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On "*Exceptional Circumstances*" Provisions for the Management Strategy for the Greenland Halibut Stock in Subarea 2 + Divisions 3KLMNO based especially on Survey Results occurring Outside the Range Simulated

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Abstract

"Exceptional Circumstances" occur when a resource moves outside the range of parameters compatible with the various scenarios considered in the simulation testing, on which selection of the management strategy for that resource was founded. Acknowledging that such "Exceptional Circumstances" apply necessitates a review and possible revision of the management measure indicated under implementation of the MS. This study show that for Greenland Halibut in NAFO Subarea 2 + Divisions 3KLMNO, probably the clearest indications that this has occurred would be provided by the survey estimates of abundance, falling outside the range of values projected to occur in these simulation tests.

Introduction

The primary basis for considering "*Exceptional Circumstances*" to apply when a Management Strategy (MS) has been adopted for a resource, is that the resource has moved outside the range compatible with the various scenarios considered in the simulation testing on which selection of the Strategy was founded. Acknowledging that such "*Exceptional Circumstances*" apply necessitates a review and possible revision of the management measure indicated under implementation of the MS.

For an empirical MS such as that adopted by NAFO for Greenland Halibut in Subarea 2 + Divisions 3KLMNO, probably the clearest indications that this has occurred would be provided by the survey estimates of abundance, falling outside the range of values projected to occur in these simulation tests. These survey estimates are particularly important in this instance as they provide the (only) inputs to the harvest control rule used to calculate catch limits within the MS.

Figure 1 shows these projections for each of the three surveys whose results are utilised in the harvest control rule of the MS adopted for this Greenland Halibut stock under the Reference Case SCAA operating model (SCAA0) used in the simulation testing. The results are shown in the form of probability envelopes about the median future survey trajectories projected: specifically here the 50%, 75% and 90% probability envelopes are plotted. Numerical values for these envelopes are provided in Table 1.

More usual practice is to utilise the full Reference Set of operating models, rather than the Reference Case alone, to provide such probability envelopes. The corresponding results here are shown here in Figure 2 and Table 2, where the Reference Case (SCAA0) and each of the other models within the Reference Set (SCAA1 to SCAA7) have been equally weighted in computing the probability envelopes.

The Figures also show the first set of survey results to eventuate following adoption of this MS. Note that the Canadian Fall and EU survey results fall well within the probability envelopes shown, though the Canadian Spring survey result is slightly above the upper 5%-ile of the projected distributions.

Figure 3 shows the catch projections under the adopted MS under the Reference Case SCAA and the Reference Set, with numerical values for the 50%, 75% and 90% probability envelopes provided in Table 3. The TAC recommendations for 2011 and 2012 under the adopted MS are also shown, together with the SC and STATLAND estimates of catch for 2010.

Figure 4 plots the exploitable biomass projected under the adopted MS under the Reference Case SCAA. The assessment on which these estimates are based has not been updated to take account of updated information because of insufficient time.

A FEW COMMENTS

The Canadian spring survey result being marginally above the projected 90% probability envelope for this survey (Figs 1 and 2) weakly suggests a resource at higher abundance than anticipated, but would not seem strong grounds for invoking "Exceptional Circumstances" or recommending any associated (upward) revision of the TAC or revision of the MP.

The absence of variability in the TAC plots in Fig. 3 for the years 2011-2013 may surprise, given the variability in the simulated abundance estimates from surveys over that period. The reason is that the way in which the TAC rule works is that an overall abundance index trend is calculated over the last few surveys, and the value of this trend has an impact on the TAC initially calculated - the more negative the trend, the lower the TAC initially indicated. Because the calculations project into the future, noise is generated for each future survey result simulated, and this means that different simulations will lead to different trend inputs to the TACs calculated, so that there *will* be variation in those initial TACs. However, TACs are subject to the constraint of a máximum 5% downward adjustment in any one year. Thus in the simulations, if the initial TAC value calculated is more than 5% less than the TAC for the previous year, it is replaced by one exactly 5% lower than that previous TAC. For the operating models considered here, particularly since the most recent actual surveys are mainly above model predictions, simulated trends for the immediate future are downwards, to the extent that fewer than 2.5% of the simulated initial TAC calculations are less than 5% below the previous year's TAC. This leads to virtually all the simulated final TACs being exactly equal at the 5% reduction level, so that the 90% probability envelope for the TAC projections for the years in question collapses to a single line.

