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Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO – Short-term and Medium-term Projections from an Extended Survivor Analysis

by

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Abstract

In order to provide some information for short and medium-term management of the stock of Greenland Halibut in NAFO Subarea 2 and Divisions 3KLMNO, a catch projection associated with a risk analysis were performed for a ten years period starting in 2002 on the basis of a *statu quo* fishing level corresponding to the level of fishing mortality assuming a catch in 2001 at the level of the TAC (40 000 t). The input data were taken from an extended survivor analysis. The results show that on the *statu quo* assumption catches are expected to increase to around 44000 t in 2003 and to slowly decrease after to fluctuate slightly around an average of 40 000 t.

Materials and Methods

The input data are from an extended survivor analysis (Shepherd, 1999, 2000, Mahé and Bowering, 2001) and are summarised in Table 1.

Numbers in 2001 from age 2 to 14+ from the XSA

Numbers at age 1 in 2001 and following years are bootstrapped from the 1975-1999 XSA estimates

Catch in weights are the average from 1998 to 2000 and are also used as stock weight.

The *statu quo* F vector was derived using the average 1998-2000 PR scaled to the F corresponding to a 40 000 t catch in 2001.

Natural mortality was assumed equal to 0.2

As in the similar projection carried in 2000 (Mahé and Darby, 2000) the year-classes 1994 to 1996 from the XSA were considered to be potentially over estimated and were shrinked to the long-term geometric mean:

N=0.5*Nxsa+0.5*GM(75-98)

The catch prediction in year y:

$$C_y = \sum_{a=1}^{14} W_a F_a N_{ay} \left(1 - e^{-Z_a}\right) \Big/ Z_a$$

Numbers in succeeding years for ages 1 to 13:

$$N_{a+1\,y+1} = N_{ay} e^{-Za}$$

Numbers in succeeding years for age 14 (plus group):

$$N_{14y+1} = \left(N_{13y} + N_{14y}\right)e^{-Z_{13}}$$

The risk analysis was performed through a Monte-Carlo simulation (software @Risk, 5000 iterations). CVs for numbers at age are from the XSA output, CVs for the *statu quo* vector are from the average 1998-2000 exploitation pattern, CVs for the stock (=catch) weights are from the 1998-2000 average. CVs for natural mortality were given an assumed value of 0.15. Except for the numbers at age for which a lognormal error model was used, all the parameters were given an normal error distribution.

Results and Discussion

The deterministic short term catch prediction for 2002 at F *statu quo* is of 44000 t. The probability profiles (fig. 1) shows that the 90% confidence interval is (34000 t –53000 t). There is a less than 10% probability of exceeding F *statu quo* at a level of catch of 36000 t. Catch projection are also given for relative Fishing mortalities of +/- 30% Fsq. An increase of 30% would lead to an increase to a catch level of around 55000t in 2002 and to a sharp decline to 45000t in 2004. A reduction of 30% would result in a catch level of 32000t in 2002 and an increase to 35000t in 2004.

A ten year projection was carried with recruitment bootstrapped in the 1975-1999 estimates fom the XSA assuming a *statu quo* fishing mortality and +/- 30 % Fsq. The trajectories of catches, 5+ biomass as a proxy for the exploitable biomass and the 10+ biomass as a proxy for the spawning stock biomass are given in figure 2. Under the *statu quo* scenario, catches are expected to remain stable in 2002 and 2003, to slowly decrease after to fluctuate slightly around an average of 40 000t.The 5+ biomass remains relatively stable around 220000t and the 10+ biomass is expected to increase until 2005 to decrease slightly after with fluctuation as the recent and relatively strong 1999 year class transit in the stock. A 30 % decrease in fishing effort would result in the short and medium term in an increase of the 10+ biomass to a level about 33 % higher than under the *statu quo* scenario and almost double than with a 30% increase in fishing mortality. All options result in an increase of the 10+ biomass in the short term, but while under the *statu quo* and 30% reduction options the 10+ biomass would stabilise at a higher level than the present situation, a 30% increase in F would result in the medium term in a drop to around the present level.

