GREATER SILVER SMELT

Argentina silus

GENERAL INFORMATION

Greater silver smelt is a rather small silvery bathypelagic species that can form large schools close to the seafloor mainly at depths >500 m. In Icelandic waters it can live to around 26 years old. Juveniles tend to aggregate in shallower depths. Greater silver smelt mainly feed on zooplankton (e.g., euphausiids, amphipods, and copepods) or small nekton (e.g., squids, jellyfish, or fish).

THE FISHERY

LANDINGS TRENDS

Landings of greater silver smelt are presented in Table 1 and Figure 1. Since directed fishery started in 1997–1998, the landings increased from 800 t in 1996 to 13000 t in 1998. Between 1999 and 2007 catches varied between 2600 to 6700 t. Since 2008 landings have increased substantially, from 4200 t in 2007 to almost 16500 t in 2010. In 2011 landings started to decrease due to increased management actions, and landings in 2022 amounted to approximately 6914 tonnes in Icelandic and Greenlandic waters. Substantial landings were reported in Greenlandic waters in 2017 and 2018; however, these exploratory directed fisheries appear to have ceased in 2019 but should be monitored for re-appearance.

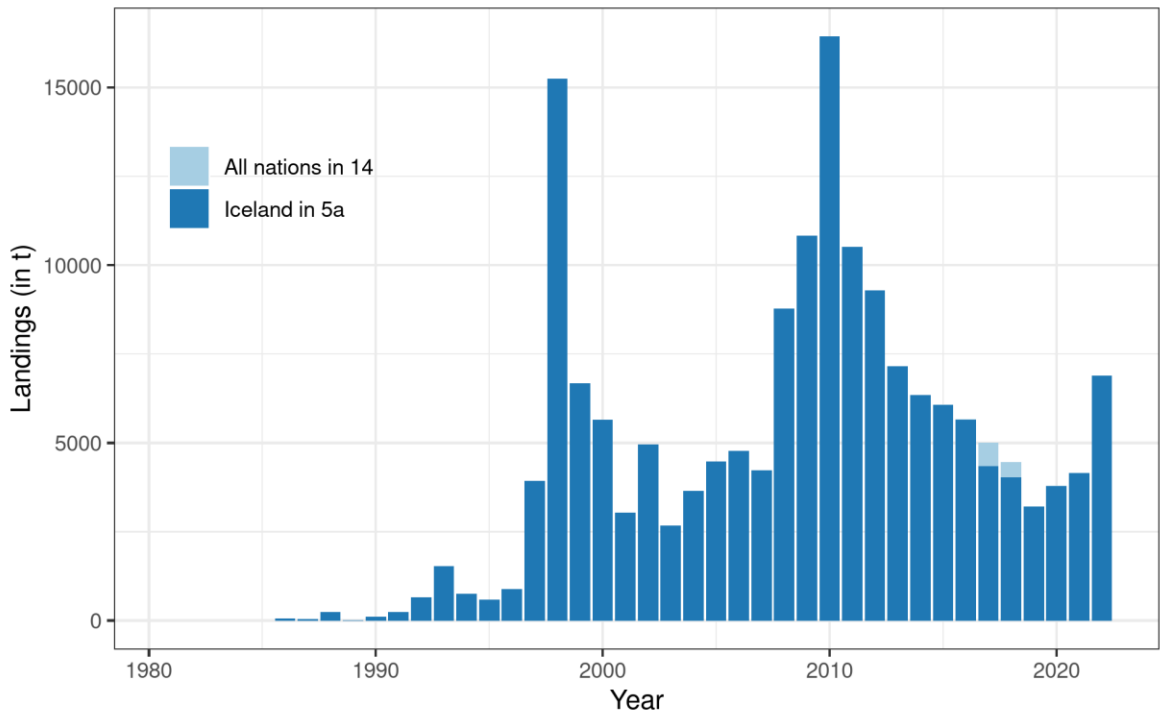

Figure 1. Greater silver smelt in Icelandic (5a) waters and Greenland Sea (14). Nominal landings.

Table 1. Greater silver smelt in Icelandic waters. Information on the fleet reporting catches of greater silver smelt.

YEAR	NUMBER TRAWLERS	NUMBER HAULS	REPORTED CATCH (KG)	NO. HAULS WHICH GSS >50% OF CATCH	PROPORTION OF REPORTED CATCH IN HAULS WERE GSS >50%
1997	26	854	2257	384	0.846
1998	39	2587	11132	1968	0.955
1999	24	1451	4456	824	0.865
2000	23	1263	3491	643	0.827
2001	26	767	1577	255	0.715
2002	32	1134	3127	504	0.777
2003	30	1127	1965	253	0.538
2004	27	1017	2688	340	0.705
2005	30	1368	3520	361	0.732
2006	31	1542	3725	395	0.715
2007	26	1259	3440	461	0.759
2008	31	3143	8428	863	0.663
2009	34	3434	10233	1010	0.694
2010	36	4724	16280	1836	0.740
2011	34	3244	10155	973	0.723
2012	31	3334	9732	985	0.713
2013	31	2704	7192	618	0.651
2014	24	2336	6157	487	0.614
2015	24	1836	5312	334	0.600
2016	26	2090	5708	387	0.596
2017	21	1347	4344	241	0.593
2018	20	1424	3876	216	0.481
2019	28	1169	2570	143	0.560
2020	25	1170	2968	174	0.475
2021	27	1166	3439	189	0.663
2022	18	782	2803	223	0.735

Greater silver smelt is mostly fished along the south and southwest coast of Iceland, at depths between 500 and 800 m, as targeted fishing is only allowed at depths greater than 400 m (Figure 2). Greater silver smelt has been caught in bottom trawls for years as a bycatch in the redfish fishery. Only small amounts were reported prior to 1996 as most of the greater silver smelt was discarded. However, discarding is not considered significant because of the relatively large mesh size used in the redfish fishery. Since 1997, a directed fishery for greater silver smelt has been ongoing. This caused the landings to increase significantly in the past with the highest amount recorded in 2010, despite relatively low recent levels (Table 1).

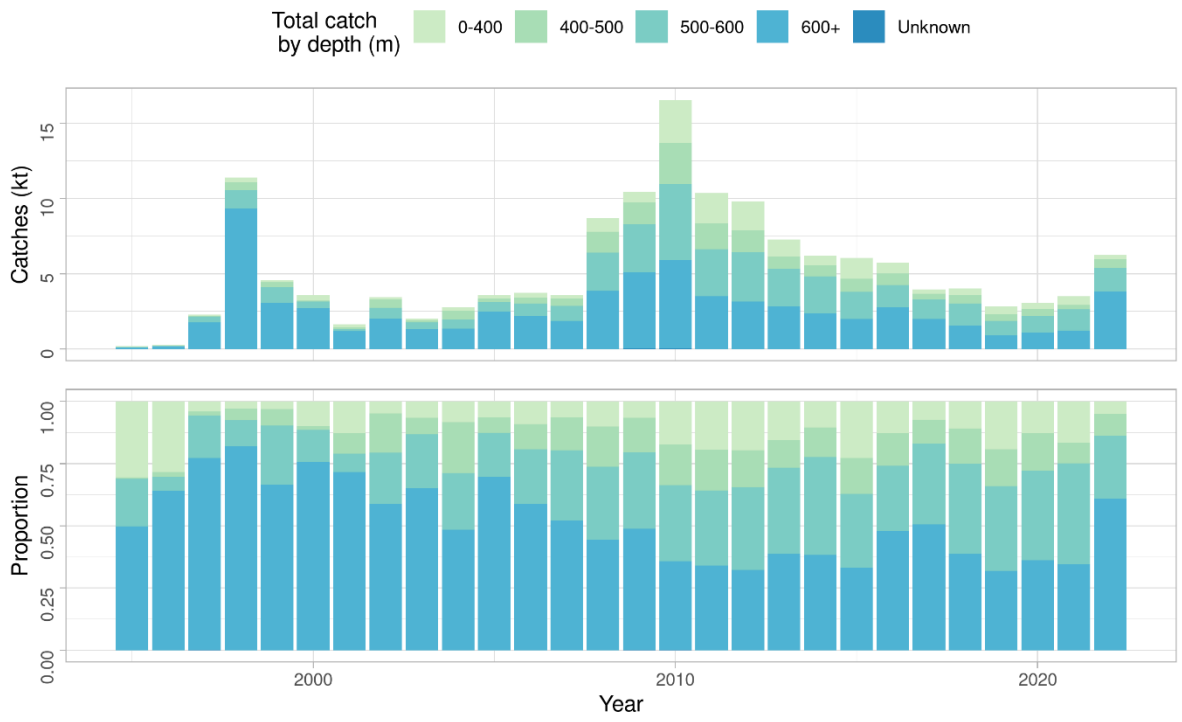

Figure 2. Greater silver smelt. Depth distribution of catches according to logbooks by the Icelandic fleet. All gears combined.

FLEETS

Since 1996 between 20 and 40 trawlers have annually reported catches of greater silver smelt in Icelandic waters (Table 1). The trawlers participating in the greater silver smelt fishery also target redfish (*Sebastes norvegicus* and *S. mentella*) and to lesser extent Greenland halibut and blue ling. Number of hauls peaked in 2010, but the number of hauls has decreased since then in line with lower total catches. In most years over 50% of the greater silver smelt catches are taken in hauls where the species is more than 50% of the catch (Table 1).

TARGETING AND MIXED FISHERIES ISSUES IN THE GREATER SILVER SMELT FISHERY IN ICELANDIC WATERS

MIXED FISHERIES ISSUES: SPECIES COMPOSITION IN THE FISHERY

Redfish spp. (*Sebastes norvegicus* and *S. mentella*) are the main bycatch species in the mixed fishery encompassing greater silver smelt. Other species of lesser importance are Greenland halibut, blue ling and ling. Other species than these rarely exceed 10% of the bycatch in the greater silver smelt fishery in Icelandic waters (Table 2).

Table 2. Greater silver smelt in Icelandic waters. Proportional bycatch species composition where greater silver smelt was more than 50% of the total catch in a haul.

YEAR	REDFISH		GREENLAND HALIBUT	LING	BLUE LING	OTHER
	S. norvegicus	*S. mentella*				
1997	1.4	79	0.0	6.9	7.2	5.5
1998	5.3	77.9	0.0	3.6	6.4	6.8
1999	4	79.9	0.0	2.5	5.9	7.6
2000	4.8	71	0.2	0.3	9.7	14.1
2001	22.4	55.4	4.5	0.5	0.9	16.3
2002	16.9	74.2	0.4	1.2	4.0	3.2
2003	37.7	52	0.4	0.1	5.1	4.7
2004	25.1	68.4	0.7	0.1	0.9	4.8
2005	15.6	69.5	4.3	1.4	3.0	6.2
2006	28.8	59.8	1.4	0.9	1.0	8.1
2007	12.1	70.9	5.9	0.3	6.1	4.6
2008	26.7	60.8	2.8	1.2	5.0	3.4
2009	20.9	63.7	3.3	0.2	7.9	4.1
2010	16	63.7	2.0	0.9	6.4	11.1
2011	13.4	66.3	2.2	0.4	4.8	12.9
2012	8.9	67.5	1.3	0.2	7.5	14.5
2013	9.6	63.8	4.7	0.2	9	12.8
2014	2.4	78.3	2.8	0.3	5.5	10.7
2015	13.8	67.1	3.1	0.3	4.2	11.7
2016	10.9	73.5	5.5	0.2	2.8	7.1
2017	2.9	85.6	1.6	0.2	2.9	6.8
2018	4.7	87.7	2.1	0.1	1.6	4.0
2019	7.8	81.1	1.8	0.2	0.6	7.0
2020	5.6	87.5	1.7	0.1	0.9	4.2
2021	4.5	27.9	2.2	0.1	0.6	3.3
2022	2.8	30.3	1	0	1.3	2.2

SPATIAL DISTRIBUTION OF CATCHES THROUGH TIME

Spatial distribution of catches in 1995–2022 is presented in Figures 3 and 4. Most of the catches have been from the southern edge of the Icelandic shelf. In the period, a gradual relative increase is seen in the southwestern area and a gradual decrease in the southeastern area.

