

GREATER SILVER SMELT – GULLLAX

Argentina silus

GENERAL INFORMATION

Greater silver smelt is a rather small (<60 cm) silvery bathypelagic species that can form large schools close to the seafloor mainly at depths greater than 500 m. In Icelandic waters greater silver smelt 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

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 1). 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 and the landings have increased significantly in the past (Table 1).

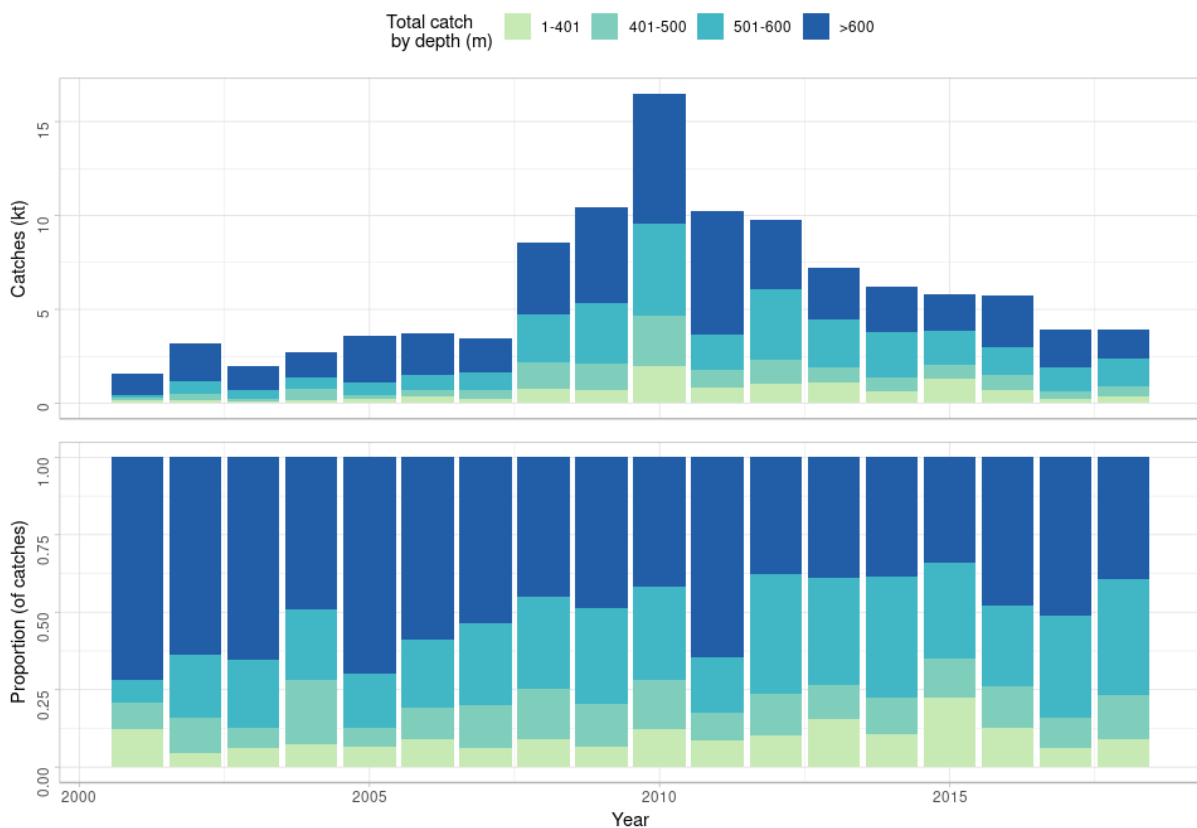


Figure 1. Greater silver smelt. Depth distribution of catches according to logbooks by the Icelandic fleet.

Mynd 1. Gulllax. Dýpi samkvæmt afladagbókum íslenskra skipa.

FLEETS

Since 1996 between 20 and 39 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 marinus* and *S. mentella*) and to lesser extent Greenland halibut and blue ling. Number of hauls peaked in 2010, but the number of hauls have 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).

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

Tafla 1. Gulllax. Fjöldi íslenskra skipa sem veitt hafa gulllax ásamt lönduðum afla í botnvörpu.

YEAR	NUMBER TRAWLERS	NUMBER HAULS	REPORTED CATCH	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

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 marinus* 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.

Tafla 2. Gullax. Hlutfall meðafla í botnvörpuveiðum þar sem meira en 50% aflla var gullax.

YEAR	REDFISH		GREENLAND HALIBUT	LING	BLUE LING	OTHER
	<i>S. marinus</i>	<i>S. mentella</i>				
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

SPATIAL DISTRIBUTION OF CATCHES THROUGH TIME

Spatial distribution of catches in 1996–2018 is presented in Figures 2 and 3. With the exception of 1996, most of the catches have been from the southern edge of the Icelandic shelf. However, in recent years there has been a gradual increase in the proportion caught in the western area and even in the northwestern area. The likely reason for this is that the fleet focusing on redfish and Greenland halibut in more northern regions also takes a few hauls of greater silver smelt in the area (Figures 2 and 3).

