

Plaice

Pleuronectes platessa

GENERAL INFORMATION

Icelandic plaice (*Pleuronectes platessa*) is found on the continental shelf around Iceland with the highest abundance in the southwest and west of the island. It is mainly found on a sandy or muddy substrate, occurring at depths ranging from the coast down to 200 meters, sometimes even deeper (Jónsson & Pálsson, 2013). Sexual dimorphism occurs in plaice, as females grow larger than males and mature at larger size. Only a small proportion of males become longer than 45 cm, but about the same proportion of females grow larger than 55 cm. Size at sexual maturity differs between the sexes, whereas at the length of 33 cm about half the males have reached maturity, but females reach that level at 38 cm length. Spawning occurs mostly at 50–100 m depth in the relatively warm waters south and west of Iceland, but there is small-scale spawning off the northwest and north coast (Sigurðsson, 1989 and Sólmundsson et al., 2005). After metamorphosis, the 0-group juveniles seek bottom in shallow waters and spend the first summer just below the tidemark (Pálsson & Hjörleifsson, 2001).

Genetic studies (Le Moan, Bekkevold, and Hemmer-Hansen 2021), (Hoarau et al. 2004) suggest that plaice found on the Icelandic and Faroese shelf areas are genetically different from plaice found elsewhere. Sigurdsson (1982) observed long distance migrations to the Barents Sea. Similar migrations were not observed in recent tagging studies in Icelandic waters (Solmundsson, Pálsson, and Karlsson 2005) and the validity of these older observations are considered questionable (Sigurdsson pers. comm). Furthermore, the older observations are in conflict with the results from Le Moan, Bekkevold, and Hemmer-Hansen (2021).

Tagging data suggests considerable movement within Icelandic waters, this is in accordance with the observed distributional shifts between the spring and autumn surveys and suggests that sub-stock structure for plaice in Icelandic waters is negligible.

FISHERY

Main fishing grounds for plaice are in the west and southwest of Iceland, with smaller fishing areas in the southeast and several fjords in the north (Figure 1 and Figure 2). Demersal seine is the main fishing gear for plaice (65–71% since 2011) in area 5a followed by demersal trawl (23–30%), while a small proportion of the catch is taken in gillnets and longline (Figure 4). Seinners dominate the coastal plaice fishery, but trawlers catch them deeper and further offshore. Plaice fishing grounds in 2014–2022, as reported by mandatory logbooks, are shown in Figure 1.

Since 2000, the main fishing grounds of plaice have been on the southwestern, western and north-western part of the Icelandic shelf (Figure 2). Spatial distribution of the Icelandic plaice fishery has been relatively stable, with around 60% of the plaice caught on the western and north-western part of the shelf. In the last decade, reported catches have increased in the southwestern part but decreased again last year to previous

proportions. On the contrary, an increase in reported catches was observed in western and north-western part of the self in 2020. Plaice is caught in relatively shallow water, with most of the catch (60–80%) taken at depths of 21–80 m (Figure 3). Plaice is primarily caught in demersal seine and demersal trawl or around 95% of the total catch (Figure 4). This proportion has been relatively stable through the years, as well as the relative amount caught in other gears (predominantly gillnets) with around 5–10% of the catch since 2004.

Since 2000, the number of vessels reporting catches of plaice annually has decreased, whereas total catches have been increasing in the past few years. This decrease is most noticeable in the demersal seiner fleet, where the number dropped from 92 vessels in 2004, to 41 in 2018. The number of trawlers has remained relatively stable since 2010 (Table 1). Total annual catch of plaice has been relatively stable (4900–8300 t) over the last 20 years. In 2020, a total of 7505 t of plaice were caught, about 675 t more than in 2019.

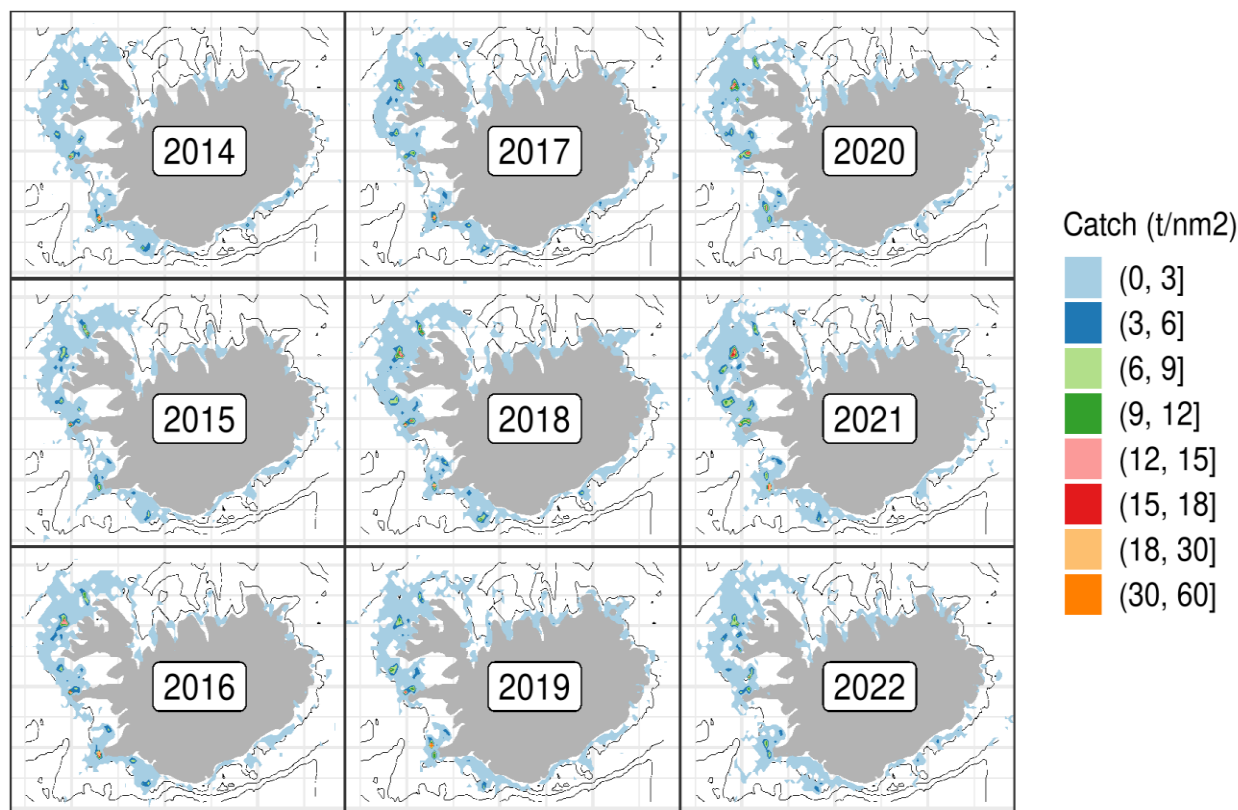


Figure 1: Plaice in 5a. Spatial distribution of catches by all gears according to Logbooks.

Table 1: Plaice in 5a. Number of Icelandic vessels landing plaice, and all landed catch divided by gear type.

Year	Nr. Danish Seine	Nr. Bottom Trawl	Nr. Other	Danish Seine	Bottom Trawl	Other	Total catch
2000	125	134	450	3070	1747	442	5259
2001	95	127	521	2924	1402	600	4926
2002	96	118	420	3426	1270	446	5142
2003	95	115	389	3590	1295	372	5257
2004	95	108	399	4037	1375	294	5706
2005	88	105	352	3909	1638	255	5802
2006	87	99	365	3720	2449	212	6381
2007	82	98	355	3311	2232	267	5810
2008	80	93	322	3836	2605	285	6726
2009	70	85	315	3889	2125	310	6324
2010	61	85	328	3647	2038	299	5984
2011	55	80	357	3021	1655	267	4943
2012	54	88	374	4079	1410	437	5926
2013	56	87	317	4040	1583	364	5987
2014	45	74	317	4239	1380	308	5927
2015	50	74	319	4403	2001	350	6754
2016	44	73	280	4896	2120	430	7446
2017	48	71	282	4579	1765	351	6695
2018	47	66	257	5584	2436	321	8341
2019	44	63	276	4287	2231	316	6834
2020	41	65	213	4682	2474	350	7506
2021	37	63	238	4719	3604	355	8678
2022	40	64	210	4303	2746	227	7276

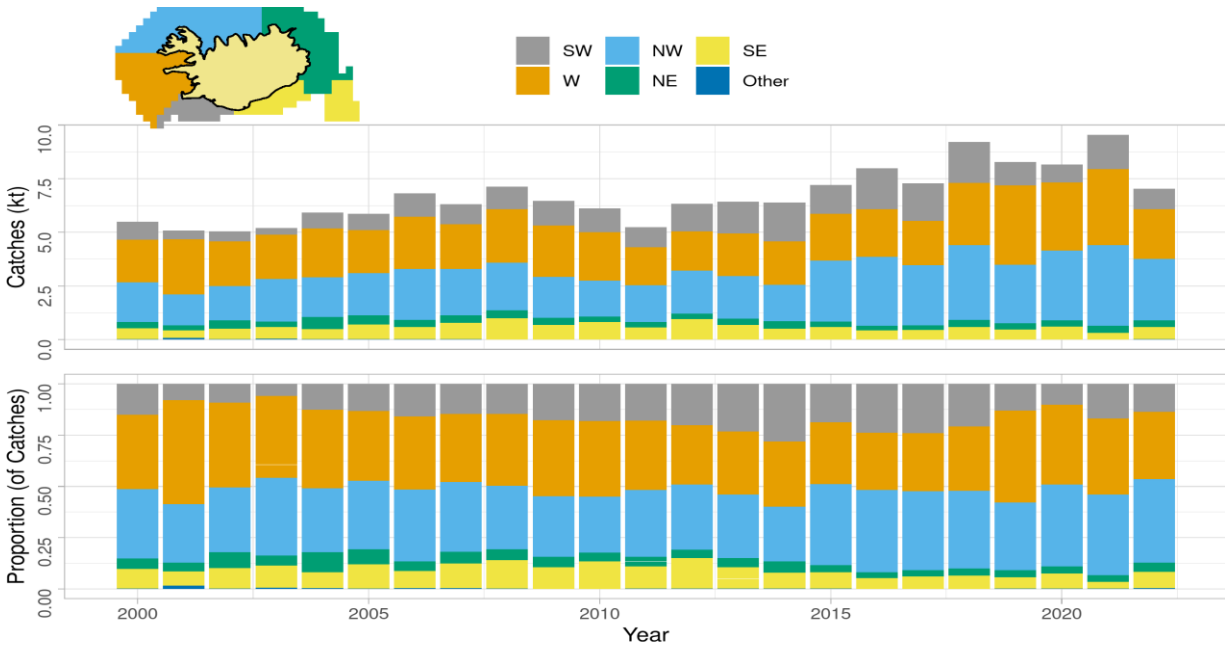


Figure 2: Plaice in 5a. Changes in spatial distribution of plaice catches as recorded in Icelandic logbooks.

