

# PLAICE – SKARKOLI

## *Pleuronectes platessa*

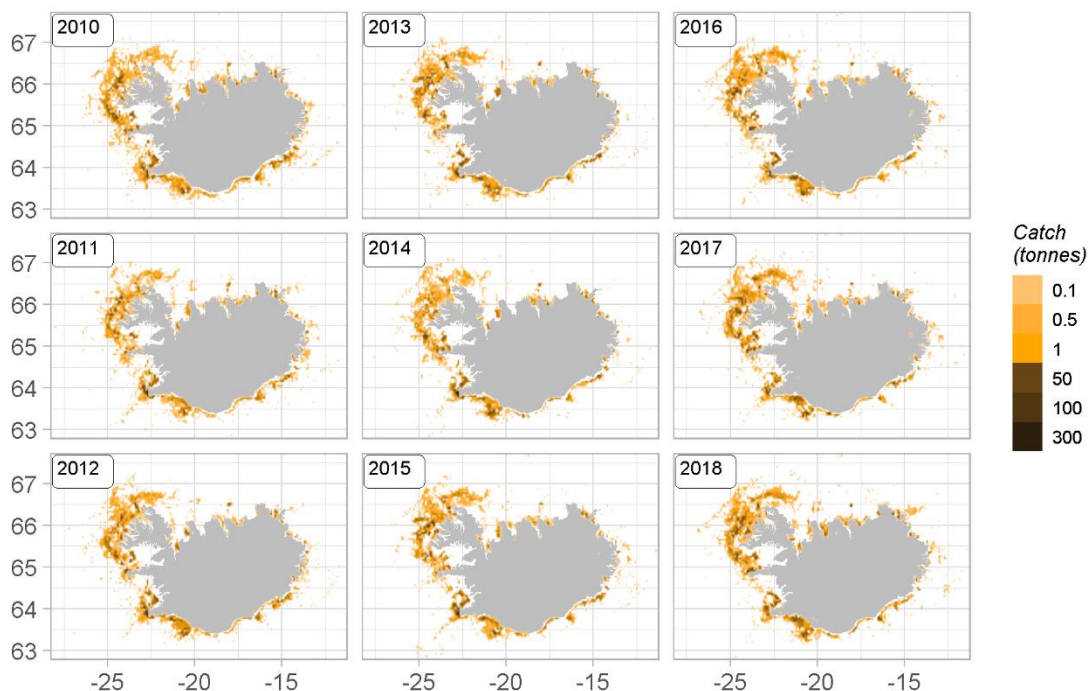
### GENERAL INFORMATION

Plaice 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.

Females grow larger than males. 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. 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. After metamorphosis the juveniles seek bottom in shallow waters and spend the first summer just below the tidemark.

### THE FISHERY

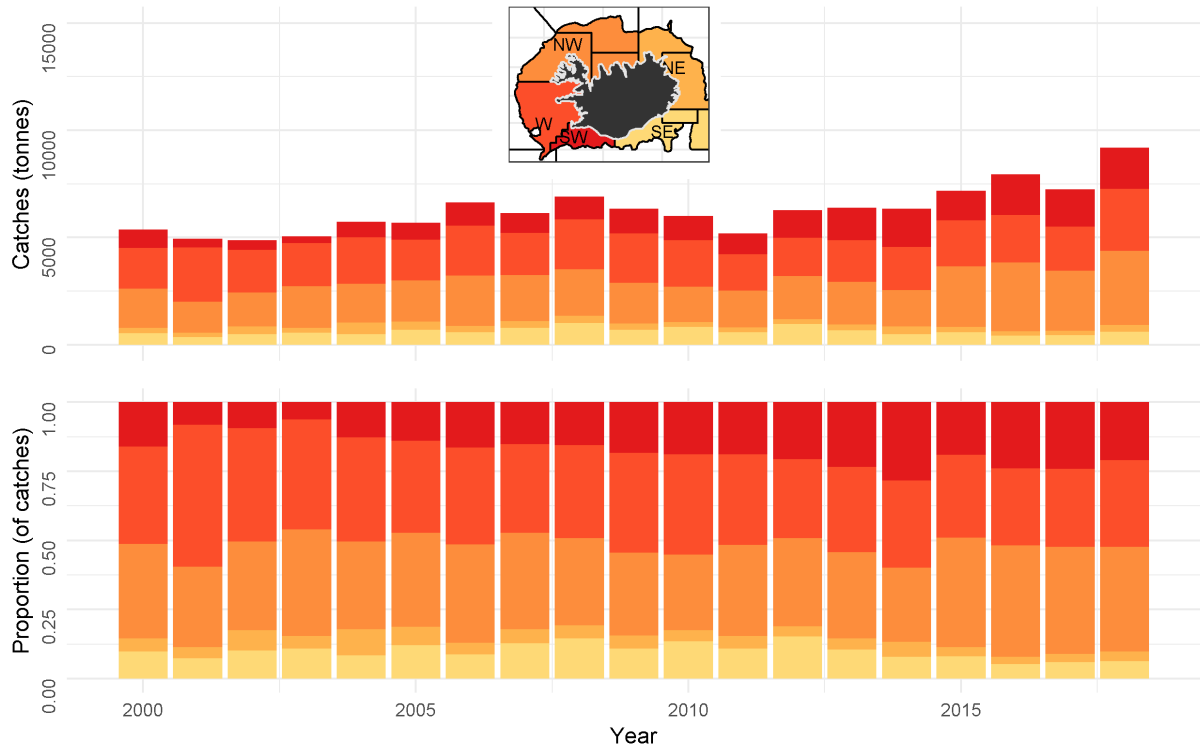
Main fishing grounds for plaice are in the west and southwest of Iceland, with smaller fishing grounds in the southeast and several fjords in the north. Demersal seine is the main fishing gear for plaice in Iceland followed by demersal trawl, while a small proportion of the catch is taken in gillnets and longline. Seiners dominate the coastal plaice fishery, but trawlers catch them deeper and further offshore. Plaice fishing grounds in 2010-2018, as reported by mandatory logbooks, are shown in Figure 1.



