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Barents Sea Capelin - Report of the Joint Russian-Norwegian Working Group on Arctic Fisheries (JRN-AFWG) 2023

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Barents Sea Capelin - Report of the Joint Russian-Norwegian Working Group on Arctic Fisheries (JRN-AFWG) 2023

Barentshavslodde - rapport frå Den bilaterale norsk-russiske arbeidsgruppa for arktiske fiskeri (JRN-AFWG) 2023

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Summary (Norwegian):

Den bilaterale norsk-russiske arbeidsgruppa for arktiske fiskeri (JRN-AFWG) hadde møte per korrespondanse 9.-10. oktober 2023 for bestandsvurdering og kvoterådgjeving på barentshavslodde.

Den geografiske dekninga av loddebestanden under toktet i Barentshavet tilnærma fullstendig, og biomassen ab den totale bestanden 2.952 millionar tonn. Omlag 44% (1.286 million tonn) av totalbiomassen var modnande fisk (>14.0 cm). Gjennomsnittsvekt ved alder i 2023 var lågare enn langtidssnittet for fisk eldre enn 2 år. Antalet 3 og 4-åringar var det høgaste sidan 1992 og 1980, høvesvis. Talet på 1-åringar var 108.5 milliardar, som er om lag halvparten av langtidssnittet.

I bestandsrådgjevinga for lodde blir det gjennomført ei framskriving av den modnande loddebiomassen frå 1. oktober til 1. april (gytetidspunkt) året etter. Framskrivingsmodellen (*bifrost*) inneheld ein eigen modul for torskekonsum av lodde, og modellen brukt i årets bestandsvurdering var revidert etter ICES metoderevisjonsmøtet for lodde i november 2022. I framskrivinga blei median gytebiomasse 1. april 2024 berekna til 785 000 tonn utan fangst (90% konfidensintervall: 392-1207 000 tonn), og sannsynet for å ligga over referansepunktet (200 000 tonn) i haustingsregelen var 99.8%. Med ein fangst på 196 000 tonn er det 5% sannsyn for at gytebiomassen er under referansepunktet som er i tråd med haustingsregelen. Median gytebiomasse i 2024 med ein fangst på 196 000 blei berekna til 590 000 tonn (90% konfidensintervall: 201-1011 000 tonn). Torskekonsum i perioden januar-mars 2024 i dette scenariet er berekna til 296 000 tonn.

Content

1 - Barents Sea Capelin

1.1 - Barents Sea Capelin

The Joint Russian-Norwegian Arctic Fisheries Working Group (JRN-AFWG) met by correspondence 9-10 October 2023 to assess and give quota advice for the Barents Sea capelin stock.

Participants:

- Bjarte Bogstad (Norway, Chair of meeting)
- Anatoly Chetyrkin (Russia)
- Sondre Nedreås Hølleland (Norway)
- Stine Karlson (Norway)
- Yury Kovalev (Russia)
- Pavel Krivosheya (Russia)
- Dmitry Prozorkevich (Russia)
- Frøydis Rist (Norway)
- Georg Skaret (Norway)
- Alexey Stesko (Russia)

1.2 - Regulation of the Barents Sea Capelin Fishery

Since 1979, the Barents Sea capelin fishery has been regulated by a bilateral fishery management agreement between Russia (former USSR) and Norway. A TAC has been set separately for the winter fishery and for the autumn fishery. From 1999, no autumn fishery has taken place, except for a small Russian experimental fishery in some years and small by-catch in the northern shrimp fishery. A minimum landing size of 11 cm has been in force since 1979. Scientific advice is to carry out capelin fishery only on mature fish during the period from January to April.

1.3 - TAC and Catch Statistics (Table 10.1-10.2)

The Joint Norwegian-Russian Fishery Commission (JNRFC) set a TAC of 70 000 tonnes for 2022 and 62 000 tonnes for 2023. For both years, the quotas were in accordance with the advice. The international historical catch by country and season in the years 1965–2023 is given in Table 10.1. The Norwegian catch in 2023 was 37652 tonnes which was 502 tonnes above the national TAC. Russian catches were 23 040 tonnes which was 1810 tonnes below the national TAC.

The age-length distribution of Norwegian and Russian catches in 2023 are summarized in Table 10.2a-b. The capelin sampling from the Barents Sea in 2023 is summarised below:

Investigation	No. of trawl hauls	Length measurements	Aged individuals
Sampling from fishing vessels in winter-spring 2023 (Norway)	16	1539	480
Sampling from fishing vessels in winter-spring 2023 (Russia)	86	11006	350
Winter capelin survey 2023 (Norway)	13	1300	280
Joint Winter survey 2023 (Norway)	251	10094	2308
Joint Winter survey 2023 (Russia)	59	2556	175
BESS 2023 (Norway)	310	19194	4873
BESS 2023 (Russia)	130	7238	627

1.4 - Stock assessment

1.4.1 - Acoustic stock size estimates in 2023 (Table 10.3, Figure 10.1-10.3)

The geographical survey coverage of the Barents Sea capelin stock during the BESS in 2023 was close to complete; the capelin distribution seemed to continue a little bit further northwards in the north-east. The geographical distribution of capelin in 2023 is shown in Figure 10.1.

As decided during the 2016 assessment meeting, the capelin abundance was estimated using the software StoX v.2.7 (Johnsen et al. 2019), applying standard settings (see background document BS0 in Annex 3 in ICES, 2023). Since this old java-based StoX program is no longer maintained and has been replaced with an R-based version, the estimate was also made in new StoX (v.3.6). The difference in estimates between the versions was negligible.