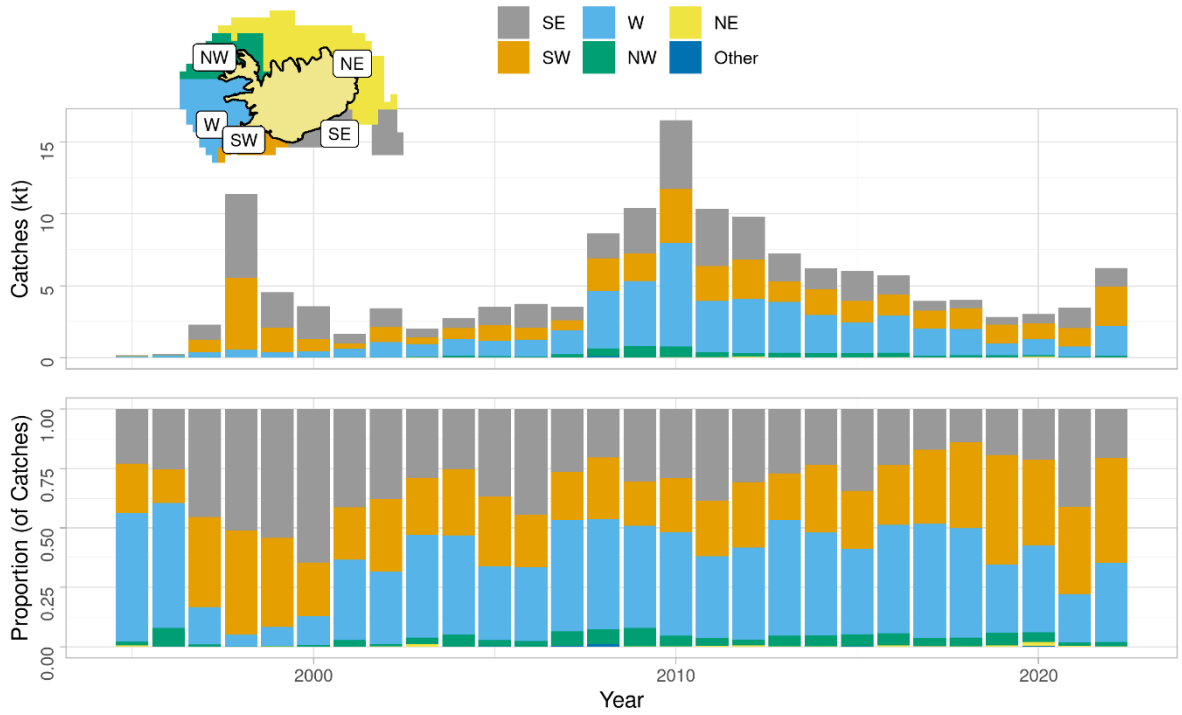

Figure 3. Greater silver smelt in Icelandic waters. Catch distribution and proportions by area according to logbooks.

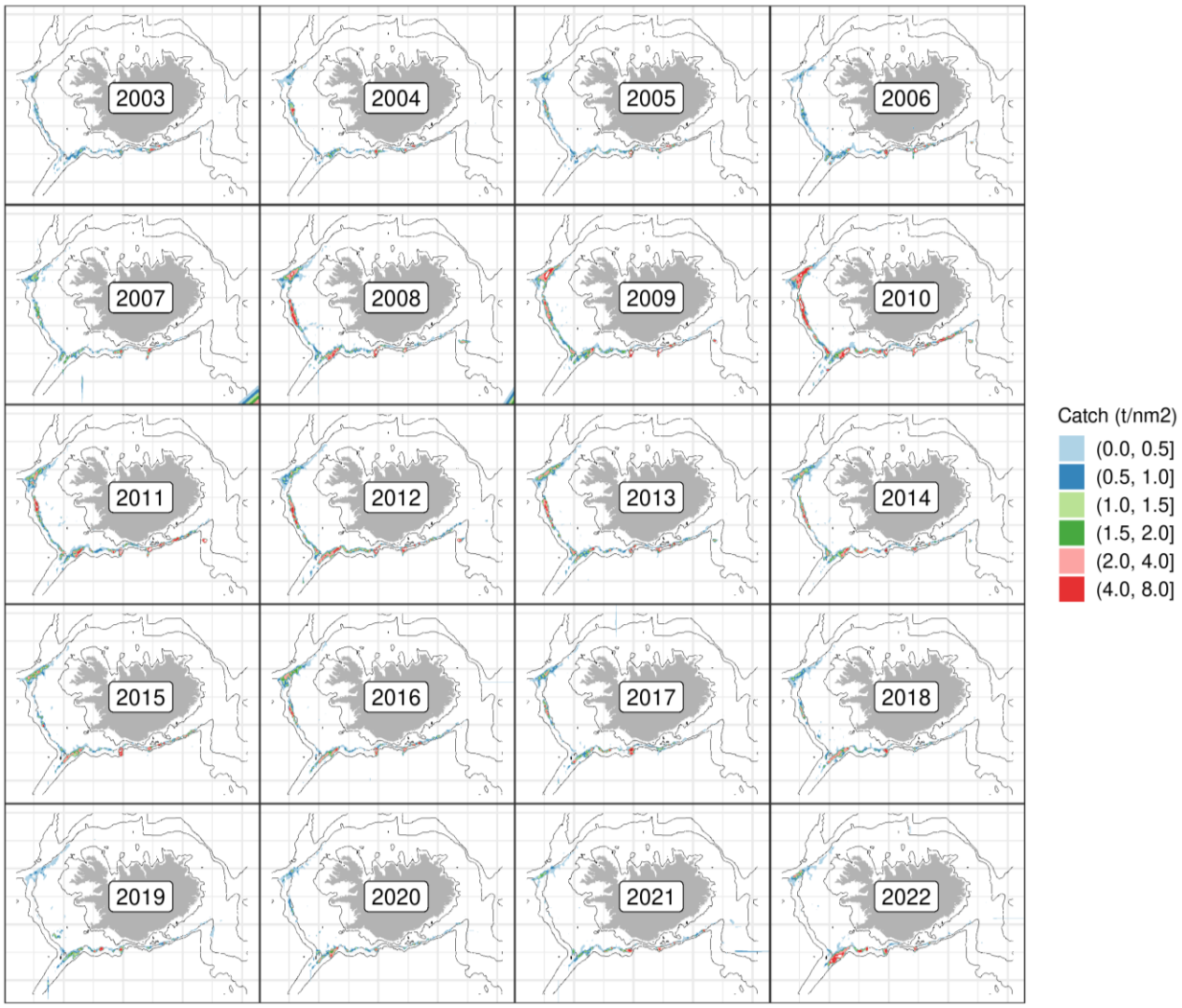

Figure 4. Greater silver smelt in Icelandic waters. Spatial distribution of catches as reported in logbooks.

Table 3. Greater silver smelt. Landings (tonnes) records from the Icelandic directorate of Fisheries and Greenland (WGDEEP:WD05).

YEAR	CATCHES		
	Section 5.a	Section 14.b	TOTAL
1988			240
1989			8
1990			113
1991			246
1992			657
1993			1526
1994			756
1995			586
1996			881
1997			3935
1998			15242
1999			6681
2000			5657
2001			3043
2002			4960
2003			2680
2004			3645
2005			4482
2006			4769
2007			4227
2008			8778
2009			10828
2010			16428
2011			10516
2012			9289
2013	7155		7155
2014	6344	4	6348
2015	6058	12	6070
2016	5646	16	5662
2017	4344	666	5010
2018	4035	425	4460
2019	3209	1	3210
2020	3775	22	3797
2021	4140	15	4155
2022	6886	28	6914

DATA AVAILABLE

In general, sampling from commercial catches is considered representative of the stock, as one of the requirements of owning a fishing license for greater silver smelt is the retention of scientific samples (Table 4). Samples were only obtained from bottom trawls. The sampling does seem to cover the spatial and temporal distribution of catches. The sampling coverage in 2022 is shown in Figure 5, but in recent years there has been a large decline in sampling. No age data were collected in 2019.

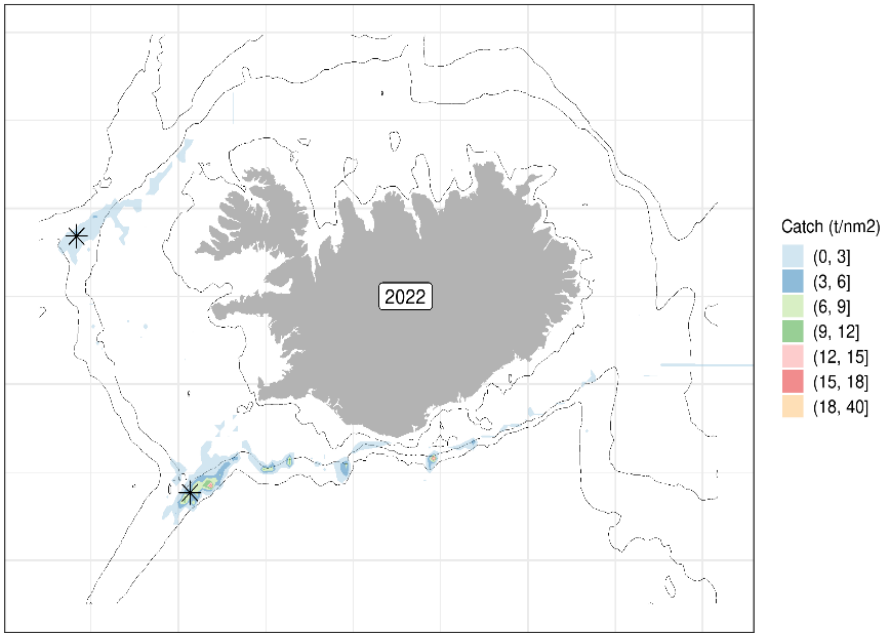

Figure 5: Greater silver smelt. Fishing grounds in 2022 as reported in logbooks and positions of samples taken from landings (asterisks).

LANDINGS AND DISCARDS

Landings by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Discarding is banned in Icelandic waters, and currently there is no available information on greater silver smelt discards. It is however likely that unknown quantities of greater silver smelt were discarded prior to 1996.

LENGTH COMPOSITIONS

Table 4 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in Icelandic waters. Length distributions from autumn survey and commercial samples are presented in Figures 6 and 7, respectively. Length distributions from the autumn survey are rather stable, with 2022 being close to the long-term average (Figure 6).