All these projections scenario are driven by the strong recruitment from the mid 90s year-classes and the late 1999 year class. With the revised formulation used in the XSA this year, the level of increase in catch in the medium term as predicted in 2000 is revised downward. This is due to the revision of recruiting year-classes estimates whose contributions in the catch start with a 3 to 4 years delay. The present exploitation pattern should allow an increase in the older population biomass. The effect of this increase in the spawning component on future recruitment is unknown and could not be taken in consideration in this projection. Also, the recent exploitation pattern (in 2000) has shown some evolution towards a more dome shape due to the increased contribution of the gillnet fishery. The present scenarios do not take into account year to year changes in the exploitation pattern.

Therefore, if some confidence can be given in the short-term prediction, caution should be used when interpreting the medium term prediction figures.

References

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MAHE J.C. and C.DARBY, 2000. Greenland Halibut in Subarea 2 and Divisions 3KLMNO - Short-term and Medium-term Projections from an Extended Survivors Analysis. *NAFO SCR Doc.* 00/54, Serial No. 4288, 5p.

Table 1. Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO - Input parameters for the short- and medium-term predictions and risk analysis.

Greenland Halibut in subareas 2+3 Short and Medium term predictions

Input data

Age	N2001	CWt	SWt	M	PR
1	Bootstrapped	0.000	0.000	0.2	0.000
2	193074	0.000	0.000	0.2	0.000
3	36927	0.000	0.000	0.2	0.000
4	65671	0.245	0.000	0.2	0.002
5*	66938	0.359	0.359	0.2	0.019
6*	78550	0.533	0.533	0.2	0.093
7*	70120	0.807	0.807	0.2	0.347
8	34847	1.216	1.216	0.2	0.316
9	12394	1.734	1.734	0.2	0.286
10	5123	2.306	2.306	0.2	0.261
11	1698	2.959	2.959	0.2	0.293
12	992	3.721	3.721	0.2	0.342
13	395	4.691	4.691	0.2	0.305
14	462	5.815	5.815	0.2	0.305

Source N = From XSA output except *

N* = 0.5NXSA+0.5NGM(1975-1998)

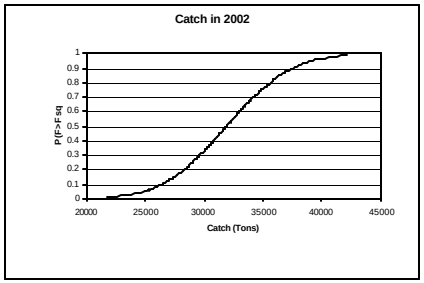
PR = F 98-2000 scaled to F2001 for a 40000t catch,

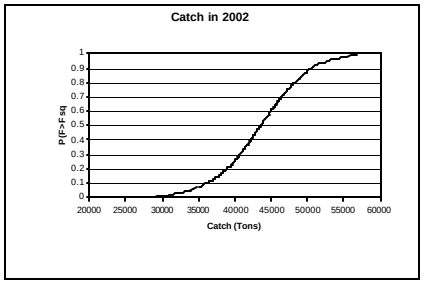
PR CV from average PR 98-2000 scaled to 1