The stock estimate from the area covered by the 2023 survey was 2.952 million tonnes (Table 10.3). About 44% (1.286 million tonnes) of the estimated stock biomass consisted of maturing fish (>14.0 cm). The mean weight at age in the 2023 survey was low than the long-term average for ages 2 and older (Figure 10.2). The abundance of age 3 and 4 fish was the highest since 1992 and 1980, respectively. Estimates of stock in number by age group and total biomass for the historical period are shown in Table 10.4. The stock numbers and biomass for 2004-2021 are updated following the data evaluation workshop in 2021, and the subsequent WKCAPELIN benchmark in 2022. The comparison with previous estimates is presented in detail in Annex3 number BS0 in the WKCAPELIN benchmark report (ICES, 2023). Survey mortality for ages 1-2 and 2-3 is shown in Figure 10.3.

A fixed sampling variance expressed as Coefficient of Variation (CV) of 0.2 for all age groups has previously been applied as input for CapTool for the forecast in the capelin assessment (Tjelmeland 2002; Gjøsæter *et al.* 2002). The survey design and estimation software now allow for estimation of a direct CV by age group. CV estimates by age group for the years 2004-2021 and 2023 are given in Table 10.5. It was found that age groups with very low abundance in the survey usually have very high CVs. That is expected since there are only few observations in the survey for such age groups. Vice versa an abundant age group normally has much lower CV. WKCAPELIN recommended to use the average CV for each age group from the 5 the last five years with high-quality surveys in the stock projection. However, including age groups with very low abundance in the averaging is inappropriate.

Because of the incomplete spatial coverage in 2022, that year was not included in the averaging. Averaging the CVs for 2018-2021 and 2023 by age group gave quite high values for ages 3 and 4, as shown in the text table below. Since the abundance estimates for ages 3 and 4 in 2023 are much higher than in any of the years 2018-2021, and the CVs for ages 2, 3 and 4 in 2023 are relatively similar, it was not considered appropriate to use the 2018-2021 and 2023 averages for ages 3 and 4. Using the average of CVs weighted by abundance was explored. However this gave a very low value for age 2 (0.14) due to high weight to the estimated CV for age 2 in 2021 (0.10) when the abundance was very high. It was decided to use the unweighted average for the years 2018-2021 and 2023 for ages 1 and 2 and apply this value for ages 3 and 4 also, based on the similarity in CV for 2023 for ages 2, 3 and 4. The summary results are presented below:

CV	Age 1	Age 2	Age 3	Age 4
Average	0.22	0.22	0.29	0.57
Weighted average	0.23	0.14	0.21	0.22
2023	0.28	0.17	0.17	0.20
Value to use	0.22	0.22	0.22	0.22

A methodology for handling very small or very large CV values and abundance estimates of different orders of magnitude in the averaging should be explored, together with exploring using annual CVs. With a low CV there is a risk that sampling variance is not a good reflection of total uncertainty, since other sources of uncertainty than sampling variance could dominate the total uncertainty.

1.4.2 - Stock assessment in 2023 (Table 10.4-10.5, Figure 10.4-10.6)

All projections described below were based on a maturation and predation model as described in the 2023 WKCAPELIN Benchmark report (ICES, 2023), with parameters estimated by the model Bifrost and data on predicted cod abundance and size at age in 2024 from the 2023 Bilateral Norwegian-Russian Assessment Group (Anon. 2023).

The methodology is described in the Benchmark report (ICES 2023). The changes from the previous model are described in section 10.3.3.

With no catch, the estimated median spawning stock size on 1 April 2024 is 785 000 tonnes (90% confidence interval: 392-1207 000 tonnes) (Figure 10.4), and the probability for the spawning stock to be above 200 000 tonnes is 99.8 %.

With a catch of 196 000 tonnes, the probability for the spawning stock in 2024 to be below 200 000 tonnes, is 5 % (Figure 10.4). The median spawning stock size in 2024 will then be 590 000 tonnes (90% confidence interval: 201-1011 000 tonnes), and the corresponding median modelled consumption by immature cod in the period January-March 2024 will then be 296 000 tonnes. Figure 10.5 shows the probability of SSB < 200 000 tonnes as a function of the catch.

As in previous years, the catch corresponding to 95% probability of being above 200 000 tonnes is calculated to the nearest 1000 tonnes.

For comparison, half-year predictions and quota advice was also calculated using the previous assessment model which gave a TAC advice of about 145 000 tonnes.

The 2022 estimate should be corrected based on the 2021 and 2023 estimates and such correction may be made in the future.

Summary plots for catch, stock size and recruitment are given in Figure 10.6.

Recruitment

The 0-group series was recalculated by WGIBAR in 2022 (ICES 2022). No 0-group estimate was yet available for 2023.

The 1-group abundance in 2023 in the area covered by the survey was 108.5 billion which is about half the long-term average (Table 10.4).

High abundance of young herring (mainly age groups 1 and 2) has been suggested to be an important but not a single factor causing recruitment failure in the capelin stock (Hjermann *et al.,* 2010; Gjøsæter *et al.* 2016). In 2022, high abundance of 0-group herring was observed during the BESS. Preliminary results from BESS 2023 shows some areas with high acoustic herring recordings, but no abundance estimates of herring in the Barents Sea for 2023 were available at the time of the 2023 capelin assessment.

1.4.3 - Benchmark results and changes from last year

An ICES benchmark meeting joint for the Iceland East Greenland Jan Mayen capelin and Barents Sea capelin (WKCAPELIN) was held in Reykjavik 21-25 November 2022 (ICES, 2023). The benchmark was held without Russian participation due to their suspension from ICES, but all information from the benchmark has been shared with Russian scientists. A summary of the main outcome relevant for Barents Sea capelin is given below. The benchmark treated issues related to monitoring and abundance estimation and stock projection model, and basis for the harvest control rule. The outcome regarding estimation of survey CV is described in section 10.3.1 and the outcome regarding the reference point and basis for the harvest control rule is discussed in section 10.4.

Swept area estimates of capelin near the bottom

Some capelin are present in the acoustic dead zone close to the bottom, and these are currently not included in the survey estimate. A method for adding capelin swept area estimates from demersal trawl to the acoustic estimate was

presented to WKCAPELIN, but it was not accepted by the benchmark group in its present form. There are strong outliers in the data with significant impact on the estimate, and the method for treating these outliers was not accepted by WKCAPELIN. A method for estimating the combined uncertainty from swept area and acoustic estimates must also be developed prior to possible implementation. These issues could be resolved in a revision earlier than the next benchmark meeting.