Further biomass and fishing mortality projection plots of the nature shown may be requested of the SC in the future. The SC needs to deliberate for which biomass component (e.g. total, exploitable, spawning), and for which definition of fishing mortality (e.g, for most highly selected age, for an average over some age range), such plots might be presented to be most informative.

A key reason to implement MSs is to avoid the large burden of work associated with annual assessments, restricting this rather to reviews at multi-year intervals so that time can be better spent in developing longer term improvements to research and its results. The agreed primary level of comparison to survey results under the Exceptional Circumstances Protocol put forward by the FC Working Group of Fishery Managers and Scientists on Management Strategy Evaluation is trivially easy to provide each year. In contrast, at the secondary level, provision of calculations and associated plots for, say, every reference set operating model used in the testing process runs the risk of requiring more time and effort each year than annual assessments themselves would do. Consideration should be given to whether in view of the large amount of work required, this secondary level need not be pursued *every* year, but rather only perhaps every second year, or only if the survey results indicate problems, to allow a more appropriate allocation of limited research resources.

Table 1: Medians and 50%, 75% and 90% probability envelopes for the projected survey catch rates under the Management Strategy adopted for the Reference Case SCAA operating model (SCAA0).

	Canadian Fall							EU (0-1400m)							Canadian Spring							
	Percentiles								Percentiles								Percentiles						
	5.0	12.5	25.0	50.0	75.0	87.5	95.0		5.0	12.5	25.0	50.0	75.0	87.5	95.0		5.0	12.5	25.0	50.0	75.0	87.5	95.0
2010	8.11	10.40	12.69	16.25	19.95	22.85	25.98	2010	16.58	19.60	22.70	27.73	33.69	38.78	44.52	2010	0.31	0.40	0.51	0.72	1.00	1.29	1.64
2011	7.77	10.06	12.43	16.13	20.22	23.58	27.23	2011	15.10	18.03	21.29	26.59	32.87	37.91	44.22	2011	0.33	0.45	0.59	0.88	1.30	1.70	2.25
2012	8.02	10.34	12.69	16.54	21.03	24.32	27.90	2012	14.15	17.11	20.43	25.72	32.28	37.53	43.86	2012	0.38	0.52	0.70	1.04	1.54	2.01	2.70
2013	8.32	10.52	12.94	16.84	21.10	24.68	28.48	2013	13.79	16.84	20.39	25.81	32.71	38.55	45.59	2013	0.43	0.58	0.78	1.17	1.74	2.28	3.12
2014	8.42	10.55	13.20	17.00	21.43	25.22	29.67	2014	14.59	17.46	21.10	27.15	34.33	40.79	47.53	2014	0.45	0.60	0.81	1.23	1.84	2.45	3.29