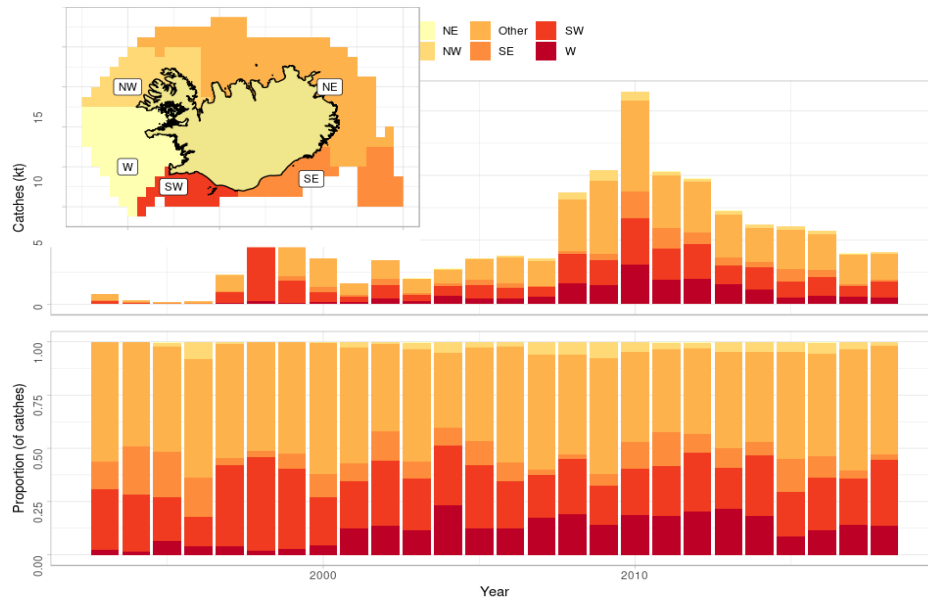


Figure 2. Greater silver smelt in Icelandic waters. Catches defined by regions deeper than 400 m by year. Above are the catches on absolute scale and below in proportions.

Mynd 2. Gullfax. Afli eftir svæðum og árum. Efri mynd sýnir heildarfla og sú neðri hlutfall eftir svæðum fyrir hvert ár.

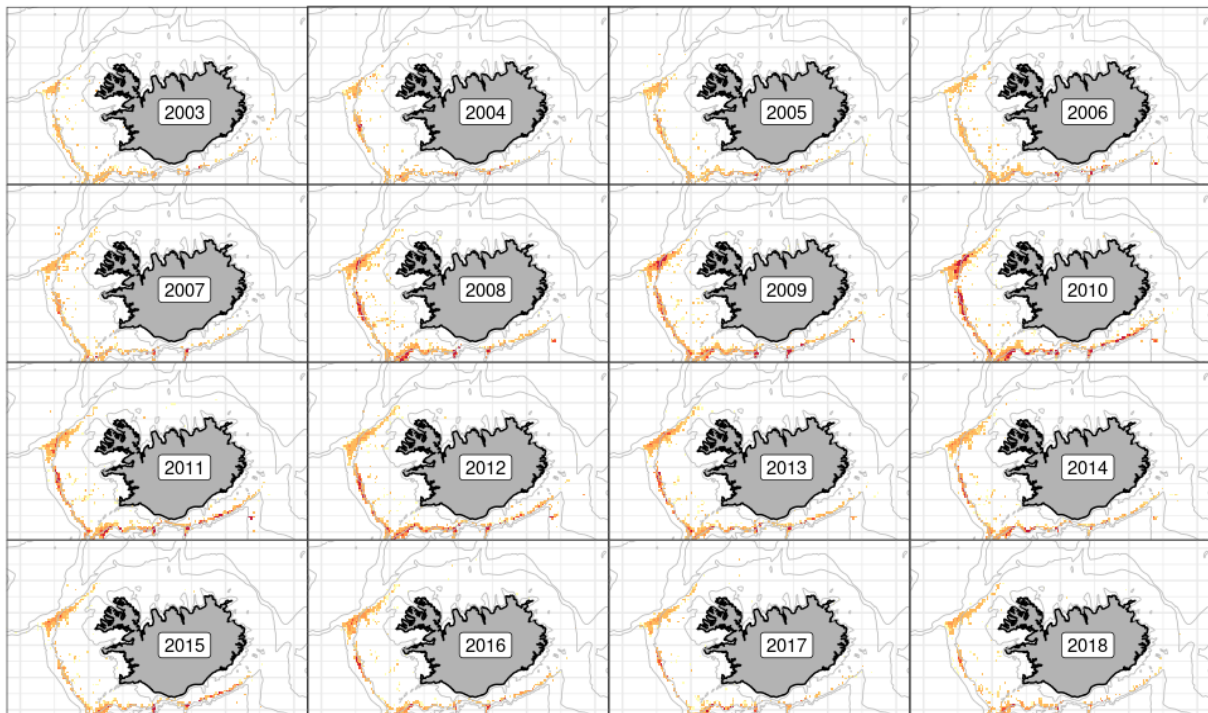


Figure 3. Greater silver smelt in Icelandic waters. Spatial distribution of catches as reported in logbooks.

Mynd 3. Gullfax. Afli eftir svæðum samkvæmt afladagbókum.

LANDINGS TRENDS

Landings of Greater Silver Smelt are presented in Table 3 and Figure 4. Since directed fishery started in 1997–1998, the landings increased from 800 t in 1996 to 13 000 t in 1998. Between 1999 and 2007 catches varied between 2 600 to 6 700 t. Since 2008 landings have increased substantially, from 4 200 t in 2007 to almost 16 500 t in 2010. In 2011 landings started to decrease due to increased management actions, and landings in 2018 amounted to approximately 4460 tonnes in Icelandic and Greenlandic waters.