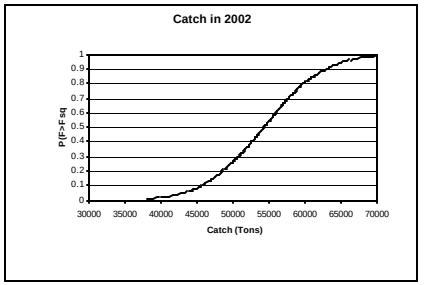
R= Bootstraped in 1975-1999 time series

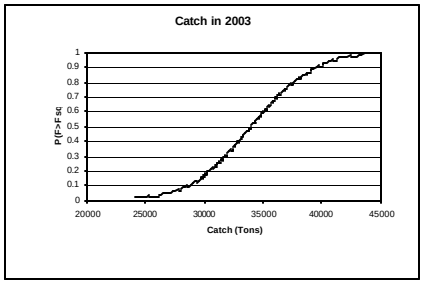
CVs

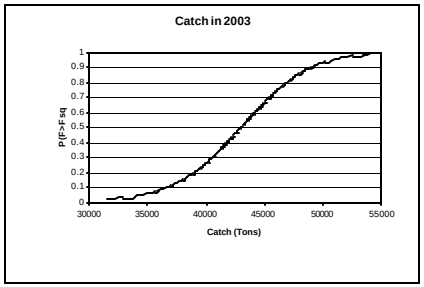
Source	VPA	Aver. 96-99	Aver. 96-99	Assumed	Average PR(98-2000)
Error model	lognormal	normal	normal	normal	normal
Age					
1	Bootstrapped	0.000	0.000	0.15	0.000
2	0.45	0.000	0.000	0.15	0.000
3	0.40	0.000	0.000	0.15	0.000
4	0.26	0.060	0.000	0.15	0.291
5	0.19	0.038	0.038	0.15	0.471
6	0.17	0.018	0.018	0.15	0.239
7	0.16	0.024	0.024	0.15	0.260
8	0.15	0.027	0.027	0.15	0.284
9	0.15	0.030	0.030	0.15	0.564
10	0.16	0.017	0.017	0.15	0.055
11	0.18	0.040	0.040	0.15	0.130
12	0.20	0.070	0.070	0.15	0.297
13	0.23	0.081	0.081	0.15	0.311
14	0.25	0.051	0.051	0.15	0.311

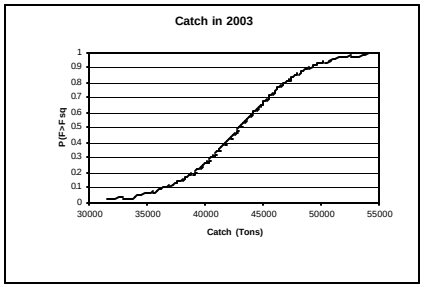


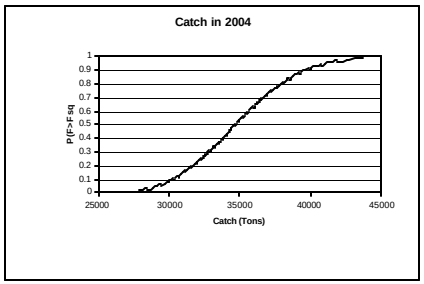


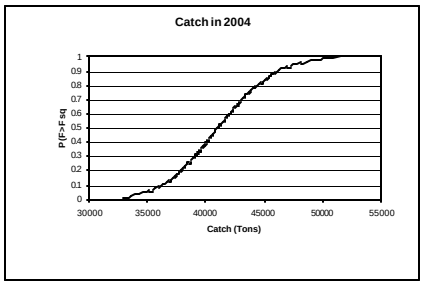


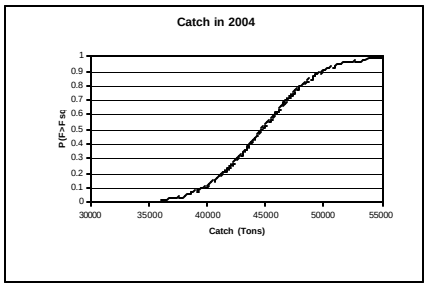












Greenland Halibut in Subarea 2+3 Short term catch projection at 0.7 Fsq

Year	2002	2003	2004
Deterministic	32265	34577	35137
P=0.05 X<=	24936	27458	29299
P=0.50 X<=	31997	34431	34959
P=0.95 X<=	39150	41542	41658

Greenland Halibut in Subarea 2+3 Short term catch projection at Fsq

Year	2002	2003	2004
Deterministic	43945	43434	41343
P=0.05 X<=	33829	35156	35136
P=0.50 X<=	43562	43071	41084
P=0.95 X<=	52904	51317	48153

Greenland Halibut in Subarea 2+3 Short term catch projection at 1.3 Fsq

Year	2002	2003	2004
Deterministic	54845	50261	44881
P=0.05 X<=	43054	41726	38492
P=0.50 X<=	54232	49877	44742
P=0.95 X<=	65491	59015	52082

Figure 1. Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO – probability profiles of catch predictions in 2002, 2003 and 2004 at 3 levels of fishing mortality: F *statu quo*, F sq = 30% and Fsq + 30%.

