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**Canadian Research Survey Data
Conversions for Redfish in SA2 + Div.
3K based on Comparative Fishing
Trials between an Engel 145 Otter
Trawl and a Campelen 1800 Shrimp
Trawl**

**Conversion de données sur le sébaste de la
sous-zone 2 et de la division 3K issues de
relevés de recherche canadiens reposant sur
des essais de pêche comparée d'un chalut à
panneaux Engel 145 et d'un chalut à
crevettes Campelen 1800**

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Abstract

In 1995, the Department of Fisheries and Oceans (DFO) Newfoundland Region replaced the research vessel, standard survey gear and fishing protocol that been utilized on groundfish surveys in Divs. 2J3K from 1977 to 1994. Comparative fishing trials were conducted in 1995 between the new vessel and gear (CCGS Teleost with Campelen 1800 shrimp trawl) the previous vessel and gear (MV Gadus Atlantica with Engel 145 Otter trawl). The data collected were analysed by length groups to provide a means to convert the older data time series into Campelen equivalents. The conversions did not distort any trends in the historic series for Div. 2J3K redfish but suggest that the rate of decline in the survey index since the 1970's was even greater. This is a reflection of the increased catchability of the Campelen for all size groups, particularly for those less than 30 cm.

Résumé

En 1995, la Région de Terre-Neuve du ministère des Pêches et des Océans (MPO) a remplacé le navire de recherche, l'engin de relevé normalisé et le protocole de pêche utilisés pour les relevés du poisson de fond dans les divisions 2J3K de 1977 à 1994. Des essais de pêche comparée des nouveaux navire et engin (NGCC Teleost armé d'un chalut à crevettes Campelen 1800) et des anciens navire et engin (NM Gadus Atlantica armé d'un chalut à panneaux Engel 145) ont été effectués en 1995. L'analyse des données recueillies selon les classes de longueur a permis de convertir les anciennes séries de données en équivalents Campelen. La conversion n'a pas faussé les tendances dans les séries historiques de données sur le sébaste des divisions 2J3K, mais donne à penser que le taux de diminution de l'indice de relevé depuis les années 1970 était beaucoup plus élevé, ce qui reflète le potentiel de capture accru de toutes les classes de longueur au chalut Campelen, en particulier les sébastes de moins de 30 cm de long.

Introduction

Multispecies comparative fishing trials were carried out in 1995 by the Department of Fisheries and Oceans (DFO) Newfoundland region for the purpose of deriving data conversion factors between an Engel 145 survey trawl and a *Campelen 1800* shrimp trawl. The Engel survey gear with bobbin footgear had been the standard survey gear for the Newfoundland region on the MV *Gadus Atlantica* from 1977-1994 primarily in Div 2J3K. The fishing trials were necessary to provide a means to maintain continuity with the older data time series.

There was also a change in vessel in the Div. 2J3K series with the change in survey gear to the *Campelen 1800* with rockhopper footgear. Trials were conducted between the *CCGS Teleost* (new vessel, new survey gear) and the *Gadus Atlantica* (previous vessel, previous survey gear). Details of the fishing trials and a formulation of the experimental design and the length based data modelling are outlined in Warren (1996). Six target species were investigated (including redfish) because of their commercial significance and management requirements. A total of 285 successful parallel tows, spread over three trips, were accomplished in February-March 1995. For redfish, of the 250 trawl pairs in which fish were caught by one or both vessels, 8 pairs were determined to have been a situation where one vessel fished on an aggregation missed by the other vessel and were removed from the analysis.

The purpose of this paper is to illustrate the results of the conversion factors and the impact on length distribution as well as trends in stock size using the newly converted data time series. The method of applying the conversion factors was similar to Stansbury (1997).

Materials and Methods

For the applicable surveys in Div. 2J3K between 1978 and 1995, redfish length frequencies for each fishing set were first adjusted to a standardized for distance the net was towed and were then converted from Engel trawl catches to *Campelen 1800* trawl catch equivalents. Conversion factors as presented in Warren (1996) for redfish were applied using weighted least squares as follows:

For the *Gadus Atlantica* conversion from Engel to *Campelen* Warren (1996):

The converted numbers at length $y_x = R_x * n_x$

where R = ratio of *Campelen* numbers caught to Engels number caught at length X (in 1 cm length classes)

n = number at length in the Engels fishing set

where

Model used: $\log R = 6.7580137 + 0.006839 * X - 1.927210 \log (X)$

Ratios for $X < 10$ were fixed at $X = 10$ because it was again considered that the model was estimating beyond the range of the data.

Weights were applied in the modeling as the number of fishing sets used to estimate the ratio for a given length class.

After the length frequencies were converted to a Campelen trawl catch equivalent with the model, a sampling ratio was applied if necessary to each length group and then summed to provide total numbers of redfish caught per standard Campelen set (0.8 nautical mile tow distance in 15 minutes with a wing spread of 16.84 m). These numbers were used to calculate a set weight using the following standard length-weight relationship:

$$\begin{aligned} \text{WT (males)} &= 0.01659 \text{ Forklength}^{2.9548} \\ \text{WT (females)} &= 0.013272 \text{ Forklength}^{3.0210} \end{aligned}$$

This dataset was then used to generate mean number and weight (kg) per set by stratum and year for converted data. For comparative and information purposes the previous Engel data are presented here in Tables 1-4 (upper panels) for Div. 2J and Tables 5-8 (upper panels) for Div. 3K. The Campelen equivalent data are listed in the lower panels of the same tables. No adjustments have been made for differences due to revisions to the stratum areas based on updated hydrography charts (Bishop, MS 1994). These revisions were implemented on the 1993 survey.

