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Updated estimates of exploitation rates and biomass for cod *(Gadus morhua)* in NAFO Divisions 3KL and Subdivision 3Ps during 1997-2000 from tagging experiments in these years

Mise à jour des estimations des taux d'exploitation et de la biomasse de morue *(Gadus morhua)* dans les divisions 3KL et la sous-division 3Ps de l'OPANO pour 1997-2000 d'après les résultats d'expériences d'étiquetage

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Abstract

We update the analyses in Cadigan and Brattey (2001a) using additional recaptures from tagging experiments conducted in NAFO Divisions 3K and 3L (3KL) and Subdivision 3Ps during 1997-2001. The additional recaptures we consider occurred up to April 1, 2001. The methods of analysis we use are identical to those in Cadigan and Brattey (2001a), with a few exceptions.

We estimate exploitable biomass for three regions in 3KL and 3Ps for weeks in which sufficient landings (>100 tonnes) were reported to get reasonable estimates. The average (over weeks) biomass estimated in the inshore of 3K was 8 500 tonnes in 1999, and 12 000 tonnes in 2000. The exploitation rates (landings divided by average biomass) in this region for 1999 and 2000 were 43% and 12%, respectively. In the northern part of 3L the average biomass and exploitation rates (in parentheses) were estimated to be 33 000 tonnes (10%) in 1999 and 39 000 tonnes (7%) in 2000, while in the southern part of 3L the estimates were 11 000 tonnes (16%) in 1999 and 9 000 tonnes (11%) in 2000. In 3Ps, the estimates for Placentia Bay were 36 000 tonnes (32%) in 1999 and 40 000 tonnes (24%) in 2000. For the area west of the Burin Peninsula and including Burgeo Bank, Hermitage Channel, and Northwestern St. Pierre Bank, the estimates were 67 000 tonnes (10%) in 1999 and 30 000 tonnes (19%) in 2000. In the remaining offshore areas of 3Ps, including the southern portion of St. Pierre Bank and the Halibut Channel, the estimates were 331 000 tonnes (1%) in 1999 and 464 000 tonnes (2%) in 2000. However, the high estimates are based on small numbers of tag-returns and a spatially restricted offshore fishery, and the estimates are not substantiated by other information.

Résumé

Nous avons fait une mise à jour des analyses de Cadigan et Brattey (2001a) en utilisant des données additionnelles sur les morues recapturées issues d'expériences d'étiquetage menées dans les divisions 3K et 3L (3KL) et la sous-division 3Ps de l'OPANO de 1997 à 2001. Ces données additionnelles couvrent la période allant jusqu'au 1er avril 2001. Les méthodes d'analyse que nous avons utilisées sont les mêmes que celles présentées dans Cadigan et Brattey (2001a), à quelques exceptions près.

Nous avons estimé la biomasse exploitable dans trois secteurs de 3KL et 3Ps pendant les semaines où des débarquements suffisants (>100 t) ont été déclarés afin d'obtenir des estimations raisonnables. D'après nos estimations, la biomasse moyenne (pendant ces semaines) dans les eaux côtières de 3K se chiffrait à 8 500 t en 1999 et 12 000 t en 2000 et les taux d'exploitation (les débarquements divisés par la biomasse moyenne), à 43 % et 12 %, respectivement. Pour ce qui est des estimations de la biomasse moyenne et des taux d'exploitation (entre parenthèses) pour 1999 et 2000, respectivement, nous avons obtenu les résultats suivants : dans la partie nord de 3L, 33 000 t (10 %) et 39 000 t (7 %); dans la partie sud de cette division, 11 000 t (16 %) et 9 000 t (11 %); dans 3Ps, soit la baie de Plaisance, 36 000 t (32 %) et 40 000 t (24 %); pour le secteur à l'ouest de la péninsule Burin, y compris le banc Burgeo, le chenal Hermitage et la partie nord-ouest du banc de Saint-Pierre, 67 000 t (10 %) et 30 000 t (19 %); et dans les secteurs hauturiers restants de 3Ps, y compris la partie sud du banc de Saint-Pierre et le chenal du Flétan, 331 000 t (1 %) et 464 000 t (2 %). Par contre, les estimations élevées reposent sur un petit nombre d'étiquettes retournées et une pêche hauturière limitée au plan spatial. D'autres renseignements ne sont pas disponibles pour les corroborer.

1 Introduction

Cadigan and Brattey (2001a), which we refer to as CBa, presented estimates of exploitation rates and migrations rates for cod in NAFO Divisions 3KL and Subdivision 3Ps during 1997-2000. The migrations were modelled for eight geographic regions around the coast of Newfoundland and the offshore part of 3Ps. The exploitation rates were length and week specific, but were combined using estimates of the length frequencies of the commercial landings to produce weekly estimates of the total exploitation rates by the fishery for these geographic regions.

In this paper we present an update of the analyses in CBa. Our update is based on additional recaptures of cod from tagging experiments conducted in 1997-2001. We only use recaptures whose reported capture date was before April 1, 2001, which corresponds to the end of the management year for 3Ps cod. We do not repeat the description of the model and estimation methods that was presented in CBa; however, we describe a small number of changes in the model that we use for this paper. These minor changes involved the growth model and the migration model. We also provide an updated description of the data we used for estimation.

2 The data

We analyze the tag-returns from 125 tagging experiments conducted in 3Ps and 3KL during 1997-2001. The number of fish released in each experiment ranged from 3 to 2 494, with an average of approximately 500. Over 49 000 fish in total have been tagged and released in 3KL and 3Ps during 1997-2001. From these releases, 7 915 tags have been returned from fisheries in these regions, and also from fisheries in NAFO Divisions 3N and 3O (3NO), 4R-4S and Subdivision 3Pn (3Pn-4RS).

We grouped the locations of recaptures into the same geographic regions used in CBa. The numbers of fish released and returned in each region are shown in Tables 1 and 2, respectively. The only difference in Table 1 and Cba (Table 1) is the 588 fish tagged in

Table 1: Number of fish tagged and released in each region and year

	Year					
Region	1997	1998	1999	2000	2001	total
3K_IN	259	118	1705	397	0	2479
3L_INN	1565	0	4848	2389	0	8802
3L_INS	1529	0	1229	724	0	3482
3Ps_OF	0	1840	1807	1044	0	4691
3Ps_PB	5969	5805	4828	6337	0	22939
3Ps_WB	0	2285	1814	2422	588	6521
total	9322	10048	16231	13313	588	49502

Table 2: Number of tagged fish recaptured in each region and year

	Year					
Region	1997	1998	1999	2000	2001	total
3K_IN	1	30	478	122	0	631
3L_INN	6	56	321	339	2	724
3L_INS	11	87	143	87	0	328
3Ps_OF	1	23	41	56	29	150
3Ps_PB	341	721	1960	2056	303	5381
3Ps_WB	11	130	218	255	2	616
3NO	0	3	2	1	0	6
3Pn_4RS	0	22	35	22	0	79
total	371	1072	3198	2938	336	7915

3Ps_WB. Table 2 and Cba (Table 2) differ more, because of a small number of additional recaptures reported for 1997-2000.

3 Model

Two minor adjustments and one correction were made to the model used by CBa. In CBa, gear selectivity was assumed to be the same between years (i.e. constant throughout 1997-2000), and we extend this assumption to 1997-2001. This was the first adjustment. The second was that the lower bound on L_∞ in the nonparametric Von Bertalanffy growth model (see Cadigan and Brattey, 2001b) was increased from 112 cm to 140 cm. The estimated L_∞ is constrained by this bound.

A correction was also applied to the migration transition matrix. In CBa, between-week movements from

$$\begin{aligned} \text{3Ps\_PB} &\rightarrow \text{3NO} \\ \text{3NO} &\rightarrow \text{3Ps\_PB} \\ \text{3Ps\_OF} &\rightarrow \text{3Pn\_4RS} \end{aligned}$$

were estimated. This was a mistake because these regions are not adjacent, and between-week movements of cod are only allowed to adjacent regions in the migration model. We correct this in the present application. This reduces the number of migration transition parameters to estimate for each experiment from 21 in CBa to 18 here.

4 Results

We show results that differ significantly from those in CBa, as well as some additional results for illustration purposes.