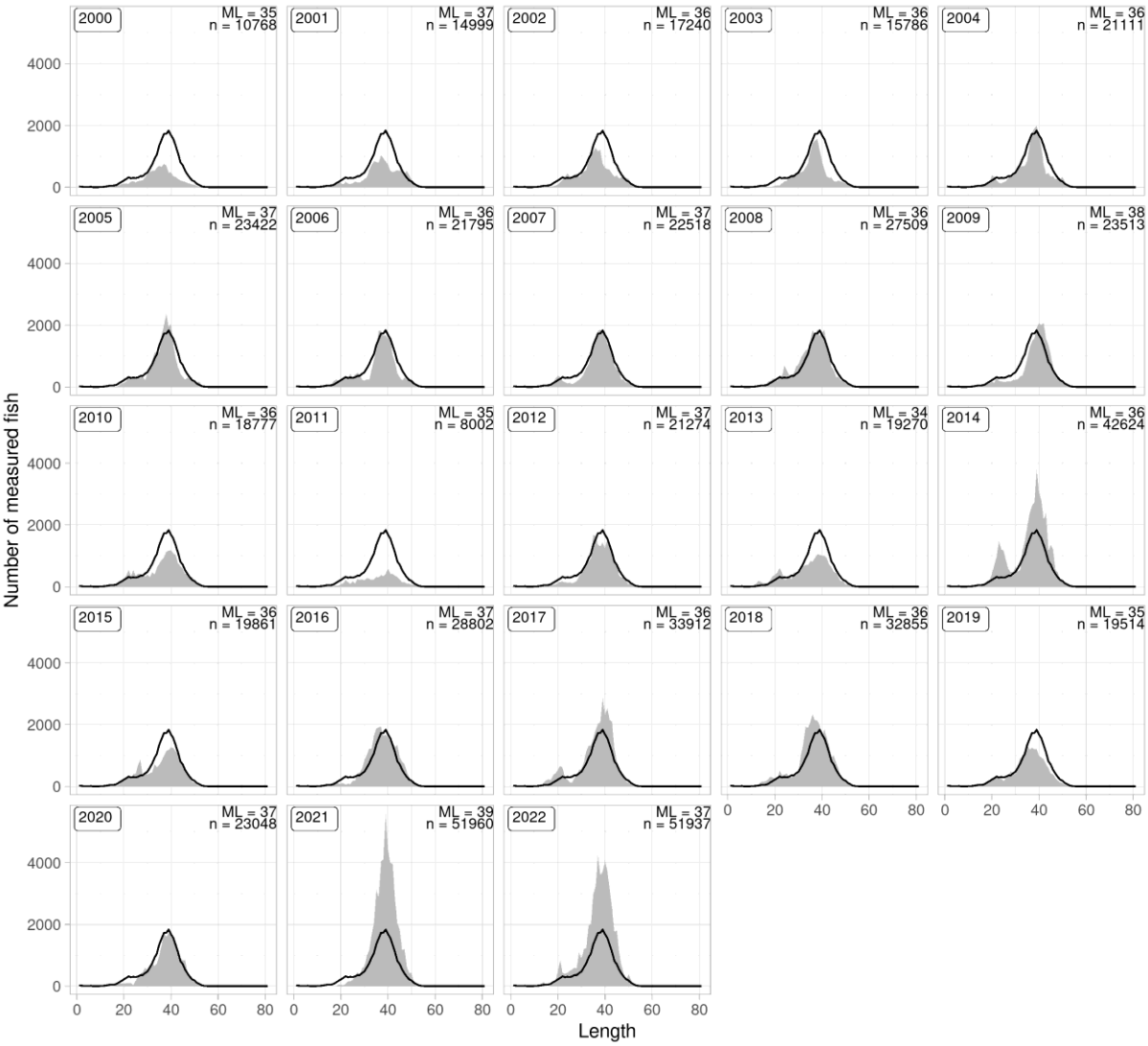

Figure 6. Greater silver smelt. Length distribution from the autumn survey (grey area) and mean length distribution (black line).

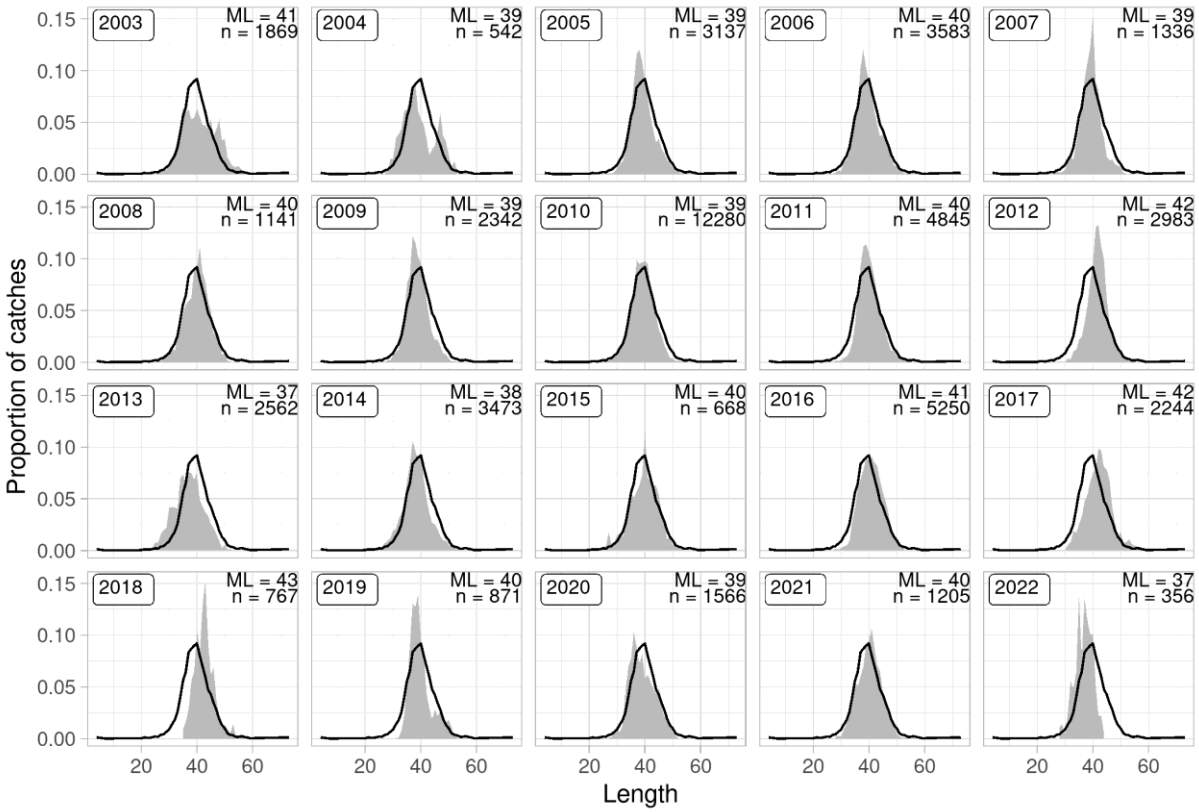

Figure 7. Greater silver smelt. Relative length distributions from Icelandic commercial bottom trawl catches.

AGE COMPOSITIONS

Table 4 gives the number of samples and measurements available for calculations of catch in numbers of greater silver smelt in Icelandic waters. Age distributions from the autumn survey in Figure 8 and estimated as catch in numbers are given in Figure 9.

Table 4. Greater silver smelt in Icelandic waters. Summary of sampling intensity and overview of available data.

YEAR	NO. LENGTH SAMPLES	NO. LENGTH MEASUREMENTS	NO. OTOLITH SAMPLES	NO. OTOLITHS	NO. AGED OTOLITHS
1997	45	4863	28	1319	985
1998	141	14911	102	6018	890
1999	58	4163	44	2180	82
2000	27	2967	18	1011	113
2001	10	489	6	245	17
2002	21	2270	10	360	127
2003	63	5095	13	425	0
2004	34	996	7	225	84
2005	49	3708	14	772	0
2006	29	4186	13	616	465
2007	14	2158	8	285	272
2008	44	3726	39	1768	1387
2009	53	5701	36	1746	1387
2010	134	16351	68	3370	3120
2011	63	6866	40	1953	1774
2012	35	3891	23	1094	405
2013	47	4925	34	710	704
2014	32	4709	16	350	340
2015	11	1275	8	221	217
2016	45	5880	13	285	184
2017	20	2927	12	250	206
2018	12	1437	9	185	181
2019	8	1010	0	0	0
2020	8	1566	2	50	25
2021	13	1205	4	195	194
2022	4	381	2	105	105

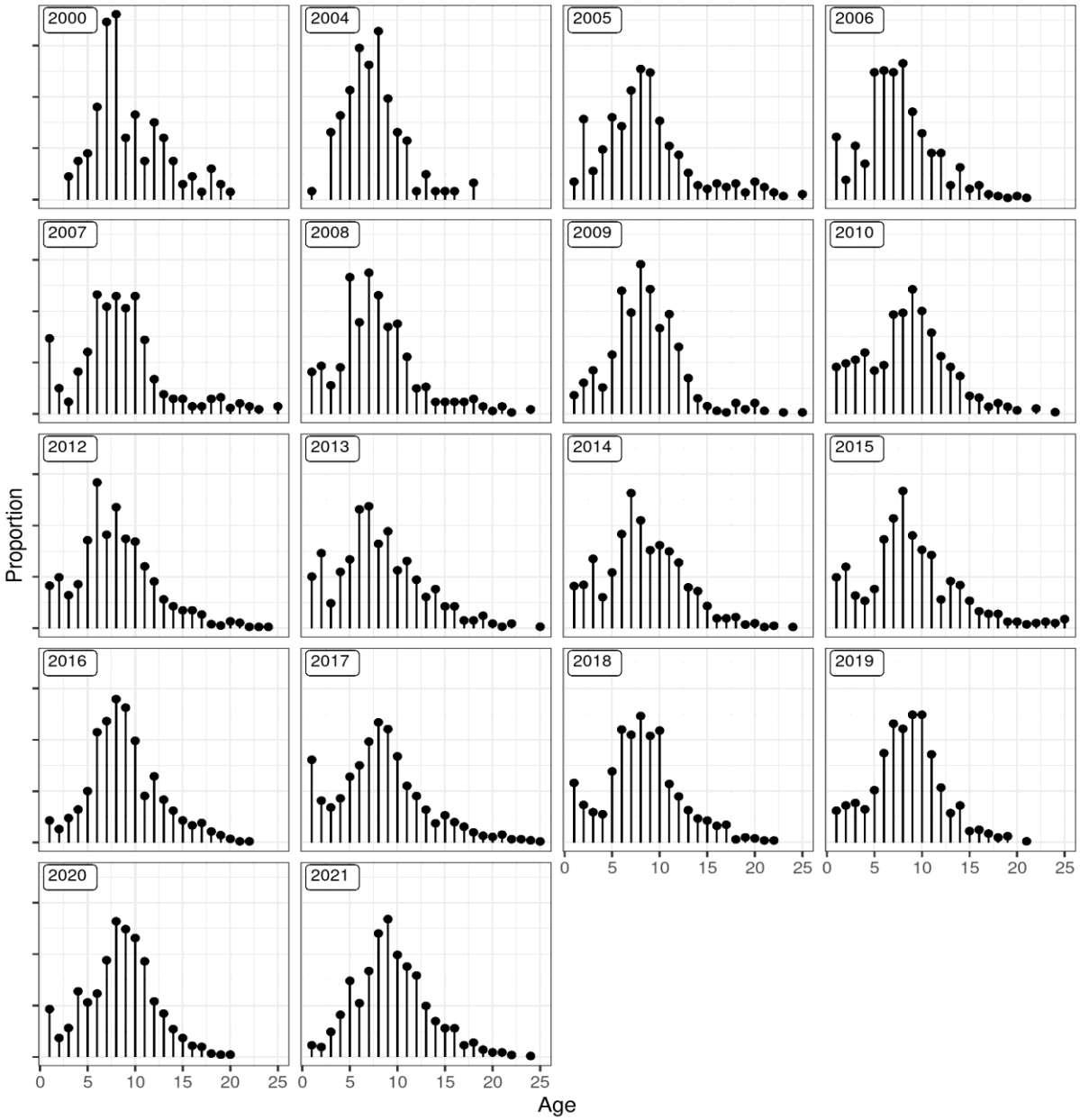

Figure 8: Greater silver smelt. Age distributions in proportions from the Icelandic autumn survey.