**Figure 1. Plaice. Geographical distribution of the Icelandic fishery since 2010. Reported catch from logbooks.**

*Mynd 1. Skarkoli. Útbreiðsla veiða á Íslandsmiðum frá 2010 samkvæmt afladagbókum.*

Since 2000, the main fishing grounds of plaice have been in the southwestern, western and northwestern part of the Icelandic shelf (Figure 2) according to logbook entries. Spatial distribution of the Icelandic plaice fishery has been relatively stable, with around 60% of the plaice caught on the western and northwestern part of the shelf. However, in the last decade, reported catches have increased in the southwestern part.



**Figure 2. Plaice. Spatial distribution of the Icelandic fishery by fishing area from 2000 according to logbooks. All gears combined.**

*Mynd 2. Skarkoli. Útbreiðsla veiða við Ísland frá árinu 2000 samkvæmt afladagbókum. Öll veiðarfæri samanlagt.*

Plaice is caught in relatively shallow water, with most of the catch (60-80%) taken at depths of 21-80 m (Figure 3).

Most of the plaice is caught in demersal seine (65-71% since 2011) and demersal trawl (23-30%) 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 gear (predominantly gillnets) with around 5-10% of the catch since 2004.

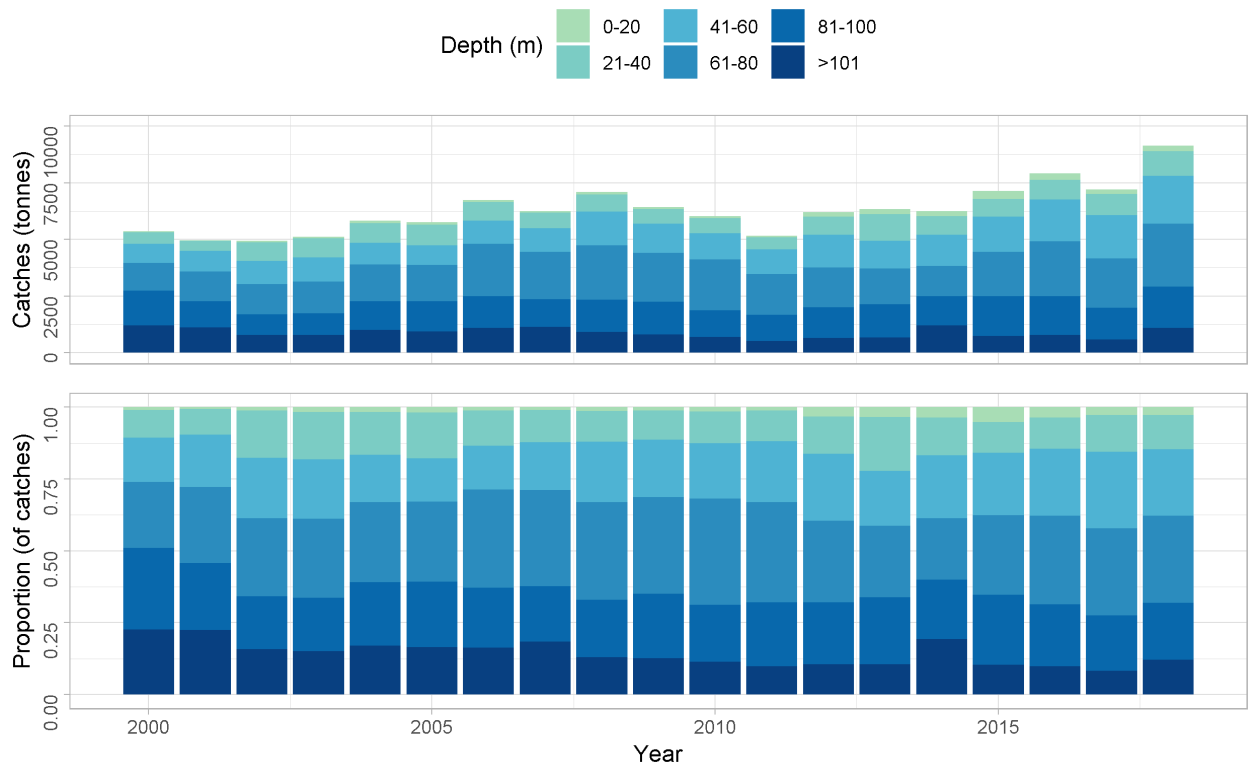


Figure 3. Plaice. Depth distribution of demersal seine and trawl catches according to logbooks.

Mynd 3. Skarkoli. Afli í dragnót og botnvörpu samkvæmt afladagbókum, skipt eftir dýpi.

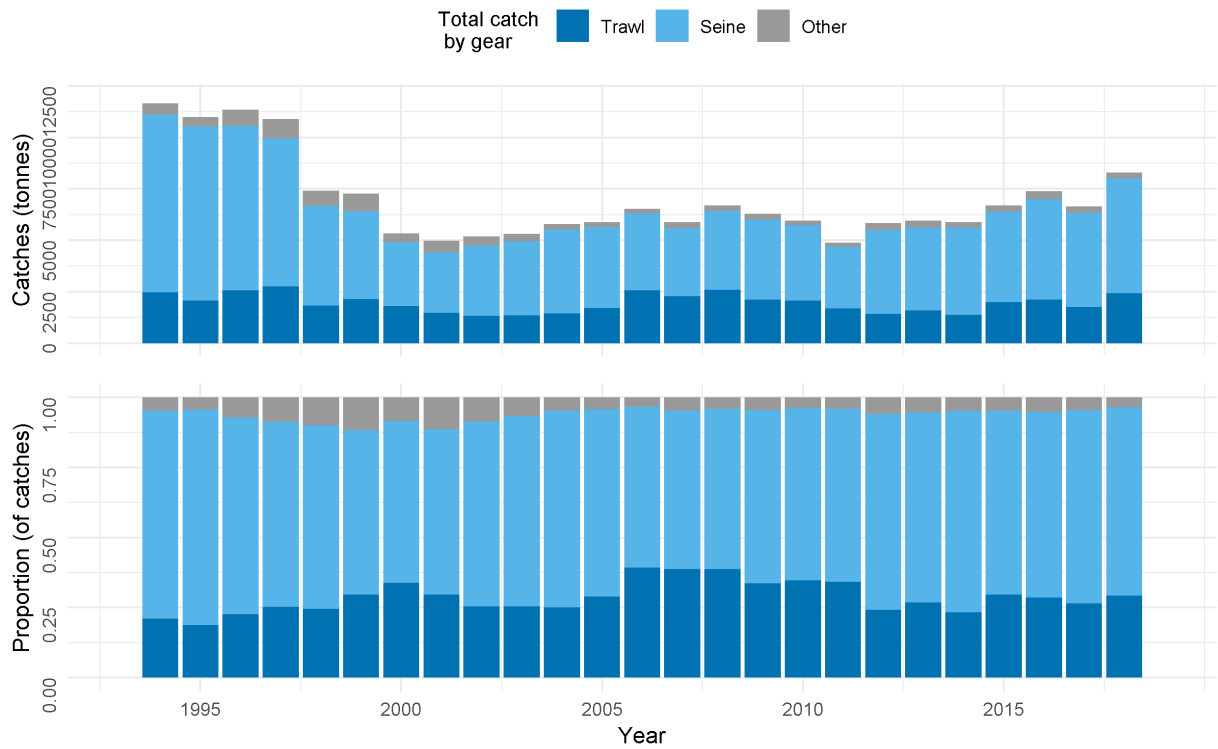


Figure 4. Plaice. Total catch (landings) by fishing gear since 1994, according to statistics from the Directorate of Fisheries.

Mynd 4. Skarkoli. Landaður afli eftir veiðarfærum frá árinu 1994, samkvæmt aflskráningarkerfi Fiskistofu.