Selection of trawl stations to attain length distributions used for the acoustic estimate

In the BESS capelin are sampled using three platforms; 0-group trawl hauls at fixed positions, demersal trawl hauls at fixed positions and pelagic target hauls on significant acoustic recordings. There is currently no standard method for which trawl stations to include in order to obtain length distributions for the acoustic estimate. A contribution to WKCAPELIN showed the impact of using different selections of stations, both on the estimate and on consistency in age group composition in the time series. WKCAPELIN recommended to be careful with inclusion of length distributions from demersal trawl hauls since consistency then was poor, but a standard method could not be recommended since the outcome of all alternatives were not on the table at the WKCAPELIN meeting. This could be addressed in a revision earlier than the next benchmark meeting.

Capelin spawning survey

Presently only results from the annual Barents Sea ecosystem survey in autumn are used as input on capelin stock status for the assessment. A survey close to spawning and close to when the fishery happens can potentially reduce uncertainty in the assessment by eliminating some sources of uncertainty in the stock projection. Norway has conducted a capelin spawning survey from 2019-2023, and WKCAPELIN evaluated **t** he quality of the survey to be appropriate for advice, but there are issues with the survey coverage on the Russian side due to the present political situation, so no proposal to implement the survey results in the annual stock assessment and advice process was forwarded. WKCAPELIN recommended that results from the survey could be used as a fallback in case of failure of the autumn survey.

The 2023 survey was carried out 26 February–9 March 2023 using the fishing vessel ‘Vendla’ (Skaret et al. 2023). The surveying of the capelin spawning migration was successful and the estimate of ca. 275 000 tonnes with a CV of 0.35 was within the uncertainty range from the predictions made in the autumn 2022.

Estimating proportion maturing capelin

In the stock projection of maturing capelin from 1 October to 1 April next year, the proportion of maturing capelin relative to total amount of capelin must first be estimated. The proportion has been estimated as a function of capelin length where the parameters are P1 (intensity of maturation) and P2 (median 50% length at maturation). A likelihood function has been used in the estimation comparing abundance of immatures at age 2 and 3, respectively in year Y with abundance of all capelin at age 3 and 4, respectively in year Y+1, so a natural mortality parameter (P3) has also been used. P3 is kept fixed since the years 1972-1980 is used to estimate P1 and P2 and P3 for that period is assumed to be stable. A fixed P1 estimate of 3.5 has been used in the assessment, and 1000 replicates of P2 from CapTool based on a P2 estimate of 13.89 ± SD=0.075. The parameter settings of P1 and P2 were evaluated during WKCAPELIN, but no new estimates were made. The existing estimates are therefore kept the same, but a P2 of 14 cm and a high value of P1(resulting in a cut-off maturation length) should be consistently used for both stochastic stock projection and estimates of spawning stock on historical data (this has not been consistent before).

Estimating capelin mortality from 1 October to 1 January

Capelin mortality from 1 October to 1 January is based on estimates from survey data. Previously, replicates were estimated in Bifrost from observed abundance of immature capelin in the autumn survey at age 2 in year Y versus observed total abundance of capelin at age 3 in year Y+1 and observed abundance of immature capelin at age 3 in year Y versus observed total abundance of capelin at age 4 in year Y+1 using the maturation function parameters

described in the section above. From these estimates, a selection of annual estimates (The years 1980-1985, 1990-1993 and 1997-2002) were selected based on expert evaluation and included in the assessment. During WKCAPELIN it was agreed that autumn mortality should only be based on observed abundance of immatures in the autumn survey at age 2 in Year Y versus observed total abundance of capelin at age 3 in year Y+1. A cut-off at 14 cm is used to separate out maturing capelin. All years after 1987 (abnormal ecosystem state prior to this year due to NSS-herring collapse) are included, except years associated with the anomalous survey year 2016. No replicates are generated, simulations are based on random selection of estimated annual mortalities. For some years negative mortalities are estimated. These are also included to reflect that negative mortality can result from under-estimates of abundance at age in the autumn survey.

Capelin mortality from 1 January to 1 April (cod consumption)

Capelin natural mortality from 1 January to 1 April in the stock projection is modelled explicitly as consumption by immature cod. For WKCAPELIN, both the consumption model and the empirical cod consumption data used to fit the model were reviewed. Previously, cod consumption was based on a Type II predator-prey functional response. The functional response was fitted to empirical consumption through a likelihood optimization in Bifrost to estimate the parameter pair B_{max} (maximum consumption) and $B_{1/2}$ (prey biomass at half of the maximum consumption). 1000 replicas were estimated and used in CapTool, but the parameter values estimated unintendedly implied that for almost all replicas the functional response curve became one of Type I for the range of capelin biomass observed. In the annual assessment, pairs were selected randomly from the replicates for each simulation run. WKCAPELIN agreed that a Type III functional response with possibility for prey switching at low capelin levels was most appropriate to reflect cod consumption of capelin. The parameters are fitted to updated estimates of consumption based on annual estimates of consumption by cod as presented to ICES AFWG using the methodology described in Bogstad and Mehl (1997).

A cod component assumed to not feed on maturing capelin due to its northerly geographical distribution - the ‘Svalbard component’ was previously defined based on annual estimates of proportion of immature cod by age not overlapping with maturing capelin from 1983-2003. The estimates used a combination of surveys as proxies for the abundance of young cod off Svalbard during 1 January to 1 April. The ‘Svalbard component’ was updated for WKCAPELIN and is now based on winter survey data from 2014-2023.

The cod abundance in January-March is no longer calculated assuming mortality for cod; mortality and growth of cod in this period are assumed to cancel out.