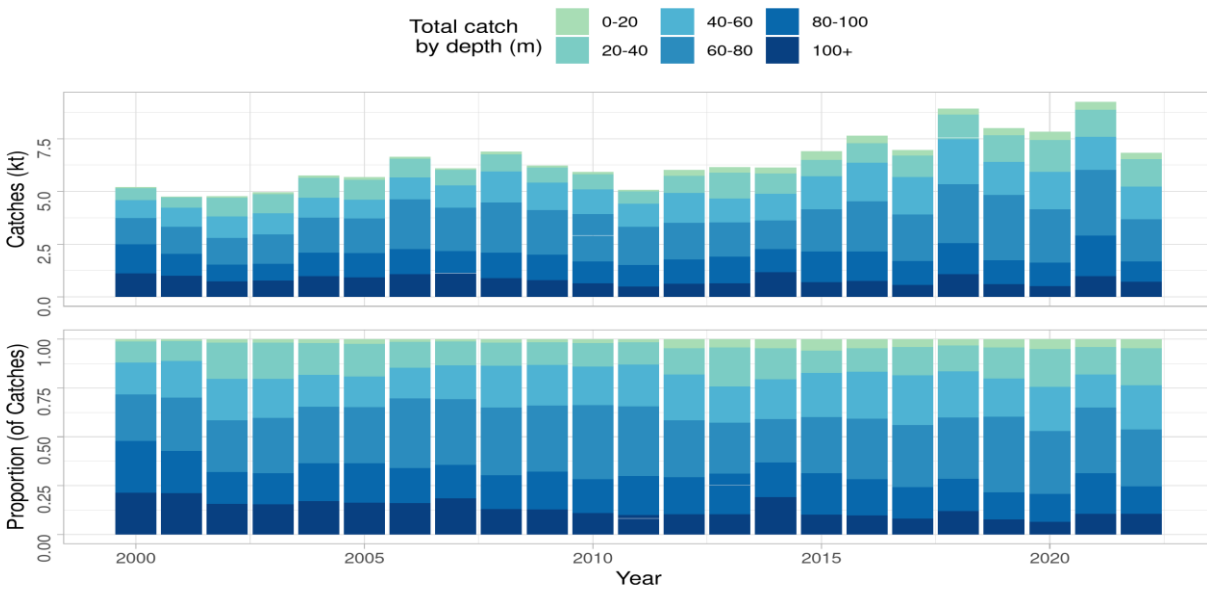


Figure 3: Plaice in 5a. Depth distribution of plaice from demersal trawl and seine according to Icelandic logbooks.

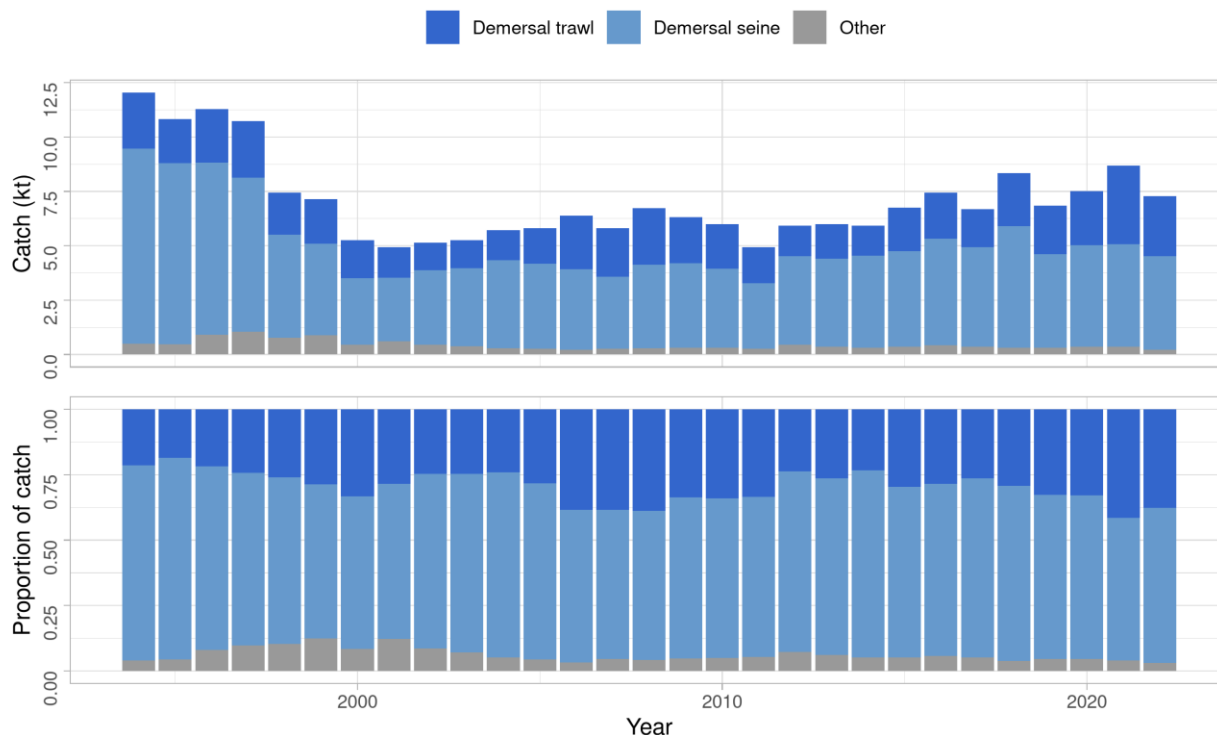


Figure 4: Plaice in 5a. Landings in tonnes and percent of total by gear and year.

LANDINGS TRENDS

Plaice fishery in 5a has been considered stable in last two decades and annual landings have been between 5 and 8 thousand tonnes (Figure 5). Landings of plaice in 2022 are estimated to have been 7276 tonnes, see Figure 5 and Table 2. Landings in division 5.a. have decreased from around 14.5 thous. tonnes in 1985, which historically was the maximum level observed to the current level. Landings by foreign vessels were considerable before the Icelandic EEZ was expanded to 200 nautical miles in 1975, afterwards landings were primarily by the Icelandic fleet. Foreign vessels were the most significant with regards to landed plaice before WW2, but during the war period the Icelandic fleet picked up and took over the majority of fisheries in Icelandic waters. Through years 1946–1973 the landings were divided between both foreign and Icelandic fleet.

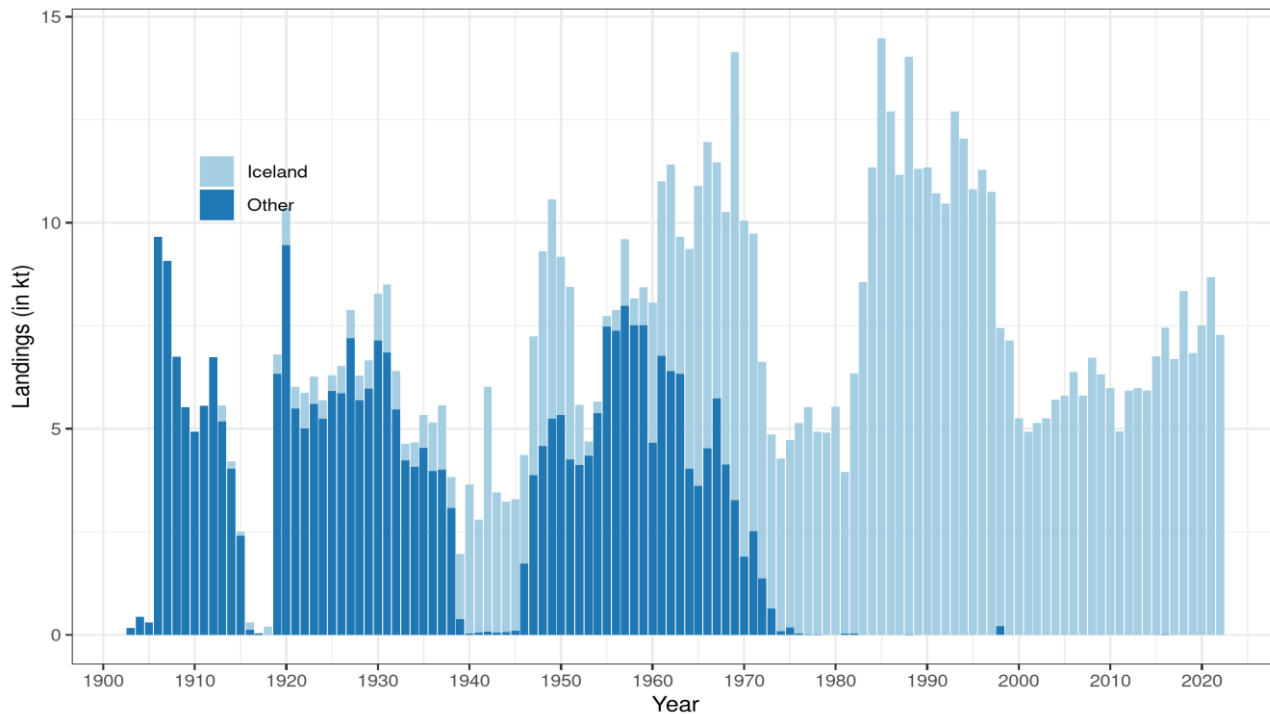


Figure 5: Plaice in 5a. Recorded landings since 1905.

DATA AVAILABLE

Sampling of biological data from main gears (demersal seine and bottom trawl) in commercial catches is considered good in general. The sampling does cover the spatial distribution of catches to a satisfactory extent. The sampling coverage by gear in 2022 is shown in Figure REF samplplot /w:instrText>{=openxml} and overview of the number of samples is shown in Figure REF samploverview /w:instrText>{=openxml}. Due to the COVID-19 pandemic in 2020, researchers from MFRI and inspectors from Directorate of Fisheries in Iceland had difficult time obtaining necessary samples for biological measurements from the fisheries, therefore sampling locations and numbers were fewer than usual during this year.



Figure 6: Plaice in 5a. Fishing grounds in 2022 as reported in Icelandic logbooks (colours) and positions of samples taken from landings (asterisks) by main gear types.