Results and Discussion

In general the conversion factors derived for each comparative fishing trial reflect the increased catchability for smaller redfish (≤ 20 cm). For the Teleost/Gadus trials, the model estimated a ratio of fish caught by the Campelen to the Engel at about 1.0 for 38 cm fish and increased gradually to about 2 as the length approached 25 cm. This covers most of the range of fish lengths which comprise a good deal of the catches in various surveys in Div. 2J3K by the Gadus Atlantica. Ratios increased rapidly for fish length less than 25 cm, and the ratio at lengths less than 10 were fixed because there were few data for the smaller fish from the fishing trials.

For illustration, a comparison of indices of abundance and biomass between the converted and unconverted data sets in Div. 2J and Div. 3K is presented in Fig. 1. Overall trend in was the same except that the relative values estimated for the Campelen trawl are higher. This is also seen in a comparison of stratified mean number per tow at length for a few illustrative years in the surveys (Fig. 2). The catching efficiency of the Campelen for smaller fish (< 20 cm) is demonstrated by these plots.

The Campelen equivalent conversions did not distort any trends in the historic series for Div. 2J3K redfish but suggest that the rate of decline from the late 1970's was even greater. This is a reflection of the increased catchability of the Campelen for all size groups, particularly for those less than 30 cm.

Adopting the Campelen has technically enabled a sampling tool that will detect recruitment to the stock at an earlier stage than before, not only for redfish but other species as well.

References

Bishop, C.A. MS 1994. Revisions and additions to stratification schemes used during research vessel surveys in NAFO areas 2 and 3NAFO SCR Doc. 94/43 Ser. No. N2413. 23p.

Stansbury, D.E. MS 1997. Conversion factors for cod from Comparative Fishing Trials for Engel 145 Otter Trawl and the Campelen 1800 Shrimp Trawl used on Research Vessels. NAFO SCR Doc. 97/73, Ser. No. N2907: 10p.

Warren, W. MS 1996. Report on the Comparative Fishing trial between the Gadus Atlantica and Teleost. NAFO SCR Doc. 96/28, Ser. No. N2701. 16p

Table 2. Mean number of redfish per standard tow in Division 2J from 1993-1994. Upper panel shows results of the Engels 145 otter trawl (MV Gadus Atlantica, 30 min tow @ 3.5 knots). Lower panel show Campelen trawl conversion based on comparative fishing trials (CCGS Teleost, 15 min tow @ 3.0 knots) Number of successful sets in brackets, 'NS' = unsampled strata.

| Original Survey Data (Engel 145) | | | | | |
|-----------------------------------|-----------------|----------------------|-------------------------|----------|----------|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) 1978-1992 | (sq.n.mi.) 1993-Onwards | | |
| 209 | 201-300 | 1608 | 680 | 0.0 (3) | 0.0 (2) |
| 210 | 201-300 | 774 | 1035 | 0.0 (4) | 0.0 (6) |
| 213 | 201-300 | 1725 | 1583 | 0.3 (6) | 0.3 (3) |
| 214 | 201-300 | 1171 | 1341 | 0.0 (5) | 0.2 (6) |
| 215 | 201-300 | 1270 | 1302 | 1.0 (5) | 0.2 (5) |
| 228 | 201-300 | 1428 | 2196 | 0.3 (9) | 0.7 (3) |
| 203 | 301-400 | 480 | 487 | 1.0 (2) | 0.0 (2) |
| 208 | 301-400 | 448 | 588 | 0.0 (2) | 0.0 (3) |
| 211 | 301-400 | 330 | 251 | 0.0 (2) | 0.0 (3) |
| 216 | 301-400 | 384 | 360 | 4.0 (2) | 1.5 (2) |
| 222 | 301-400 | 441 | 450 | 1.5 (2) | 3.3 (3) |
| 229 | 301-400 | 567 | 536 | 7.0 (2) | 0.3 (3) |
| 204 | 401-500 | 354 | 288 | 0.5 (2) | 4.3 (3) |
| 217 | 401-500 | 268 | 241 | 28.5 (2) | 29.7 (3) |
| 223 | 401-500 | 180 | 158 | 22.6 (2) | 3.0 (3) |
| 227 | 401-500 | 686 | 598 | 12.8 (3) | 3.8 (5) |
| 235 | 401-500 | 420 | 414 | 4.0 (3) | 10.7 (3) |
| 212 | 501-750 | 664 | 557 | 5.0 (2) | 2.0 (3) |
| 218 | 501-750 | 420 | 362 | 25.0 (2) | 34.0 (2) |
| 224 | 501-750 | 270 | 228 | 77.0 (2) | 49.3 (3) |
| 230 | 501-750 | 237 | 185 | 9.0 (2) | 74.0 (3) |
| 219 | 751-1000 | 213 | 283 | 10.5 (2) | 0.5 (2) |
| 231 | 751-1000 | 182 | 186 | 2.5 (2) | 2.7 (3) |
| 236 | 751-1000 | 122 | 193 | 5.0 (2) | 0.7 (3) |
| Stratified Analysis: | | | Upper | 18.6 | 11.7 |
| | | | Mean | 4.4 | 4.1 |
| | | | Lower | -9.7 | -3.4 |
| Total Survey Abundance (millions) | | | | 4.905 | 4.6 |