The updated growth model estimates are presented in Figure 1. Increasing the bound on the estimated L_∞ has lead to a decrease in the estimated growth increments for small cod, but an increase in the estimated growth increments for large cod. For example, in Cadigan and Brattey (2001b), the estimated three-year growth increment for a 40 cm fish released at the beginning of 1998 was about 23 cm, while the three-year growth increment for an 80 cm fish released at the same time was 10 cm. In Figure 1 the estimate for a 40 cm fish is slightly less than 20 cm, while the estimate for an 80 cm fish is almost 12 cm.

We used Kirkwood's tag loss model to estimate the tag shedding rate, similar to Cadigan and Brattey (2001c) which we refer to as Cbc. The updated estimates are very similar to those in CBc, and are not shown.

Some of the updated reporting rates (see Table 3) differ somewhat from those in CBc. The reporting rate that differs the most with CBc is for single tags from OFF_SH. The

Table 3: Reporting rate estimates for each region. Combined reporting rates are estimated for 3Ps_OF and 3NO (denoted as OFF_SH). Lower and upper profile likelihood confidence intervals are denoted with an L and U.

	Single Tags				Double Tags			
Region	Est.	st.err.	L	U	Est.	st.err.	L	U
3K_IN	0.79	0.11	0.61	1.00	0.88	0.14	0.65	1.00
3L_INN	0.71	0.10	0.55	0.92	0.84	0.14	0.61	1.00
3L_INS	0.69	0.09	0.52	0.89	1.00	-	0.75	1.00
3Pn_4RS	0.42	0.13	0.23	0.76	0.72	0.22	0.40	1.00
3Ps_PB	0.77	0.04	0.70	0.84	0.90	0.05	0.81	1.00
3Ps_WB	0.63	0.08	0.50	0.79	0.84	0.11	0.64	1.00
OFF_SH	0.66	0.15	0.43	1.00	0.75	0.21	0.46	1.00

updated estimate decreased from 0.74 to 0.66. The next largest difference is for 3L_INN, where the updated double tag reporting increased from 0.79 to 0.84. The reporting rates directly influence the values of the exploitation rates we estimate.

The updated selectivity estimates for some of the less commonly used gear types (i.e. handlines, linetrawls) changed somewhat from the estimates presented in CBa. This may be due to the additional information available; however, we feel that it is more likely due to changes in the updated growth increment estimates that we referred to above. We do not feel these differences have much consequence on our exploitation rate estimates because these gear types account for only a small part of the exploitation rates; therefore, we do not show these results.

The selectivity of gillnets is important to estimate accurately to get reliable estimates of total exploitation rates, because this is the dominant gear type used in the fisheries in 3KL and 3Ps during 1997-2001. We show the updated gillnet selectivity estimates in Figure 2. The estimates in this figure are very similar to those in Figure 2 in CBa, although the number of tag-returns in each length class (shown at the top of each panel) are considerably different. These numbers are different because of the changes in the updated growth increment estimates. Similar to CBa, we conclude that the parametric selectivity estimates (solid lines) in Figure 2 are more reliable than the nonparametric estimates (dashed lines). This is also true for the other gear types. We use the parametric selectivity estimates when computing total exploitation rates.

We present the updated estimates of fully-selected exploitation rates for 2000 in Figures 3 and 4. We also present the new estimates for the first three months of 2001 in the 3Ps regions (see Figure 5). Almost no fishing occurred in 3KL during the first three months of 2001, so we do not present estimates for these regions. The updated estimates of fully selected exploitation rates for 1997-1999 are very similar to CBa, and are not presented. The similarity is expected because the number of tag-returns for 1997-1999 in the updated data are very similar to the numbers used in CBa. The estimates in Figure 3-4 are also very similar to the corresponding estimates in Figures 8-13 in Cba.

The 2001 estimates of fully-selected exploitation rates (see Figure 5) are new; that is, CBa did not have data to estimate exploitation rates for 2001. The estimates may only be partial because we expect more tags from fish caught during this period to be reported. Nonetheless, the weekly exploitation rates estimated for January of 2001 are similar to those for 2000, but the February estimates for 2001 in 3Ps_PB are much lower than for 2000 (compare Figures 5 and 4). The pulse of fishing that occurred in 3Ps_WB during March of 2000 did not occur in 2001 (see Brattey et al., 2001). The January-March exploitation rate estimates in 3Ps_OF are similar for 2000 and 2001.

A migration model is used to estimate the fraction of survivors from each experiment that are present in each of the eight regions. This information is required to estimate exploitation rates. The updated estimates of the transition parameters in the migration model are very similar to those in CBa, and are not presented in this paper.

Estimates of total exploitation rates and exploited biomass for 1999-2000 are presented in Figures 6-9. Estimates of catch-at-length were not available for the first part of 2001, so we could not produce estimates for this period. Methods are outlined in CBa to produce estimates of total exploitation rates and exploited biomass from estimates of fully selected exploitation rates and relative gear selectivity. There are some differences between the results in Figures 6-9 and the corresponding figures in CBa (see Figures 40, 41, 43, and 44), which we summarize in the next two paragraphs.

The estimates in Figures 6-9 are further combined to produce estimates of average stock size in each region, and average exploitation rates based on this stock size. This is described more fully on pg. 17 in CBa. The estimates are presented in Table 4. They are comparable to Table 4 in CBa. A difference in the estimates in Table 4 compared to CBa is the way the total estimates are derived. In Table 4, the biomass totals for 3KL and 3Ps are just the sum of the regional biomass estimates. The total exploitation rate in 3KL and 3Ps is then estimated as the total catch divided by the total biomass estimate. A different procedure was used in CBa to estimate total biomass in 3KL and 3Ps (see **Discussion**); nonetheless, the regional estimates are directly comparable.

The 3KL regional estimates of biomass and exploitation rates in Table 4 are similar to those in CBa. The regional estimates in 3Ps are more different; for example, the estimate

Table 4: Summary estimates of annual landings (C, Kt), average exploitable biomass (B, Kt), and total exploitation rates (μ, %) in each region and year.

	1999			2000		
Region	C	μ	B	C	μ	B
3K_IN	3.7	43.0	8.5	1.4	12.0	12.1
3L_INN	3.2	9.8	32.9	2.8	7.2	38.8
3L_INS	1.7	16.0	11.0	1.0	11.0	9.2
total	8.6	16.5	52.4*	5.2	8.7	60.0*
3Ps_OF	3.6	1.1	331.2	8.2	1.8	463.8
3Ps_PB	11.3	32.0	35.5	9.5	24.0	40.0
3Ps_WB	7.0	10.0	67.1	5.8	19.0	29.9
total	22.0	5.1	433.8*	23.5	4.4	533.7*

*Note: Sum for each region.

of exploited biomass in 3Ps_PB decreased from 53 000 tonnes in CBa to 40 000 tonnes in Table 4. This difference appears to be related to a single large biomass estimate in Cba (275 000 tonnes in week 37) that in the present analyses is reduced to 150 000 tonnes (see Figure 9). Ignoring the week 37 estimate, the annual-average biomass estimate from CBa is 35 000 tonnes, and in the present analysis the estimate is 31 000 tonnes. The problem is that the landings in week 37 in 3Ps_PB were reported as slightly above the annual weekly average, but the total exploitation rate estimate for that week was very low; hence, small additive changes in the exploitation rate estimate produces large changes in the biomass estimate. Similar reasons seem to account for the other differences in the results in Table 4 and the corresponding results in CBa.

The weekly biomass estimates in Figures 6-9 are the sums of estimates of weekly biomass-at-lengths. The length composition of the population is also interesting to examine to assess the validity of the weekly totals. The results corresponding to Figures 6-9 are presented in Figures 10-21. Note that these results were not presented in CBa. Figures 10-12 suggest that most of the biomass in 3KL during 1999 was close to 70 cm in length. In 3Ps_PB (see Figure 13) a substantial fraction of the biomass in 1999 was also close to 70 cm in length, but a much larger fraction of the biomass was greater than 90 cm. This was even more pronounced in 3Ps_WB and 3Ps_OF (see Figures 14 and 15). In 2000 a smaller fraction of the biomass in 3K_IN was in the plus group (see Figure 16), but a larger fraction was in the plus group in 3L_INN (see Figure 17). The biomass length compositions in 2000 for 3L_INS and the three regions in 3Ps (see Figures 18-21) were fairly similar to the respective length compositions in 1999.