Retrospective analysis

Gjøsæter *et al*. (2015) calculated what the quota advice and spawning stock would have been in the period 1991—2013, given the present assessment model and updated knowledge about the cod stock. They replaced the cod composition and abundance from the forecast with the updated data from the cod assessment model run later in time. When they reran the model, they showed that considerably smaller annual quotas would have been advised if the updated cod stock information had been known at the time of the assessment. Following from this work, a retrospective analysis of the capelin assessment as well as of the assessment performance should be included annually. This is a feature which so far has been missing from the capelin assessment.

1.5 - Reference points

A B_{lim} (SSB_{lim}) management approach has been suggested for this stock (Gjøsæter *et al.,* 2002). In 2002, the JNRFC agreed to adopt a management strategy based on the rule that, with 95% probability, at least 200 000 tonnes of capelin should be allowed to spawn. Consequently, 200 000 tonnes was used as a B_{lim}. Alternative harvest control rules of 80, 85 and 90% probability of SSB > B_{lim} were suggested by JNRFC and evaluated by ICES (ICES 2016). ICES considers these rules not to be precautionary. At its 2016 meeting, JNRFC decided not to change the adopted management strategy.

The B_{lim} used up until present is based on SSB in 1989 (estimated to 96 000 tonnes) with an uncertainty buffer added (SSB + uncertainty buffer assumed to add up to 200 000 tonnes). The SSB in 1989 is the lowest in the time series which resulted in good recruitment.

In WKCAPELIN it was considered that B_{lim} should not be based on years which are affected by the NSS-herring collapse in the Barents Sea, like is the case for 1989. Among the included years, 1990 (68 000 tonnes) had the lowest estimated SSB that still produced an above average recruitment.

The procedure of including an uncertainty buffer to B_{lim} like it was done previously, was not accepted by WKCAPELIN. Separate terms for the biological reference point (B_{lim}) and the reference point used in the harvest control rule ($B_{escapement}$) were therefore introduced. A $B_{escapement}$ of 200 000 tonnes was evaluated to still be precautionary by WKCAPELIN, but it has not been evaluated whether it would be precautionary to set $B_{escapement}$ lower, potentially as low as B_{lim}. This year's advice is thus based on a $B_{escapement}$ of 200 000 tonnes, as in previous years.

1.6 – References

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Table 10.1. Barents Sea capelin. International catch ('000 t) as used by the Working Group.

Year	Winter-Spring				Summer-Autumn			Total
	Norway	**Russia**	**Others**	**Total**	**Norway**	**Russia**	**Total**	
1965	217	7	0	224	0	0	0	224
1966	380	9	0	389	0	0	0	389
1967	403	6	0	409	0	0	0	409
1968	460	15	0	475	62	0	62	537
1969	436	1	0	437	243	0	243	680
1970	955	8	0	963	346	5	351	1314
1971	1300	14	0	1314	71	7	78	1392
1972	1208	24	0	1232	347	13	360	1591
1973	1078	34	0	1112	213	12	225	1337
1974	749	63	0	812	237	99	336	1148
1975	559	301	43	903	407	131	538	1441
1976	1252	228	0	1480	739	368	1107	2587
1977	1441	317	2	1760	722	504	1226	2986
1978	784	429	25	1238	360	318	678	1916
1979	539	342	5	886	570	326	896	1782
1980	539	253	9	801	459	388	847	1648
1981	784	429	28	1241	454	292	746	1986
1982	568	260	5	833	591	336	927	1760
1983	751	373	36	1160	758	439	1197	2357
1984	330	257	42	629	481	368	849	1477
1985	340	234	17	591	113	164	277	868
1986	72	51	0	123	0	0	0	123
1987-1990	0	0	0	0	0	0	0	0
1991	528	159	20	707	31	195	226	933
1992	620	247	24	891	73	159	232	1123
1993	402	170	14	586	0	0	0	586
1994-1996	0	0	0	0	0	0	0	0
1997	0	0	0	0	0	1	1	1
1998	0	2	0	2	0	1	1	3
1999	50	33	0	83	0	22	22	105
2000	279	94	8	381	0	29	29	410

2001	376	180	8	564	0	14	14	578
2002	398	228	17	643	0	16	16	659
2003	180	93	9	282	0	0	0	282
2004	0	0	0	0	0	0	0	0
2005	1	0	0	1	0	0	0	1
2006	0	0	0	0	0	0	0	0
2007	2	2	0	4	0	0	0	4
2008	5	5	0	10	0	2	0	12
2009	233	73	0	306	0	1	1	307
2010	246	77	0	323	0	0	0	323
2011	273	87	0	360	0	0	0	360
2012	228	68	0	296	0	0	0	296
2013	116	60	0	177	0	0	0	177
2014	40	26	0	66	0	0	0	66
2015	71	44	0	115	0	0	0	115
2016-2017	0	0	0	0	0	0	0	0
2018	129	66	0	195	0	0	0	195
2019-2021	0	0	0	0	0	0	0	0
2022	42	23	0	65	0	0	0	65
2023	38	23	0	61				

Table 10.2a. Barents Sea capelin. Age-length distribution of Norwegian catch in 2023 (million individuals). Lengths in cm.

Length group (cm)	Age 3	Age 4	Age 5	Total	%
12.5-12.9	4.0	0.0	0	4	0.2
13.0-13.4	0.0	5.0	0	5	0.3
13.5-13.9	15.0	23.0	0	38	2.0
14.0-14.4	0.0	67.0	6	73	3.9
14.5-14.9	11.0	150.0	0	161	8.7
15.0-15.4	14.0	286.0	14	314	16.9
15.5-15.9	16.0	218.0	6	240	12.9
16.0-16.4	32.0	371.0	20	423	22.8
16.5-16.9	4.0	250.0	26	280	15.1
17.0-17.4	0.0	137.0	12	149	8.0
17.5-17.9	0.0	116.0	4	120	6.5
18.0-18.4	3.0	30.0	3	36	1.9
18.5-18.9	0.0	7.0	0	7	0.4
19.0-19.4	0.0	7.0	1	8	0.4
Total	99.0	1667.0	92	1858	
%	5.3	89.7	5		100.0

Table 10.2b. Barents Sea capelin. Age-length distribution of Russian catch in 2023 (million individuals). Lengths in cm.