Note: Survey area was restratified based on revised hydrography charts and implemented on the 1993 survey For further information see Bishop (1994), Murphy (1996))

| Converted Survey Data (Campelen Equivalents) | | | | | |
|--|-----------------|------------|------------|-----------|-----------|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) | (sq.n.mi.) | | |
| 209 | 201-300 | 1608 | 680 | 0.0 (3) | 0.0 (2) |
| 210 | 201-300 | 774 | 1035 | 0.0 (4) | 0.0 (6) |
| 213 | 201-300 | 1725 | 1583 | 0.5 (6) | 0.3 (3) |
| 214 | 201-300 | 1171 | 1341 | 0.0 (5) | 0.3 (6) |
| 215 | 201-300 | 1270 | 1302 | 3.8 (5) | 1.2 (5) |
| 228 | 201-300 | 1428 | 2196 | 2.1 (9) | 4.3 (3) |
| 203 | 301-400 | 480 | 487 | 3.0 (2) | 0.0 (2) |
| 208 | 301-400 | 448 | 588 | 0.0 (2) | 0.0 (3) |
| 211 | 301-400 | 330 | 251 | 0.0 (2) | 0.0 (3) |
| 216 | 301-400 | 384 | 360 | 10.5 (2) | 6.0 (2) |
| 222 | 301-400 | 441 | 450 | 4.5 (2) | 8.0 (3) |
| 229 | 301-400 | 567 | 536 | 21.0 (2) | 3.7 (3) |
| 204 | 401-500 | 354 | 288 | 1.5 (2) | 14.3 (3) |
| 217 | 401-500 | 268 | 241 | 70.0 (2) | 67.7 (3) |
| 223 | 401-500 | 180 | 158 | 52.5 (2) | 5.7 (3) |
| 227 | 401-500 | 686 | 598 | 26.7 (3) | 8.4 (5) |
| 235 | 401-500 | 420 | 414 | 9.0 (3) | 26.3 (3) |
| 212 | 501-750 | 664 | 557 | 12.0 (2) | 5.0 (3) |
| 218 | 501-750 | 420 | 362 | 48.0 (2) | 65.0 (2) |
| 224 | 501-750 | 270 | 228 | 162.5 (2) | 100.3 (3) |
| 230 | 501-750 | 237 | 185 | 17.0 (2) | 140.3 (3) |
| 219 | 751-1000 | 213 | 283 | 17.0 (2) | 0.5 (2) |
| 231 | 751-1000 | 182 | 186 | 3.5 (2) | 3.7 (3) |
| 236 | 751-1000 | 122 | 193 | 8.0 (2) | 1.0 (3) |
| Stratified Analysis: | | | Upper | 40.3 | 14.6 |
| | | | Mean | 10.0 | 9.3 |
| | | | Lower | -20.2 | 3.9 |
| Converted Survey Abundance (millions) | | | | 20.4 | 18.8 |

2J Autumn 1993-1994 Mean Number per tow

Table 4. Mean number of redfish per standard tow in Division 2J from 1993-1994. Upper panel shows results of the Engels 145 otter trawl (MV Gadus Atlantica, 30 min tow @ 3.5 knots). Lower panel show Campelen trawl conversion based on comparative fishing trials (CCGS Teleost, 15 min tow @ 3.0 knots) Number of successful sets in brackets, 'NS' = unsampled strata.