5 Discussion and Conclusions

Our results suggest that exploitation rates have decreased between 1999 and 2000 for the three regions in 3KL. This appears to be related to both a reduction in landings and a small increase in exploited stock size. Our combined estimate of the exploitation rate for 2000 in 3KL based on 5 200 tonnes of landings is 8.7%. The trends in exploitation rates in 3Ps are more variable. We estimate that the exploitation rate in Placentia Bay decreased from 32% in 1999 to 24% in 2000, while west of the Burin Peninsula and including St. Pierre Bank (3Ps_WB) the exploitation rate is estimated to have increased from 10% in 1999 to 19% in 2000. In the remaining offshore areas of 3Ps the exploitation rates have not changed much and appear to be low; i.e. in the range of 1-2%.

The 3Ps estimates of exploitation rates in the offshore and, to a lesser extent, in 3Ps_WB may be inaccurate because of the limited spatial extent of tagging experiments and the spatially concentrated distribution of fishing. In addition, the estimates for 3Ps_OF are based on substantially fewer returns than inshore regions (see Table 2). It seems possible that the offshore fishery in 3Ps is simply missing the populations of tagged cod. This could be caused by seasonal movements of tagged cod into 3NO or other areas that are not exploited by the fishery. This could also be the result of local exploitation in the offshore whereby the fishery has simply missed tagged cod in the past several years. Other explanations for the low exploitation rates estimated for the offshore include very high tagging mortality rates or very low tag reporting rates. Note that we do not have evidence to support either of these two scenarios, nor do we have strong evidence to reject them. Nonetheless, it is difficult to conclude from the tagging information that exploitation rates in the offshore are high (i.e. $> 20\%$).

Our estimates of total biomass for 3KL and 3Ps could suffer from under- or over-counting. For example, the 3Ps estimate is the sum of biomass estimates for three regions, and each regional estimate is the average of a number of weekly biomass estimates. If the weeks used for averaging are different for each region than seasonal movements of fish between regions could result in under- or over-counting.

The weekly estimates of exploitation rates and biomass can be highly variable, partly because of errors in tag capture dates and errors in fishing dates. The variability is well beyond realistic fluctuations in population size. Utilizing methods that accommodate errors in capture dates should improve our results.

In CBa the total biomass estimates for 3KL and 3Ps were based on a small number of overlapping weeks in which at least 100 tonnes of cod were landed in each of the three regions in 3Ps and 3KL. The method we used here was presented as an alternative in CBa. Weekly biomass estimates are additive across regions, and the potential for under- or over-counting should be eliminated by restricting the estimates of 3Ps and 3KL total biomass to an average of total biomass in synoptic weeks where substantial fishing occurred in all regions. However, this approach was problematic because there were only a small number of weeks in which at least 100 tonnes of cod were landed in each of the three regions, and the average estimate had very poor precision because it was based on a small number of highly variable weekly estimates. This is the main reason why the 3Ps biomass estimates in CBa (see Table 4) differ substantially from those in Table 4, although the lower reporting rate we estimate for 3Ps_OFF also contributes to some of the differences in the biomass estimates.

Another problem with our biomass estimates is that landings in either 3KL or 3Ps that could not be assigned to one of the three geographic regions we use were not taken into account. Unaccounted landings will mean that our regional estimates of biomass are too low. If the fraction of landings not accounted for is approximately x%, then this means that our biomass estimates are too low by the same percentage. Unaccounted landings do not affect our estimates of fully selected exploitation rates, but could have a small affect on our estimates of total exploitation rates. This might occur if the length composition of the unaccounted landings were substantially different from the length compositions we have used in our analyses. We do not expect that this is the case, which is why we focus on the exploitation rate estimates in this discussion and not the biomass estimates.

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6 Appendix: Figures

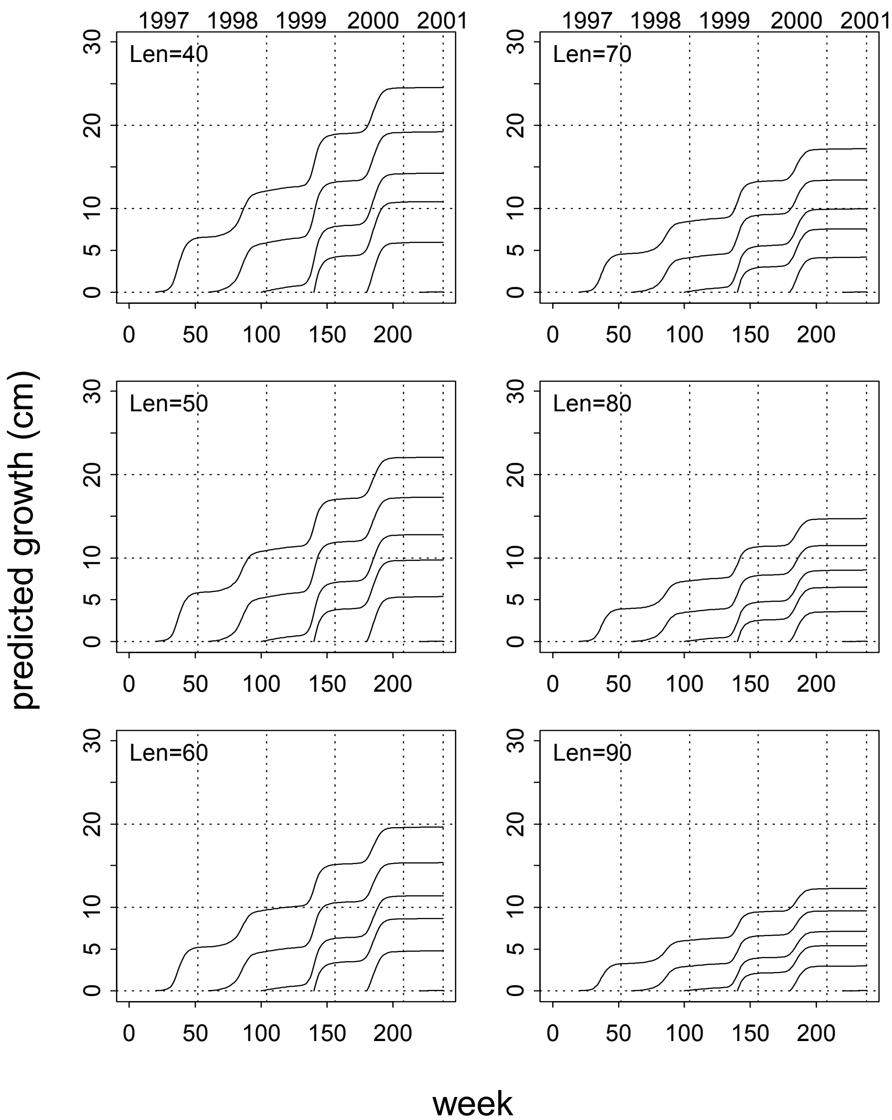

Figure 1: Some estimated growth curves for cod in 3PS and 3KL during 1997-2001, based on the semi-parametric Von Bertalanffy growth model. The time scale is weeks since the beginning of 1997. Each curve represents the growth of a fish. Each panel represents a different size of fish at release, and the intersection of a curve with the zero growth line (dotted) is the release week. Growth is estimated up to week 238 (July, 2001). Dotted lines mark 10 and 20 cm growth increments. The vertical dotted lines mark the year boundaries.