2015	8.90	11.13	13.59	17.65	22.25	26.06	30.59	2015	14.88	18.08	21.68	27.82	35.37	42.03	50.35	2015	0.45	0.61	0.82	1.24	1.87	2.50	3.39
2016	8.88	11.22	13.86	17.91	22.71	26.51	30.64	2016	15.17	18.16	21.58	27.77	35.22	41.81	49.71	2016	0.46	0.63	0.84	1.25	1.93	2.55	3.44
2017	8.71	11.04	13.55	17.65	22.40	26.28	30.69	2017	15.03	18.14	22.04	28.59	36.40	43.09	50.67	2017	0.49	0.65	0.86	1.29	1.94	2.61	3.58
2018	9.02	11.35	14.13	18.40	23.24	26.95	31.43	2018	15.61	18.98	22.72	29.26	37.19	43.75	51.44	2018	0.51	0.68	0.90	1.35	2.01	2.65	3.56
2019	9.29	12.08	14.85	19.25	24.27	28.34	32.76	2019	15.89	19.33	23.43	30.27	38.31	45.14	53.92	2019	0.51	0.70	0.93	1.43	2.14	2.88	3.91
2020	9.54	12.35	15.26	19.96	25.16	29.34	34.10	2020	16.52	20.12	24.05	31.07	39.55	47.28	55.61	2020	0.54	0.71	0.97	1.49	2.25	3.01	4.08
2021	10.24	13.23	16.10	20.79	26.08	30.44	35.23	2021	16.84	20.79	25.23	32.45	40.89	48.37	57.98	2021	0.56	0.75	1.00	1.52	2.34	3.12	4.23
2022	10.76	13.59	16.67	21.54	27.21	32.03	37.30	2022	17.82	21.65	26.03	33.28	42.59	49.77	58.24	2022	0.56	0.76	1.02	1.56	2.39	3.15	4.23
2023	10.78	13.75	16.88	22.02	27.85	32.54	37.76	2023	18.12	22.36	26.74	34.60	44.26	51.98	61.02	2023	0.57	0.77	1.03	1.59	2.43	3.20	4.15
2024	10.80	13.89	16.97	22.18	28.01	32.47	38.14	2024	19.39	23.34	27.93	35.94	45.70	53.71	63.44	2024	0.61	0.82	1.08	1.63	2.44	3.28	4.42
2025	11.02	13.96	17.15	22.56	28.38	33.20	38.06	2025	19.97	24.04	29.18	37.10	47.38	55.57	66.13	2025	0.59	0.82	1.09	1.65	2.49	3.34	4.53
2026	11.04	14.20	17.44	22.70	28.63	33.12	38.25	2026	20.45	24.78	30.13	38.55	48.99	58.21	69.09	2026	0.62	0.83	1.12	1.71	2.55	3.43	4.57
2027	11.41	14.29	17.45	22.85	28.86	33.53	39.30	2027	20.72	25.54	30.84	39.64	50.31	58.88	69.58	2027	0.60	0.82	1.10	1.65	2.49	3.40	4.57
2028	11.20	14.15	17.47	22.60	28.90	34.26	39.89	2028	20.96	25.55	30.77	39.99	51.51	61.12	71.99	2028	0.60	0.82	1.12	1.69	2.52	3.37	4.46
2029	11.37	14.55	17.84	23.08	29.24	34.23	39.83	2029	22.32	27.04	32.54	41.87	53.58	63.14	73.72	2029	0.60	0.82	1.12	1.70	2.54	3.39	4.48
2030	11.60	14.70	17.99	23.28	29.44	34.40	40.73	2030	21.94	26.98	32.82	42.13	53.85	63.59	74.76	2030	0.62	0.85	1.14	1.70	2.55	3.42	4.57
2031	11.28	14.28	17.90	23.30	29.54	34.57	40.24	2031	22.48	27.01	33.02	43.00	54.46	64.43	75.83	2031	0.63	0.84	1.13	1.71	2.57	3.40	4.61

Table 2: Medians and 50%, 75% and 90% probability envelopes for the projected survey catch rates under the Management Strategy adopted for the full SCAA Reference Set (SCAA0 to SCAA7), where each operating model within the Set is accorded the same weight.