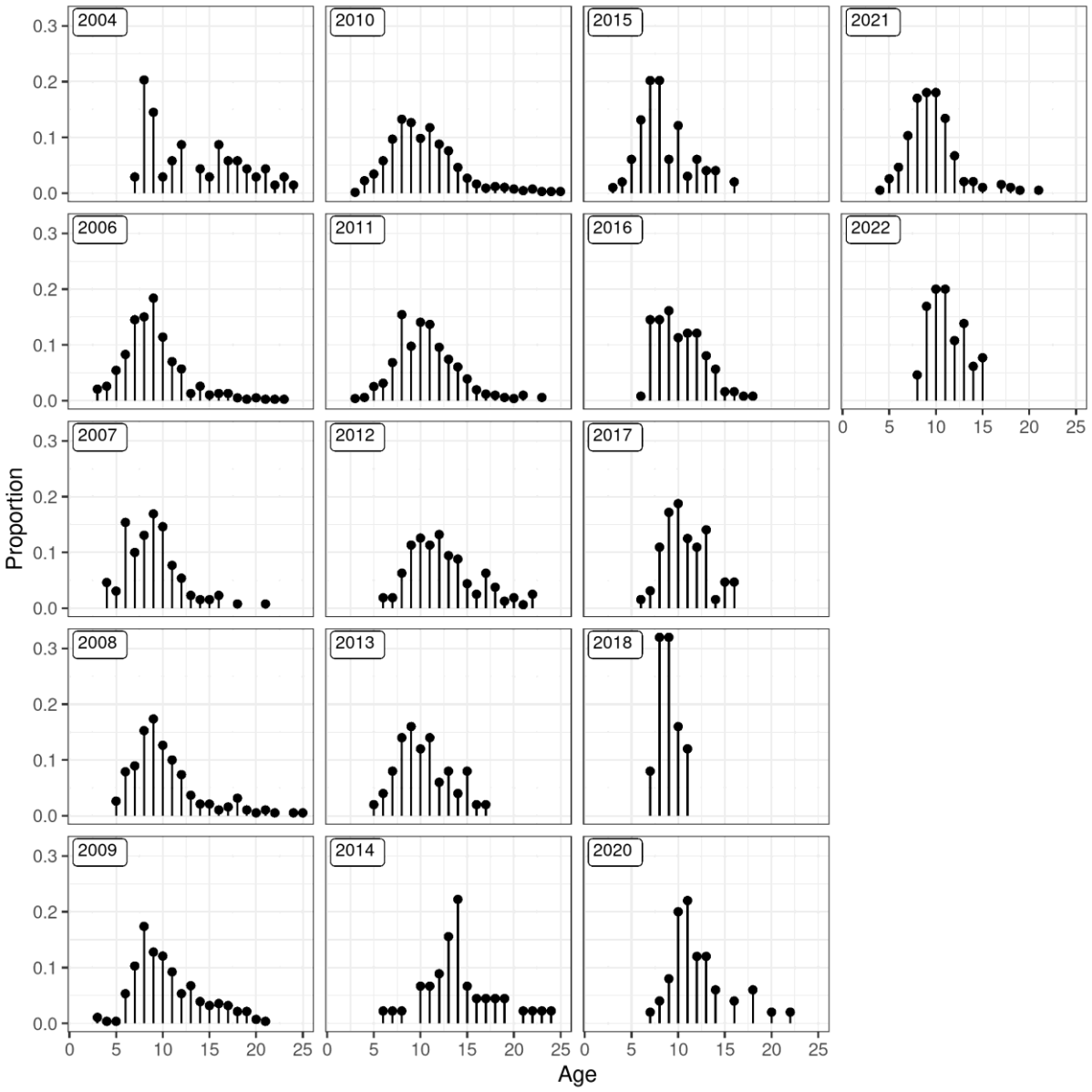

Figure 9. Greater silver smelt. Catch in numbers by age (proportion). No age data available in 2019 from commercial catches.

WEIGHT AT AGE

Biological data from the spring survey, autumn survey, and commercial catches were combined to analyse growth. Von Bertalanffy growth curves were fitted and plotted within a series of time periods, including 2016-2019, 2011-2015, 2006-2010, 2001-2005, 1994-2000, and prior to 1994 to increase sample sizes for estimating each curve. The exponential length-weight relationship is extremely consistent across periods. In general, there is very little variation between periods, although females can be seen to grow larger sizes than males.

MATURITY AT AGE AND NATURAL MORTALITY

Estimates of maturity ogives of greater silver smelt in 5.a were presented at the ICES 2020 meeting for both age and length (ICES 2020) using data collected in the Icelandic autumn survey (See stock annex for details). Males tend on average to mature at a slightly higher age or at 6.5 compared to 5.6 for females but at a similar length as females 35.3 cm. Most of the greater silver smelt caught in commercial catches in Icelandic waters are mature.

No information exists on natural mortality of greater silver smelt in Icelandic waters.

CATCH, EFFORT AND SURVEY DATA

CATCH PER UNIT OF EFFORT AND EFFORT DATA FROM COMMERCIAL FISHERIES

At WKDEEP 2010 a glm cpue series was presented (WKDEEP 2010, GSS-05), however because of strong residual patterns the group concluded that the glm-cpue series was not suitable to use as an indicator of stock trends. The cpue is not considered to represent changes in stock abundance as the fishery is mostly controlled by market factors, oil prices and quota status in other species, mainly redfish.

ICELANDIC SURVEY DATA

The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, gives trends on fishable biomass of many exploited stocks on the Icelandic fishing grounds. In total, about 550 stations are taken annually at depths down to 500 m. The survey area does not cover the most important distribution area of the greater silver smelt fishery in Icelandic waters and is therefore not considered representative of stock biomass. The survey may be indicative of recruitment; however, the data have not been explored in sufficient detail to be used for this purpose.

The Icelandic groundfish autumn survey was commenced in 1996 and expanded in 2000. A detailed description of the autumn groundfish survey is given in the stock annex (ICES 2020) for greater silver smelt in Icelandic waters. The survey is considered representative of stock biomass of greater silver smelt since it was expanded in 2000. Figure 11 gives the most recent catch quantities and locations of surveys. Due to a strike in 2011 the autumn survey was cancelled after about one week of survey time. Greater silver smelt is among the most difficult demersal fish stocks to get reliable information on from bottom-trawl surveys. This is in large part because most of the greater silver smelt caught in the survey is taken in few but relatively large hauls. This can result in very high indices with large variances particularly if the tow-station in question happens to be in a large stratum with relatively few tow-stations. For example, survey indices in 1999, 2014, and 2021 are especially high in comparison with

survey indices from adjacent years (Figure 10). No substantial changes in spatial distribution are seen in general in Figures 12 & 13.

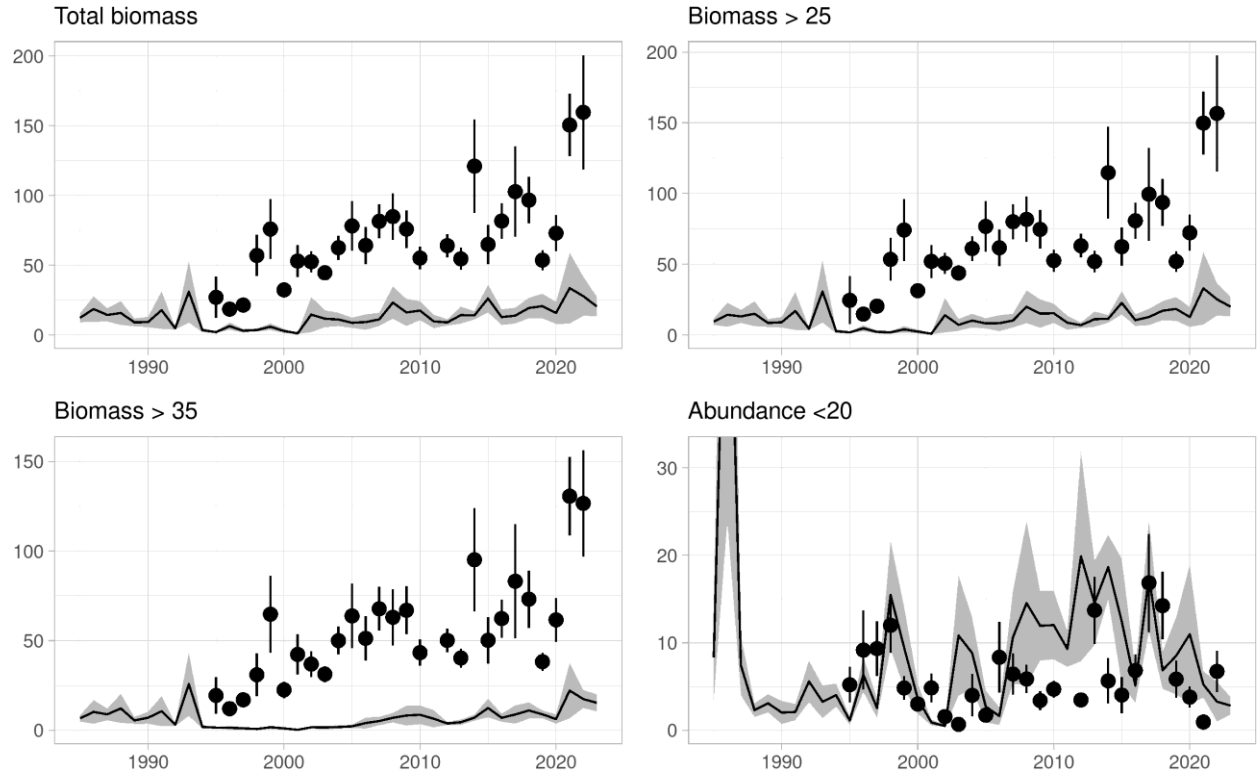

Figure 10. Greater silver smelt. Indices calculated from the Icelandic spring survey (lines and shaded area) and from the autumn survey (dots). Vertical lines and shaded area represent +/- 1 standard error.

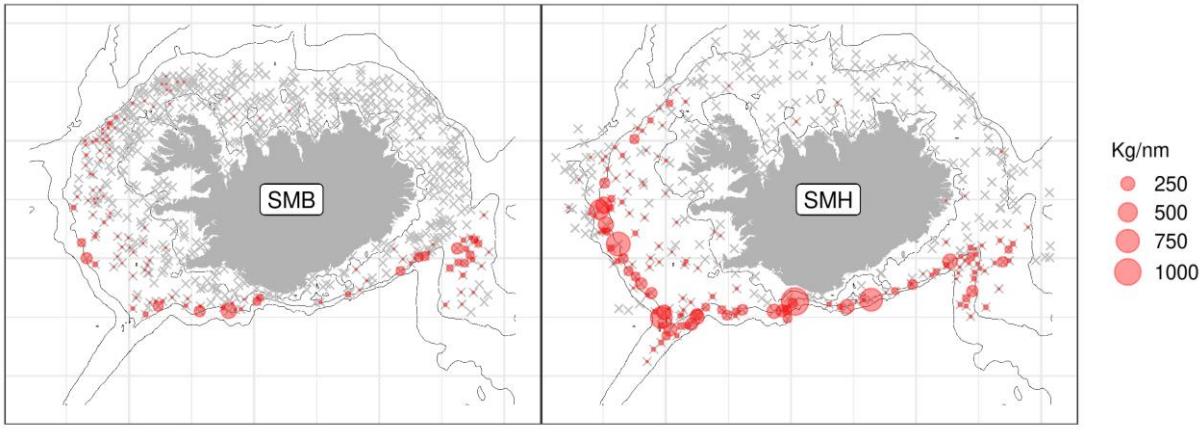

Figure 11. Greater silver smelt. Abundance and distribution of greater silver smelt in the spring survey (SMB) in 2022 and in the autumn survey (SMH) in 2022.