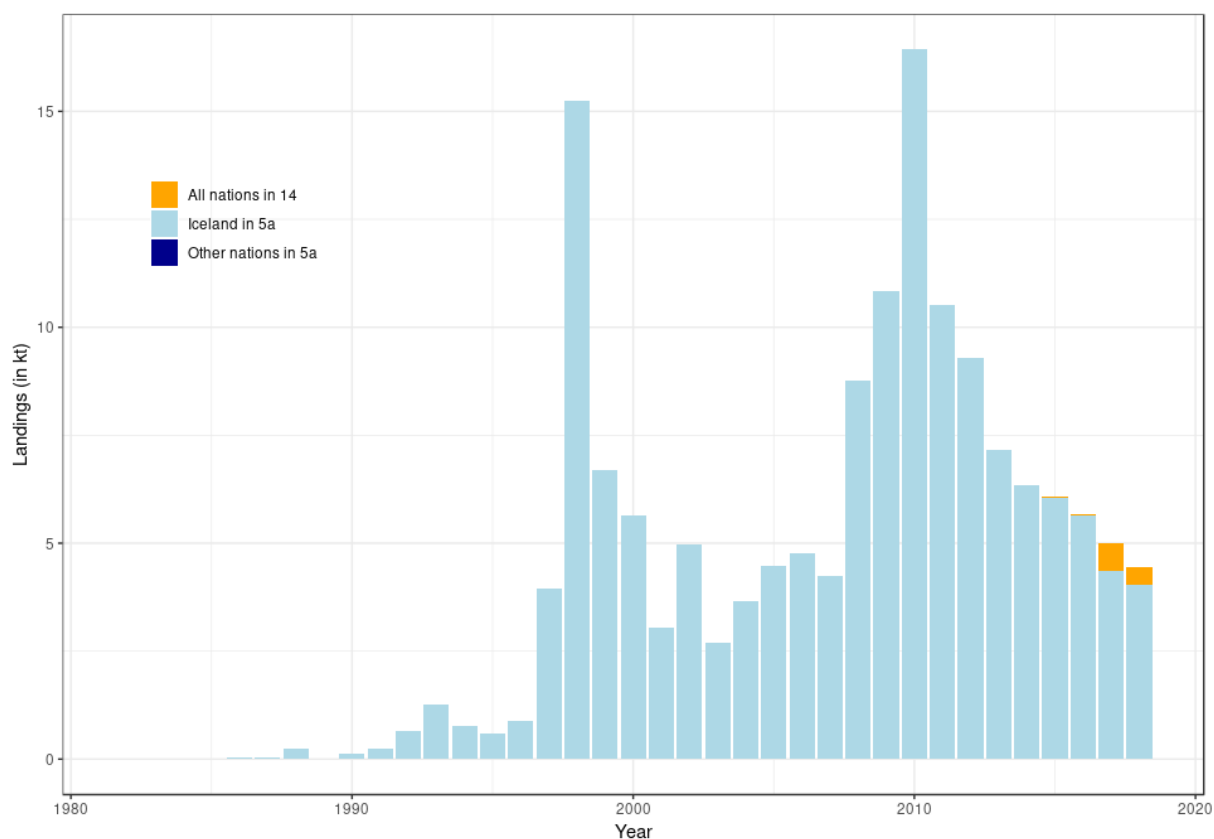


Figure 4. Greater silver smelt in Icelandic waters. Nominal landings. 23 tonnes were landed by foreign vessels (England and Wales) in 1999, which is the only year of catch reported by foreign vessels.

Mynd 4. Gullfax. Landaður afli á Íslandsmiðum. Einungis 23 tonnum var landað af erlendum skipum (England og Wales árið 1999).

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

Tafla 3. Gulllax. Landaður afli af Íslandsmiðum (5.a) og Grænlandsmiðum (14.b).

YEAR	INSIDE THE NEAFC RA		OUTSIDE THE NEAFC RA	CATCHES
	Section 5.a		Section 14.b	
1988				206
1989				8
1990				112
1991				247
1992				657
1993				1255
1994				613
1995				492
1996				808
1997				3367
1998				13387
1999				6704
2000				5657
2001				3043
2002				4960
2003				2686
2004				3637
2005				4481
2006				4775
2007				4226
2008				8778
2009				10829
2010				16428
2011				10515
2012				9290
2013	0	7154		7154
2014	0	7241	4	7245
2015	0	6056	12	6068
2016	0	5646	16	5662
2017	0	3946	666	4612
2018	0	4035	425	4460

DATA AVAILABLE

In general sampling is considered good from commercial catches, as one of the requirements of owning a fishing license for greater silver smelt is the retention of scientific samples (Table 4). The sampling does seem to cover the spatial distribution of catches. Similarly sampling does seem to follow the temporal distribution of catches (see MRI 2012). The sampling coverage by gear in 2018 is shown in Figure 5.

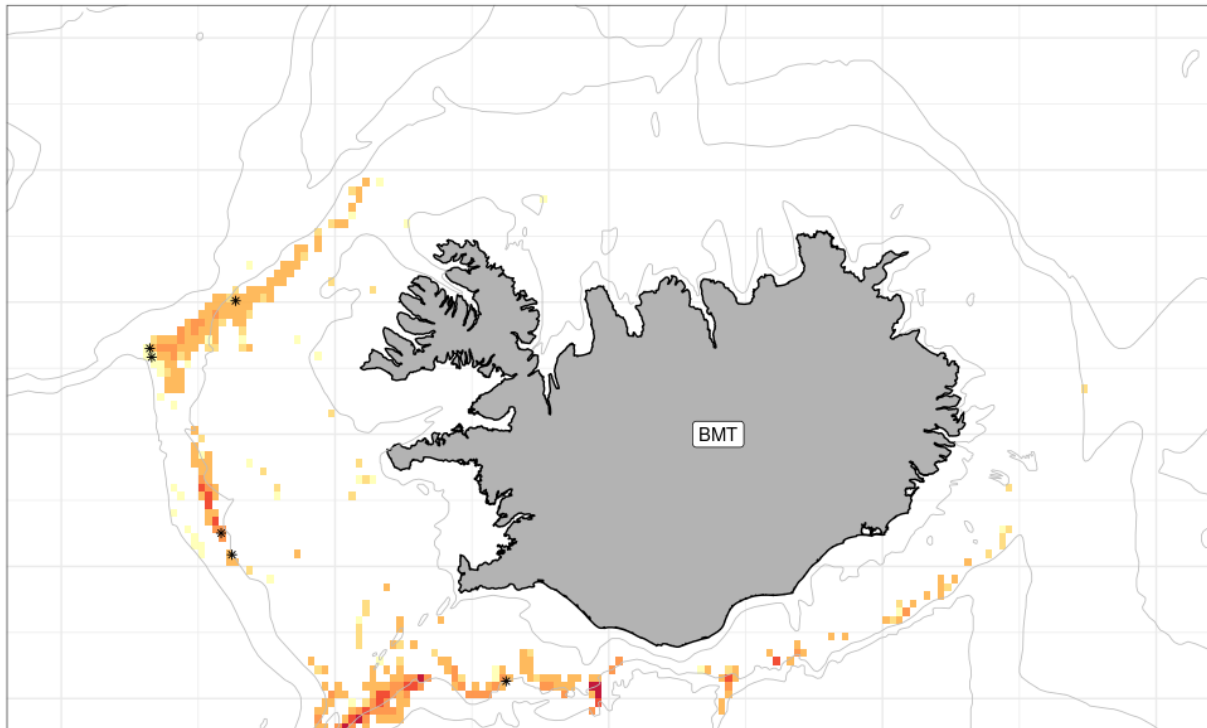


Figure 5: Greater silver smelt. Spatial distribution of length samples (black) from commercial catches (red) in Icelandic waters.