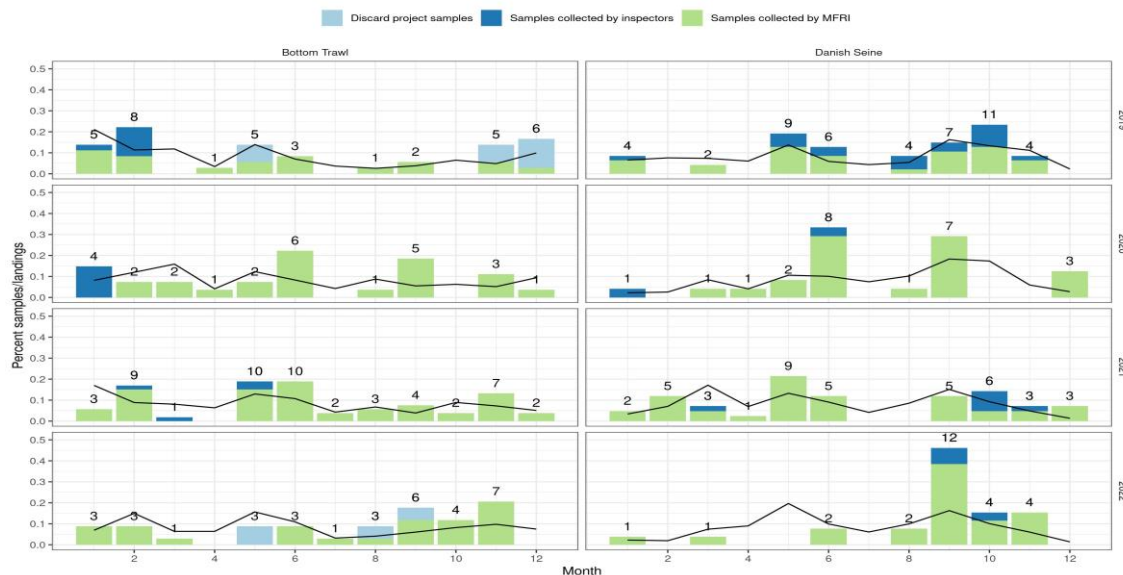


Figure 7: Plaice in 5a. Ratio of samples by month (blue bars) compared with landings by month (solid black line) split by year and main gear types. Numbers of above the bars indicate number of samples by year, month, and gear.

LANDINGS AND DISCARDS

All landings in 5.a before 1982 are derived from the STATLANT database, and also all foreign landings in 5.a to 2005. The years between 1982 and 1993 landings by Icelandic vessels were collected by the Fisheries Association of Iceland (Fiskifélagið). Landings after 1994 by Icelandic vessels are given by the Icelandic Directorate of Fisheries. Landings of foreign vessels (mainly Norwegian and Faroese vessels) are given by the Icelandic Coast Guard prior to 2014 but after 2014 this are also recorded by the Directorate (Figure 3). Discarding is banned by law in the Icelandic demersal fishery. Discard rates in the Icelandic fishery for plaice are estimated negligible at least since 2001. Measures in the management system such as converting quota share from one species to another are used by the fleet to a large extent and this is thought to discourage discarding in mixed fisheries. In addition to prevent high grading and quota mismatch the fisheries are allowed to land fish that will not be accounted for in the allotted quota, provided that the proceedings when the landed catch is sold will go to the Fisheries Project Fund (Verkefnasjóður sjávarútvegsins). A more detailed description of the management system can be found on <https://www.responsiblefisheries.is/seafood-industry/fisheries-management/statement-on-responsible-fisheries>.

LENGTH COMPOSITION

An overview of available length measurements from 5.a is given in Table **Error! Reference source not found.** Most of the measurements are from the two main fleet segments, i.e. trawls and demersal seine. Length distributions from the main fleet segments are shown in Figure 8. The sizes caught by the main gear types (bottom trawl and Danish seine) appear to be fairly stable, primarily catching plaice in the size range between 35 and 55 cm. There has been a shift towards larger fish in the length distribution. As a result, the

average length in the samples taken from commercial catch has increased from 35 cm in 1991 to 43.1 cm in 2016.

Table 1: Plaice in 5a. Number of samples and length measurements from landed catch.

Year	Bottom Trawl Nr. lengths	Bottom Trawl Nr. samples	Danish Seine Nr. lengths	Danish Seine Nr. samples
2000	4261	33	7185	49
2001	1003	9	7517	51
2002	2392	18	11263	69
2003	3278	21	13804	96
2004	3834	28	21216	150
2005	5251	35	20583	139
2006	8102	60	19222	135
2007	6837	49	17073	124
2008	11359	77	17471	129
2009	7201	50	19106	136
2010	9608	62	17387	126
2011	7609	55	16857	110
2012	5723	39	18329	129
2013	4688	31	16647	115
2014	2531	21	7271	53
2015	4142	33	5997	44
2016	4757	32	8075	58
2017	3527	28	6231	52
2018	3506	24	5666	43
2019	4838	36	5990	47
2020	2788	27	3031	24
2021	6922	53	5067	42
2022	4507	34	3211	26

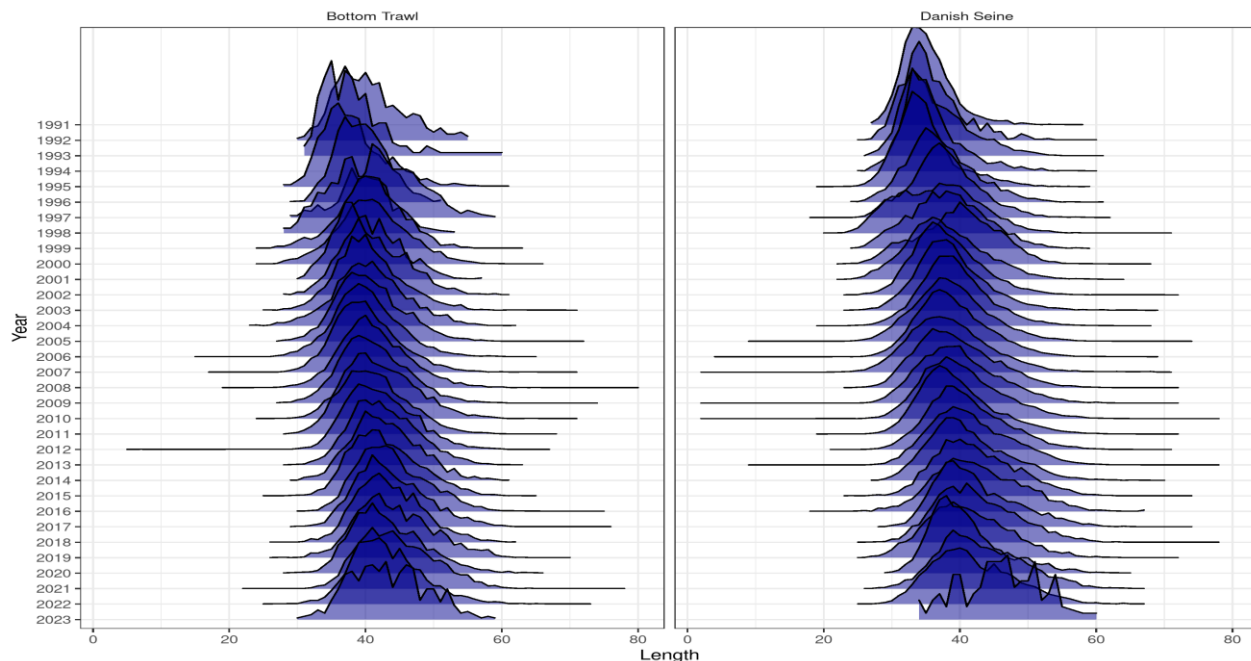


Figure 8: Plaice in 5a. Commercial length distributions by gear and year

AGE COMPOSITION

Table gives an overview of otolith sampling intensity by gear types in 5.a. In 2002–2005 the majority of the catch was 4–7 years old plaice, or about 60% of landings in terms of estimated numbers (Figure 9). The proportion of these age classes in the catch then decreased and for the last five years it has been 40–45%. Thus, plaice in the catch have gradually become older, and as an example the average age of plaice caught has increased from 6.3 years in 2001–2007 to 7.0 years in 2012–2016. In recent years, 2017–2019, the largest cohorts have been 6–8-year-old fish, however in last two years 4–7-year-old fish were most common, similar to 2001–2007.

Table 2: Plaice in 5a. Number of samples and otoliths collected from landed catch.

Year	Bottom Trawl Nr. otol	Bottom Trawl Nr. samples	Danish Seine Nr. otol		Danish Seine Nr. samples
2000	1507	33	2400		49
2001	350	9	2250		51
2002	599	18	2424		69
2003	550	21	3149		96
2004	820	28	3701		150
2005	1000	35	3036		139
2006	1450	60	3200		135
2007	1500	49	3199		124
2008	1850	77	3099		129
2009	1250	50	3180		136
2010	2016	62	3951		126
2011	2452	55	4200		110
2012	1835	39	5199		129
2013	1350	31	5010		115
2014	575	21	900		53
2015	670	33	800		44
2016	573	32	1125		58
2017	550	28	974		52
2018	400	24	880		43
2019	476	36	750		47
2020	550	27	550		24
2021	1225	53	900		42
2022	560	34	470		26