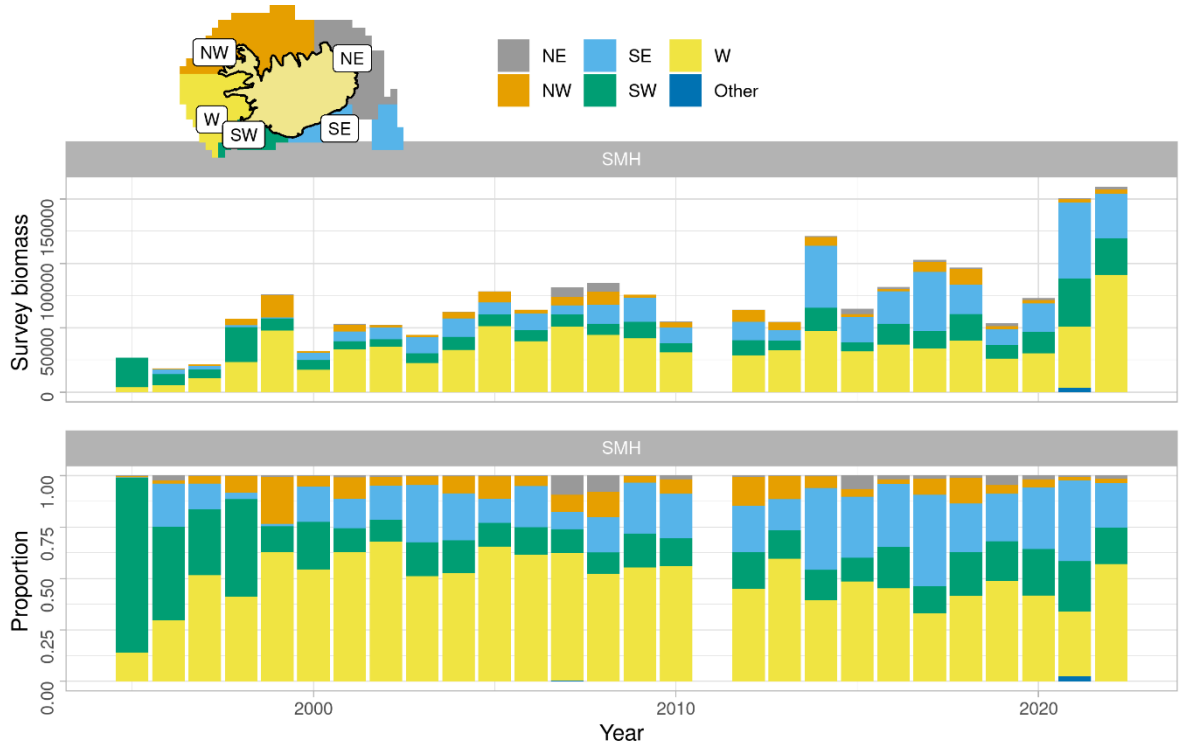

Figure 12. Greater silver smelt. Estimated survey biomass in the autumn survey by year from different areas (upper figure) and as proportions of the total (lower figure).

DATA ANALYSES

LANDINGS AND SAMPLING

Spatial distribution of catches in Icelandic waters has not changed markedly in recent years and fishing for greater silver smelt in the NW area seems to have reduced (Figures 2 and 3). Landings of greater silver smelt increased rapidly from 2007 to 2010 when they peaked at around 16 000 tonnes, since then they have decreased to around 6889 tonnes in 2022 (Figure 4 and Table 3). The decrease in catches is the result of increased vigilance by the managers to constrain catches to those advised and also lesser interest by the fleet in the stock. Mean length of greater silver smelt in catches has been rather stable from 2005 in the range of 37 – 43 cm (Figure 7). However, there was a slight increase in mean length in 2012 which can also be seen in recent years (Figures 7 and 8). A similar continuous downward trend in mean age in the commercial catches is also observed. Mean ages from catches have been variable from 2000 in the range 8 – 14 years, with relatively high mean ages recently. The reason for these changes is not known as there is no marked difference in the spatial distribution of the fishery; however, reduced fishing pressure may be a factor.

SURVEYS

As mentioned above, greater silver smelt is a difficult species to survey in trawl surveys and the indices derived from the both the spring and autumn surveys have high CVs. Occasional spikes in the indices without any clear trend characterize the spring survey biomass indices. The only thing that can be derived from the spring survey is that the biomass indices (total and >25 cm), in 1985–1993 and again from 2002 to 2022 are at a higher level than in 1994–2001. The juvenile index (spring survey) has a very

high peak in 1986 but then hardly any juveniles are detected in the survey in 1987 to 1995. Since 1998 there have been several small spikes in the recruitment index (Figure 10).

The observed trends in the biomass indices from the autumn survey have a considerably different trend than those observed in the spring survey (Figure 10). According to the autumn survey, biomass increased more or less year on year from 2000 to 2008 but then decreased in 2009 and 2010. The total biomass index in the autumn survey showed slight variations until 2014 when the index increased to the highest value observed, and thereafter has been relatively stable but with high variability. In 2022, the index reached the highest value in the timeseries.

There is a clear gradient in mean length of greater silver smelt with depth, larger fish being in deeper water, and therefore the spring survey, which is conducted at shallower depths, is not considered representative of the stock.

ANALYTICAL ASSESSMENT

In 2020 a model of greater silver smelt in Icelandic and Greenlandic waters (ICES areas 5.a and 14) developed in the Gadget framework (**G**lobally applicable **A**rea **D**isaggregated **G**eneral **E**cosystem **T**oolbox, see http://www.hafro.is/gadget for further details) was benchmarked for the use in assessment (ICES 2020). This year, Gadget 3 was used instead of Gadget 2. Gadget 3 is the same model except that it uses template model builder (TMB) which allows it to utilize TMB's automatic differentiation procedures producing models that can be optimized faster and that can use R optimizers (rather than Gadget 2's inbuilt optimizers).

DATA USED AND MODEL SETTINGS

Data used for tuning and model settings used in the Gadget model are described in more detail in the stock annex (ICES 2020).

DIAGNOSTICS

OBSERVED AND PREDICTED PROPORTIONS BY FLEET

Overall fit to the predicted proportional length and age–length distributions is close to the observed distributions, except for a small peak of small-sized fish (Figures 13-16). This peak does not shift from year to year and therefore is considered due to high catchability in aggregations of small fish rather than cohorts in recruitment peaks. These peaks are likely absent from commercial data due to the requirement of fishing at >400 m depth.

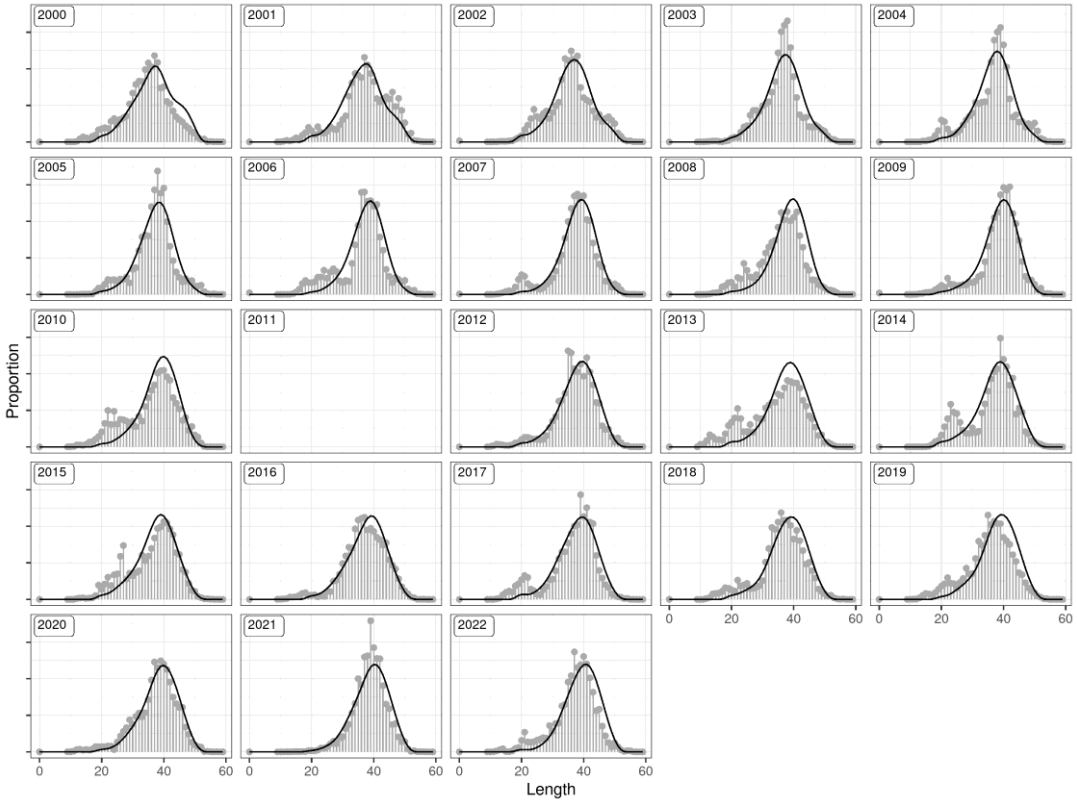

Figure 13: Greater silver smelt. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions in the autumn survey (vertical lines and points).

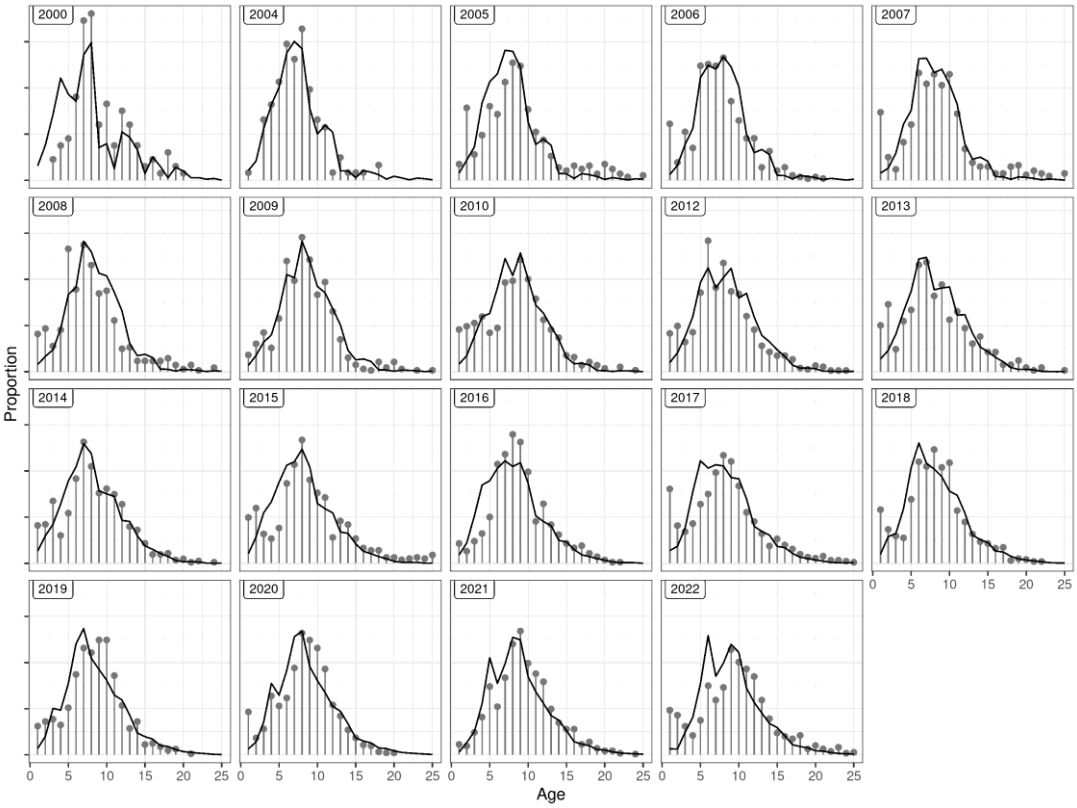

Figure 14: Greater silver smelt. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in the autumn survey catches.