Mynd 5. Gullax. Dreifing lengdarmælinga (svart) og afla (rautt) á Íslandsmiðum.

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.

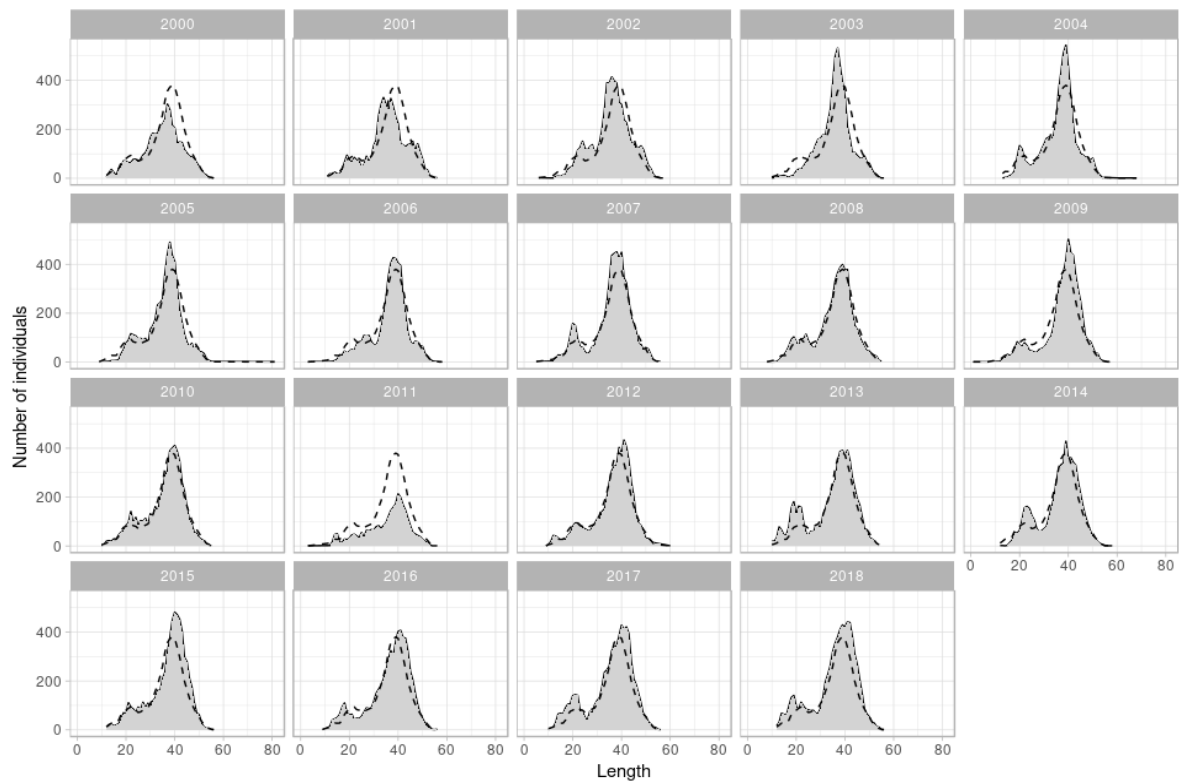


Figure 6. Greater silver smelt. Length distributions from the autumn survey.

Mynd 6. Gullax. Lengdardreifing úr stofnmælingu botnfiska að hausti.