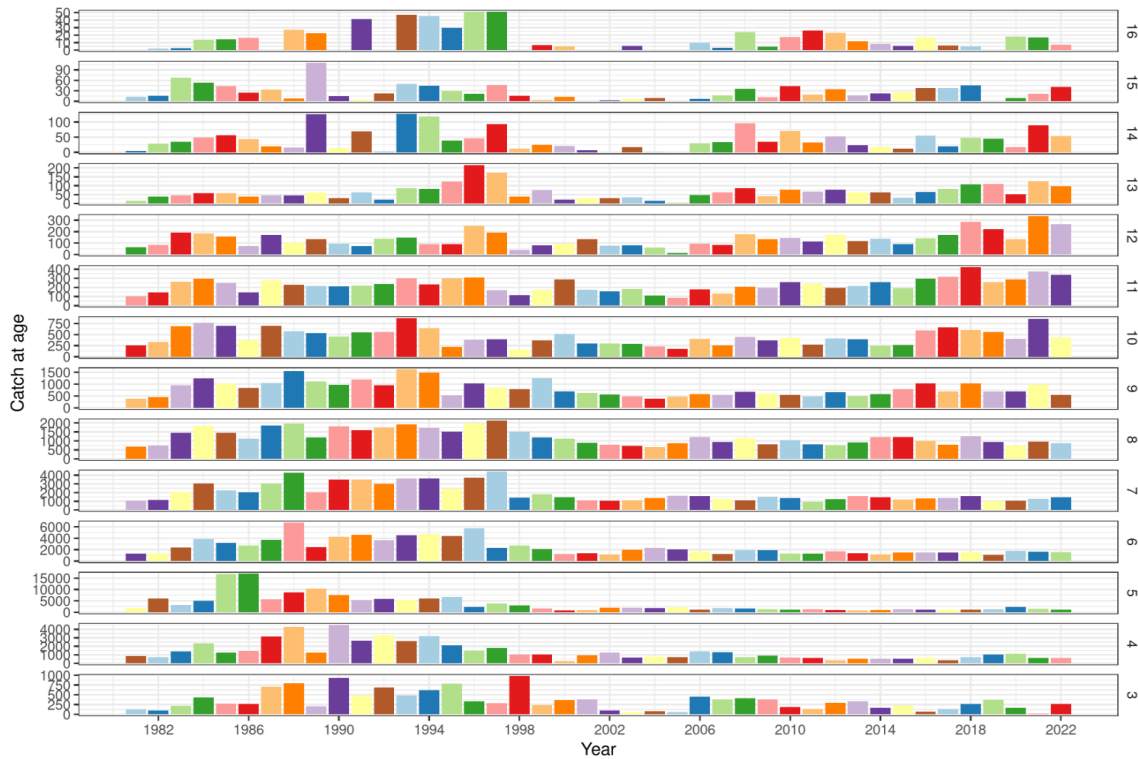


Figure 9: Plaice in 5a. Catch at age from the commercial fishery in Iceland waters. Bar size is indicative of the catch in numbers and bars are coloured by cohort.

WEIGHT AT AGE

Mean weight at age in commercial catches is shown in Figure 10. Mean weight at age has been increasing in all age groups since 1995.

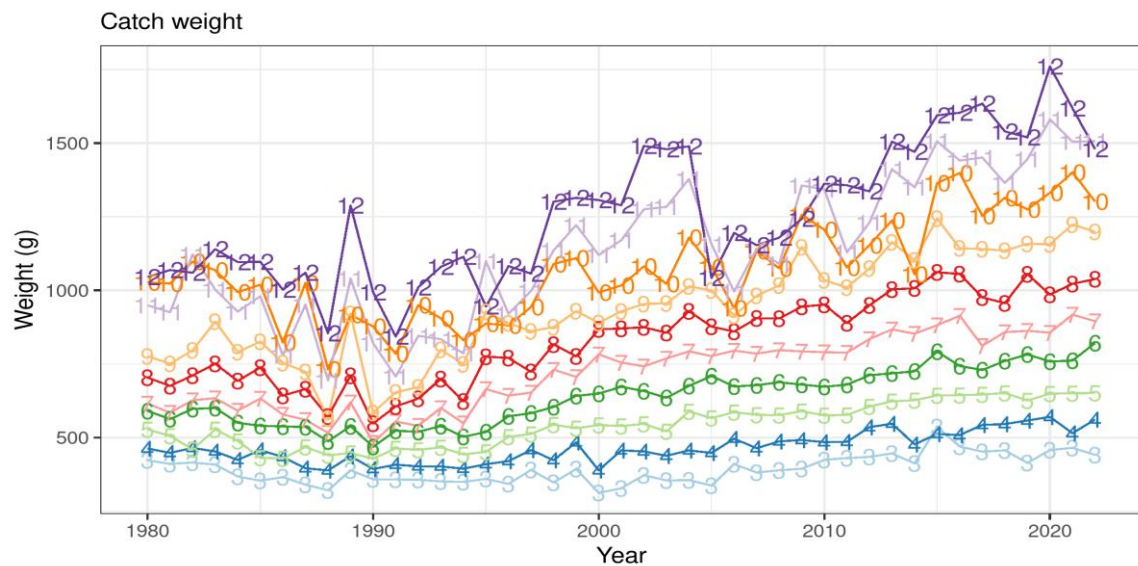


Figure 10: Plaice in 5a. Catch weights from the commercial fishery in Icelandic waters.

NATURAL MORTALITY

No information is available on natural mortality.

CATCH, EFFORT AND RESEARCH VESSEL DATA

CATCH PER UNIT OF EFFORT (CPUE) AND EFFORT DATA FROM COMMERCIAL FISHERIES

CPUE estimates of plaice in Icelandic waters are not considered representative of stock abundance as changes in fleet composition and technical improvements have not been accounted for when estimating CPUE. Non-standardised estimates of CPUE in demersal seine (kg/set) is calculated as the total weight in sets in which plaice was more than 50% of the catch. CPUE gradually increased from 250 kg/set to about 700 kg/set in 2016 (Figure 11). CPUE of plaice in demersal seine has been around that level since then with some fluctuations in last two years. CPUE of demersal trawl (kg/hour), in hauls where plaice is more than 50% of the catch, remained relatively stable around 150 kg/hour until 2010. CPUE of plaice in trawl, like in the demersal seine fishery, gradually increased from 200 kg/hour in 2000 to about 500 kg/hour in 2019 and has stayed at that level.

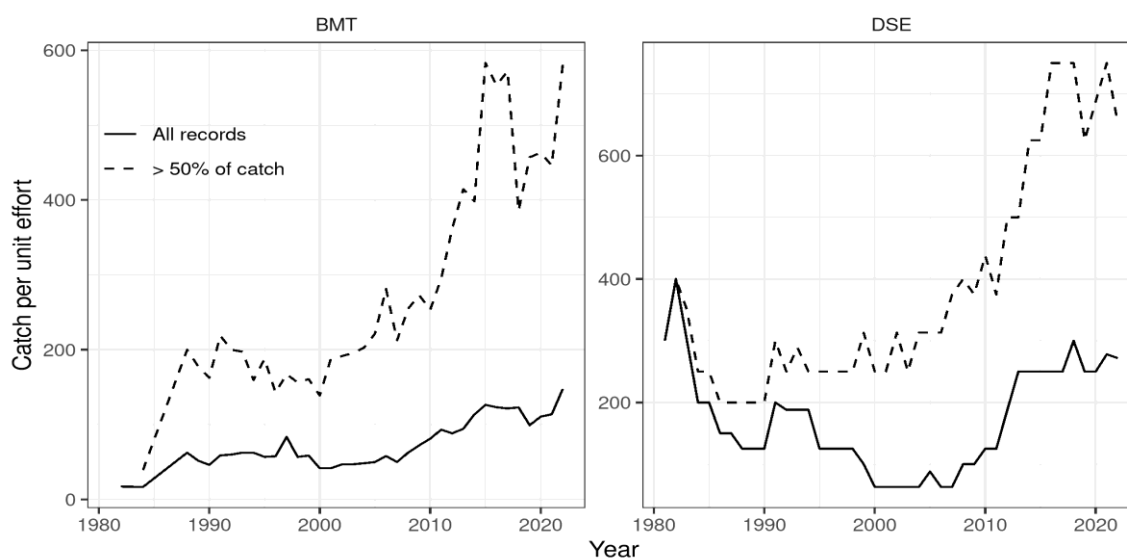


Figure 11: Plaice in 5a. Catch per unit of effort in the most important gear types. The dashed lines are based on locations where more than 50% of the catch is plaice and solid lines on all records where plaice is caught. A change occurred in the longline fleet starting September 1999. Earlier only vessels larger than 10 BRT were required to return logbooks but later all vessels were required to return logbooks. Effort data is not available for 2022.

ICELANDIC SURVEY DATA

Information on abundance and biological parameters from plaice in 5.a is available from two surveys, the Icelandic groundfish spring survey and the Icelandic groundfish autumn survey. The Icelandic spring groundfish survey, which has been conducted annually in March since 1985, covers the most important distribution area of the plaice fishery. In addition, the Icelandic autumn groundfish survey was commenced in 1996. The autumn survey was not conducted in 2011. The spring survey is considered to measure changes

in abundance/biomass better than the autumn survey. It does not, however, adequately cover the main recruitment grounds for plaice, as recruitment takes place in shallow water in habitats unsuitable for demersal trawling. In addition to these two major surveys, there was a designated flatfish survey with beam trawl, conducted annually in July/August from 2016 to 2022, with the aim to cover most of the recruitment grounds of plaice and other flatfish species. This survey was discontinued in 2023.

Figure 12 shows trends in various biomass indices and a recruitment index based on abundance of plaice smaller than 20 cm. Survey length-disaggregated abundance indices are shown in Figure 15 and changes in spatial distribution in Figure 13. Total biomass index of plaice and plaice larger than 30 cm (harvestable part of the stock), decreased rapidly in the first years of the spring survey and were at the lowest level in 1997–2002. In 2003–2016 the indices gradually increased and stabilized. Since 2017 there have been minor annual fluctuation in the indices, but they are still fairly stable. This year's spring survey biomass index is in correspondence with the biomass from early 1990. The indices are now only one-third to half of what they were in the first four years of the time series. The index of plaice larger than 50 cm in the spring survey also decreased to lowest levels in 1997–2002 but has increased and has been in recent years at similar level as in the beginning of the time series. The index of juvenile abundance (<20 cm) has maintained at the low level since 1998 with occasional small peaks. Trends in the autumn survey are similar to those observed from the spring survey, but standard deviations in the measurements are higher.