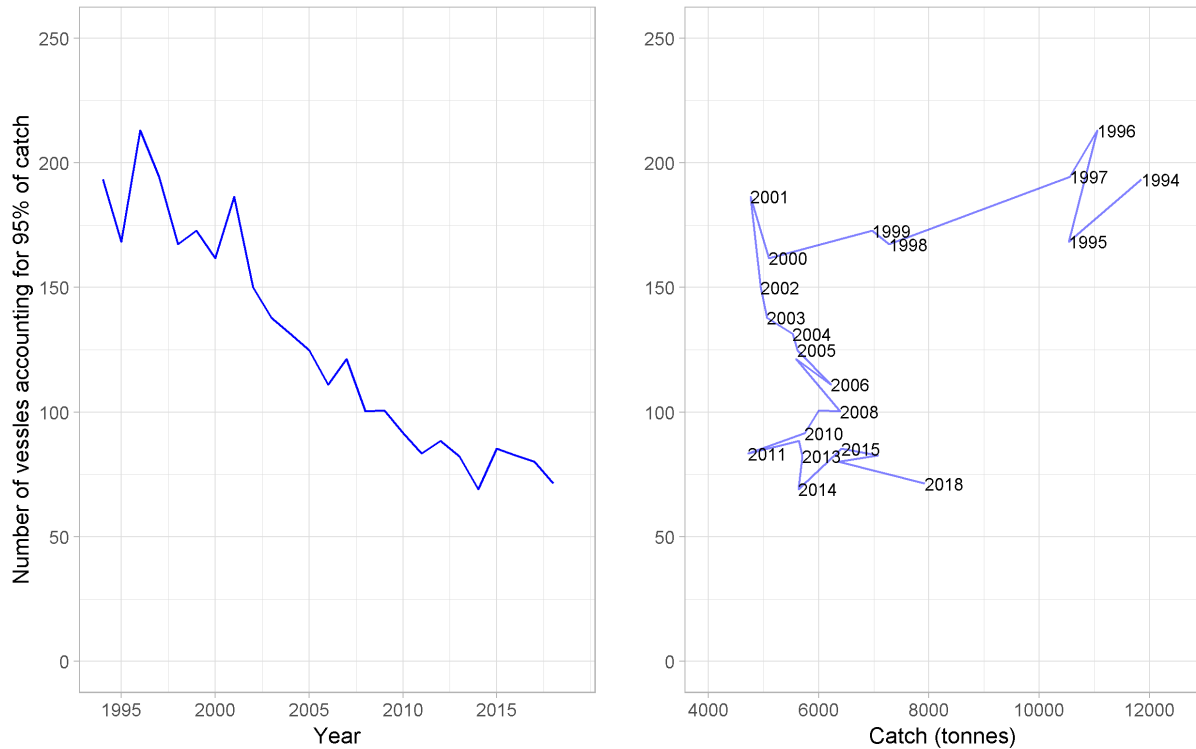
Since 2000, the number of vessels reporting catches over 1000 kg of plaice in total annually has decreased, whereas total catches have been increasing in the past few years. This decrease is most noticeable in the seiner fleet, where the number dropped from 92 vessels in 2004, to 41 in 2018. The number of trawlers has remained relatively stable since 2010 (Table 1). Total catch of plaice has been relatively stable (4900-8300 tonnes) over the last 19 years but has been slowly increasing since 2011 with about 8300 tonnes caught in 2018.

**Table 1. Plaice. Number of Icelandic vessels landing catch of 1000 kg or more of plaice, and all landed catch divided by gear type.**

**Tafla 1. Skarkoli. Fjöldi íslenskra skipa sem landað hafa yfir 1000 kg af skarkola og allur landaður afli eftir veiðarfærum.**

YEAR	NUMBER OF VESSELS			CATCHES (TONNES)			
	<i>Trawlers</i>	<i>Seiners</i>	<i>Other</i>	<i>Demersal trawl</i>	<i>Demersal seine</i>	<i>Other</i>	<i>Sum</i>
2000	89	81	78	1759	3052	409	5220
2001	77	87	106	1393	2906	610	4909
2002	67	87	86	1257	3420	465	5142
2003	71	90	65	1288	3602	342	5232
2004	60	92	73	1368	4015	309	5692
2005	67	81	63	1637	3894	261	5792
2006	70	75	44	2443	3704	223	6370
2007	74	68	59	2242	3282	292	5816
2008	66	67	52	2600	3828	290	6718
2009	62	65	57	2121	3872	323	6316
2010	57	55	66	2033	3639	311	5983
2011	42	52	65	1658	3020	265	4943
2012	44	48	85	1402	4075	453	5930
2013	45	48	65	1559	4041	379	5979
2014	40	43	61	1374	4235	313	5922
2015	55	45	66	2001	4404	363	6768
2016	52	41	71	2118	4893	432	7443
2017	52	43	64	1762	4578	354	6694
2018	53	41	59	2436	5578	327	8341

The number of vessels accounting for 95% of the catch of plaice in Icelandic waters was relatively constant around 160-200 vessels in 1994-2001, despite a 50% reduction in total catch (Figure 5). In 2001-2011 catches were stable but the number of vessels accounting for 95% of the catch dropped by half, to around 80. The number of vessels has not changed much since 2011, despite an increase in total catch of about 3000 tonnes.