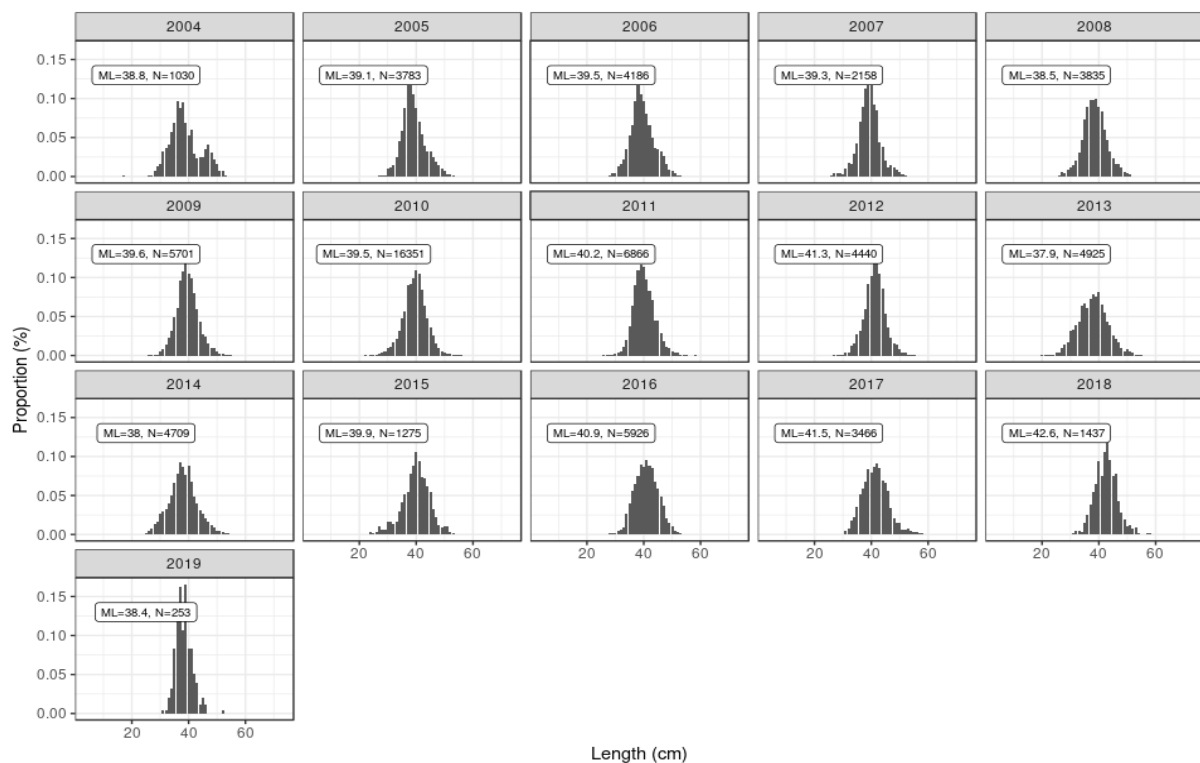


Figure 7. Greater silver smelt. Length distributions from Icelandic commercial bottom trawl catches with mean length (ML) and sample size (N).

Mynd 7. Gullax. Lengdardreifing úr botnvörpuveiðum Íslendinga ásamt meðallegnd (ML) og sýnastærð (N).

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 estimated from catch in numbers are given in Figure 8.

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

Tafla 4. Gullfax. Samantekt á lengdar og aldursgagnasöfnun ásamt fjölda aldursgreininga.

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

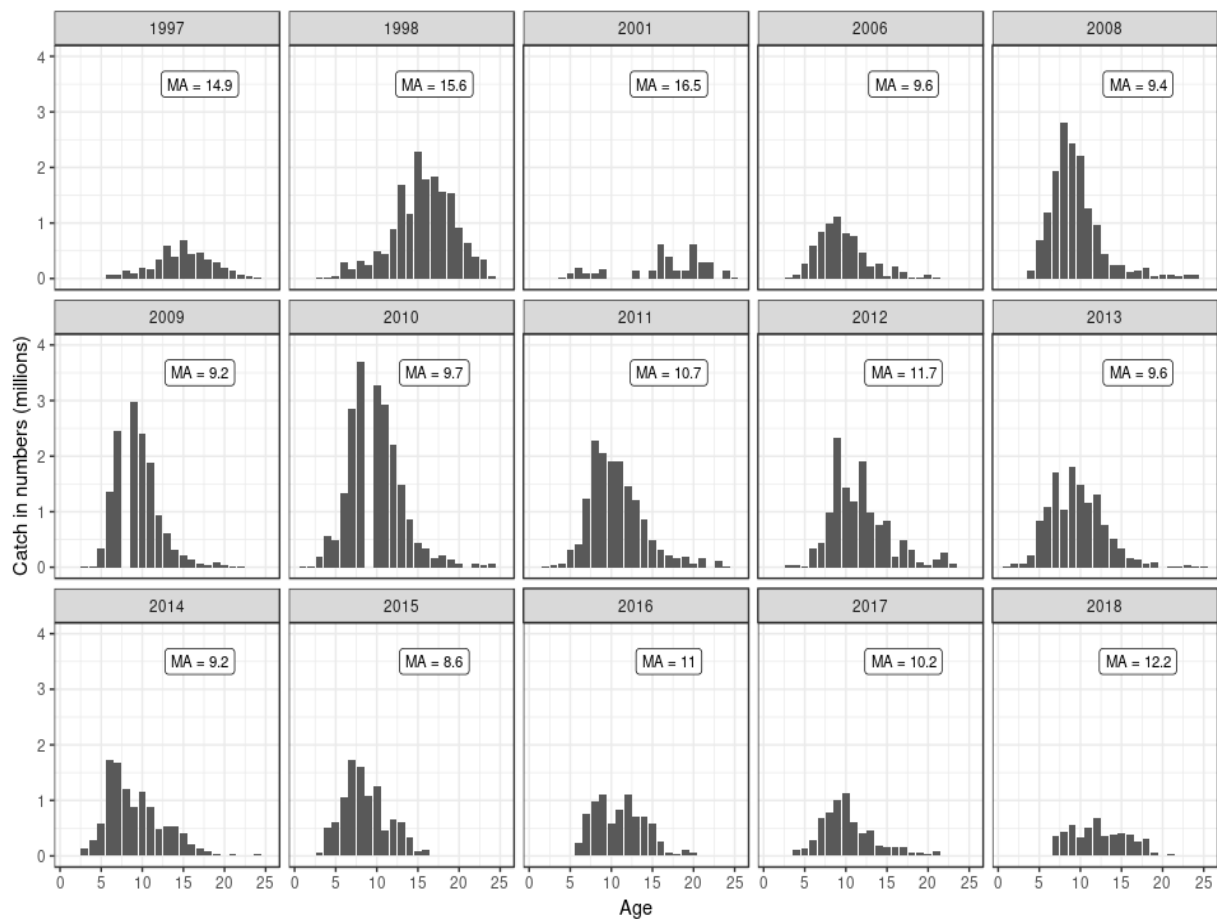


Figure 8. Greater silver smelt. Catch in numbers and mean age (MA).

Mynd 8. Gullfax. Fjöldi einstaklinga í afla eftir aldri og meðalaldur (MA).

WEIGHT AT AGE

No marked changes can be observed in mean weight-at-age from commercial catches.

MATURITY AT AGE AND NATURAL MORTALITY

Estimates of maturity ogives of greater silver smelt in Icelandic waters were presented at the WKDEEP 2010 meeting for both age and length (WKDEEP 2010, GSS-04) 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 RESEARCH VESSEL 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. In addition, the autumn survey was commenced in 1996 and expanded in 2000. A detailed description of the autumn groundfish survey is given in the stock annex 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 9 gives trends in biomass density and juvenile density (numbers) for the spring survey in 1985 to 2018 and for the autumn survey in 2000 to 2017. These values represent simple mean densities over stations; no stratification was used in these as the standard spring and autumn stratification schemes are inappropriate. Due to industrial action 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 due to the fact that 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. Therefore, a special stratification scheme was developed and the index is winsorized when used in the advisory procedure (See stock annex for details). A comparison of indices, with or without winsorization are shown in Figure 10. No substantial changes in spatial distribution are seen in general in Figure 11.