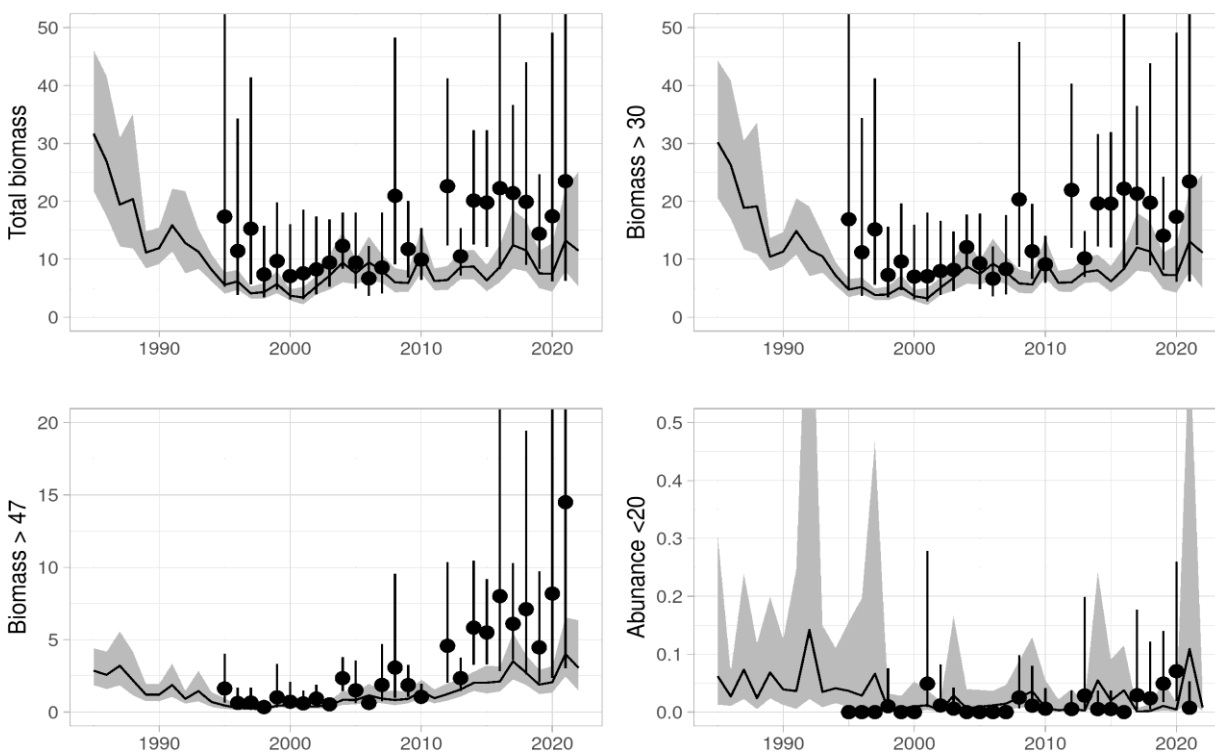


Figure 12: Plaice in 5a. Indices in the Spring Survey (March) 1985 and onwards (line shaded area) and the autumn survey (point ranges).

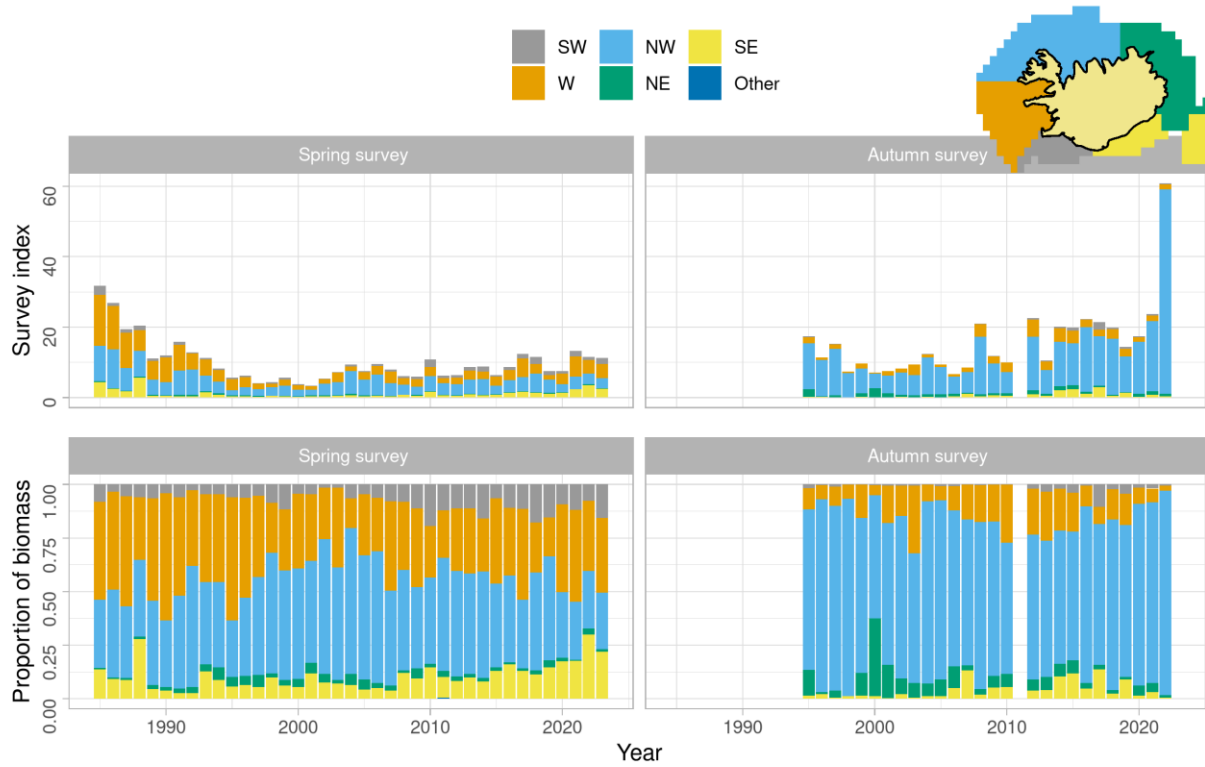


Figure 13: Plaice in 5a. Changes in geographical distribution of the survey biomass.

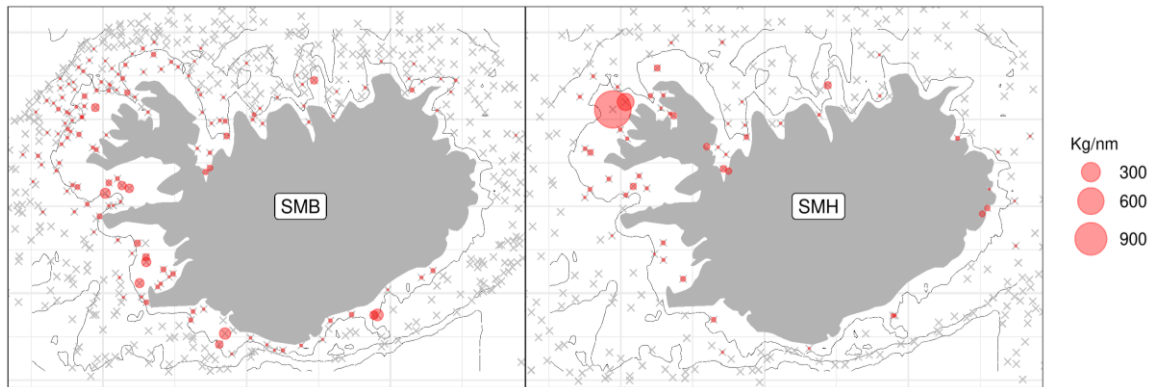


Figure 14: Plaice in 5a. Location of plaice in the most recent March (SMB) and the Autumn (SMH) surveys, bubble sizes are relative to catch sizes.

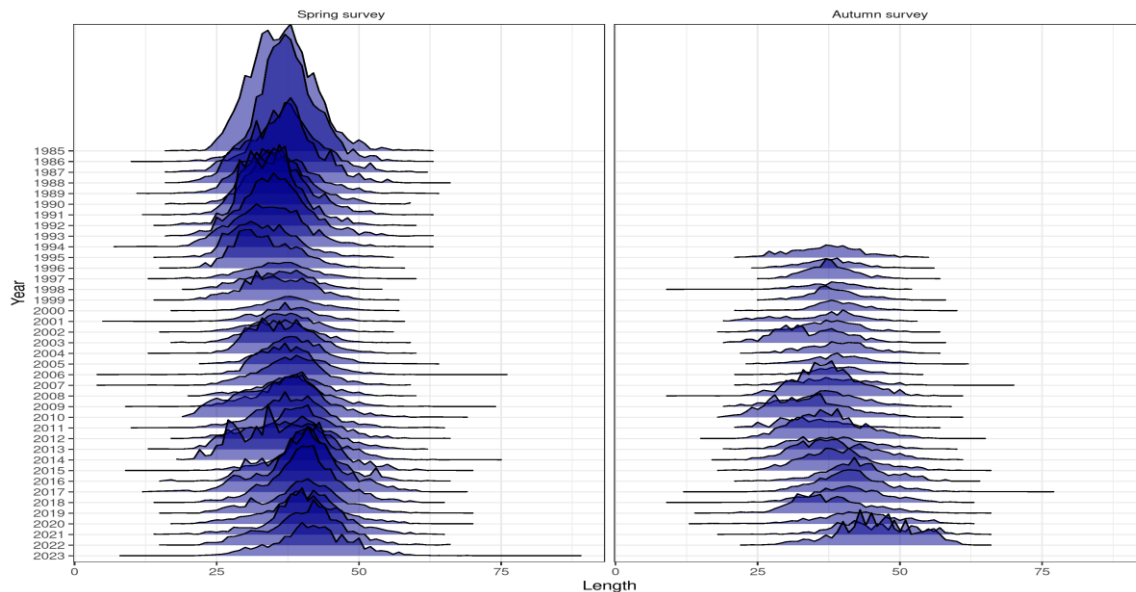


Figure 15: Haddock in 5a. Length distributions from the spring and autumn surveys.

Mean weight at age in SMB is shown in Figure 16. Mean weights at age from SMB are also used as mean weight at age in the spawning stock, approximated from lengths. For stock weights for age 9 are smoothed using a running 3-year average. Prior to 1985 the stock weights are assumed fixed at 1985 levels.

Maturity-at-age data from SMB are given in Figure 17. Based on guidelines from PGCCDBS (ICES, 2017) it was decided to use mature females as the basis for maturity at age. Prior to 1985 the proportion mature is assumed fixed at 1985 levels. Maturity at age is estimated from yearly maturity at length ogives estimated using logistic regression treating individuals as fixed effects. Maturity at age was smoothed with a 3-year running average.

Plaice is mainly caught in the northwest area as well as on the main spawning grounds off the western part of the country in the spring survey and on the species main feeding grounds in the northwest of the country in the autumn survey (Figure 14). Spatial distribution of plaice catch in the surveys shows some temporal changes, particularly between catches taken in the west and northwest areas (Figure 13). This could be due to annual variation in timing of plaice moving to their traditional spawning grounds in the western part of the country as the survey takes place around that same time every year.