Length group (cm)	Age 2	Age 3	Age 4	Age 5	Total	%
9.0-9.9	3.6	0.0	0.0	0.0	3.6	0.3
10.0-10.9	3.7	0.0	0.0	0.0	3.7	0.3
11.0-11.9	6.0	6.0	0.0	0.0	12.0	0.9
12.0-12.9	0.0	13.3	0.0	0.0	13.3	1.0
13.0-13.9	0.0	69.3	53.3	0.0	122.7	8.8
14.0-14.9	0.0	101.6	298.8	3.0	403.3	28.9
15.0-15.9	0.0	39.4	300.8	0.0	340.2	24.4
16.0-16.9	0.0	28.0	300.0	3.3	331.3	23.7
17.0-17.9	0.0	3.6	111.9	3.6	119.1	8.5
18.0-18.9	0.0	0.0	23.6	0.0	23.6	1.7
19.0-19.9	0.0	0.0	23.6	0.0	23.6	1.7
Total	13.3	261.3	1111.9	9.9	1396.4	
%	1.0	18.7	79.6	0.7		100.0

Table 10.3. Barents Sea capelin. Stock size estimation table. Estimated stock size (10^9) by age and length, and biomass (1000 tonnes) from the acoustic survey in August-October 2023. TSN: Total stock number. TSB: Total stock biomass. MSN: Maturing stock number. MSB: Maturing stock biomass.

Length (cm)	Age/year class					Sum (10^9)	Biomass (10^3 t)	Mean weight (g)
	1	2	3	4	5			
	2022	2021	2020	2019	2018			
6.5-7.0	0.173					0.173	0.197	1.14
7.0-7.5	1.053	0.168				1.220	1.732	1.42
7.5-8.0	2.935	0.197				3.132	6.226	1.99
8.0-8.5	7.824	0.821				8.645	19.166	2.22
8.5-9.0	10.031	0.441				10.472	28.753	2.75
9.0-9.5	11.895	0.343				12.239	38.300	3.13
9.5-10.0	15.166	0.100				15.266	58.947	3.86
10.0-10.5	15.113	0.237				15.350	66.819	4.35
10.5-11.0	14.850	0.210				15.060	75.302	5.00
11.0-11.5	14.627	2.217				16.844	96.126	5.71
11.5-12.0	9.244	11.066	1.106			21.416	142.779	6.67
12.0-12.5	2.476	14.645	8.525	0.120		25.766	190.014	7.37
12.5-13.0	2.061	20.894	15.808	0.451		39.214	319.756	8.15
13.0-13.5	0.534	10.955	16.114	1.694		29.297	284.996	9.73
13.5-14.0	0.449	7.195	20.654	1.733		30.031	336.677	11.21
14.0-14.5	0.077	2.821	11.868	1.824		16.590	210.570	12.69
14.5-15.0		4.040	13.968	4.695	0.026	22.728	326.778	14.38
15.0-15.5		1.427	7.052	2.905		11.384	188.548	16.56
15.5-16.0		0.834	3.502	2.346	0.050	6.732	124.438	18.48
16.0-16.5		1.263	5.046	3.908	0.078	10.296	212.606	20.65
16.5-17.0		0.323	2.099	1.609	0.046	4.077	98.024	24.05

Length (cm)	Age/year class					Sum (10)	Biomass (10 t)	Mean weight (g)
	1	2	3	4	5			
	2022	2021	2020	2019	2018			
17.0-17.5		0.087	0.974	1.431		2.492	67.225	26.98
17.5-18.0			0.409	0.789		1.198	35.026	29.23
18.0-18.5			0.214	0.271		0.484	15.342	31.68
18.5-19.0			0.094	0.085		0.179	6.115	34.13
19.0-19.5				0.030		0.030	1.219	41.00
TSN (10^9)	108.509	80.283	107.433	23.890	0.200	320.315		
TSB (10^3 t)	480.567	723.410	1324.193	419.405	4.103		2951.679	
Mean length (cm)	9.90	12.58	13.73	15.08	15.80			
Mean weight (g)	4.43	9.01	12.33	17.56	20.51			9.21
SSN (10^9)	0.077	10.794	45.226	19.893	0.200	76.190		
SSB (10^3 t)	0.982	169.123	735.870	375.882	4.018		1285.890	

Table 10.4. Barents Sea capelin. Stock size in numbers by age, total stock biomass, biomass of the maturing component (MSB) at 1. October. The stock numbers for 2004-2021 are updated following the data evaluation workshop in 2021, and the subsequent WKCAPELIN benchmark in 2022. The comparison with previous estimates is presented in detail in Annex 3 number BS0 in the WKCAPELIN benchmark report (ICES, 2023).

Year	Stock in numbers (10^9)						Biomass (10^3 tonnes)	
	Age 1	Age 2	Age 3	Age 4	Age 5	Total	Total	MSB
1973	528	375	40	17	0	961	5144	1350
1974	305	547	173	3	0	1029	5733	907
1975	190	348	296	86	0	921	7806	2916
1976	211	233	163	77	12	696	6417	3200
1977	360	175	99	40	7	681	4796	2676
1978	84	392	76	9	1	561	4247	1402
1979	12	333	114	5	0	464	4162	1227
1980	270	196	155	33	0	654	6715	3913
1981	403	195	48	14	0	660	3895	1551
1982	528	148	57	2	0	735	3779	1591
1983	515	200	38	0	0	754	4230	1329
1984	155	187	48	3	0	393	2964	1208
1985	39	48	21	1	0	109	860	285
1986	6	5	3	0	0	14	120	65
1987	38	2	0	0	0	39	101	17
1988	21	29	0	0	0	50	428	200
1989	189	18	3	0	0	209	864	175
1990	700	178	16	0	0	894	5831	2617
1991	402	580	33	1	0	1016	7287	2248
1992	351	196	129	1	0	678	5150	2228
1993	2	53	17	2	2	75	796	330