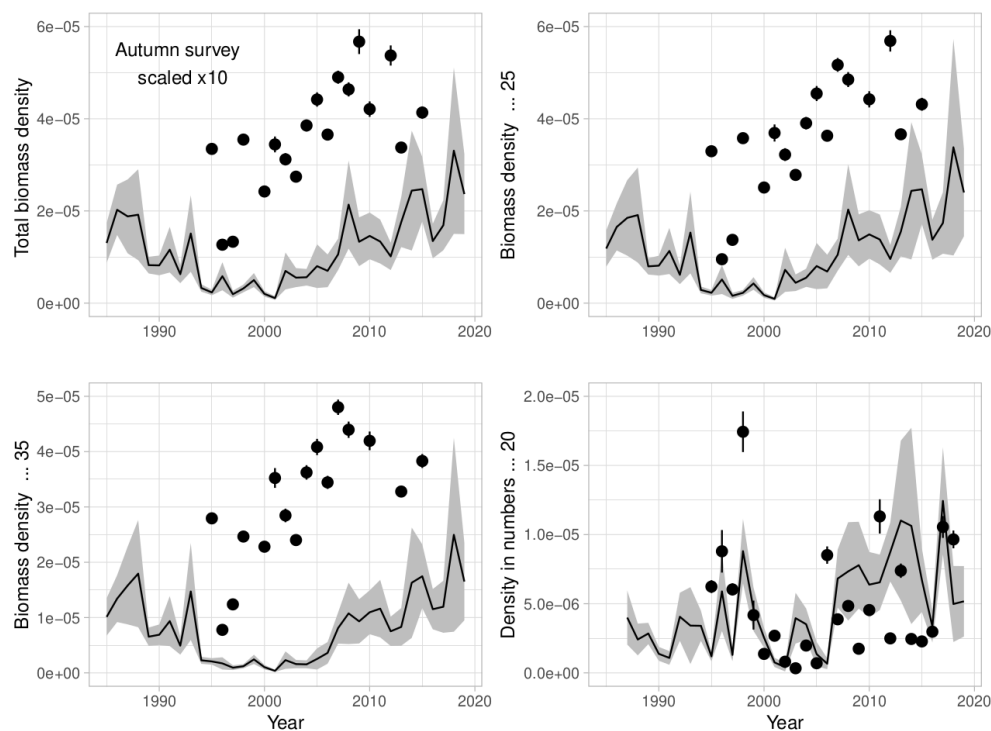


Figure 9. Greater silver smelt. Indices calculated without stratification (mean density) from the Icelandic spring survey (lines and shaded area) and from the autumn survey (dots). Vertical lines and shaded area represent +/- 1 standard error.

Mynd 9. Gullfax. Vísitala úr vorralli (lína með skyggðum svæðum) og haustralli (punktar). Skyggð svæði og lóðréttar línur tákna +/- staðalfrávik.



Figure 10. Greater silver smelt. Index from the Icelandic autumn survey divided by depth. The line colour indicates the biomass index used, either un-altered (red) or winsorized (blue).

Mynd 10. Gullax. Vísitala úr haustralli, skipt eftir dýpi. Litur skilur að vísitölu óbreytta (rauð) eða „winsorized“ (blá).