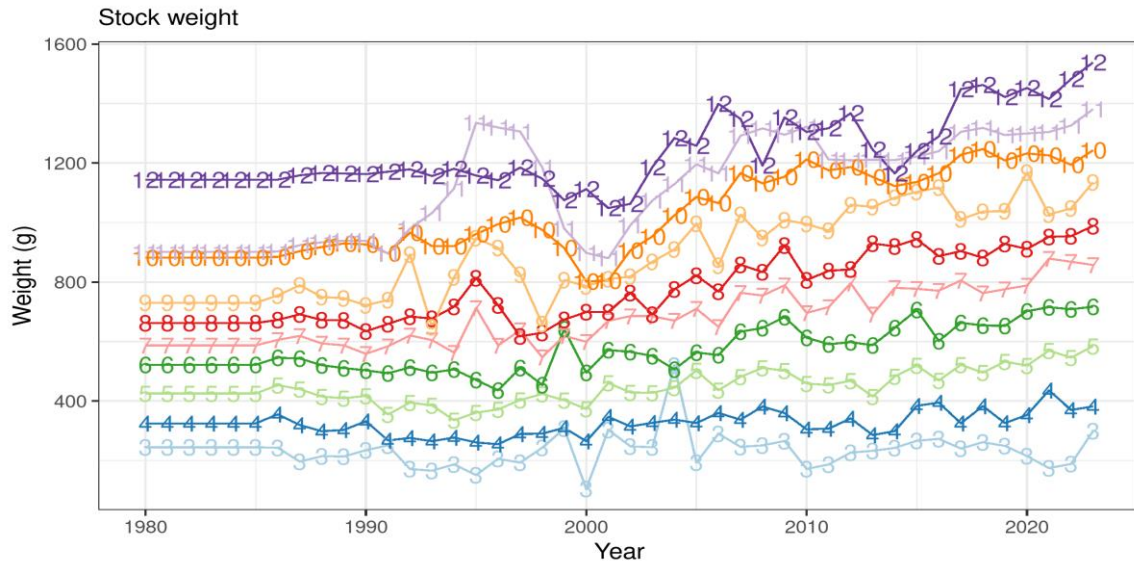


Figure 16: Plaice in 5a. Weight at age observed in the spring survey.

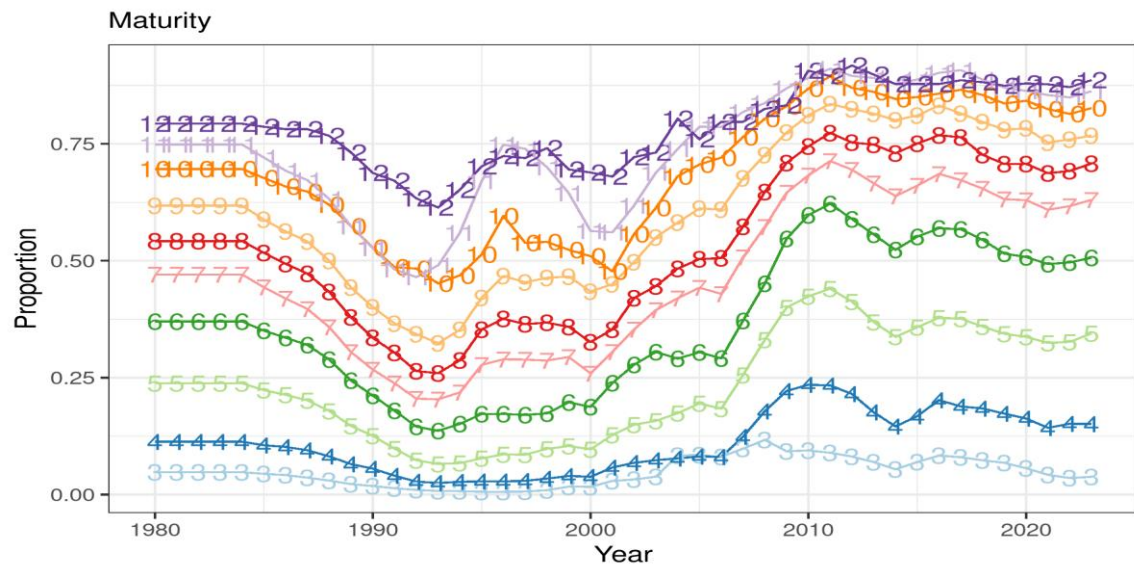


Figure 17: Plaice in 5a. Maturity at age observed in the spring survey.

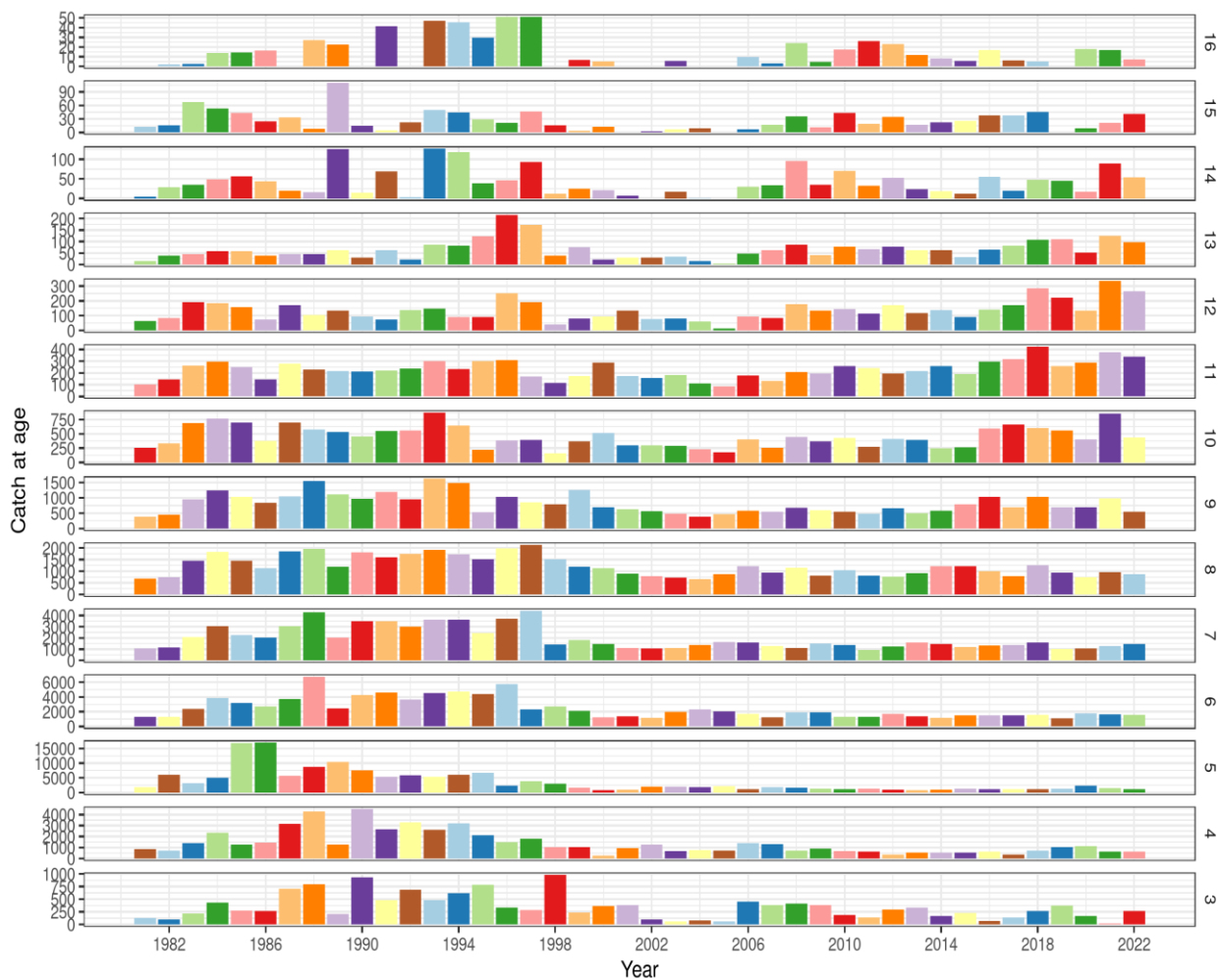


Figure 18: Plaice in 5a. Age disaggregated indices in the Spring Survey, colored by cohorts.

DATA ANALYSES

ANALYTICAL ASSESSMENT

This stock was benchmarked for the first time in April 2022 (WKICEMP 2022) and was first assessed the same year.

The assessment model for plaice in 5a is a statistical catch at age model based on:

- commercial catch-at-age data from 1979 onwards
- the Icelandic spring groundfish survey from 1985
- Recruitment estimated at age 3 every year.

Model setup and settings are described in the Stock Annex (ICES, 2022c). The maximum age of the model is 12, which is considered a plus group.

For assessment and advisory purpose, the natural mortality is set to 0.15 for all age groups.

MODEL FIT

The model fit to survey indices and catch at age data are shown in Figures 24 and 25. Generally, except for the youngest age classes, the SAM model follows the catch-at-age and spring survey data.

The fit to data is illustrated in Fig. 19 where no concerning residual patterns were revealed. The process residuals for $\log(N)$ and $\log(F)$, shown in Fig. 20, also reveal no pattern.

Fig. 21 shows the estimated model parameters. Observation variances are lowest for the spring survey and commercial catches for ages 5 to 8 and 7 to 8 respectively, with the highest variances at either ends of the age range. Survey variances are in general higher than that of the commercial catches. Strong positive correlations were estimated between ages for the commercial catches, less for survey catches. Process variances were fixed across all ages for both $\log(N)$ and $\log(F)$, with populations variances estimated at 0.06.

Survey catchability showed an increasing trend with age, peaking at the age of 10, while slightly lower at 11 and 12.