**Figure 5. Plaice. Number of vessels (all gear types) accounting for 95% of the total catch annually since 1994. Left: Plotted against year. Right: Plotted against total catch. Data from the Directorate of Fisheries.**

*Mynd 5. Skarkoli. Fjöldi skipa og báta (öll veiðarfæri) sem veiddu 95% heildaraflans hvert ár frá 1994. Vinstri: Sýnt eftir árum. Hægrí: Sýnt í samanburði við heildarafla. Gögn frá aflaskráningarkerfi Fiskistofu.*

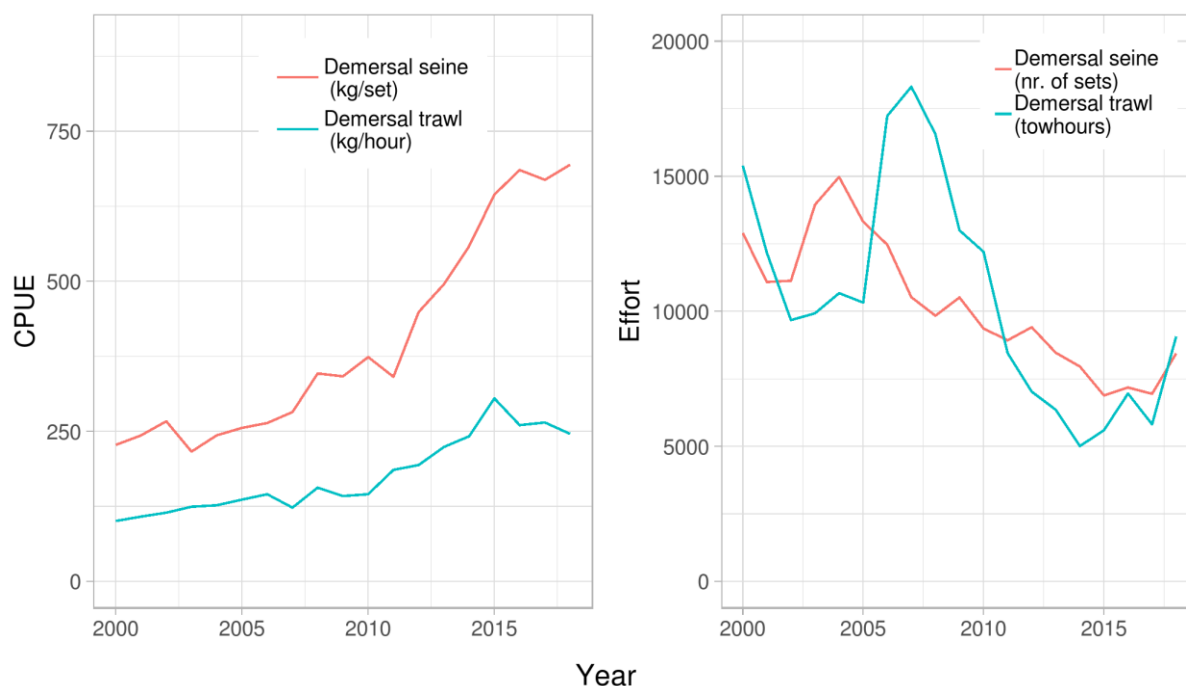
## CATCH PER UNIT EFFORT (CPUE) AND EFFORT.

CPUE estimates of plaice in Icelandic waters are not considered representative of stock abundance as changes in fleet composition, technical improvements and differences in gear setup among other things 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 10% of the catch. According to logbooks, plaice CPUE remained quite stable since 1996 with around 300 kg of plaice on average per set. However, since 2011 CPUE has increased rapidly and was about 700 kg per set last year (Figure 6).

CPUE of demersal trawl (kg/hour), in hauls where plaice is more than 10% of the catch remained relatively stable around 150 kg/hour until 2010. Since then CPUE has increased and was around 250 kg/hour in 2016-2019.

Total fishing effort for plaice in the demersal seine fishery is estimated as the number of sets where plaice was more than 10% of the total catch. Fishing effort by seiners was high but variable in 2000-2006 but since then it decreased continuously until 2015 (Figure 6). This is both due to the fact that fewer seiners are fishing and catch per unit effort is higher. Effort (number of towing hours where plaice was 10% or more of the total catch) in the demersal trawl fishery has been highly variable, but effort has reduced by half from a peak in 2006-2008 (Figure 6).