1994	20	3	4	0	0	28	200	94
1995	7	8	2	0	0	17	193	118
1996	82	12	2	0	0	96	503	248
1997	99	39	2	0	0	140	911	312
1998	179	73	11	1	0	263	2056	931
1999	156	101	27	1	0	285	2776	1718
2000	449	111	34	1	0	595	4273	2099
2001	114	219	31	1	0	364	3630	2019
2002	60	91	50	1	0	201	2210	1290
2003	82	10	11	1	0	104	533	280
2004	61	17	4	1	0	83	513	224
2005	17	21	3	0	0	42	487	348
2006	51	17	5	0	0	73	636	348
2007	195	50	6	0	0	251	1816	846
2008	289	198	24	0	0	512	3950	2185
2009	172	149	48	0	0	368	3247	1892
2010	242	137	67	2	0	448	3824	2248
2011	194	173	58	8	0	433	3604	2059
2012	175	117	88	3	0	383	3457	1996
2013	321	197	68	12	0	598	3973	1725
2014	103	81	37	2	0	223	1689	785
2015	39	42	13	1	0	95	882	434
2016	33	8	2	0	0	43	317	153
2017	115	119	14	0	0	249	2428	1547
2018	59	61	22	0	0	142	1641	1100
2019	18	10	7	1	0	36	413	302
2020	370	31	4	1	0	406	1890	542
2021	222	326	7	0	0	556	3986	1459
2022*	75	136	58	1	0	270	2174	817
2023	109	80	107	24	0	320	2958	1286

***Not adjusted for incomplete area coverage**

Table 10.5. Barents Sea capelin. CV by age group of the acoustic estimates shown in Table 10.4, for the period 2004-2023. The CV estimates for 2022 are not included due to the poor survey coverage.

Year	CV age 1	CV age 2	CV age 3	CV age 4
2004	0.253	0.235	0.225	0.513
2005	0.319	0.332	0.375	0.508
2006	0.301	0.240	0.344	0.705
2007	0.197	0.232	0.331	0.665
2008	0.228	0.198	0.302	0.634
2009	0.455	0.370	0.453	1.680

Year	CV age 1	CV age 2	CV age 3	CV age 4
2010	0.163	0.224	0.199	0.288
2011	0.231	0.205	0.276	0.463
2012	0.210	0.314	0.335	0.605
2013	0.132	0.127	0.138	0.267
2014	0.237	0.213	0.237	0.331
2015	0.235	0.252	0.234	0.364
2016	0.167	0.237	0.305	0.491
2017	0.182	0.099	0.123	0.407
2018	0.288	0.255	0.276	0.441
2019	0.138	0.322	0.355	0.405
2020	0.241	0.269	0.338	0.501
2021	0.168	0.102	0.299	1.301
2022				
2023	0.280	0.170	0.170	0.200

Figure 10.1. Survey coverage and geographical distribution of acoustic recordings of capelin in autumn 2023. The size of the circles corresponds to nautical acoustic scattering coefficient (NASC; m^2/nmi^2) per 1 nautical mile. Gray dots mark transects or transect sections without capelin recordings.

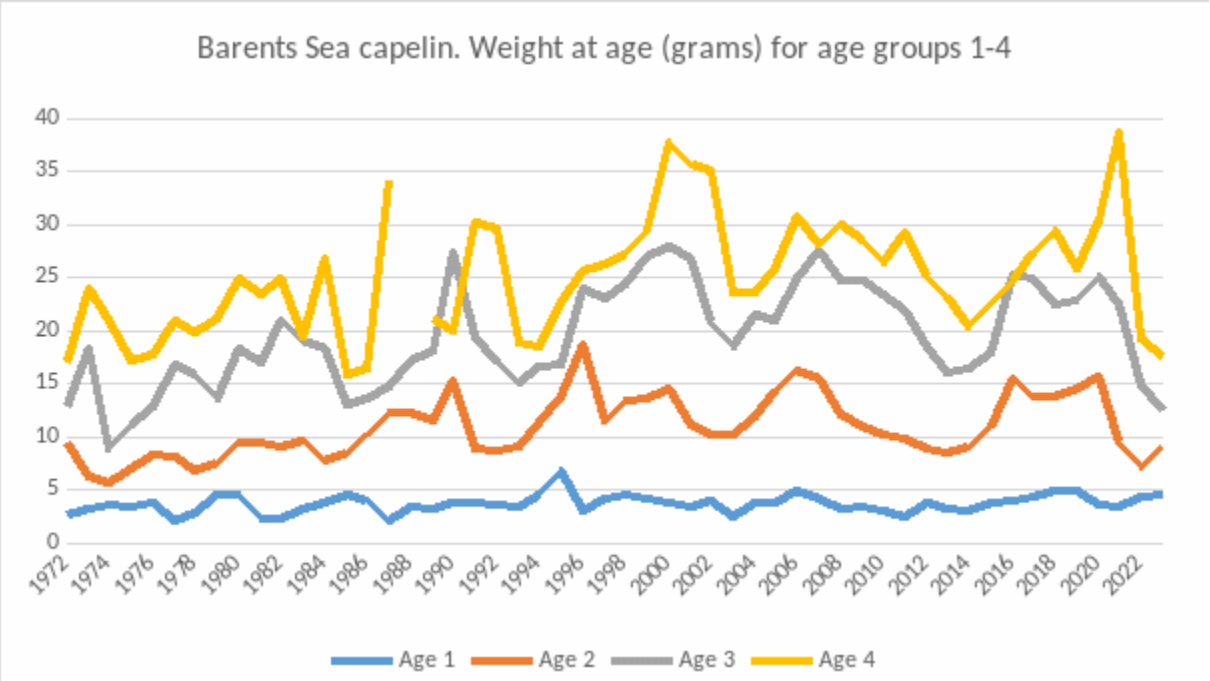

Figure 10.2. Weight-at-age (grams) for capelin from the autumn survey.