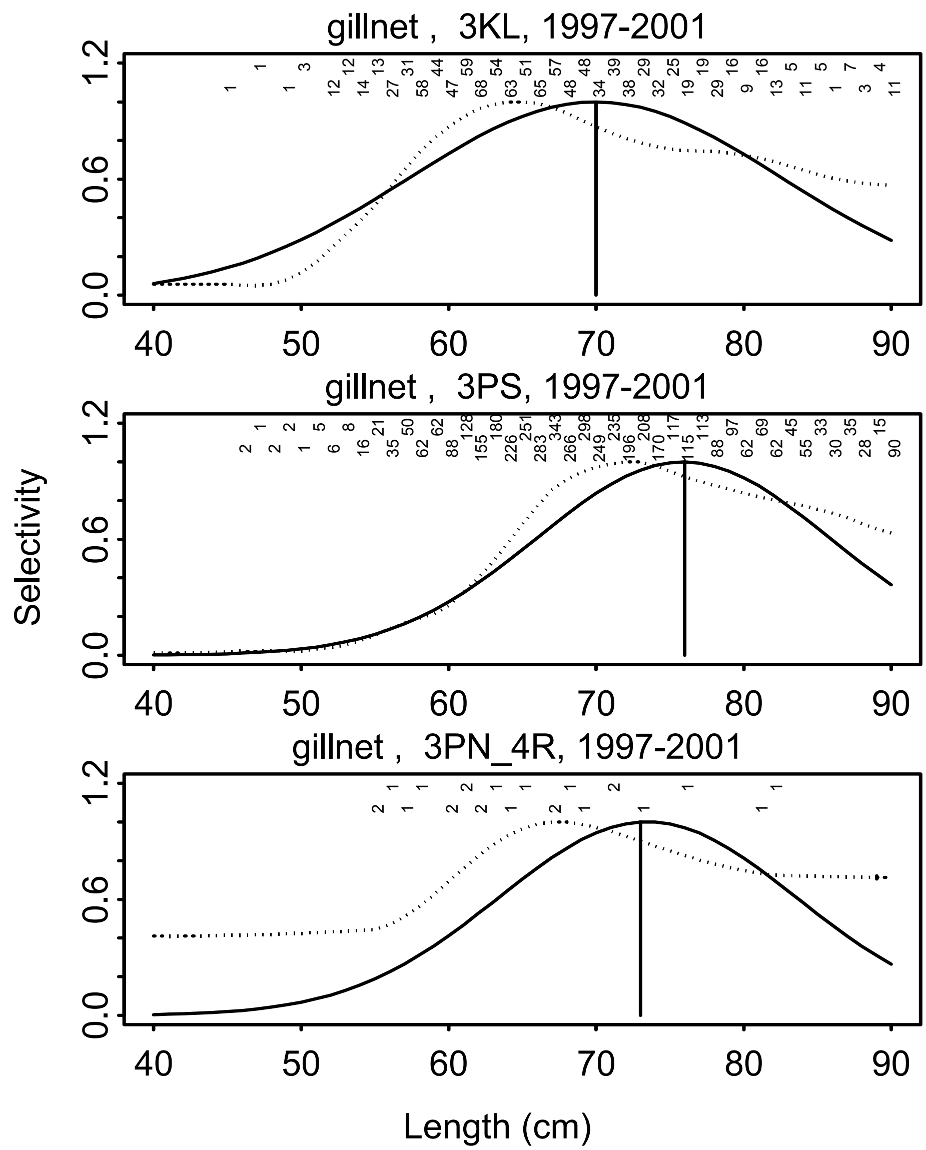

Figure 2: Estimated relative selectivity of gill-nets as a function of length. The solid line is the parametric estimate and the dotted line is the nonparametric estimate. The number of tag-returns for each 1 cm length class are shown at the top of each panel. The vertical line marks the fully selected length.

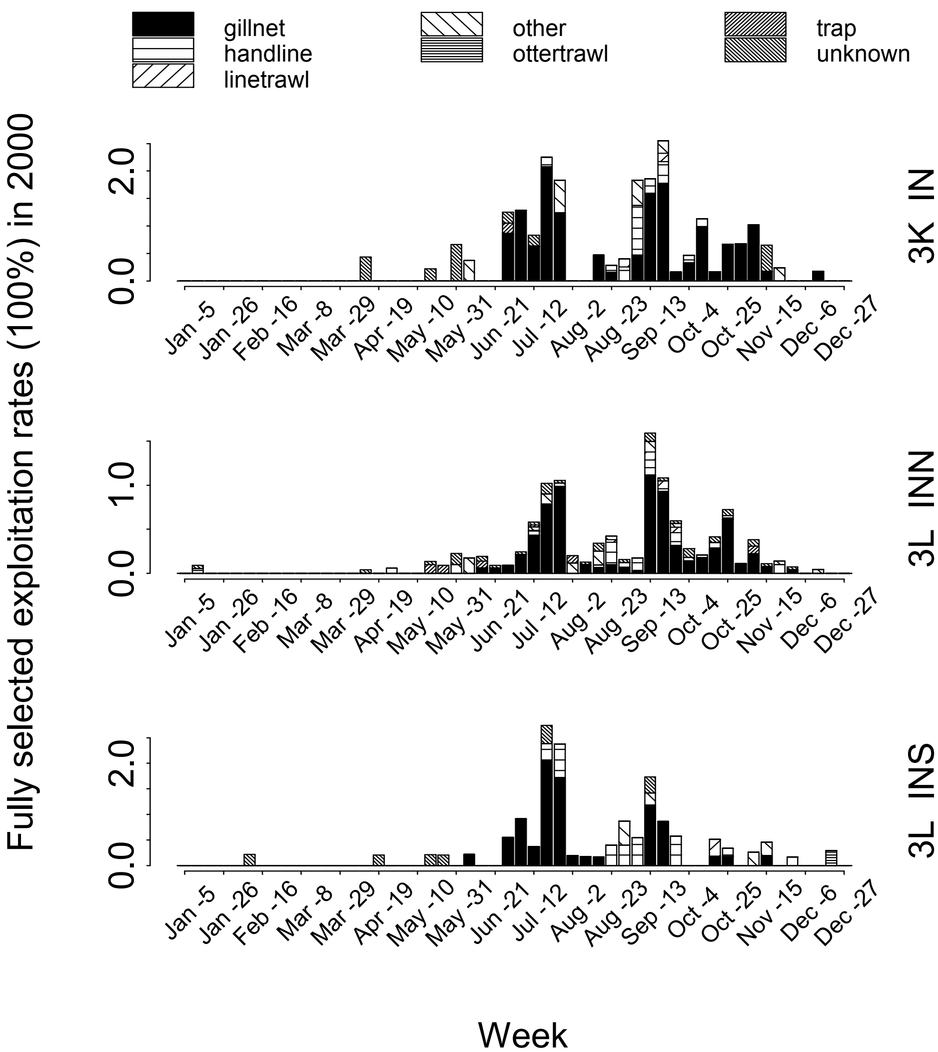

Figure 3: Weekly estimates of the fully selected exploitation rates for each gear type used in the **3KL** regions in 2000. Each panel represents a region, which is labelled on the right-hand side. The bar-blocking shows the weekly estimates for each gear type (legend at top). The calender dates of the week mid-points are shown along the x-axis in each panel. **Note:** the height of the y-axis is different in each panel.

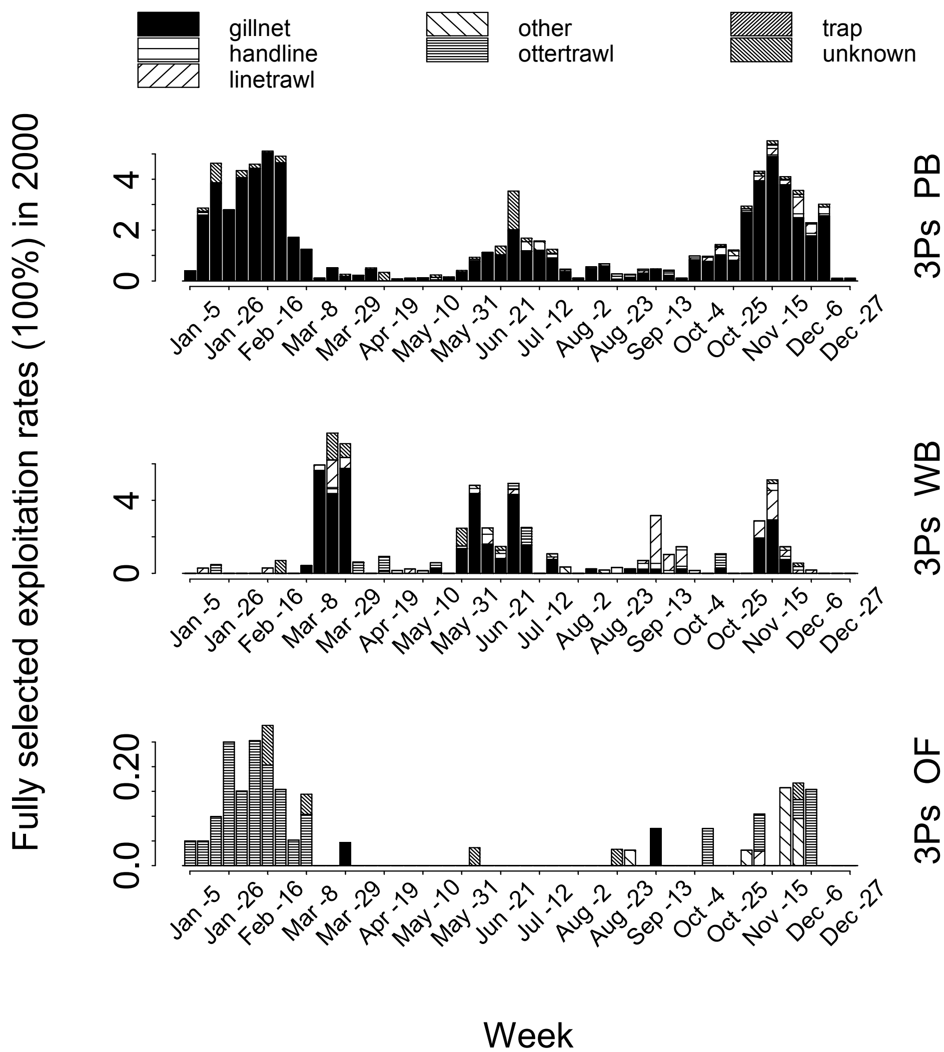

Figure 4: Weekly estimates of the fully selected exploitation rates for each gear type used in the **3Ps** regions in 2000. Each panel represents a region, which is labelled on the right-hand side. The bar-blocking shows the weekly estimates for each gear type (legend at top). The calender dates of the week mid-points are shown along the x-axis in each panel. **Note:** the height of the y-axis is different in each panel.