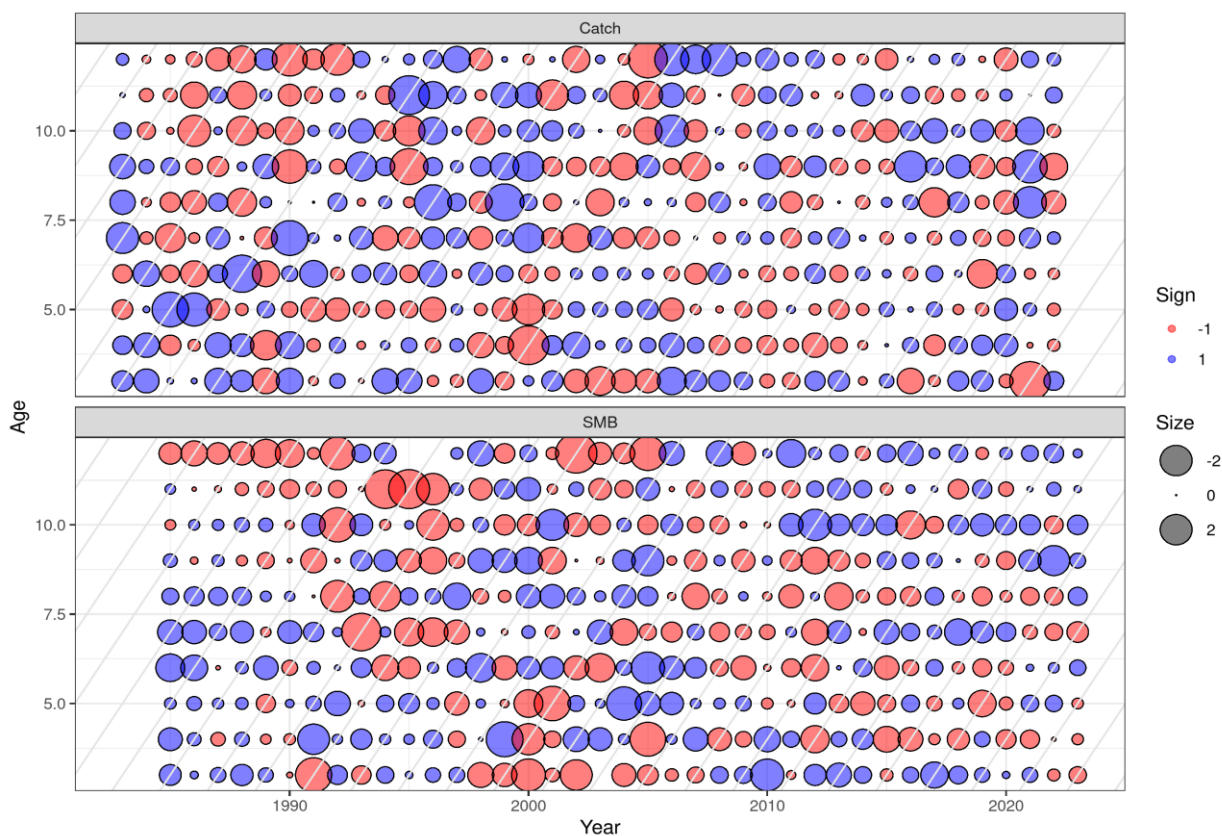


Figure 19: Plaice in 5a. Model residuals from the assessment model. Red circles indicate where the model estimates are higher than the observed while blue indicate models estimates lower than observed.

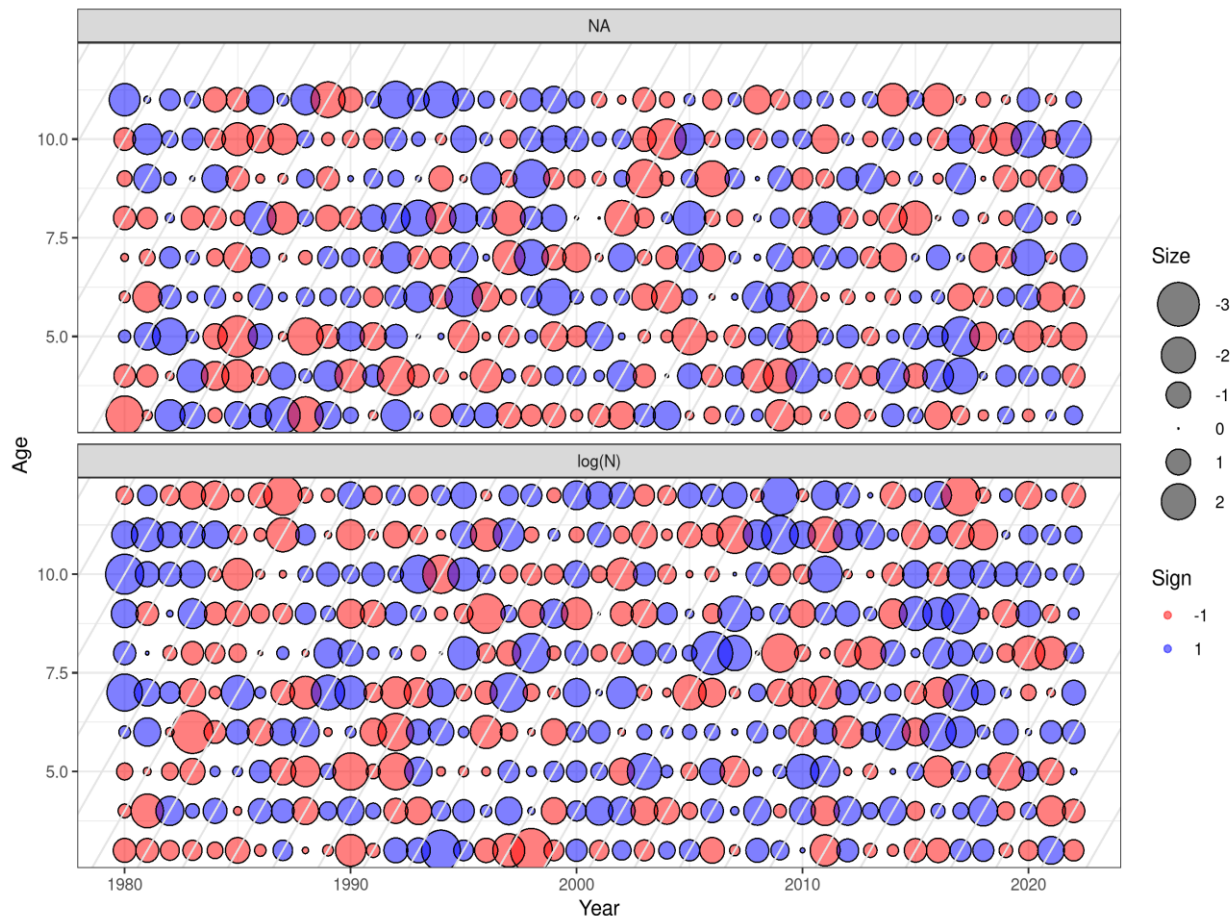


Figure 20: Plaice in 5a. Process residuals from the assessment model.

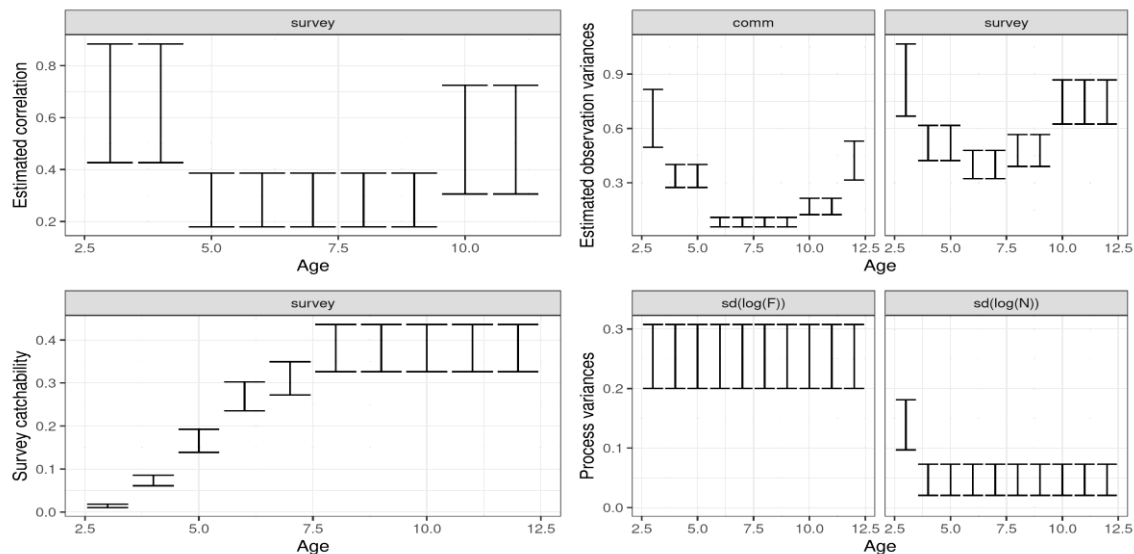


Figure 21: Plaice in 5a. Illustration of estimated model parameters.

STOCK OVERVIEW

Population dynamics of plaice estimated by this model (Fig. 22) show a clear reduction in the level of recruitment (at age 3) in 1993, and subsequently we see an increase in fishing mortality and reduction in total catches. Spawning stock biomass (SSB) was at its lowest value at the turn of the century. In recent years recruitment is seen to be stable at the post 1993 levels whereas fishing mortality has been reduced and SSB increased. Catches have remained stable, slightly increasing.

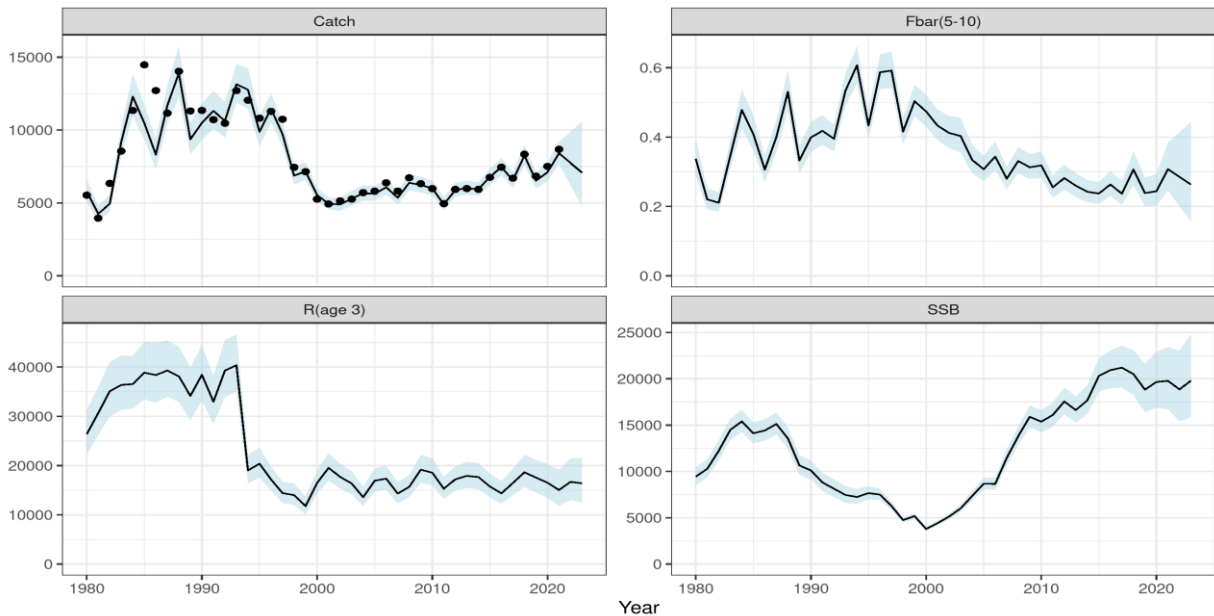


Figure 22: Plaice in 5a. Estimates of spawning stock biomass, fishing mortality (weighted average of ages 5 to 10), recruitment and landings from the best model. Black line represents the point estimates and blue ribbon the 90% confidence intervals.