| Original Survey Data (Engel 145) | | | | | |
|--|-----------------|----------------------|-------------------------|----------|----------|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) 1978-1992 | (sq.n.mi.) 1993-Onwards | | |
| 209 | 201-300 | 1608 | 680 | 0.0 (3) | 0.0 (2) |
| 210 | 201-300 | 774 | 1035 | 0.0 (4) | 0.0 (6) |
| 213 | 201-300 | 1725 | 1583 | 0.0 (6) | 0.4 (3) |
| 214 | 201-300 | 1171 | 1341 | 0.0 (5) | 0.0 (6) |
| 215 | 201-300 | 1270 | 1302 | 0.1 (5) | 0.0 (5) |
| 228 | 201-300 | 1428 | 2196 | 0.0 (9) | 0.1 (3) |
| 203 | 301-400 | 480 | 487 | 0.1 (2) | 0.0 (2) |
| 208 | 301-400 | 448 | 588 | 0.0 (2) | 0.0 (3) |
| 211 | 301-400 | 330 | 251 | 0.0 (2) | 0.0 (3) |
| 216 | 301-400 | 384 | 360 | 0.8 (2) | 0.1 (2) |
| 222 | 301-400 | 441 | 450 | 0.4 (2) | 1.2 (3) |
| 229 | 301-400 | 567 | 536 | 1.1 (2) | 0.0 (3) |
| 204 | 401-500 | 354 | 288 | 0.1 (2) | 0.4 (3) |
| 217 | 401-500 | 268 | 241 | 5.2 (2) | 6.5 (3) |
| 223 | 401-500 | 180 | 158 | 4.8 (2) | 1.1 (3) |
| 227 | 401-500 | 686 | 598 | 3.4 (3) | 1.2 (5) |
| 235 | 401-500 | 420 | 414 | 1.0 (3) | 2.6 (3) |
| 212 | 501-750 | 664 | 557 | 1.3 (2) | 0.4 (3) |
| 218 | 501-750 | 420 | 362 | 7.7 (2) | 9.4 (2) |
| 224 | 501-750 | 270 | 228 | 18.0 (2) | 12.4 (3) |
| 230 | 501-750 | 237 | 185 | 2.7 (2) | 20.8 (3) |
| 219 | 751-1000 | 213 | 283 | 4.3 (2) | 0.2 (2) |
| 231 | 751-1000 | 182 | 186 | 1.3 (2) | 1.2 (3) |
| 236 | 751-1000 | 122 | 193 | 2.1 (2) | 0.3 (3) |
| Stratified Analysis: | | | Upper | 4.6 | 1.9 |
| | | | Mean | 1.1 | 1.1 |
| | | | Lower | -2.5 | 0.3 |
| Total Survey Biomass ('000 tons) | | | | 1.2 | 1.2 |
| Converted Survey Data (Campelen Equivalents) | | | | | |
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) | (sq.n.mi.) | | |
| 209 | 201-300 | 1608 | 680 | 0.0 (3) | 0.0 (2) |
| 210 | 201-300 | 774 | 1035 | 0.0 (4) | 0.0 (6) |
| 213 | 201-300 | 1725 | 1583 | 0.3 (6) | 0.4 (3) |
| 214 | 201-300 | 1171 | 1341 | 0.0 (5) | 0.1 (6) |
| 215 | 201-300 | 1270 | 1302 | 0.3 (5) | 0.1 (5) |
| 228 | 201-300 | 1428 | 2196 | 0.1 (9) | 0.3 (3) |
| 203 | 301-400 | 480 | 487 | 0.4 (2) | 0.0 (2) |
| 208 | 301-400 | 448 | 588 | 0.0 (2) | 0.0 (3) |
| 211 | 301-400 | 330 | 251 | 0.0 (2) | 0.0 (3) |
| 216 | 301-400 | 384 | 360 | 1.7 (2) | 0.4 (2) |
| 222 | 301-400 | 441 | 450 | 0.9 (2) | 1.6 (3) |
| 229 | 301-400 | 567 | 536 | 2.5 (2) | 0.1 (3) |
| 204 | 401-500 | 354 | 288 | 0.2 (2) | 1.5 (3) |
| 217 | 401-500 | 268 | 241 | 12.3 (2) | 13.3 (3) |
| 223 | 401-500 | 180 | 158 | 10.5 (2) | 1.7 (3) |
| 227 | 401-500 | 686 | 598 | 6.1 (3) | 1.9 (5) |
| 235 | 401-500 | 420 | 414 | 1.9 (3) | 4.7 (3) |
| 212 | 501-750 | 664 | 557 | 2.0 (2) | 0.9 (3) |
| 218 | 501-750 | 420 | 362 | 13.2 (2) | 16.7 (2) |
| 224 | 501-750 | 270 | 228 | 36.3 (2) | 23.2 (3) |
| 230 | 501-750 | 237 | 185 | 4.5 (2) | 37.1 (3) |
| 219 | 751-1000 | 213 | 283 | 6.1 (2) | 0.2 (2) |
| 231 | 751-1000 | 182 | 186 | 1.5 (2) | 1.7 (3) |
| 236 | 751-1000 | 122 | 193 | 2.7 (2) | 0.4 (3) |
| Stratified Analysis: | | | Upper | 8.9 | 5.8 |
| | | | Mean | 2.1 | 2.0 |
| | | | Lower | -4.7 | -1.9 |
| Converted Survey Biomass ('000 tons) | | | | 4.2 | 4.0 |

Note: Survey area was restratified based on revised hydrography charts and implemented on the 1993 survey For further information see Bishop (1994), Murphy (1996))

2J Autumn 1993-1994 Mean Weight (kg) per tow

Table 6. Mean number of redfish per standard tow in Division 3K from 1993-1994. Upper panel shows results of the Engels 145 otter trawl (MV Gadus Atlantica, 30 min tow @ 3.5 knots). Lower panel show Campelen trawl conversion based on comparative fishing trials (CCGS Teleost, 15 min tow @ 3.0 knots) Number of successful sets in brackets, 'NS' = unsampled strata.

