6 | 2.9 | 2.1 | 6.4 | 3.7 | 4.0 | 2.5 |
| 150 mm | -2.7 | 8.3 | 1.4 | 0.3 | 11.6 | 4.5 | 1.8 | 13.3 | 6.0 | 10.2 | 6.4 |
| 170 mm | -8.9 | 15.4 | 0.1 | -4.1 | 21.6 | 5.4 | -1.6 | 24.6 | 8.1 | 21.1 | 13.3 |

Closure of 1B, assuming a redistribution loss of 5%

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Closure to trawl | 2.1 | 3.7 | 2.8 | 3.6 | 5.1 | 4.2 | 4.3 | 5.9 | 5.0 | 1.5 | 0.9 |
| Closure to line | 2.5 | 0.7 | 1.7 | 3.5 | 1.7 | 2.7 | 4.0 | 2.1 | 3.2 | 1.8 | 0.7 |
| Total Closure | 4.6 | 4.4 | 4.5 | 7.0 | 6.8 | 6.9 | 8.3 | 8.0 | 8.2 | 1.6 | 1.6 |

Closure of 1B assuming a redistribution loss of 15%

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Closure to trawl | -0.2 | 4.4 | 1.7 | 1.5 | 6.2 | 3.4 | 2.3 | 7.1 | 4.3 | 4.5 | 2.6 |
| Closure to line | 3.0 | -2.6 | 0.7 | 4.2 | -1.4 | 1.9 | 4.8 | -0.9 | 2.5 | 5.4 | 2.2 |
| Total Closure | 2.8 | 1.8 | 2.4 | 5.7 | 4.8 | 5.3 | 7.1 | 6.2 | 6.8 | 4.8 | 4.8 |