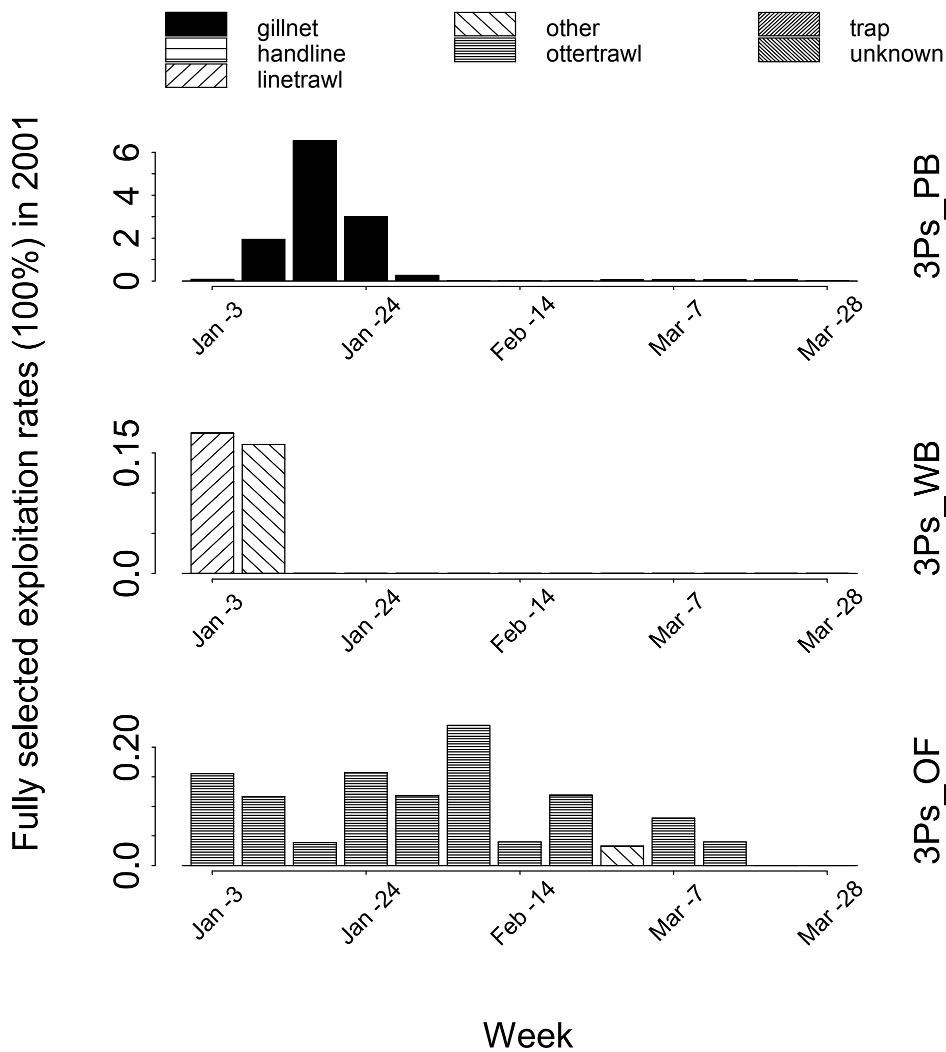

Figure 5: Weekly estimates of the fully selected exploitation rates for each gear type used in the **3Ps** regions during the first three month of 2001. Each panel represents a region, which is labelled on the right-hand side. The bar-blocking shows the weekly estimates for each gear type (legend at top). The calender dates of the week mid-points are shown along the x-axis in each panel. **Note:** the height of the y-axis is different in each panel.

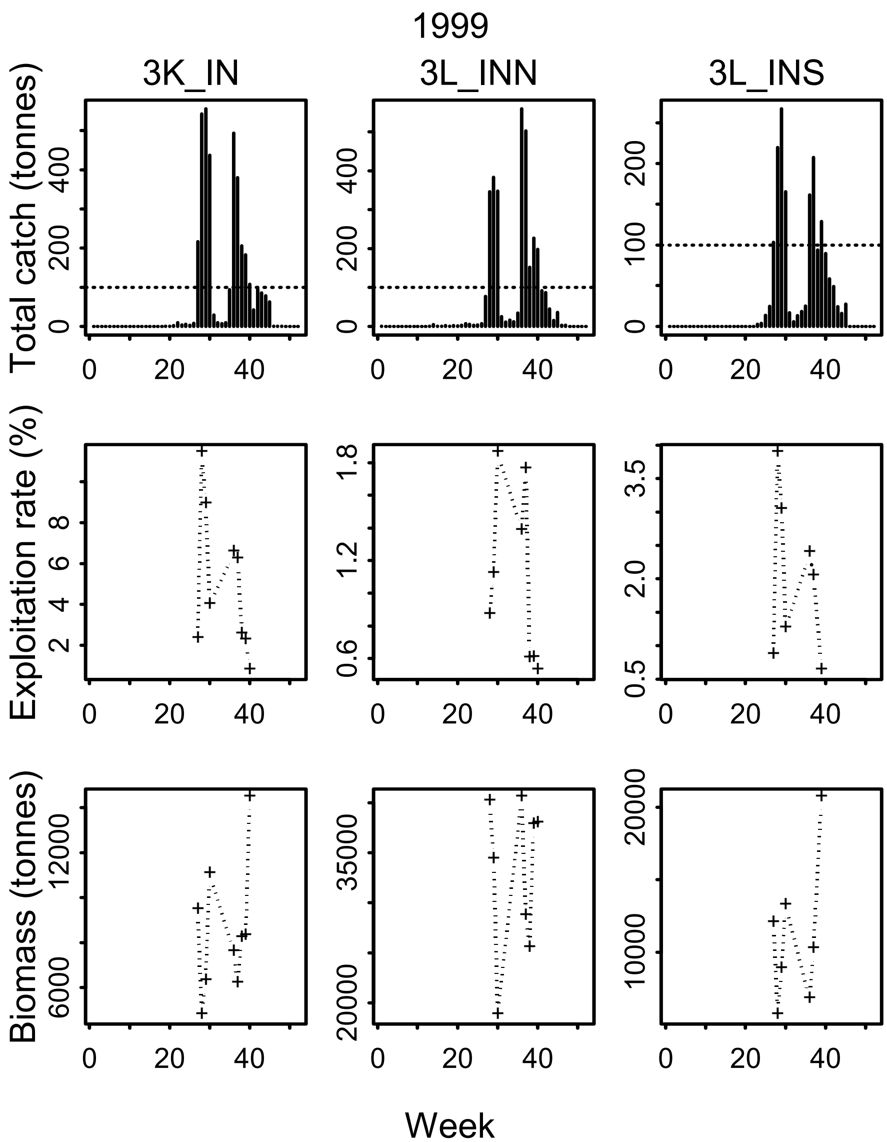

Figure 6: Estimates of total exploitation rates and biomass of cod in 3KL during 1999. The top panel shows the weekly landings in each region. The dotted line is at 100 tonnes. The middle panel shows the total exploitation rate estimates (%) for weeks in which at least 100 tonnes were landed, and the bottom panel shows the corresponding biomass estimates (tonnes).