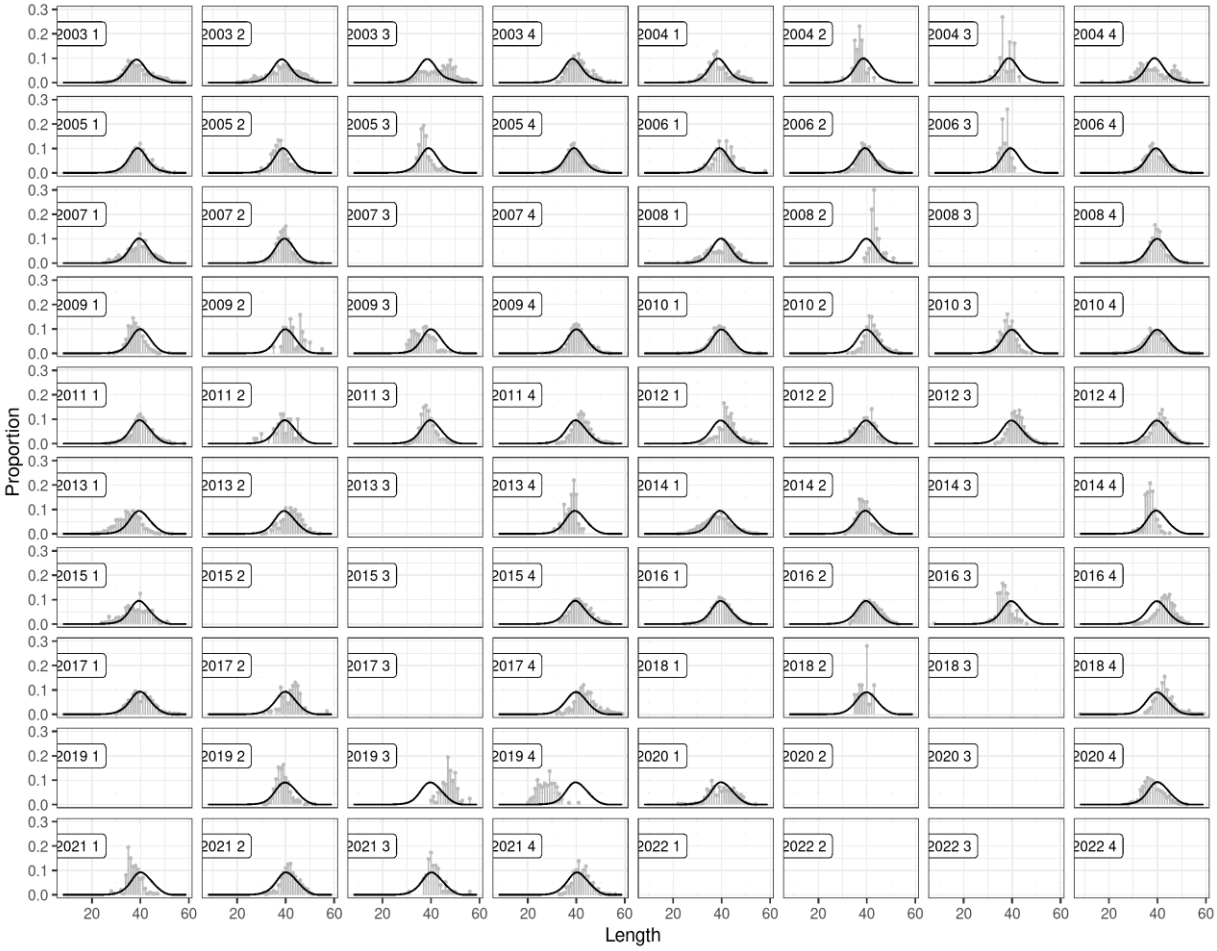

Figure 15: Greater silver smelt. Fitted proportions-at-length from the Gadget model (black lines) compared to observed proportions from commercial catches.

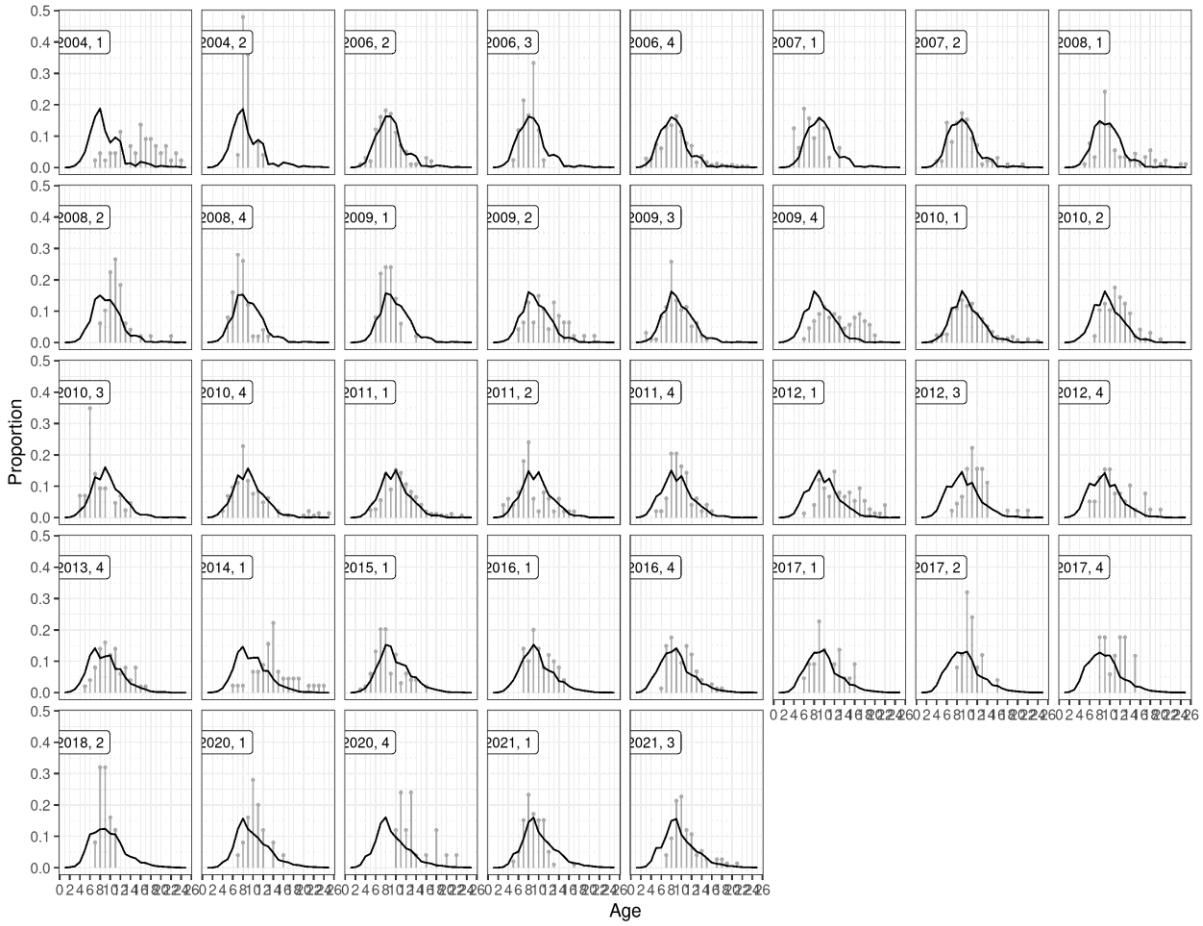

Figure 16: Greater silver smelt. Fitted proportions-at-age from the Gadget model (black lines) compared to observed proportions in commercial catches.

MODEL FIT

Figure 17 shows the overall fit to the survey indices described in the stock annex. In general, the model appears to follow the stock trends historically. In previous category 3 assessments of this stock, the autumn survey was Winsorized due to high variability in the survey index, which can also be seen here, as survey indices are not Winsorized or standardized before being used. The survey indices for the smallest tow size classes (10-25 and 25-30 cm) due to generally low selectivity the peak on small-sized fish that likely results from aggregation rather than cohort dynamics (see previous section). Last year, the terminal estimate had a large overestimation due to very low survey indices that year, indicating the potential for overestimation of biomass last year.

However, this year's indices for large-sized fish are at an historical high, indicating that last year's values were more likely to be relatively accurate. These high values may be the result of high variability in the survey index numbers in general, however. If survey indices are lower again next year, the model fit is likely to experience a correction to lower predicted index values.

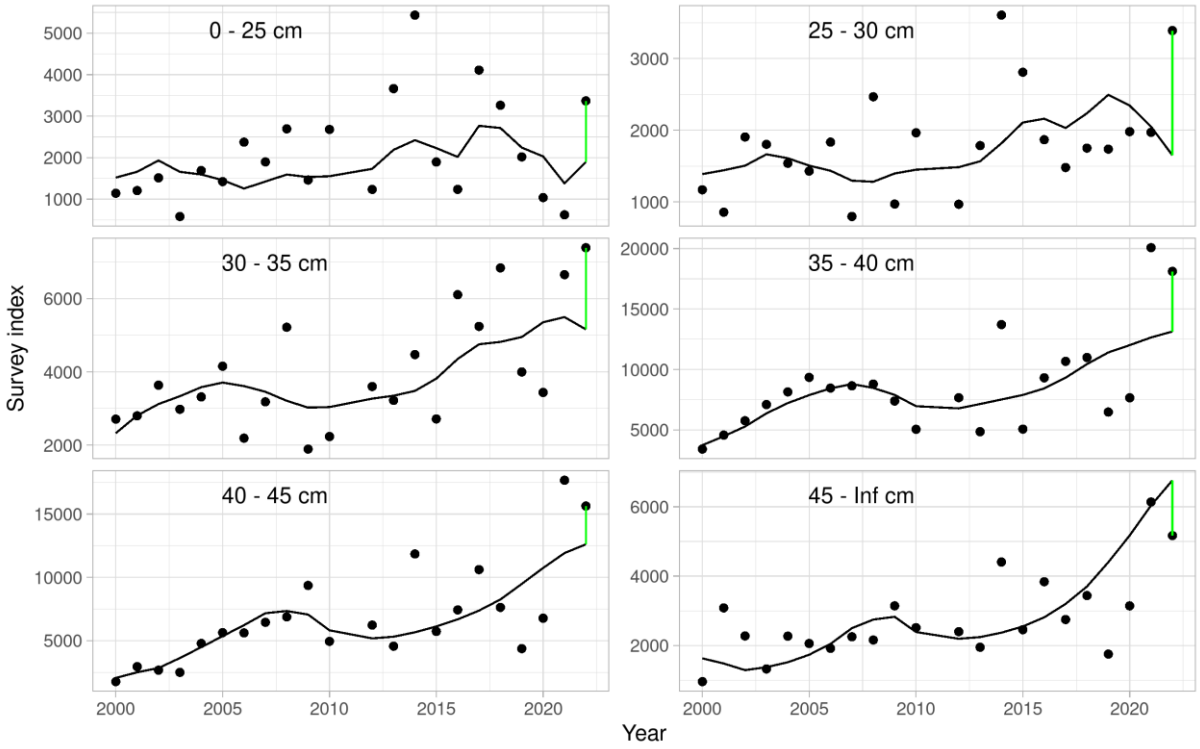

Figure 17: Greater silver smelt. Fitted autumn survey index by length group from the Gadget model (black line) and the observed number of greater silver smelt caught in the survey (points). The green line indicates the difference between the terminal fit and the observations.