| Original Survey Data (Engel 145) | | | | | |
|--|-----------------|----------------------|-------------------------|-----------|-----------|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) 1978-1992 | (sq.n.mi.) 1993-Onwards | | |
| 620 | 201 - 300 | 2709 | 2545 | 0.0 (3) | 0.0 (5) |
| 621 | 201 - 300 | 2859 | 2537 | 0.0 (3) | 0.0 (3) |
| 624 | 201 - 300 | 668 | 1105 | 1.4 (7) | 0.0 (3) |
| 634 | 201 - 300 | 1618 | 1555 | 1.0 (16) | 0.8 (4) |
| 635 | 201 - 300 | 1274 | 1274 | 0.7 (3) | 0.0 (4) |
| 636 | 201 - 300 | 1455 | 1455 | 0.7 (3) | 0.0 (3) |
| 637 | 201 - 300 | 1132 | 1132 | 0.0 (3) | 0.1 (14) |
| 623 | 301 - 400 | 1027 | 494 | 0.5 (4) | 0.0 (3) |
| 625 | 301 - 400 | 850 | 888 | 2.3 (3) | 2.0 (3) |
| 626 | 301 - 400 | 919 | 1113 | 0.0 (3) | 0.0 (3) |
| 628 | 301 - 400 | 1085 | 1085 | 0.7 (3) | 0.0 (6) |
| 629 | 301 - 400 | 499 | 495 | 0.7 (3) | 1.3 (4) |
| 630 | 301 - 400 | 544 | 332 | 0.0 (3) | 0.3 (3) |
| 633 | 301 - 400 | 2179 | 2067 | 3.8 (18) | 1.6 (5) |
| 638 | 301 - 400 | 2059 | 2059 | 1.0 (20) | 0.8 (21) |
| 639 | 301 - 400 | 1463 | 1463 | 2.3 (15) | 3.5 (8) |
| 622 | 401 - 500 | 632 | 691 | 1.8 (4) | 1.2 (5) |
| 627 | 401 - 500 | 1184 | 1255 | 1.0 (3) | 0.9 (8) |
| 631 | 401 - 500 | 1202 | 1321 | 1.7 (3) | 2.5 (4) |
| 640 | 401 - 500 | 198 | 69 | 22.3 (3) | 29.0 (3) |
| 645 | 401 - 500 | 204 | 216 | 19.0 (3) | 16.7 (3) |
| 641 | 501 - 750 | 584 | 230 | 27.7 (3) | 15.7 (3) |
| 646 | 501 - 750 | 333 | 325 | 21.7 (3) | 42.3 (3) |
| 642 | 751 -1000 | 931 | 418 | 2.0 (3) | 0.7 (3) |
| 647 | 751 -1000 | 409 | 360 | 1.3 (3) | 10.7 (3) |
| Stratified Analysis: | | Upper | | 2.3 | 2.7 |
| | | Mean | | 1.9 | 1.9 |
| | | Lower | | 1.4 | 1.0 |
| Total Survey Abundance (millions) | | | | 4.0 | 3.9 |
| Converted Survey Data (Campelen Equivalents) | | | | | |
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 |
| | | (sq.n.mi.) | (sq.n.mi.) | | |
| 620 | 201 - 300 | 2709 | 2545 | 0.0 (3) | 0.0 (5) |
| 621 | 201 - 300 | 2859 | 2537 | 0.0 (3) | 0.0 (3) |
| 624 | 201 - 300 | 668 | 1105 | 9.9 (7) | 0.0 (3) |
| 634 | 201 - 300 | 1618 | 1555 | 3.1 (16) | 1.5 (4) |
| 635 | 201 - 300 | 1274 | 1274 | 1.3 (3) | 0.0 (4) |
| 636 | 201 - 300 | 1455 | 1455 | 2.7 (3) | 0.0 (3) |
| 637 | 201 - 300 | 1132 | 1132 | 0.0 (3) | 1.4 (14) |
| 623 | 301 - 400 | 1027 | 494 | 1.3 (4) | 0.0 (3) |
| 625 | 301 - 400 | 850 | 888 | 6.7 (3) | 8.7 (3) |
| 626 | 301 - 400 | 919 | 1113 | 0.0 (3) | 0.0 (3) |
| 628 | 301 - 400 | 1085 | 1085 | 2.0 (3) | 0.0 (6) |
| 629 | 301 - 400 | 499 | 495 | 4.0 (3) | 2.5 (4) |
| 630 | 301 - 400 | 544 | 332 | 0.0 (3) | 0.7 (3) |
| 633 | 301 - 400 | 2179 | 2067 | 14.8 (18) | 3.4 (5) |
| 638 | 301 - 400 | 2059 | 2059 | 2.5 (20) | 4.2 (21) |
| 639 | 301 - 400 | 1463 | 1463 | 8.0 (15) | 12.6 (8) |
| 622 | 401 - 500 | 632 | 691 | 4.3 (4) | 4.4 (5) |
| 627 | 401 - 500 | 1184 | 1255 | 5.3 (3) | 2.8 (8) |
| 631 | 401 - 500 | 1202 | 1321 | 5.7 (3) | 9.8 (4) |
| 640 | 401 - 500 | 198 | 69 | 74.0 (3) | 100.3 (3) |
| 645 | 401 - 500 | 204 | 216 | 48.3 (3) | 47.0 (3) |
| 641 | 501 - 750 | 584 | 230 | 63.7 (3) | 31.3 (3) |
| 646 | 501 - 750 | 333 | 325 | 46.0 (3) | 89.0 (3) |
| 642 | 751 -1000 | 931 | 418 | 3.3 (3) | 2.0 (3) |
| 647 | 751 -1000 | 409 | 360 | 3.0 (3) | 17.7 (3) |
| Stratified Analysis: | | Upper | | 6.8 | 6.6 |
| | | Mean | | 5.5 | 5.0 |
| | | Lower | | 4.2 | 3.5 |
| Converted Survey Abundance (millions) | | | | 21.8 | 19.6 |