	Canadian Fall								EU (0-1400m)								Canadian Spring							
	Percentiles								Percentiles								Percentiles							
	5.0	12.5	25.0	50.0	75.0	87.5	95.0		5.0	12.5	25.0	50.0	75.0	87.5	95.0		5.0	12.5	25.0	50.0	75.0	87.5	95.0
2010	7.65	9.80	12.02	15.55	19.54	22.83	26.93	2010	15.85	18.76	21.89	27.03	33.24	38.55	44.58	2010	0.30	0.39	0.50	0.70	0.98	1.25	1.60
2011	7.11	9.29	11.59	15.30	19.69	23.41	27.94	2011	13.89	16.76	19.98	25.47	32.00	37.43	44.14	2011	0.31	0.43	0.56	0.84	1.25	1.64	2.14
2012	7.32	9.50	11.81	15.67	20.34	24.18	29.03	2012	12.54	15.53	18.76	24.21	31.12	36.93	43.82	2012	0.36	0.49	0.66	0.98	1.46	1.92	2.58
2013	7.58	9.68	12.05	15.94	20.60	24.61	29.82	2013	11.96	14.88	18.25	24.01	31.16	37.47	45.50	2013	0.41	0.55	0.74	1.11	1.66	2.20	3.00
2014	7.55	9.74	12.20	16.24	21.09	25.37	30.63	2014	12.24	15.25	18.78	24.94	32.67	39.43	47.47	2014	0.42	0.57	0.77	1.17	1.77	2.38	3.21
2015	7.97	10.25	12.79	17.05	22.15	26.56	31.90	2015	12.43	15.64	19.35	25.71	33.82	40.93	49.64	2015	0.43	0.58	0.78	1.20	1.81	2.45	3.38
2016	8.03	10.42	13.14	17.60	22.93	27.33	32.66	2016	12.29	15.57	19.20	25.68	33.78	40.81	49.48	2016	0.43	0.60	0.81	1.23	1.89	2.54	3.47
2017	7.83	10.31	13.00	17.51	23.01	27.46	32.74	2017	11.95	15.48	19.52	26.51	35.00	42.24	51.29	2017	0.46	0.63	0.83	1.28	1.94	2.62	3.62
2018	8.16	10.67	13.62	18.48	24.14	28.57	33.82	2018	12.25	16.04	20.30	27.43	36.23	43.55	52.53	2018	0.49	0.66	0.88	1.33	2.03	2.70	3.68
2019	8.57	11.28	14.45	19.53	25.38	30.10	35.56	2019	12.39	16.43	21.10	28.85	38.04	45.55	55.31	2019	0.49	0.68	0.91	1.43	2.18	2.96	4.05
2020	8.80	11.69	14.95	20.32	26.45	31.29	37.11	2020	12.58	17.10	22.03	30.02	39.94	48.23	58.07	2020	0.52	0.70	0.96	1.50	2.28	3.09	4.22
2021	9.50	12.40	15.81	21.23	27.50	32.56	38.20	2021	13.22	17.72	23.13	31.76	41.90	50.25	60.76	2021	0.53	0.73	0.99	1.53	2.38	3.22	4.38
2022	9.95	12.96	16.35	21.98	28.54	34.04	40.47	2022	13.73	18.55	24.10	33.14	43.81	52.20	62.43	2022	0.54	0.75	1.02	1.58	2.44	3.25	4.39
2023	9.97	13.14	16.54	22.39	29.13	34.56	40.85	2023	14.39	19.20	25.02	34.43	45.62	55.06	65.57	2023	0.55	0.76	1.03	1.59	2.46	3.29	4.37
2024	9.98	13.17	16.63	22.50	29.23	34.60	40.98	2024	14.94	20.24	26.19	36.13	47.78	57.29	68.75	2024	0.58	0.79	1.07	1.63	2.49	3.37	4.58
2025	10.20	13.28	16.74	22.75	29.60	34.92	41.02	2025	15.47	20.82	27.14	37.42	49.70	59.74	71.86	2025	0.58	0.79	1.07	1.65	2.53	3.41	4.69
2026	10.22	13.29	16.97	22.90	29.72	35.11	41.29	2026	16.04	21.48	28.10	38.88	51.59	62.51	75.58	2026	0.59	0.81	1.10	1.70	2.57	3.48	4.69
2027	10.41	13.39	16.95	22.93	29.96	35.47	41.92	2027	16.42	22.02	28.77	39.88	53.10	63.72	76.34	2027	0.57	0.79	1.08	1.64	2.51	3.43	4.68
2028	10.28	13.29	16.80	22.78	29.97	35.83	42.55	2028	16.34	22.03	28.74	40.22	54.27	65.75	79.48	2028	0.58	0.79	1.09	1.68	2.55	3.40	4.58
2029	10.20	13.47	17.16	23.19	30.27	36.08	42.52	2029	16.84	23.03	30.26	41.90	56.15	68.07	81.68	2029	0.56	0.79	1.09	1.69	2.57	3.44	4.65
2030	10.40	13.59	17.32	23.37	30.64	36.41	43.32	2030	17.02	22.99	30.20	42.23	56.45	68.23	82.42	2030	0.59	0.81	1.10	1.68	2.57	3.48	4.71
2031	10.09	13.29	17.04	23.37	30.71	36.52	43.09	2031	17.09	23.09	30.30	42.80	57.05	69.10	83.41	2031	0.58	0.80	1.09	1.69	2.59	3.47	4.72