**Figure 6. Plaice. Non-standardised estimates of CPUE (left) and fishing effort (right) from demersal seine (kg/set or nr. of sets) in red and demersal trawl (kg/hour or towhours) in blue.**

*Mynd 6. Skarkoli. Afli á sóknareiningu (vinstri) og sókn (hægri) með dragnót (kg í kasti eða fjöldi kasta, rautt) og botnvörpu (kg/klst eða togtímar, blátt).*

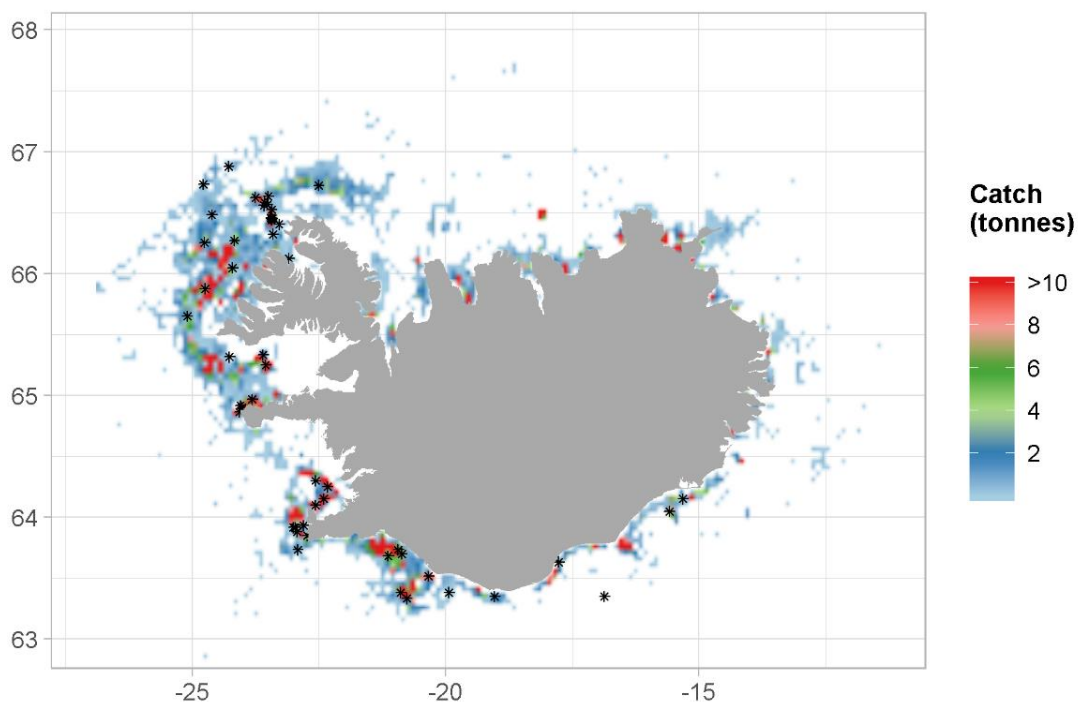
## AGE DISTRIBUTION OF LANDED PLAICE

Analysis done in 2013 suggested that excessive amounts of otoliths were being taken from commercial catches of plaice, and as a result the number of samples taken have been greatly reduced. Before this change, around 6000-7000 otoliths were being sampled yearly, but for last five years 33-45 samples from demersal seine and 14-27 samples from bottom trawl were collected, or a total of 800-1125 and 350-670 otoliths, respectively (Table 2, Figure 7). Samples are not taken from other gear, as they represent a very small proportion (~5%) of the total catch.

**Table 2. Plaice. Number of samples and aged otoliths from landed catch.**

*Tafla 2. Skarkoli. Fjöldi sýna og aldursgreindra fiska úr lönduðum aflu.*

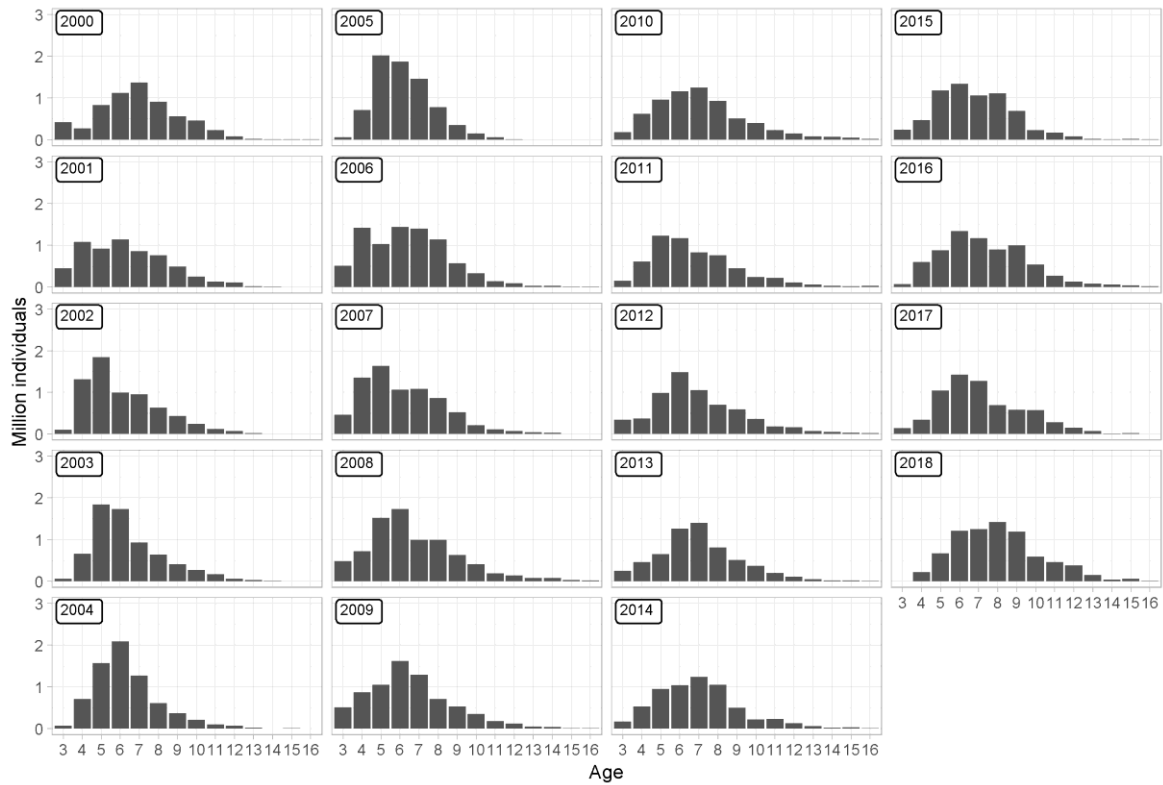
Year	Demersal seine		Demersal trawl	
	Samples	Otoliths	Samples	Otoliths
2010	92	3953	41	2017
2011	91	4200	50	2452
2012	107	5199	37	1835
2013	104	4160	27	1350
2014	37	900	20	575
2015	33	800	27	670
2016	45	1125	23	573
2017	39	974	22	550
2018	35	880	14	350