Note: Survey area was restratified based on revised hydrography charts and implemented on the 1993 survey For further information see Bishop (1994), Murphy (1996))

3K Autumn 1993-1994 Mean Number per tow

Table 8. Mean weight (kg) of redfish per standard tow in Division 3K from 1993-1994. Upper panel shows results of the Engels 145 otter trawl (MV Gadus Atlantica, 30 min tow @ 3.5 knots). Lower panel show Campelen trawl conversion based on comparative fishing trials (CCGS Teleost, 15 min tow @ 3.0 knots) Number of successful sets in brackets, 'NS' = unsampled strata.

| Original Survey Data (Engel 145) | | | | | | |
|----------------------------------|-----------------|----------------------|-------------------------|----------|----------|-----|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 | |
| | | (sq.n.mi.) 1978-1992 | (sq.n.mi.) 1993-Onwards | | | |
| 620 | 201 - 300 | 2709 | 2545 | 0.0 (3) | 0.0 (5) | |
| 621 | 201 - 300 | 2859 | 2537 | 0.0 (3) | 0.0 (3) | |
| 624 | 201 - 300 | 668 | 1105 | 0.1 (7) | 0.0 (3) | |
| 634 | 201 - 300 | 1618 | 1555 | 0.2 (16) | 0.3 (4) | |
| 635 | 201 - 300 | 1274 | 1274 | 0.2 (3) | 0.0 (4) | |
| 636 | 201 - 300 | 1455 | 1455 | 0.1 (3) | 0.0 (3) | |
| 637 | 201 - 300 | 1132 | 1132 | 0.0 (3) | 0.0 (14) | |
| 623 | 301 - 400 | 1027 | 494 | 0.1 (4) | 0.0 (3) | |
| 625 | 301 - 400 | 850 | 888 | 0.4 (3) | 0.1 (3) | |
| 626 | 301 - 400 | 919 | 1113 | 0.0 (3) | 0.0 (3) | |
| 628 | 301 - 400 | 1085 | 1085 | 0.1 (3) | 0.0 (6) | |
| 629 | 301 - 400 | 499 | 495 | 0.0 (3) | 0.3 (4) | |
| 630 | 301 - 400 | 544 | 332 | 0.0 (3) | 0.1 (3) | |
| 633 | 301 - 400 | 2179 | 2067 | 0.6 (18) | 0.4 (5) | |
| 638 | 301 - 400 | 2059 | 2059 | 0.3 (20) | 0.1 (21) | |
| 639 | 301 - 400 | 1463 | 1463 | 0.4 (15) | 0.6 (8) | |
| 622 | 401 - 500 | 632 | 691 | 0.3 (4) | 0.2 (5) | |
| 627 | 401 - 500 | 1184 | 1255 | 0.1 (3) | 0.2 (8) | |
| 631 | 401 - 500 | 1202 | 1321 | 0.1 (3) | 0.3 (4) | |
| 640 | 401 - 500 | 198 | 69 | 4.1 (3) | 3.7 (3) | |
| 645 | 401 - 500 | 204 | 216 | 4.1 (3) | 4.3 (3) | |
| 641 | 501 - 750 | 584 | 230 | 6.5 (3) | 4.9 (3) | |
| 646 | 501 - 750 | 333 | 325 | 5.8 (3) | 10.2 (3) | |
| 642 | 751 -1000 | 931 | 418 | 0.8 (3) | 0.1 (3) | |
| 647 | 751 -1000 | 409 | 360 | 0.5 (3) | 4.9 (3) | |
| Stratified Analysis: | | | | Upper | 0.5 | 0.7 |
| | | | | Mean | 0.4 | 0.4 |
| | | | | Lower | 0.3 | 0.2 |
| Total Survey Biomass ('000 tons) | | | | 0.9 | 0.9 | |

Note: Survey area was restratified based on revised hydrography charts and implemented on the 1993 survey For further information see Bishop (1994), Murphy (1996))