Table 3: Medians and 50%, 75% and 90% probability envelopes for the projected catch under the Management Strategy adopted for the Reference Case SCAA operating model (SCAA0) and for the full SCAA Reference Set (SCAA0 to SCAA7), where each operating model within the Set is accorded the same weight.

	Reference Case								Reference Set						
	Percentiles								Percentiles						
	5.0	12.5	25.0	50.0	75.0	87.5	95.0		5.0	12.5	25.0	50.0	75.0	87.5	95.0
2010	19520	19520	20320	20320	22720	23200	23200	2010	19520	19520	20320	20320	22720	23200	23200
2011	17182	17182	17182	17182	17182	17182	17182	2011	17182	17182	17182	17182	17182	17182	17182
2012	16323	16323	16323	16323	16323	16323	16323	2012	16323	16323	16323	16323	16323	16323	16323
2013	15507	15507	15507	15507	15507	15507	15507	2013	15507	15507	15507	15507	15507	15507	15507
2014	14731	14731	14731	14731	14731	15626	16139	2014	14731	14731	14731	14731	14731	15532	16175
2015	13995	13995	14073	15177	15468	16293	16892	2015	13995	13995	13995	14933	15468	16111	16929
2016	13295	13570	14475	15586	16241	16642	17476	2016	13295	13295	14158	15258	16241	16441	17478
2017	12882	13717	14628	15735	16857	17054	17680	2017	12630	13403	14137	15429	16725	17054	17674
2018	13012	13773	14658	15990	17055	17656	17906	2018	12620	13312	14419	15800	16901	17635	17906
2019	12993	13912	14719	15863	17011	17892	18530	2019	12537	13523	14449	15718	17011	17900	18606
2020	13191	13992	14621	15873	17160	18020	18951	2020	12576	13570	14580	15841	17200	18074	19064
2021	13220	13967	14813	15856	17227	18334	19321	2021	12575	13714	14664	15894	17349	18467	19488
2022	13218	14164	14863	16058	17394	18559	19582	2022	12751	13795	14722	16120	17608	18771	19761
2023	13404	14109	15051	16277	17651	18702	19912	2023	12828	13856	14931	16394	17894	19032	20215
2024	13429	14315	15199	16498	17820	18943	20053	2024	12998	14031	15102	16637	18139	19320	20568
2025	13537	14404	15300	16696	18062	19119	20249	2025	13039	14114	15233	16848	18387	19563	20800
2026	13650	14512	15455	16805	18237	19271	20495	2026	13130	14229	15345	16964	18601	19758	21049
2027	13730	14611	15496	16886	18342	19441	20716	2027	13212	14316	15402	17045	18709	19960	21324
2028	13790	14695	15587	16958	18486	19701	20904	2028	13244	14362	15467	17093	18862	20175	21580
2029	13755	14728	15627	17007	18629	19795	21086	2029	13248	14370	15508	17158	18980	20294	21756
2030	13833	14696	15619	17094	18646	19826	21215	2030	13226	14369	15483	17193	19001	20386	21901
2031	13762	14677	15580	17170	18695	19857	21316	2031	13198	14332	15485	17237	19054	20419	21958