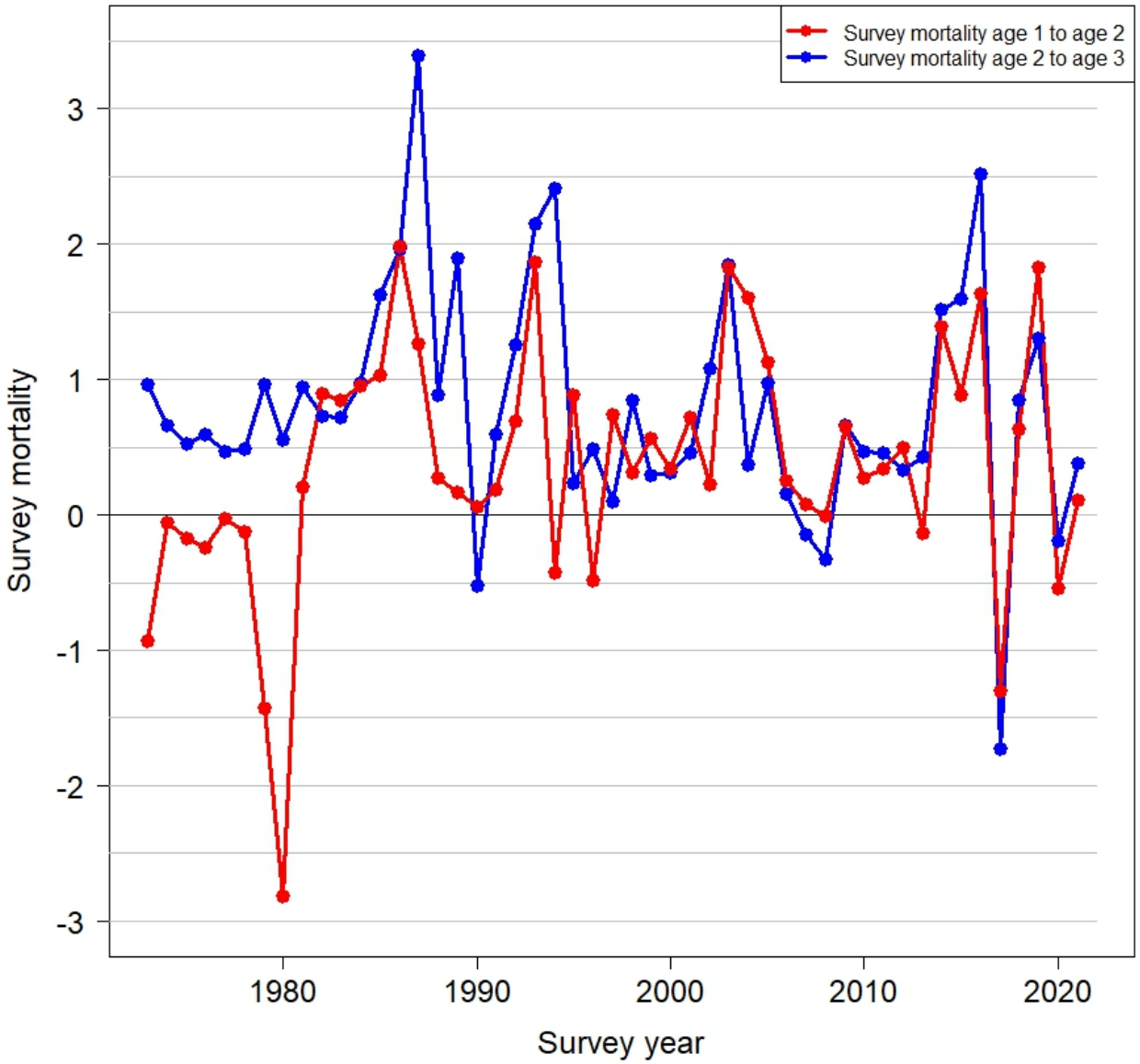

Figure 10.3. Survey mortality by survey year. Survey mortality is calculated as -log((N_{total} at age a+1 in year y+1 + catch of immatures in year y and year y+1)/$N_{immatures}$ at age a in year y). Capelin >14 cm are assumed to be maturing.