RESULTS

The results are presented in Table 5 and Figure 18. Recruitment has been increasing over the past decade. but the most recent very high estimates of age 1 recruitment in 2021 may be the result of recent high variability in survey indices and is therefore likely to be revised downwards in the next few years. Spawning–stock biomass has increased since 2012 and reached the highest SSB estimate in the time-series in 2021 after a slight decrease in 2020. Fishing mortality for greater silver smelt (age 6–14) has decreased from 0.2 in 2010 to less than 0.04 over the past several years. due to greater regulation of the fishery as well as reduced commercial interest. Uncertainty was estimated by spatially bootstrapping the data and refitting the assessment model to resampled data. The spatial bootstrap

entails refitting the model to 100 sets of data resampled by spatial areas to maintain spatial correlation in the data (see the stock annex). The base model assessment results appear unbiased as it corresponds well with the median of results (Figure 18). Asymmetry in the confidence intervals is likely to be the result of a small number of model runs with a set of resampled data that are a poor representation of the actual data. For this reason, it was suggested by WGDEEP to improve the spatial bootstrap methods so that they better represent variation in the data.

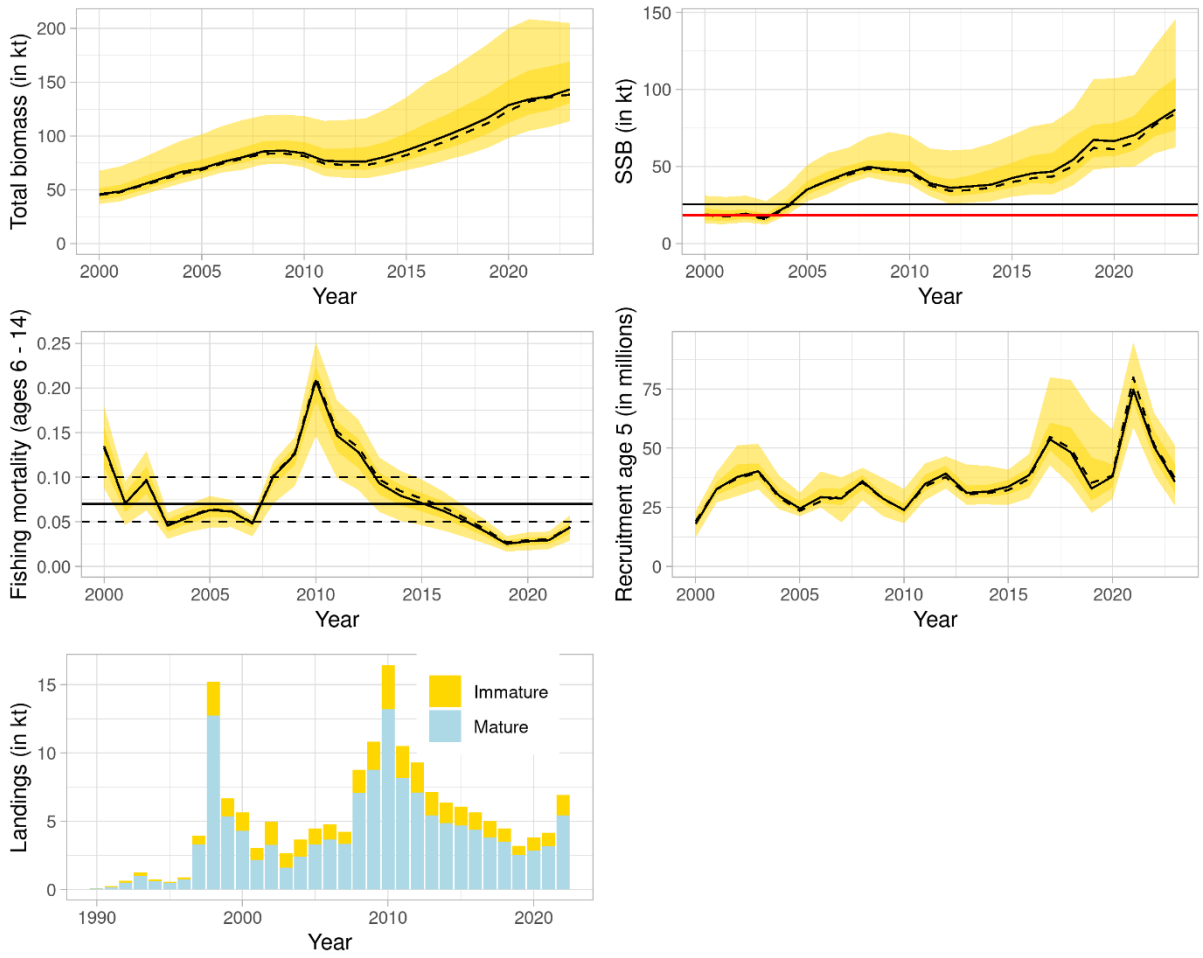

Figure 17. Greater silver smelt. Estimated biomass, spawning stock biomass (SSB), fishing mortality for fully selected fish, recruitment, and total catches. The black solid line in the SSB plot represents B_{pa} and the solid red line indicates B_{lim}. The horizontal solid line in the fishing mortality plot indicates the fishing mortality used in the ICES MSY advice rule, whereas the horizontal dashed lines indicate the bounds of the realized fishing mortality resulting from the advice rule given the uncertainty in the assessment. Uncertainty was estimated by spatially bootstrapping the data and refitting the assessment model to resampled data. Outer yellow ribbons with red borders indicate 95% interquantile ranges, whereas inner yellow ribbons indicate 50% interquantile ranges. The central red line indicates the median, and the dashed red line is the base model run for the assessment upon which advice is based.

In comparison with last year's assessment, there has been a slight upward revision of biomass levels and downward revision of fishing mortality (Figure 19), but within the range expected according to benchmark uncertainty estimates (ICES 2020).

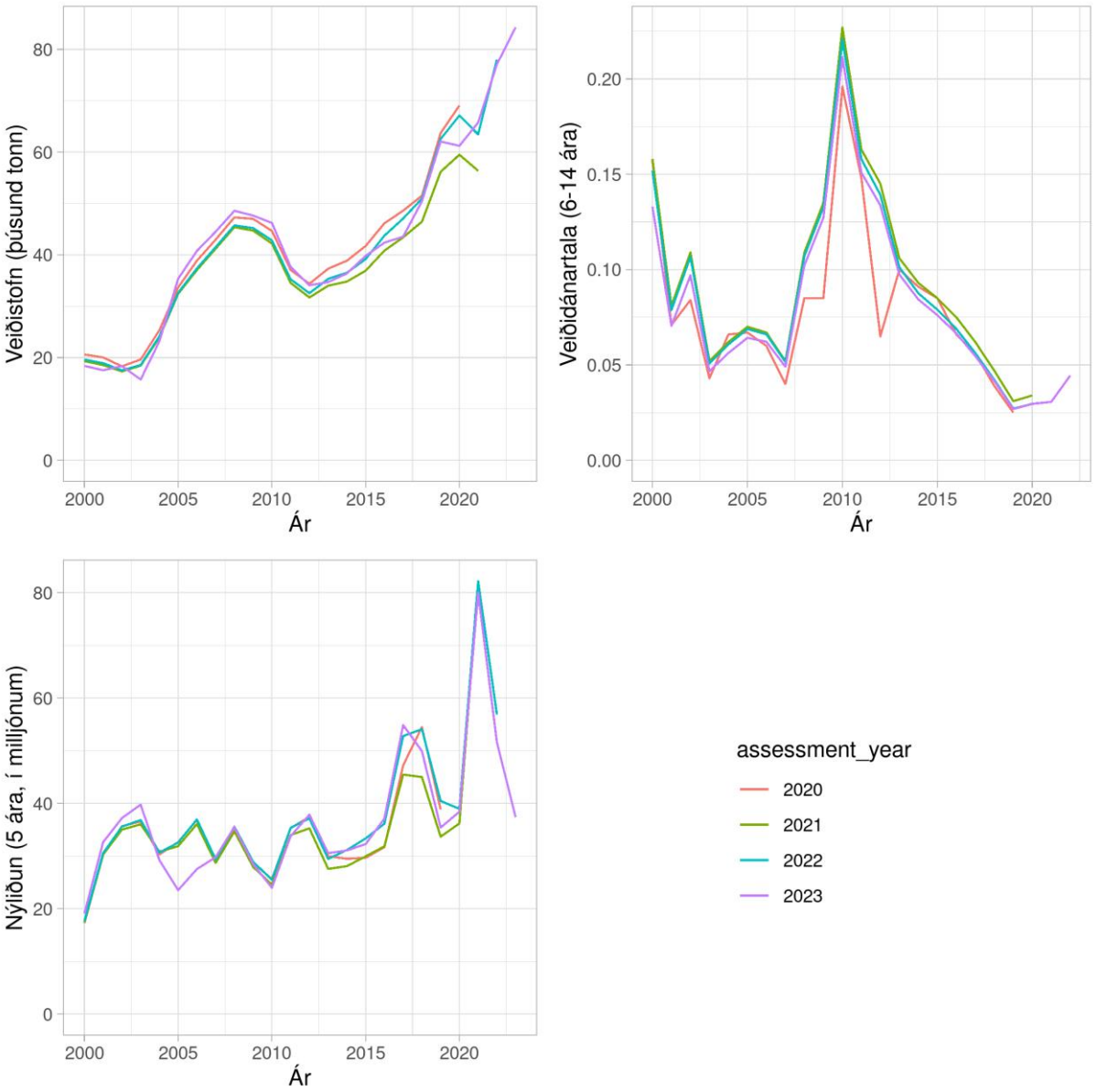

Figure 19 Greater silver smelt. This year's assessment compared with previous assessments. Spawning stock biomass (SSB), fishing mortality for fully selected fish and recruitment.

Table 5. Greater silver smelt. Gadget assessment model results including input catch values (tonnes),. estimated spawning stock biomass (SSB, tonnes), recruitment (Rec., age 5 in millions, and fishing mortality (age 6-14). Projections are given in the last year. Projections are given in the last year and also the second to last year for catch and F.

YEAR	TOTAL BIOMASS	CATCH	SSB	REC.	F
2000	45118	5.657	18382	19.082	0.133
2001	47556	3.043	17527	32.645	0.07
2002	53394	4.961	18352	37.198	0.097
2003	58708	2.68	15732	39.756	0.047
2004	64762	3.645	23181	29.214	0.056
2005	68392	4.482	35361	23.526	0.064
2006	74260	4.769	40766	27.53	0.062
2007	78868	4.227	44515	29.77	0.049
2008	83431	8.778	48580	35.509	0.102
2009	83704	10.828	47648	28.456	0.127
2010	81310	16.428	46220	23.965	0.211
2011	74263	10.516	37651	33.789	0.151
2012	72964	9.289	34076	37.843	0.134
2013	72678	7.155	34690	30.542	0.097
2014	76439	6.348	36379	31.059	0.084
2015	82088	6.07	39812	32.264	0.076
2016	88663	5.662	42368	37.114	0.067
2017	95443	5.011	43544	54.865	0.055
2018	103717	4.46	50414	49.924	0.042
2019	112007	3.21	62072	35.406	0.027
2020	123221	3.797	61228	38.408	0.03
2021	131900	4.156	65763	79.986	0.031
2022	135830	6.914	77111	51.554	0.044
2023	138445	9.188	84291	36.54	0.057
2024	139358	12.071	87926	37.669	0.077

RETROSPECTIVE ANALYSIS

An analytical retrospective analysis is presented (Figure 20). The analysis indicates that there were downward revisions of biomass over the first four years of the 5-year peel followed by an upward revision of biomass (SSB) over the last year. As a result, there was an upward then downward revision of F. Estimates of recruitment are decently stable.