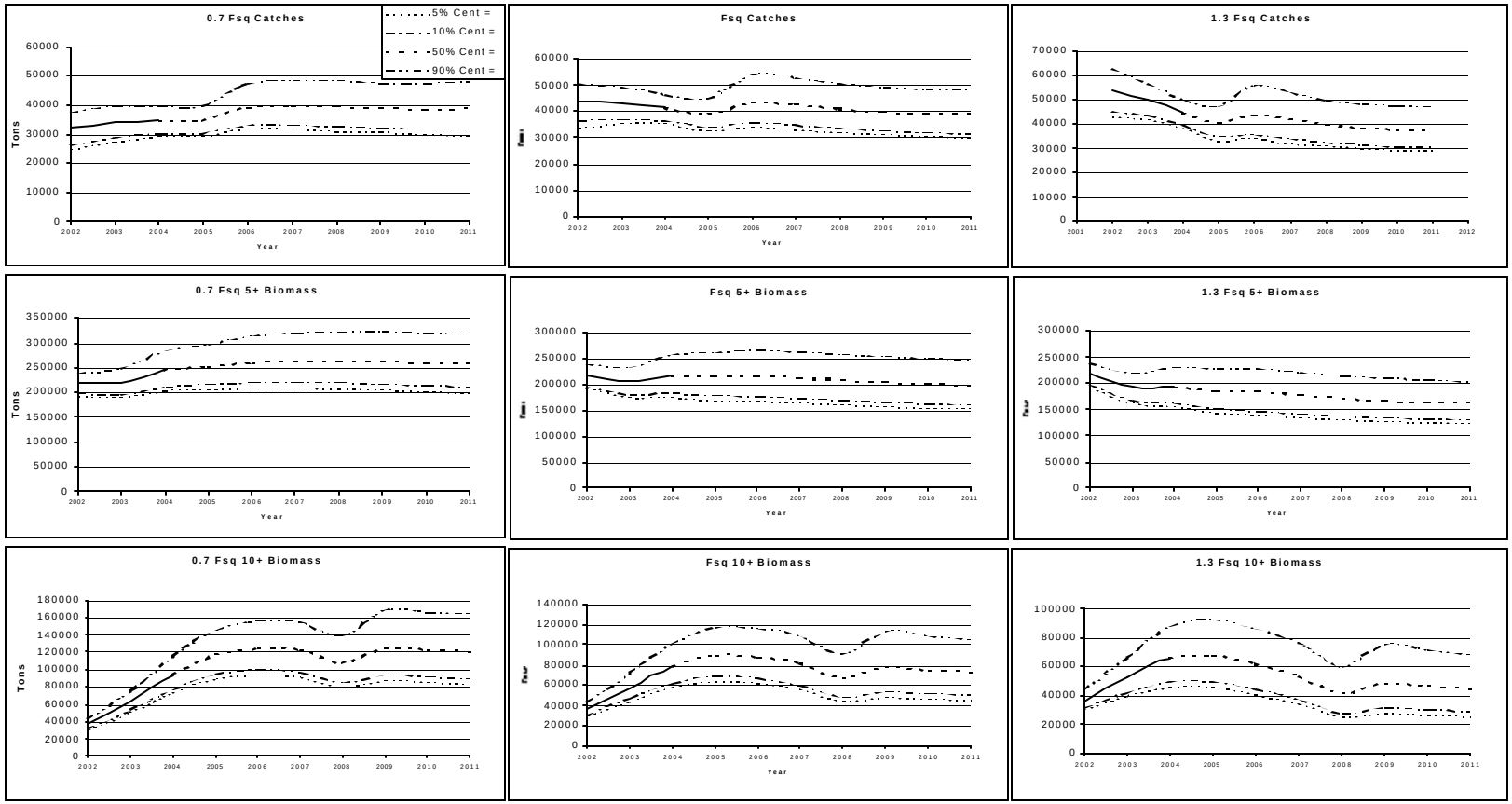


Figure 2. Greenland halibut in NAFO Subarea 2 and Divisions 3KLMNO – Medium term projections at 3 levels of Fishing mortality : F *statu quo*, F sq – 30% and Fsq + 30%.