| Converted Survey Data (Campelen Equivalents) | | | | | | |
|--|-----------------|------------|------------|----------|----------|-----|
| Stratum | Depth range (m) | Area | Area | 1993 | 1994 | |
| | | (sq.n.mi.) | (sq.n.mi.) | | | |
| 620 | 201 - 300 | 2709 | 2545 | 0.0 (3) | 0.0 (5) | |
| 621 | 201 - 300 | 2859 | 2537 | 0.0 (3) | 0.0 (3) | |
| 624 | 201 - 300 | 668 | 1105 | 0.3 (7) | 0.0 (3) | |
| 634 | 201 - 300 | 1618 | 1555 | 0.5 (16) | 0.3 (4) | |
| 635 | 201 - 300 | 1274 | 1274 | 0.3 (3) | 0.0 (4) | |
| 636 | 201 - 300 | 1455 | 1455 | 0.2 (3) | 0.0 (3) | |
| 637 | 201 - 300 | 1132 | 1132 | 0.0 (3) | 0.0 (14) | |
| 623 | 301 - 400 | 1027 | 494 | 0.3 (4) | 0.0 (3) | |
| 625 | 301 - 400 | 850 | 888 | 1.0 (3) | 0.6 (3) | |
| 626 | 301 - 400 | 919 | 1113 | 0.0 (3) | 0.0 (3) | |
| 628 | 301 - 400 | 1085 | 1085 | 0.2 (3) | 0.0 (6) | |
| 629 | 301 - 400 | 499 | 495 | 0.2 (3) | 0.6 (4) | |
| 630 | 301 - 400 | 544 | 332 | 0.0 (3) | 0.1 (3) | |
| 633 | 301 - 400 | 2179 | 2067 | 1.4 (18) | 0.8 (5) | |
| 638 | 301 - 400 | 2059 | 2059 | 0.4 (20) | 0.2 (21) | |
| 639 | 301 - 400 | 1463 | 1463 | 0.9 (15) | 1.3 (8) | |
| 622 | 401 - 500 | 632 | 691 | 0.7 (4) | 0.5 (5) | |
| 627 | 401 - 500 | 1184 | 1255 | 0.4 (3) | 0.4 (8) | |
| 631 | 401 - 500 | 1202 | 1321 | 0.5 (3) | 0.9 (4) | |
| 640 | 401 - 500 | 198 | 69 | 8.7 (3) | 10.1 (3) | |
| 645 | 401 - 500 | 204 | 216 | 8.2 (3) | 7.0 (3) | |
| 641 | 501 - 750 | 584 | 230 | 12.6 (3) | 7.9 (3) | |
| 646 | 501 - 750 | 333 | 325 | 11.2 (3) | 20.1 (3) | |
| 642 | 751 -1000 | 931 | 418 | 1.3 (3) | 0.3 (3) | |
| 647 | 751 -1000 | 409 | 360 | 1.0 (3) | 6.7 (3) | |
| Stratified Analysis: | | | | Upper | 1.0 | 1.2 |
| | | | | Mean | 0.8 | 0.8 |
| | | | | Lower | 0.6 | 0.4 |
| Converted Survey Biomass ('000 tons) | | | | 3.2 | 3.2 | |