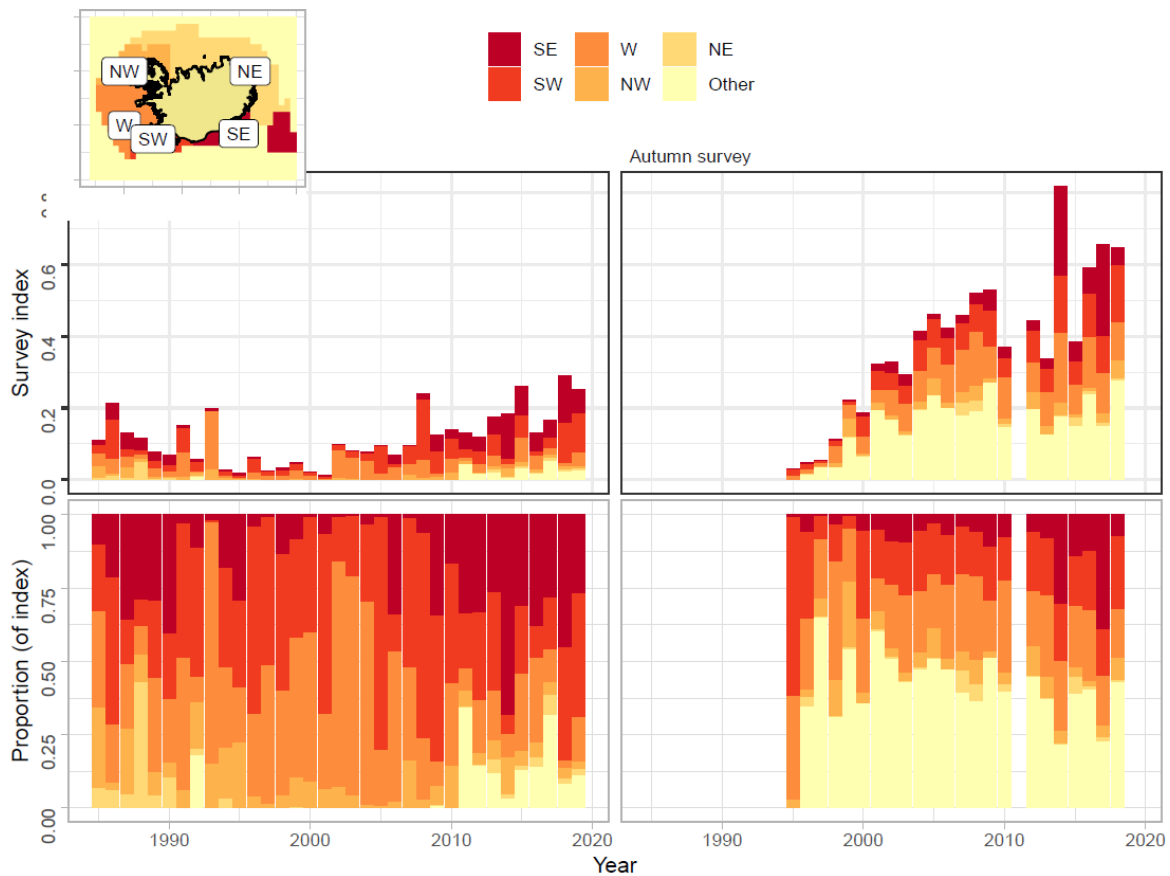


Figure 11. Greater silver smelt. Estimated survey biomass in the spring and autumn surveys by year from different areas (upper figure) and as proportions of the total (lower figure).

Mynd 10. Gullax. Áætluð vísitala úr stofnmælingu botnfiska að vori og hausti eftir árum og svæðum (efri mynd) og hlutfall milli svæða (neðri mynd).

DATA ANALYSES

LANDINGS AND SAMPLING

Spatial distribution of catches in Icelandic waters did not change markedly between 2015 and 2016 and fishing for greater silver smelt in the NW area seems to have stopped (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 4035 tonnes in 2018 (Figure 4 and Table ??). 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. At the same time mean length in catches decreased from around 44 cm in 1998 to 38–40 in 2008 to 2011. However, there is 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 age in the fishery has decreased since the late nineties from around 16 to around 10 in 2006 to 2011. However, as is the case for mean length, mean age in catches in 2012 increased, and is estimated closer to 11 years in the most recent years (Figures ?? and 9). The reason for this change 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 (without stratification). 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 2018 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 (Figures 10 and 11).

The observed trends in the biomass indices from the autumn survey have a considerably different trend than those observed in the spring survey (Figure 9). 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.

There is a clear gradient in mean length of greater silver smelt with depth, larger fish being in deeper water. Fishing for greater silver smelt in Icelandic waters is banned at depths less than 400 meters. The autumn survey index for depth greater than 400 meters is therefore considered the best indicator of available biomass to the fishery and is used in the advice procedure. As noted in the section above, the Winsorized index appears to be less sensitive to the few large hauls in the 2009 and 2014 survey years (Figure 10).

F_{PROXY}

Changes in relative fishing mortality ($F_{\text{proxy}} = \text{Yield} / \text{Survey biomass at depths greater than 400 m}$) are presented in Figure 13. F_{proxy} was relatively stable in 2004 to 2006 but then increased slowly from 2006 to 2008. This was mainly driven by increases in catches. The decrease in 2009 is the result of a very high value of the index in that year but the decrease between 2010 and 2012 is due to decrease in catches as the index was at similar levels between the two years (Figure 12).

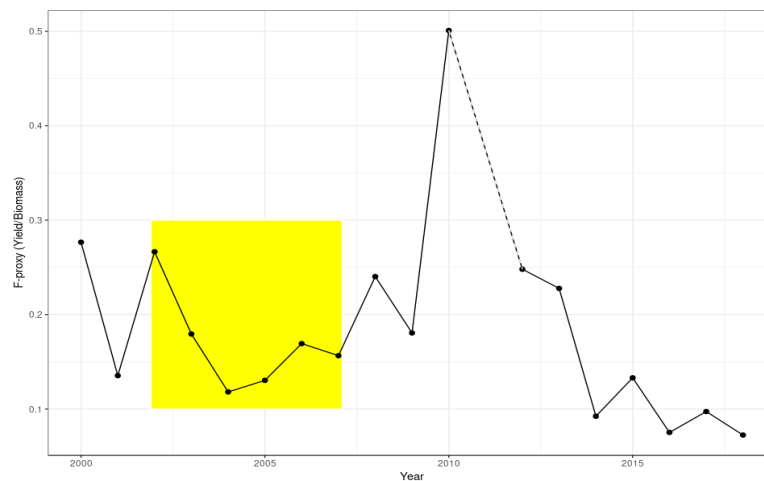


Figure 12. Greater silver smelt. Changes in relative fishing mortality (F_{proxy}). The index used is the >400 m winsorized index from the Icelandic autumn survey.

Mynd 12. Gullfax. Breytingar á vísitölu veiðihlutfalls (F_{proxy}). Winsorized vísitala gullfax á >400 m úr haustralli er notuð.

ANALYTICAL ASSESSMENT

No analytical assessment presented this year.

COMMENTS ON THE ASSESSMENT

The assessment was conducted according to the stock annex.

MANAGEMENT

Before the 2013/2014 fishing year the Icelandic fishery was managed as an exploratory fishery subject to licensing since 1997. For the 1999/2000 fishing year the government of Iceland increased TAC mid-season. A detailed description of regulations on the fishery of greater silver smelt in Icelandic waters is given in the stock annex.

The TAC for the 2013/2014 fishing year was set at 8000 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, 9 310 t for 2017/2018 and 7603 t for 2018/2019.

Figure 13 illustrates the difference between national TAC and landed catch in Icelandic waters. The difference can be attributed to species transformation (in both directions, Figure 13).