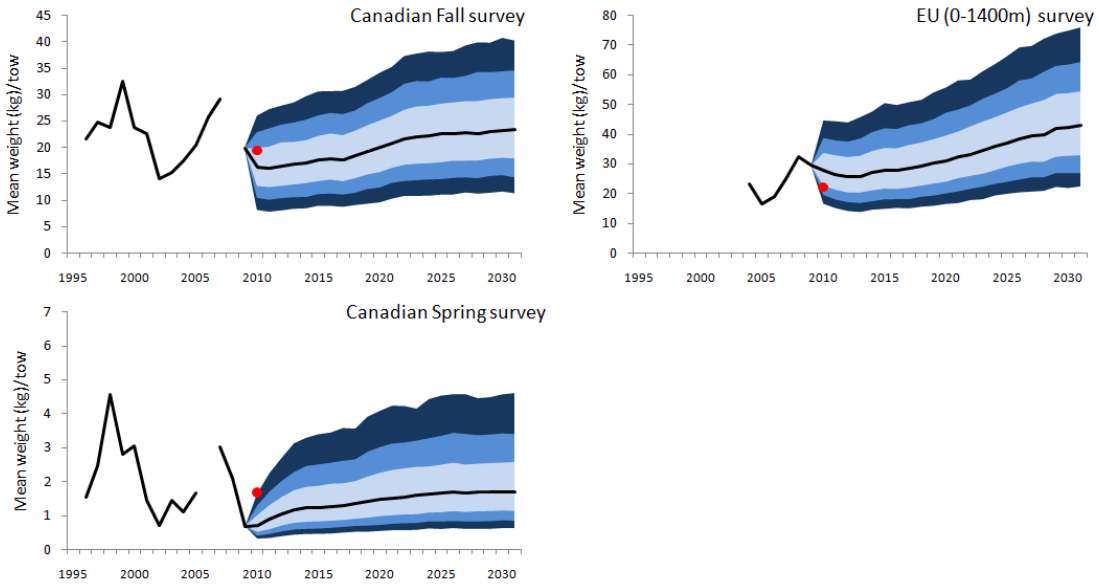

Fig. 1: Projected survey catch rates under the Management Strategy adopted for the Reference Case SCAA operating model (SCAA0). The past values are actual observations, while the projections show medians and 50%, 75% and 90% probability envelopes through use of different shades/colourations. The (red) dots on each plot show survey results subsequent to adoption of this Management Strategy.