**Figure 7. Plaice. Fishing grounds in 2018 as reported in logbooks and positions of samples taken from landings (asterisks).**

*Mynd 7. Skarkoli. Veiðisvæði við Ísland árið 2018 samkvæmt afladagbókum og staðsetningar sýna úr lönduðum aflu (stjörnur).*

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 8). 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. The largest cohorts have been 6-8 year old fish in the last 5 years, whereas 4-7 year old fish were most common in 2001-2007.



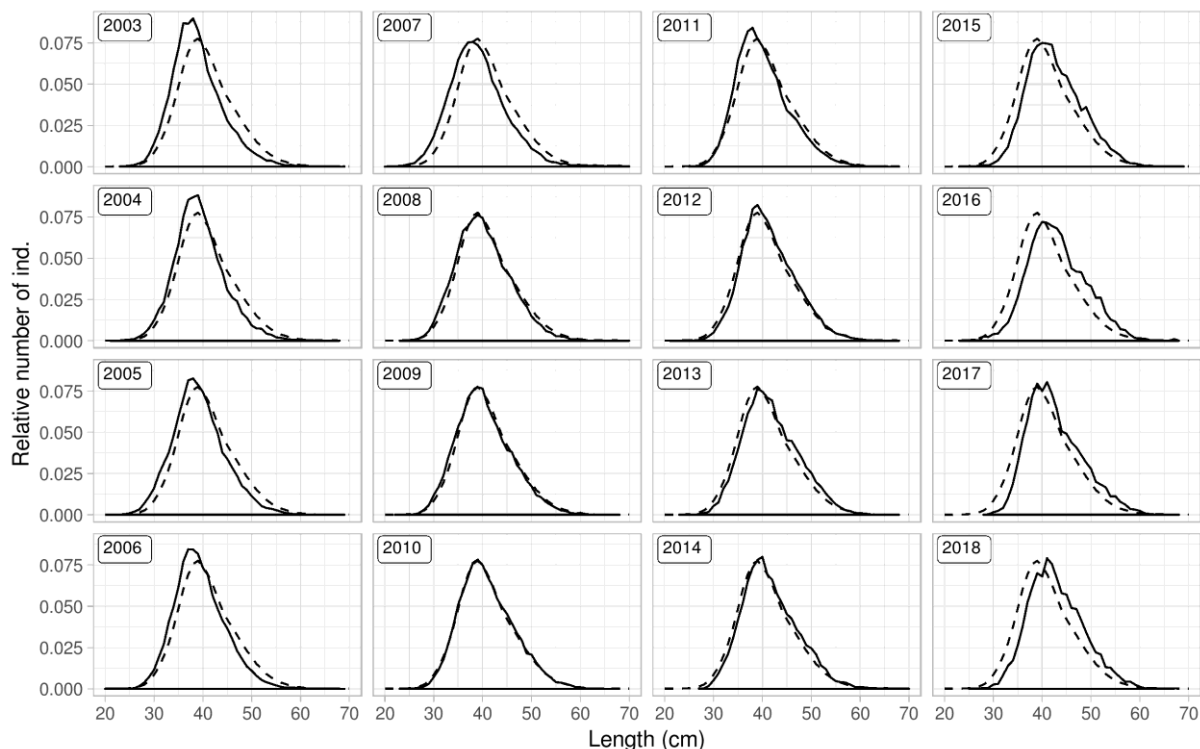
**Figure 8. Plaice. Estimated age distribution of landed catch based on landings and otoliths collected from landed catch.**