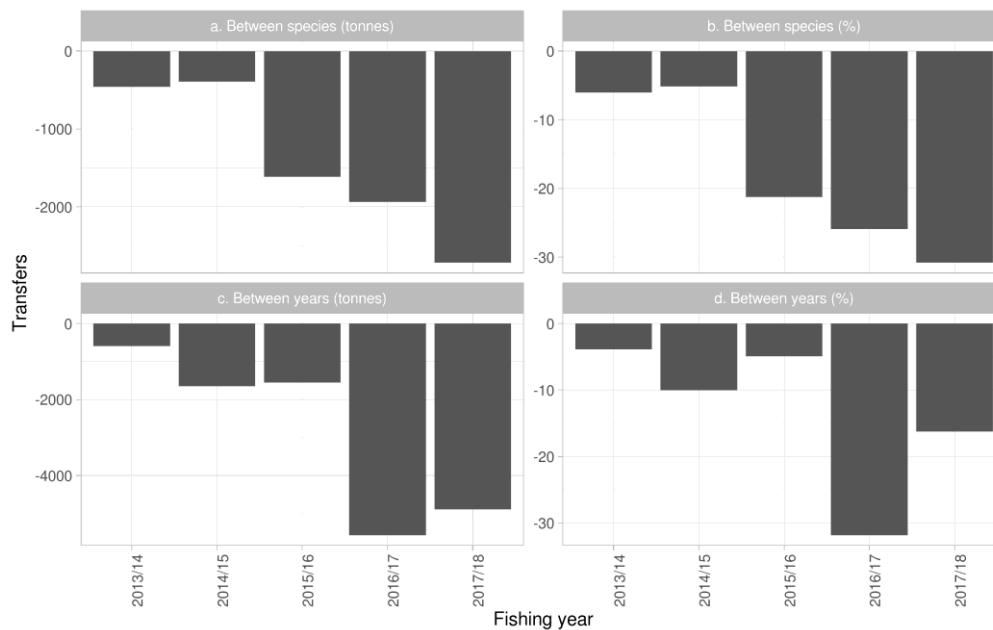


Figure 13. Greater silver smelt. Net transfer of quota in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to greater silver smelt, but negative values indicate a transfer of greater silver smelt quota to other species. Between years (lower): Net transfer of quota from a given fishing year (may include unused quota).

Mynd 13. Gulllax. Nettó tilfærsla á kvóta eftir fiskveiðiárum. Tilfærsla á milli tegunda (efri mynd): jákvæð gildi tákna tilfærslu á kvóta annarra tegunda yfir á gulllax en neikvæð gildi tilfærslu gulllaxkvóta á aðrar tegundir. Tilfærsla milli ára (neðri mynd): Nettó tilfærsla kvóta frá viðkomandi fiskveiðiári (gæti innihaldið ónotaðan kvóta).

MANAGEMENT CONSIDERATIONS

Exploitation of greater silver smelt in 5.a 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.

Although catches have increased substantially in Greenlandic waters in the past two years, stock structure for this species is unclear, catches are quite distant between Greenlandic and Icelandic waters, and therefore it is possible that ICES subarea 14 (Greenlandic waters) and section 5.a (Icelandic waters) should be treated as separate stocks (Figure 14). These data and Greenlandic biomass indices should be considered in the next benchmark. Nonetheless, the catches reported from Greenlandic waters in recent years (Table 3) has coincided with a period of low harvest rates in Icelandic waters. Therefore, the addition of these data does not change interpretations of stock status or advice given in previous years.

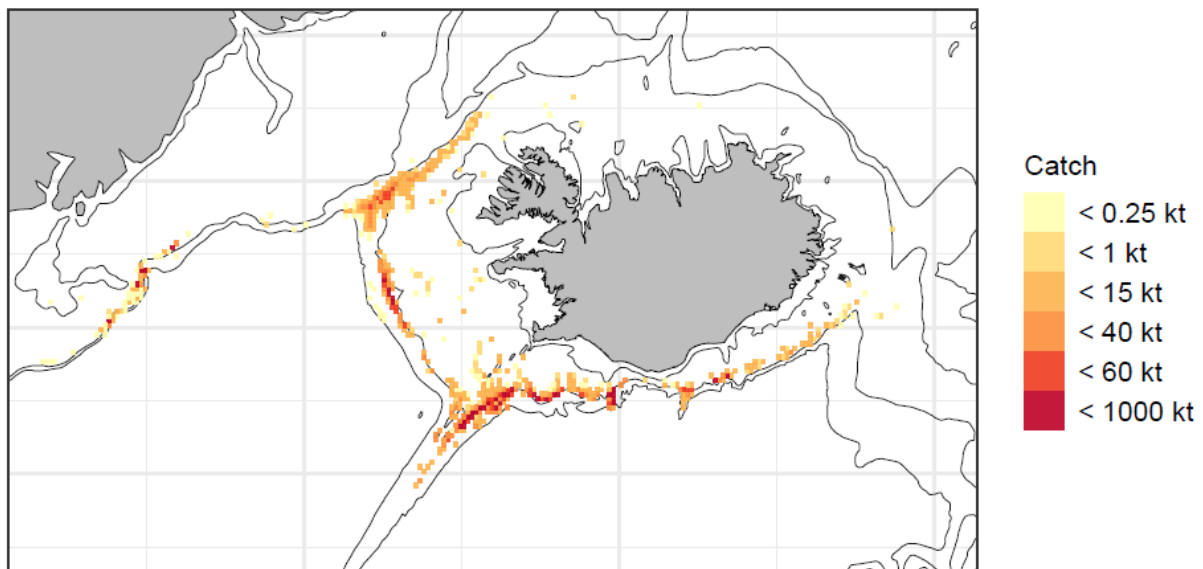


Figure 14. Greater silver smelt. Spatial distribution of catches from logbook data in ICES subarea 14 (east Greenland) and section 5.a. (Iceland).

Mynd 14. Gulllax. Dreifing veiðanna skv. afladagbókum frá ICES svæðum 5.a. (Ísland) og 14 (Grænland).

ECOSYSTEM CONSIDERATIONS FOR MANAGEMENT

Greater silver smelt is a semi-pelagic species, so questions regarding whether the index covers the full stock distribution and how aggregating behavior affects indicators of biomass. Therefore, biomass indices should continuously be evaluated for effectiveness and compared with other sources of information regarding stock status. With this in mind, potential changes in stock distribution and growth should be monitored closely, as well as the importance of this stock as a forage species (especially at younger ages) to other species in the area. These factors do not currently seem to be an issue in current management but should be monitored carefully.