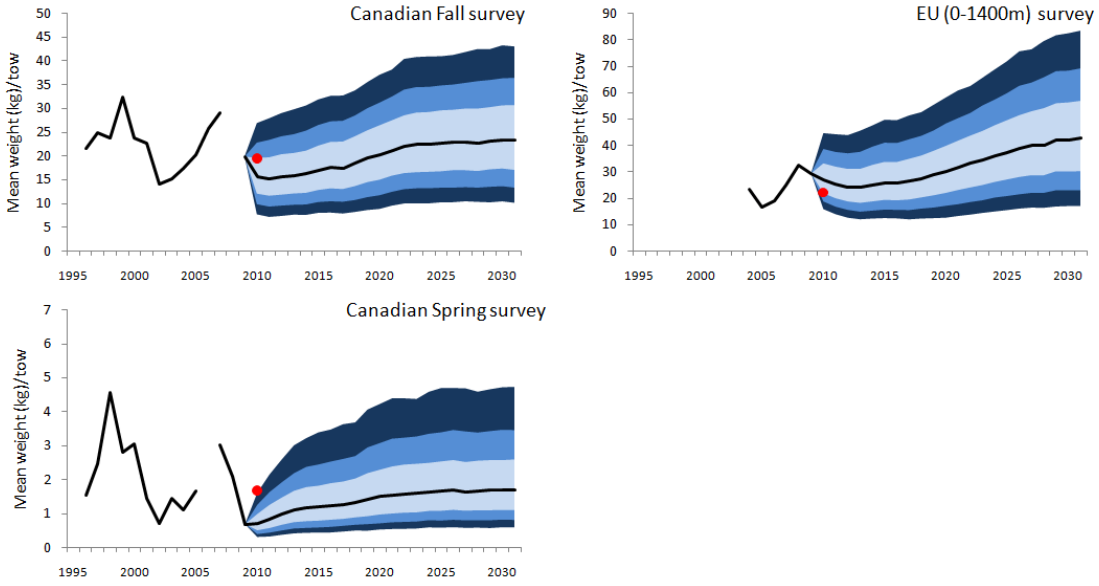

Fig. 2: As for Fig. 1, except that here results are shown for the full SCAA Reference Set (SCAA0 to SCAA7), where each operating model within the Set is accorded the same weight.

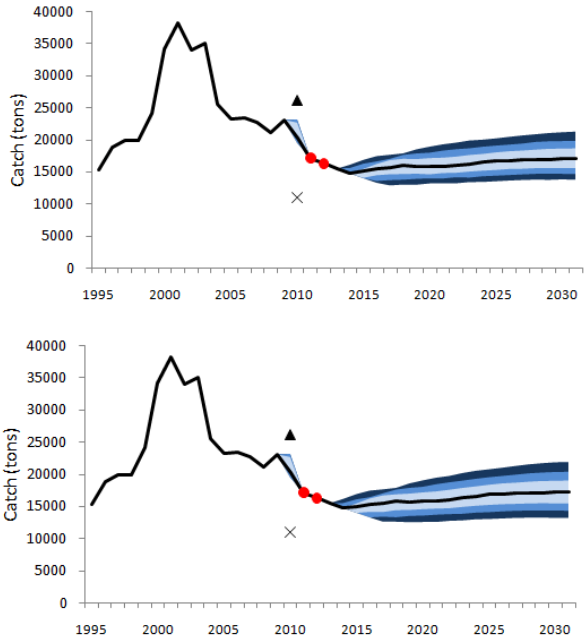

Fig. 3: Projected catch (TAC) under the Management Strategy adopted for the Reference Case SCAA operating model (SCAA0) (top plot) and for the full SCAA Reference Set (SCAA0 to SCAA7) (bottom plot). The past values are actual observations, while the projections show medians and 50%, 75% and 90% probability envelopes through use of different shades/colourations. The (red) dots show TAC values subsequent to adoption of this Management Strategy. The (black) triangle shows the 2010 SC estimate of catch, while the cross shos the 2010 STATLAND estimate of catch.

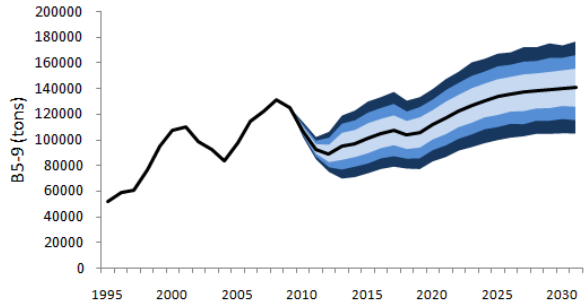

Fig. : Projected exploitable biomass (B5-9) under the Management Strategy adopted for the Reference Case SCAA operating model (SCAA0). The past values are actual model estimates, while the projections show medians and 50%, 75% and 90% probability envelopes through use of different shades/colourations.