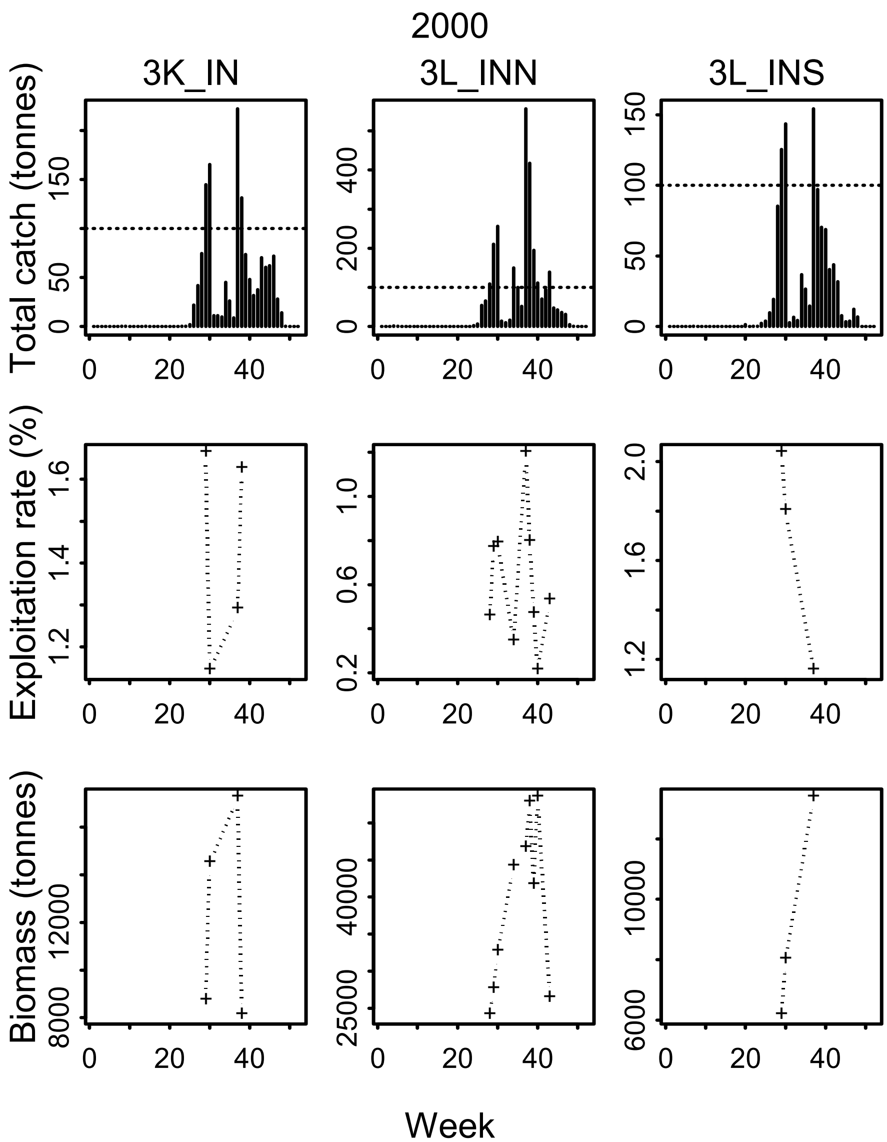

Figure 7: Estimates of total exploitation rates and biomass of cod in 3KL during 2000. The top panel shows the weekly landings in each region. The dotted line is at 100 tonnes. The middle panel shows the total exploitation rate estimates (%) for weeks in which at least 100 tonnes were landed, and the bottom panel shows the corresponding biomass estimates (tonnes).

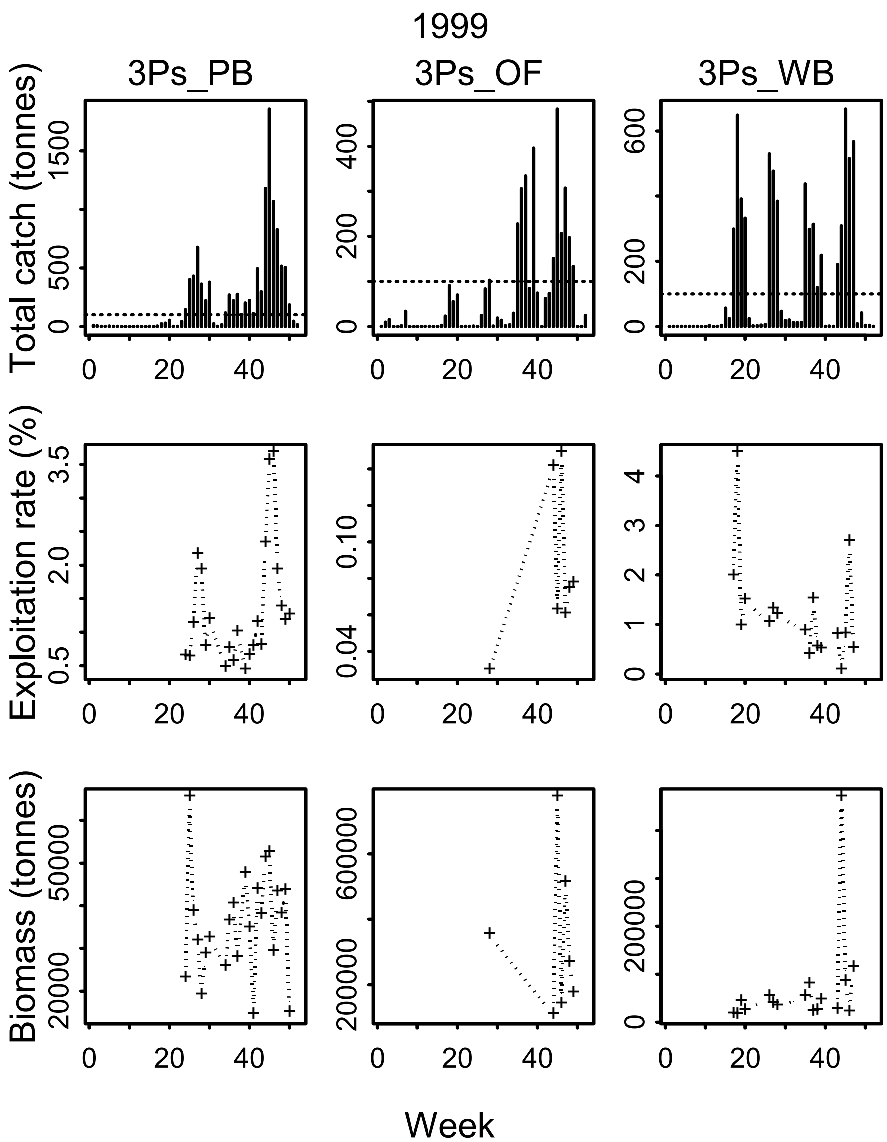

Figure 8: Estimates of total exploitation rates and biomass of cod in 3Ps during 1999. The top panel shows the weekly landings in each region. The dotted line is at 100 tonnes. The middle panel shows the total exploitation rate estimates (%) for weeks in which at least 100 tonnes were landed, and the bottom panel shows the corresponding biomass estimates (tonnes).