ANALYTICAL RETROSPECTIVE

The proposed model had low Mohn's ρ statistic values for spawning stock biomass, fishing mortality, and recruitment. Analytical retrospective plots do not indicate any substantial deviations in assessment (Fig. 23). These Mohn's ρ values are well within the range recommended by Carvalho et al. (2021).

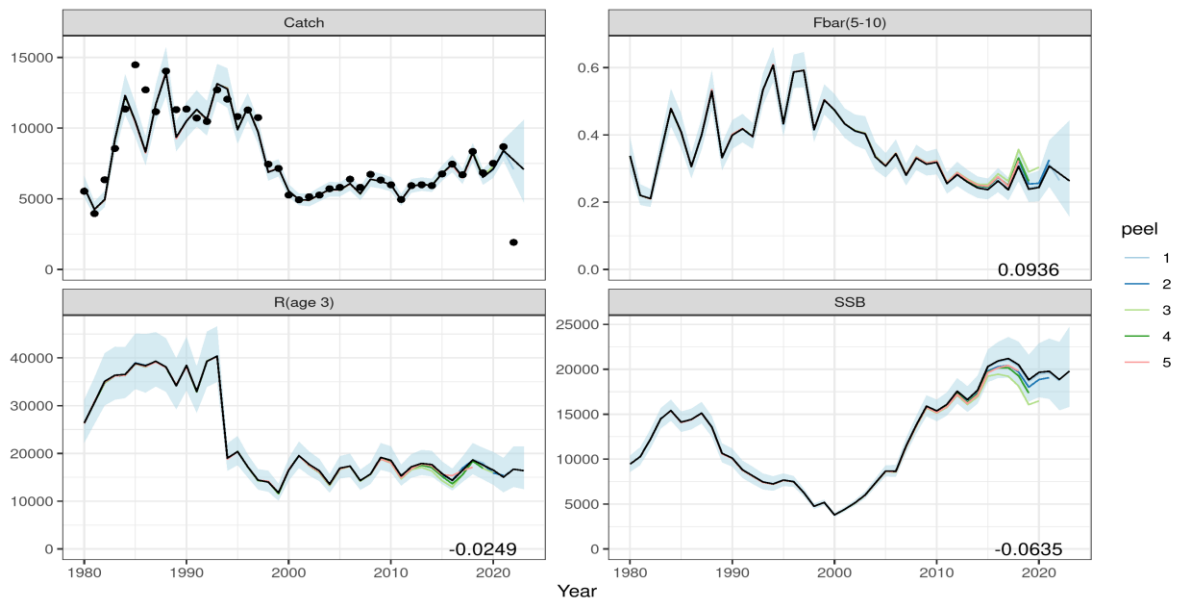


Figure 23: Plaice in 5a. Analytical retrospective estimates of SSB, catch, F and recruitment. Mohn's rho is indicated in the bottom right corner.

SHORT-TERM FORECAST

Short term projections are performed using the standard procedure in SAM using the forecast function. Three year averages are used for stock and catch weights, and maturity. From this projection the advice is derived. The advice is based on the Icelandic fishing year starting in September each year. This causes a mismatch between the assessment model, which is based on the calendar year. So in order to provide advice for the fishing year, the standard projection procedure in SAM will need to be adapted to accommodate these differences. So given the assessment in year y the interim year catches are based on the following fishing mortality:

$$F_y = \left(\frac{8}{12} F_{sq} + \frac{4}{12} F_{mgt} \right)$$

and therefore the total catches for year y will be:

$$C_y = \frac{F_y}{F_y + M} (1 - e^{-(F_y + M)}) B_y$$

and the part of the catch in the fishing year $y-1/y$ will be

$$\frac{\frac{8}{12} F_{sq}}{\left(\frac{8}{12} F_{sq} + \frac{4}{12} F_{mgt} \right)} C_y$$

and the catch in fishing year $y/y+1$ will be:

$$C_{y/y+1} = \frac{\frac{4}{12} F_{mgt}}{\left(\frac{8}{12} F_{sq} + \frac{4}{12} F_{mgt} \right)} C_y + \frac{8}{12} C_{y+1}$$

where

$$C_{y+1} = \frac{F_{mgt}}{F_{mgt} + M} (1 - e^{-(F_{mgt} + M)}) B_y$$

The results from the short term prognosis are shown in Table 4.

Table 3: Plaice in 5a. Results from the short term prognosis

Year	F ₉₋₁₄	Recruitment (age 3)	SSB	Calendar year catch
2023	0.281	16387	19803	7493
2024	0.300	16505	18567	7744
2025	0.300	16505	18015	7544

MANAGEMENT

The 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. Plaice was included in the ITQ system in the 1991/1992 quota year and as such subjected to TAC limitations. For the first six years, the TAC was set higher than recommended by Marine Research Institute (MRI), but this practice stopped in the 2010/2011 quota year (Table 5). One reason for this practice was that no formal harvest rule existed for this stock. Through this time period the landings have been fluctuating between the over- or undershoot of the set TAC. This is related to the management system that allows for transfers of quota share between fishing years and conversion of TAC from one species to another (species transformation).

Figure 24 shows the net transfers in the Icelandic ITQ-system. From 2002-2008 there was a net transfer of other species being transferred to plaice quota (positive values in the figure). However, from 2009-2015, this was reversed, and plaice quota was transferred to other species. In recent years species-transfer of quota through plaice has been low, except for 2020/2021 when around 1400 t were transferred from quotas of other species to plaice. Net transfer of plaice quota between fishing years has varied between years, and ranges from 10 to -12%.

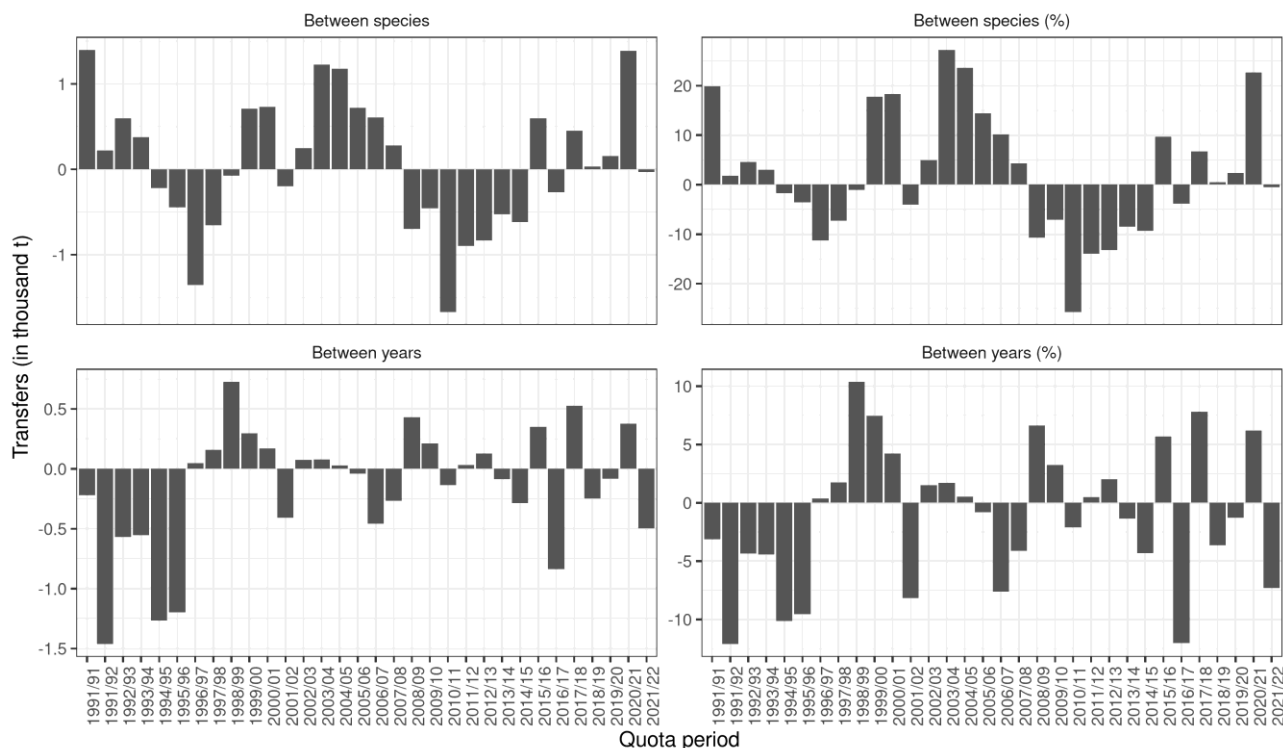


Figure 24: Plaice in 5a. An overview of the net transfers of quota between years and species transformations in the fishery in 5a.

Table 4: Plaice in 5a. National and ICES advice and official landings. All weights are in tonnes.

Year	Rec. TAC	National TAC	Catch
1991/92	10 000	11 000	10 200
1992/93	10 000	13 000	12 400
1993/94	10 000	13 000	12 300
1994/95	10 000	13 000	11 100
1995/96	10 000	13 000	11 000
1996/97	10 000	12 000	10 345
1997/98	9000	9000	8083
1998/99	7000	7000	7452
1999/00	4000	4000	4907
2000/01	4000	4000	4921
2001/02	4000	5000	4402
2002/03	4000	5000	5402
2003/04	4000	4500	5844
2004/05	4000	5000	6184
2005/06	4000	5000	5647
2006/07	5000	6000	6149
2007/08	5000	6500	6620
2008/09	5000	6500	6361
2009/10	5000	6500	6389
2010/11	6500	6500	4843
2011/12	6500	6500	5822
2012/13	6500	6500	5932
2013/14	6500	6500	6030
2014/15	7000	7000	6237
2015/16	6500	6500	7619
2016/17	7330	7330	6369
2017/18	7103	7103	8208
2018/19	7132	7132	7096
2019/20	6985	6985	7177
2020/21	7037	7037	9082
2021/22	7805	7805	7306
2022/23	7663	7663	---

MANAGEMENT CONSIDERATIONS

All the signals from commercial catch and survey data indicate that plaice in Iceland is at present in a good state. This is confirmed in the assessment. Considerable uncertainty is present in the model due to limited information on recruitment from spring survey.

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