Mohn's rho was estimated to be 0.111 for SSB, -0.071 for F, and 0.023 for recruitment.

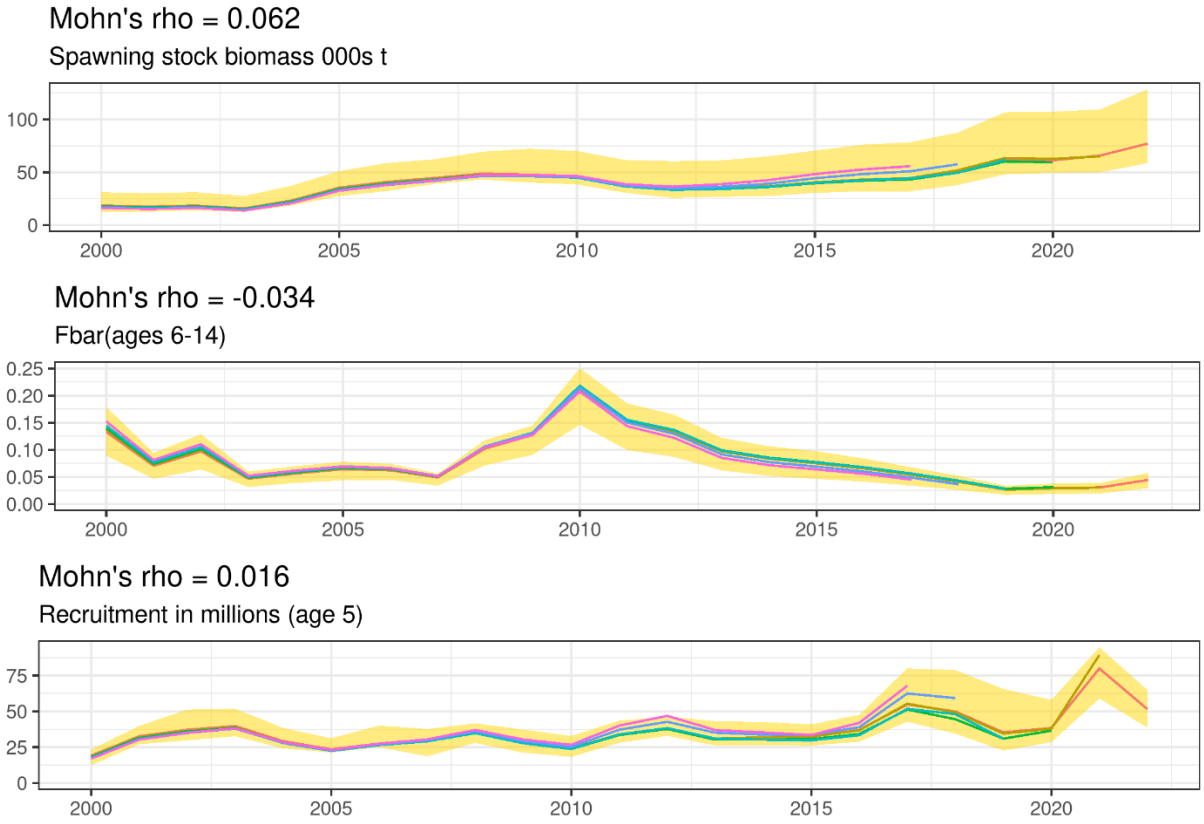

Figure 20: Greater silver smelt. Retrospective plots illustrating stability in mod-el estimates over a 5-year 'peel' in data. Results of spawning stock biomass, fishing mortality F, and recruitment (age 5) are shown.

COMMENTS ON THE ASSESSMENT

In 2020 this stock was benchmarked (ICES 2020) and a length- and age-based assessment was accepted as a category 1 assessment method. The ICES MSY advice rule is applied for this stock in 2021/2022 advice. The decision which allocates catches to the fleets requires 1) an expected quantity of catch to be removed that will complete total catch removals for the current fishing season, 2) a 1-year projection to determine the amount of biomass available to fish, and 3) application of projected fishing effort according to F_{msy} to determine the expected catch from fishing at this level. Advised catch is set to this value while $SSB_y > B_{trigger}$, scaled by $(SSB_y)/B_{trigger}$ while $B_{lim} \leq SSB_y < B_{trigger}$, and set to 0 while $SSB_y \leq B_{lim}$.

MANAGEMENT

The Icelandic Ministry of Food, Agriculture and Fisheries is responsible for management of the Icelandic fisheries and implementation of legislation. The Ministry issues regulations for commercial fishing for each fishing year (1 September–31 August), including an allocation of the TAC for each stock subject to such limitations. Before the 2013/2014 fishing year the Icelandic fishery was managed as an exploratory fishery subject to licensing since 1997. A detailed description of regulations on the fishery of greater silver smelt in Icelandic waters is given in the stock annex (ICES 2020). Fishing for greater silver smelt is banned at depths less than 400 m to avoid catching younger fish.

The TAC for the 2013/2014 fishing year was set at 8000 t based on the recommendations of MRI using a preliminary Gadget model and the 2014/2015 fishing year the recommendation was to maintain the catches at 8000 t. For the fishing year 2015/2016 it was also maintained at 8000 t, but was 7885 t for 2016/2017, 9310 t for 2017/2018, 7603 t for 2018/2019, 9124 for 2019/2020, 8729 for 2020/21, and 9244 for 2021/22 (Table 6).

Figure 21 illustrates the difference between national TAC and landed catch in Icelandic waters. Flexibility is built into the Icelandic fisheries management system in which quota is automatically transformed for use for constraining species when it is available. As this stock is consistently caught at levels lower than the TAC in recent years, it has been a source of quota that may be used to fish other species.

Table 6. Greater silver smelt in 6. TAC recommended by the Marine and Freshwater Research Institute, national TAC set by the Ministry, and total landings (tonnes).

FISHING YEAR	MFRI ADVICE	NATIONAL TAC	LANDINGS
2010/11	8000		12091
2011/12	8000		8497
2012/13	8000		11217
2013/14	8000	8000	7242
2014/15	8000	8000	6848
2015/16	8000	8000	5991
2016/17	7885	7885	3570
2017/18	9310	9310	5159
2018/19	7603	7603	2818
2019/20	9124	9124	3775
2020/21	8729	8729	4339
2021/22	9244	9244	6550
2022/23	11520	11520	

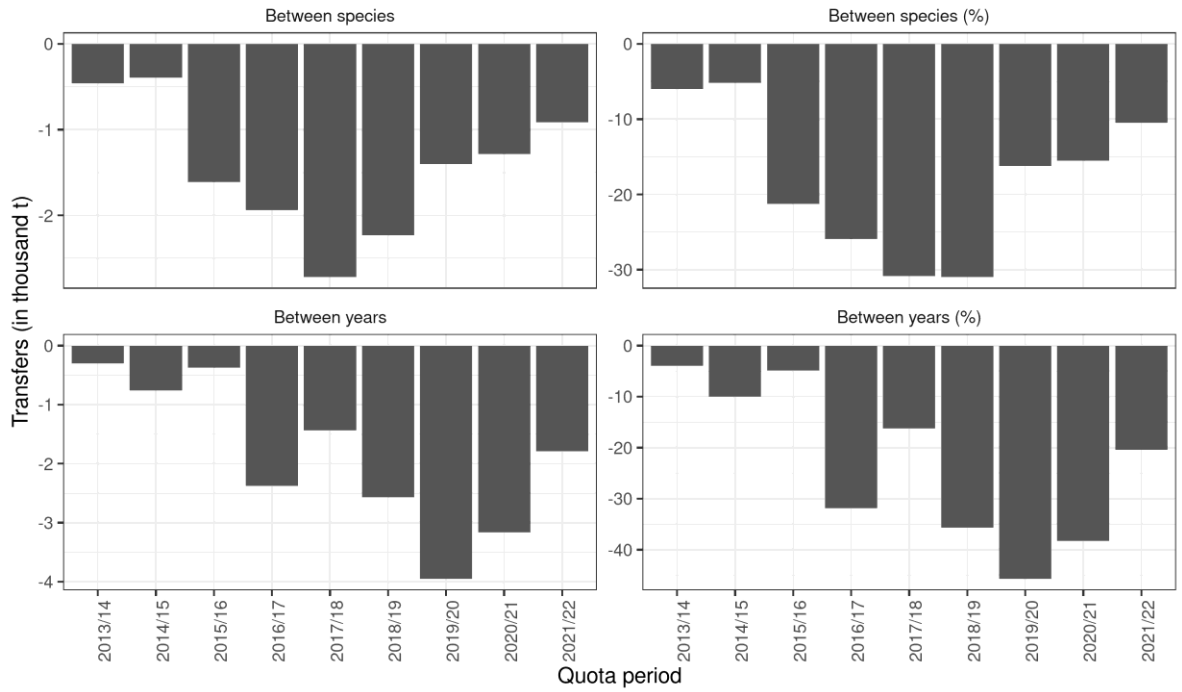

Figure 21. Greater silver smelt. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to greater silver smelt, but negative values indicate a transfer of greater silver smelt quota to other species. Between years (lower): Net transfer of quota from a given fishing year (may include unused quota).

CURRENT ADVISORY FRAMEWORK

Reference points defined for the stock are shown in Table 7.

Table 7: Greater silver smelt. Reference points.

Framework	*Reference point*	*Value*	*Basis*
MSY	MSY $B_{trigger}$	25 440 t	B_{pa}
	F_{MSY}	0.07	F that leads to long-term MSY and a <5% risk of SSB < B_{lim} in equilibrium in stochastic projections. Realized F can range from 0.050–0.10
Precautionary approach	B_{lim}	18 308 t	B_{loss}
	B_{pa}	25 440 t	B_{lim}*1.4
	F_{lim}	0.24	Equilibrium F which will maintain the stock above B_{lim} with a 50% probability
	F_{pa}	0.07	F that leads to a <5% risk of SSB < B_{lim} in equilibrium

Information on how these reference points were generated and the model setting for short-term projections can be found in ICES 2020 report (ICES 2020). The current intermediate year assumption regarding catch is set equal to the expected status quo fishing level during the fishing season (last quarter of year y and quarters 1–3 in year y+1) and projections for the following year run at a selected harvest rate. The status quo fishing level was calculated as the mean landings over the previous three fishing seasons.

Age 1 recruitment estimates are highly uncertain from the most recent three years. Therefore, in forecasts, it is proposed to use the geometric mean of the three years before these values (e.g., for 2020, this would be the geometric mean of age 1 recruitment estimates from years 2014–2016). The

projected recruitment reported from the model output is for age 5 because recruitment estimated for ages 1-4 are highly uncertain.

MANAGEMENT CONSIDERATIONS

Exploitation of greater silver smelt in Icelandic waters has been reduced in recent years, coming down from a relatively high level in 2010, to levels lower than the average exploitation rate in the reference period.

ECOSYSTEM CONSIDERATIONS FOR MANAGEMENT

Shorter periods of reduced biomass due to high fishing rates are observed in the history of greater silver smelt fishing in Iceland. However, there has been a general trend since the mid-1990s of a decrease in biomass levels from the mid-1980s to the mid-1990s, during which catch records are unreliable so the general reduction cannot directly be attributed to fishing, followed by a general increase in biomass in the past two decades. It is likely that a combination of lower fishing rates and favourable environmental conditions have led to high recruitment levels over the past decade.

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