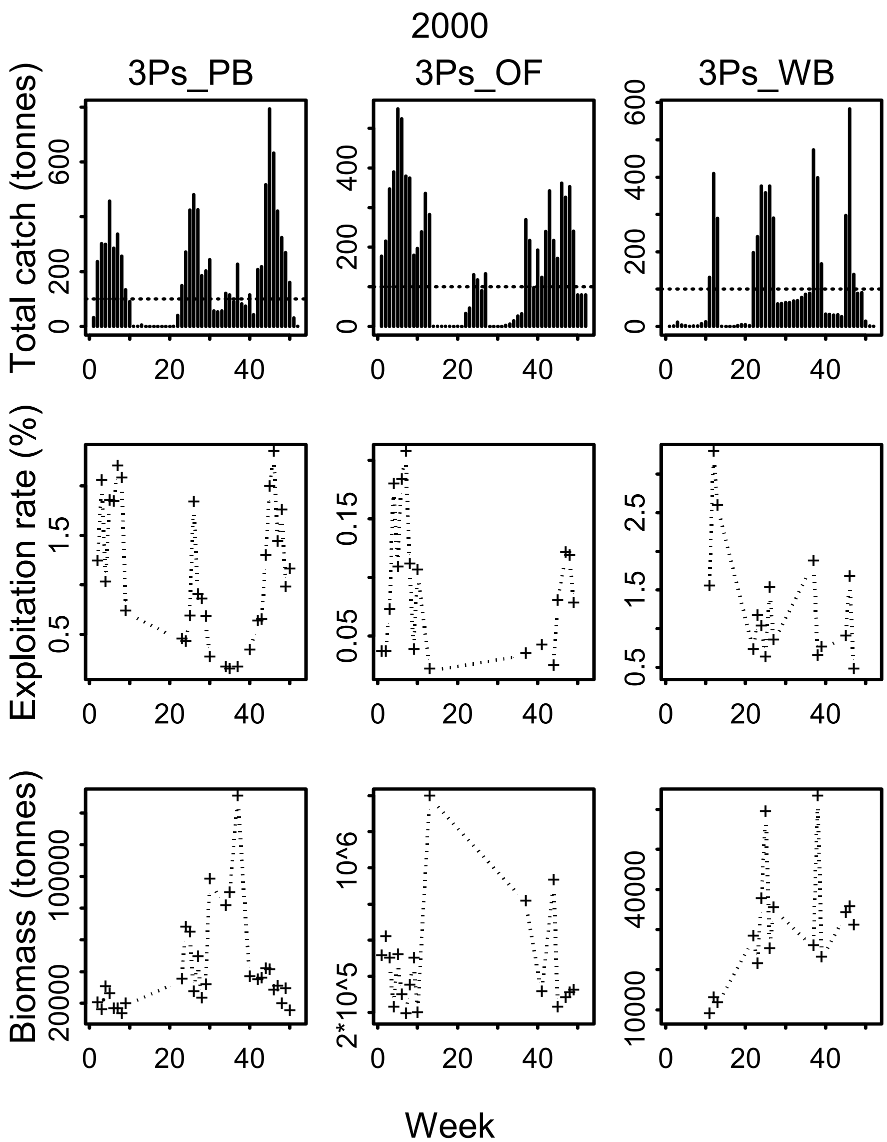

Figure 9: Estimates of total exploitation rates and biomass of cod in 3Ps during 2000. The top panel shows the weekly landings in each region. The dotted line is at 100 tonnes. The middle panel shows the total exploitation rate estimates (%) for weeks in which at least 100 tonnes were landed, and the bottom panel shows the corresponding biomass estimates (tonnes).