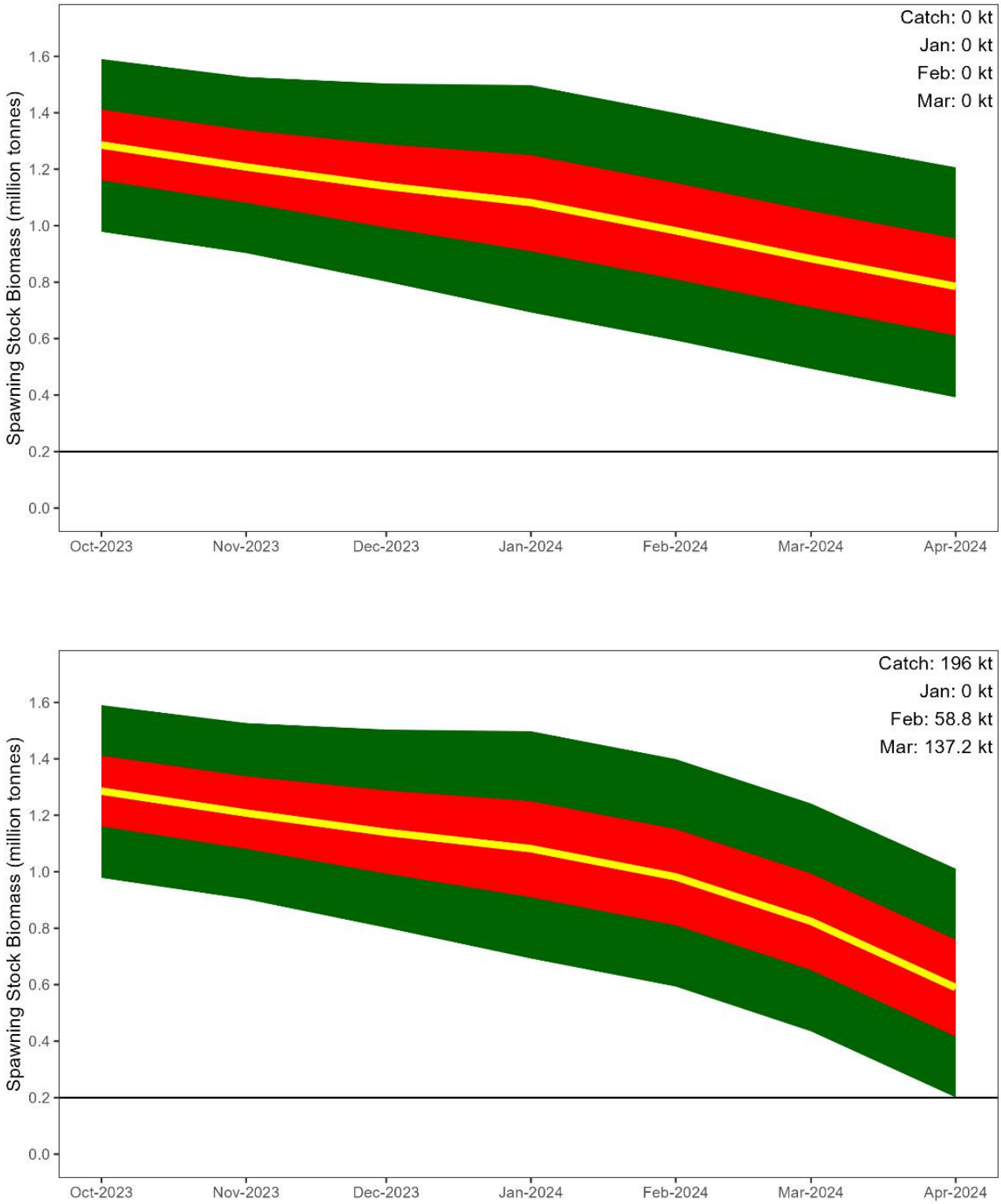

Figure 10.4. Probabilistic prognosis 1 October 2023—1 April 2024 for Barents Sea capelin maturing stock, with a catch of 0 tonnes (upper panel) and 196 000 tonnes (lower panel). Yellow line shows median, red area shows 25-75 percentiles and green area 5-95 percentiles. The prognosis is based on 50000 simulations.

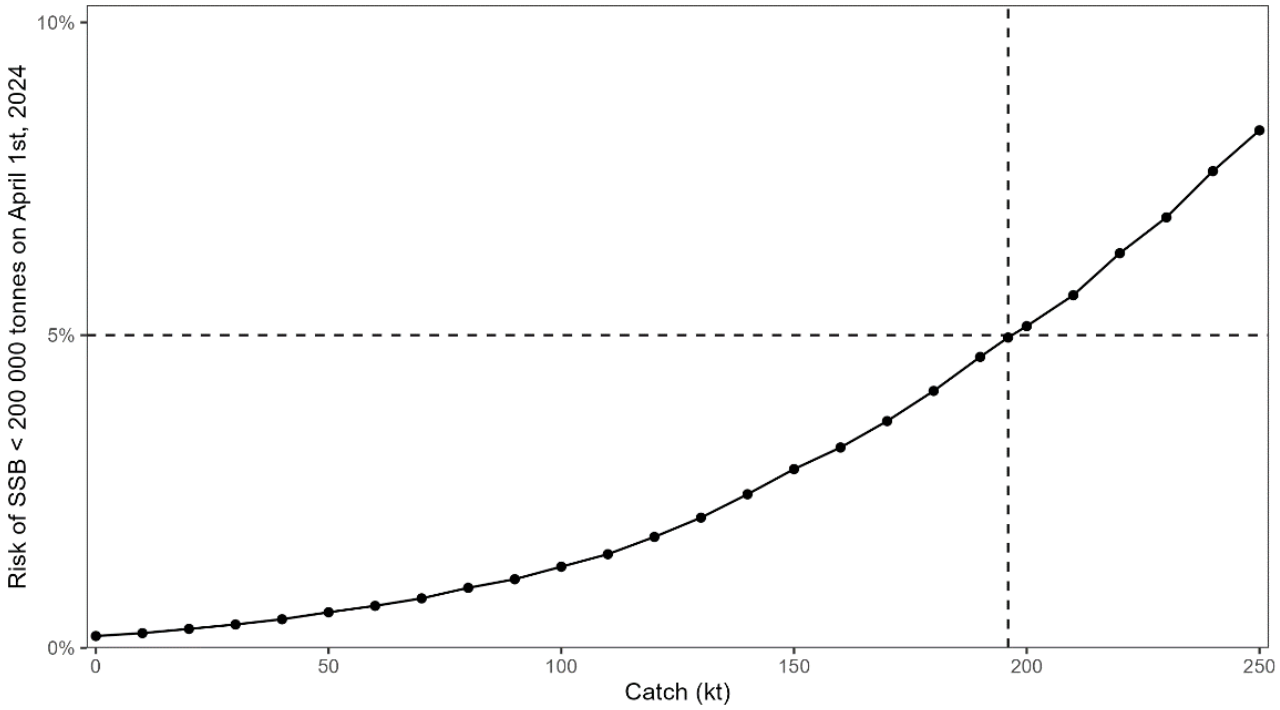

Figure 10.5. Probability of SSB 2024 < 200 000 tonnes as a function of the catch. Calculated for each 10 kt.

Figure 10.6. Capelin in subareas 1 and 2, excluding Division 2a west of 5°W (Barents Sea capelin). Catch, recruitment and summary of stock assessment (mature and immature stock biomass October 1 and SSB April 1 in tonnes). The 2022 estimate of maturing and immature stock biomass has not been corrected for incomplete survey coverage.

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