3K Autumn 1993-1994 Mean Weight per tow

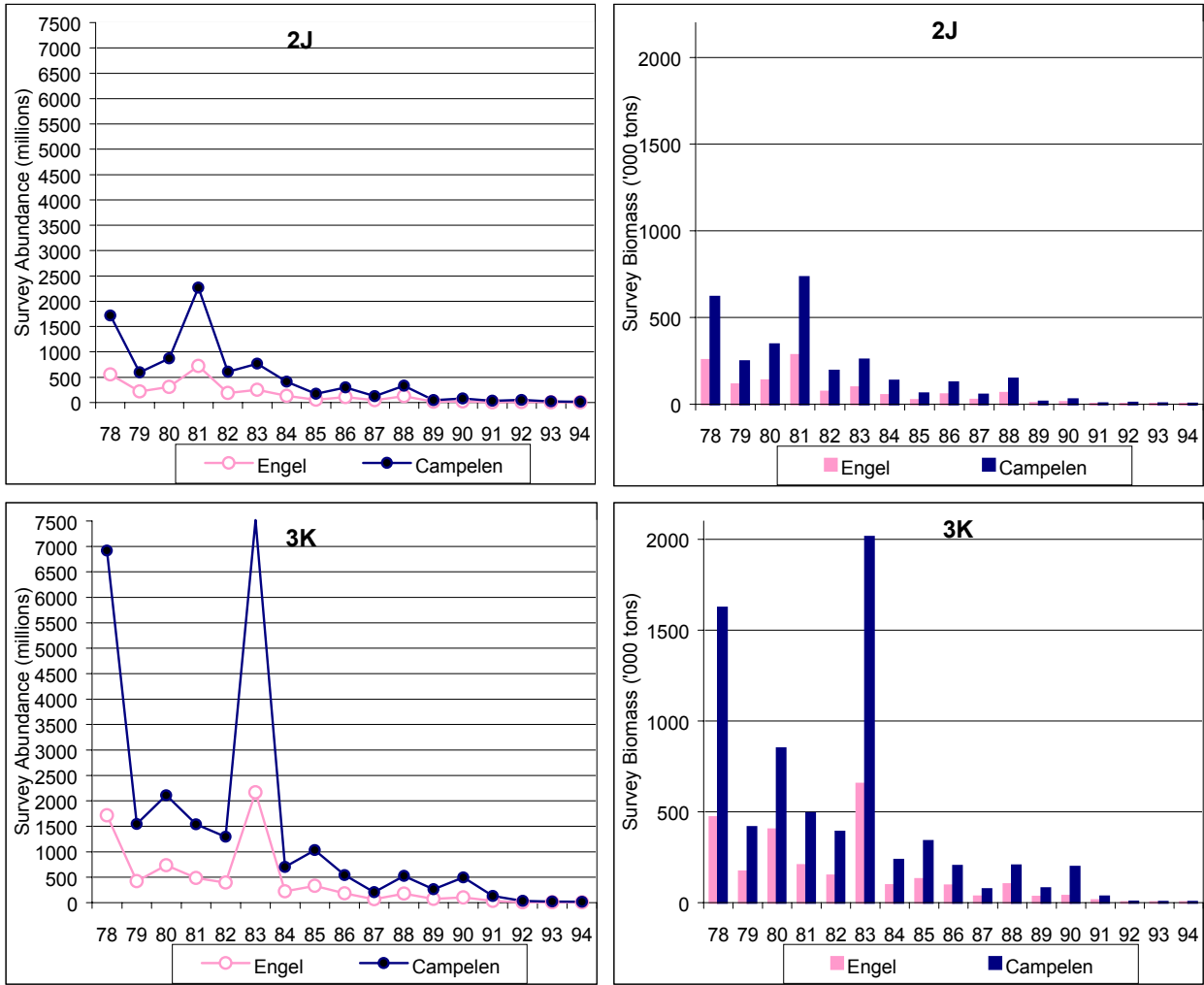


Fig 1. Comparison of survey indices of relative abundance for redfish between the Engels trawl data and values derived as Campelen equivalents based on comparative fishing trials between the MV Gadus Atlantica (Engel trawl, 30 min tows @3.5 knots) and CCGS Teleost (Campelen trawl, 15 min tows @3.0 knots)

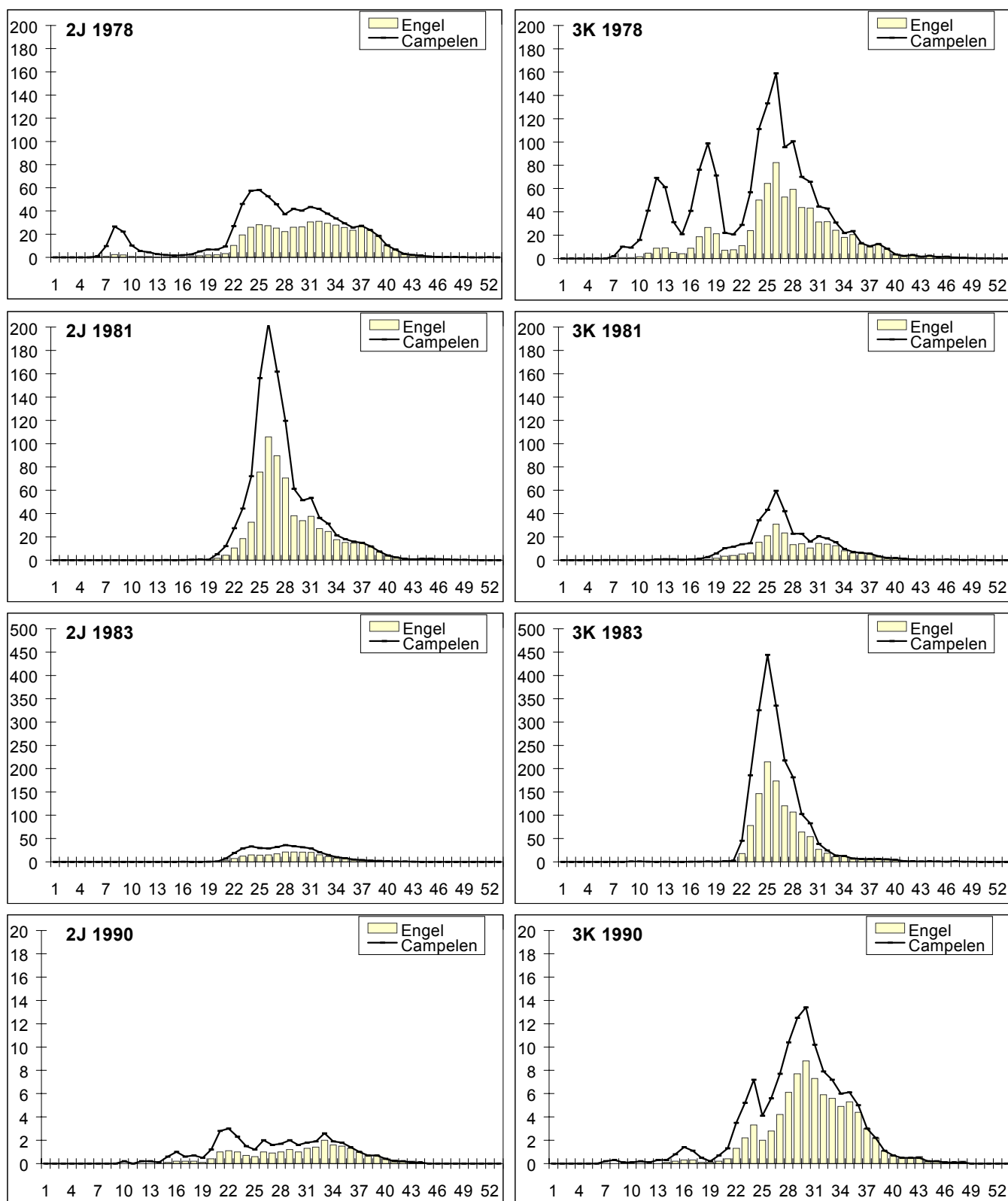


Fig. 2. Length distributions from stratified-random research surveys to Div. 2J (left panels) and Div. 3K (right panels) during various years. Plotted are mean number per standard tow. The bar frequency represents the Engels data and the line represents a conversion into Campelen equivalent units based on a comparative fishing trial (see text)