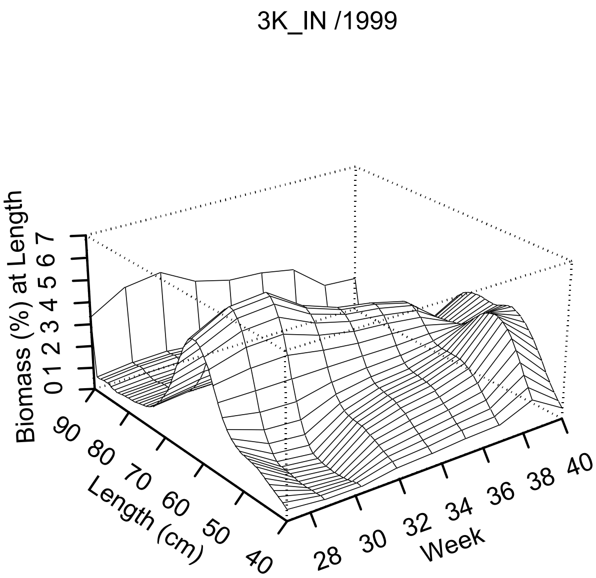

Figure 10: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

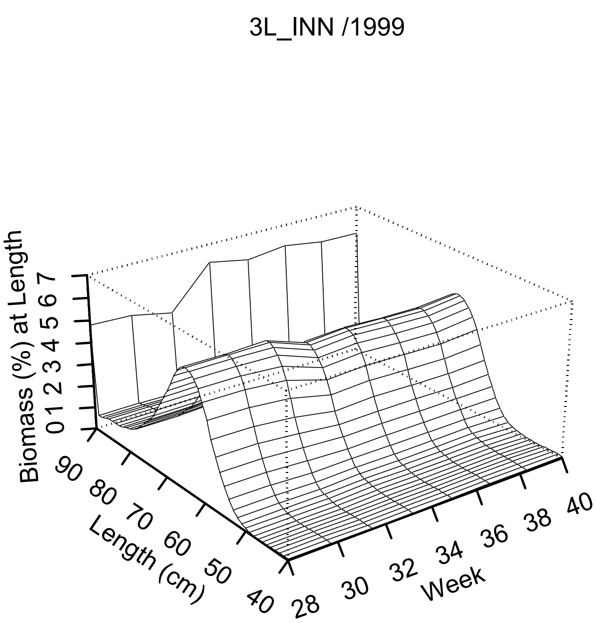

Figure 11: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

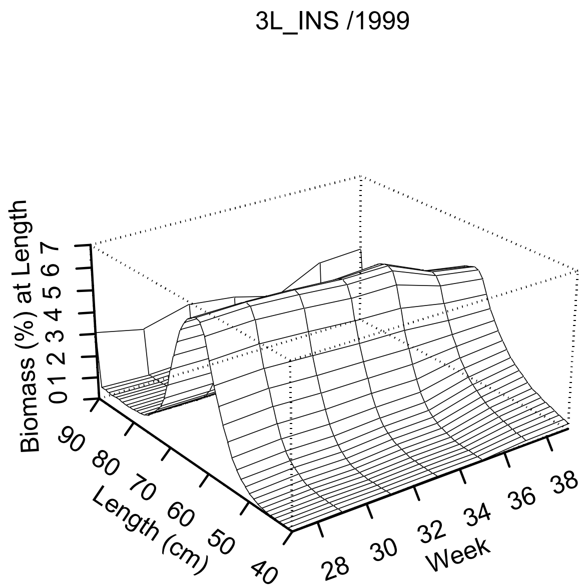

Figure 12: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

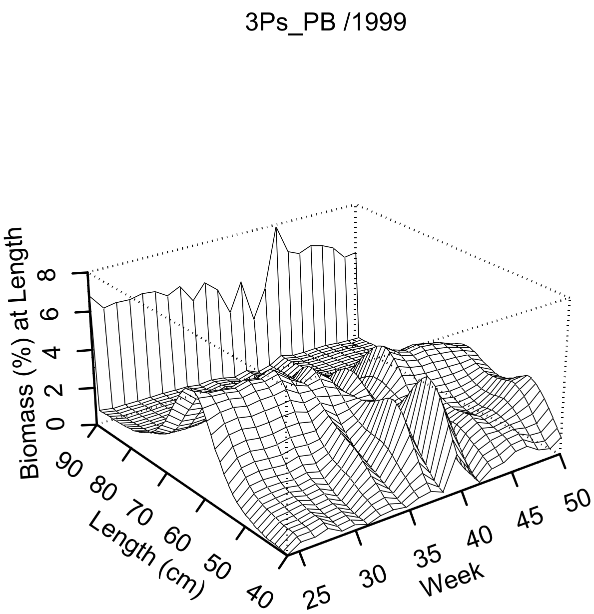

Figure 13: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

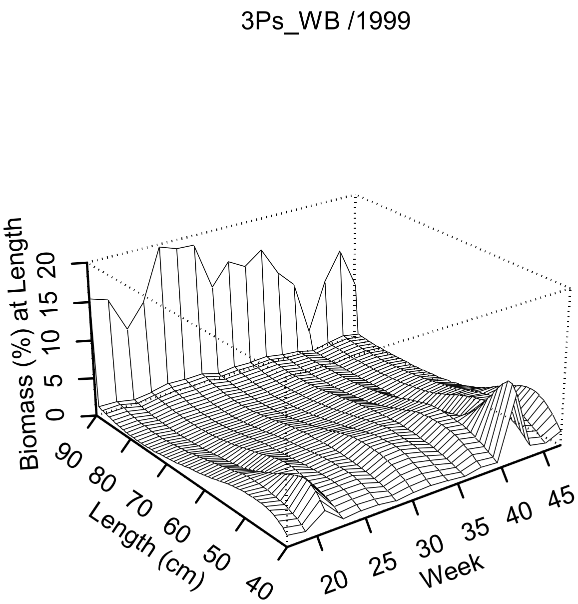

Figure 14: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

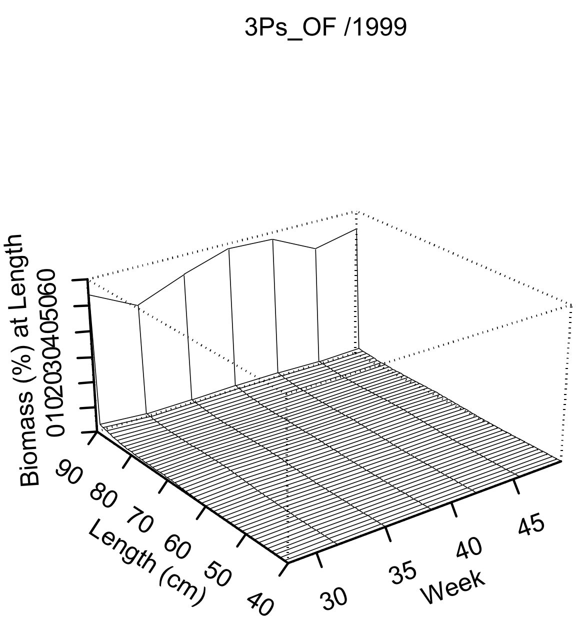

Figure 15: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

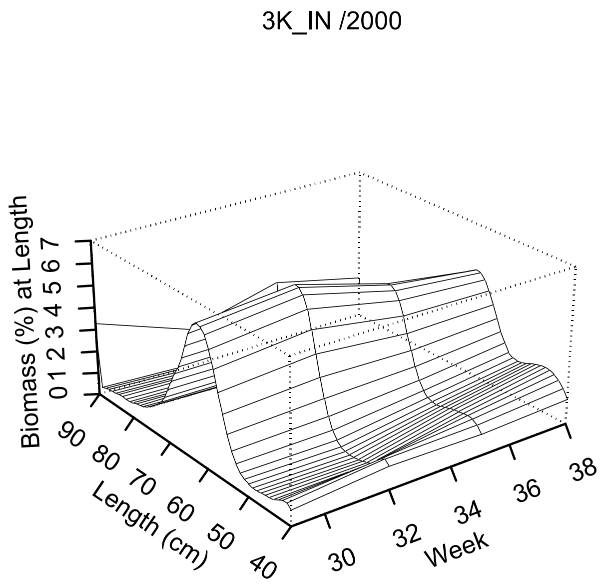

Figure 16: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

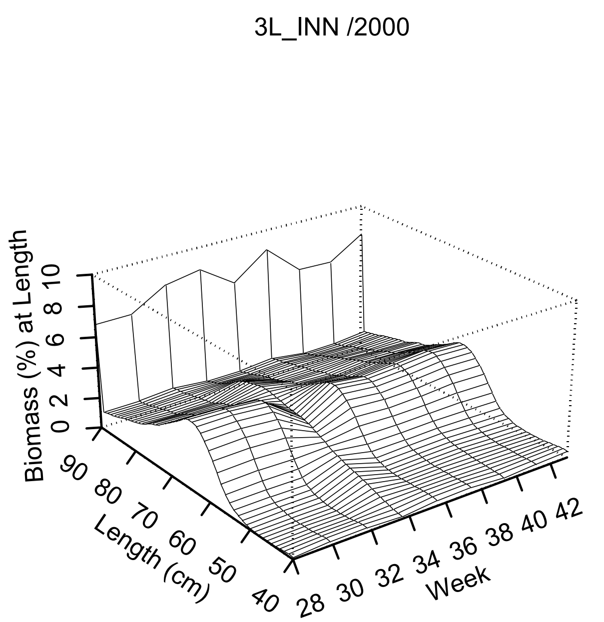

Figure 17: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

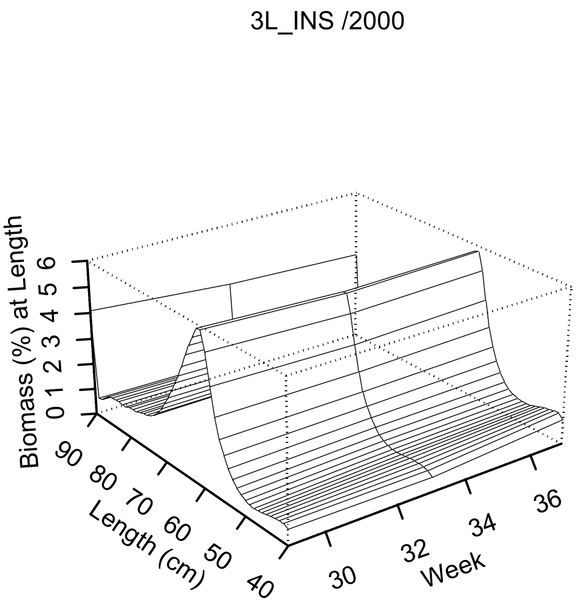

Figure 18: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

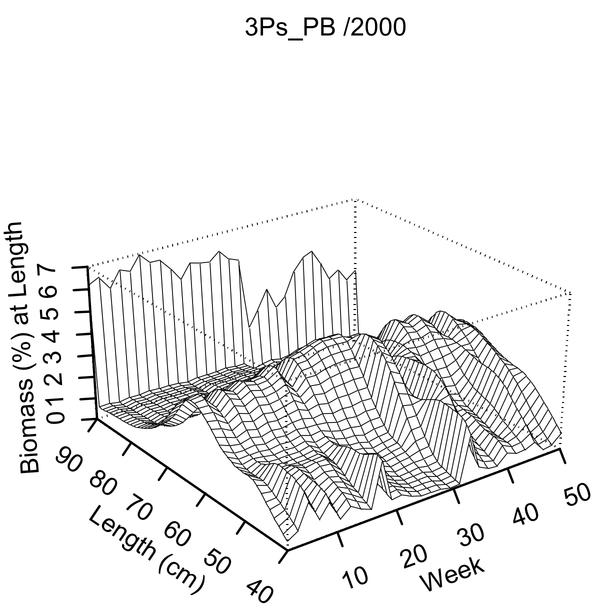

Figure 19: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

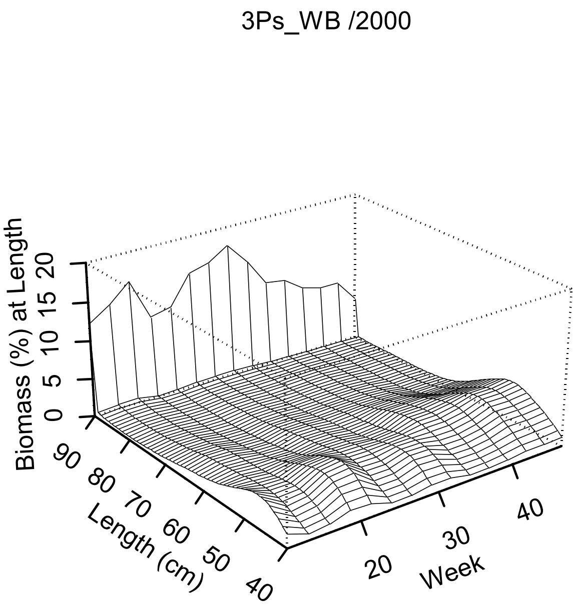

Figure 20: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.

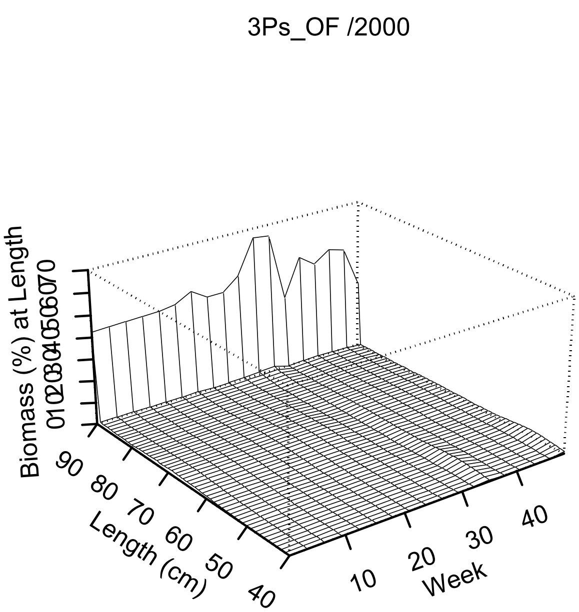

Figure 21: Weekly estimates of the length composition (biomass-at-length divided by total biomass) of the exploited population. Note: 90 is a plus group.