*Mynd 8. Skarkoli. Áætluð aldursdreifing landaðs afla byggð á aldursgreiningum á fiskum úr afla.*



## LENGTH DISTRIBUTION OF LANDED PLAICE

There has been a shift towards larger fish in the length distribution of landed catch (Figure 9). As a result, the average length in the samples taken from commercial catch has increased from 39.1 cm in 2003 to 43.3 cm in 2016 and was 42.9 cm in 2018.



**Figure 9. Plaice. Length distribution from landed catch in 2003-2018. The dotted line represents the mean length distribution for the period.**

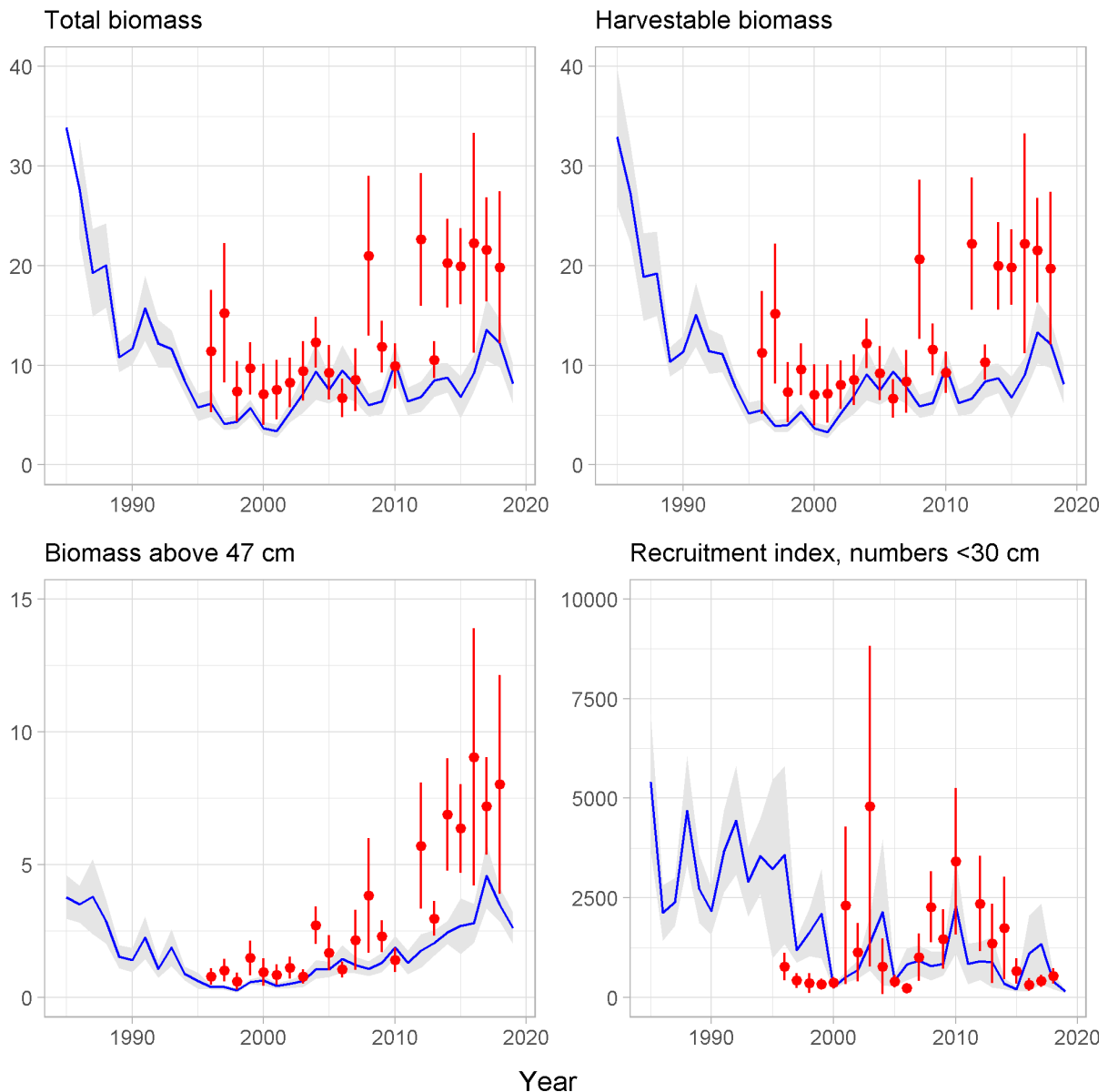
*Mynd 9. Skarkoli. Lengdardreifing aflasýna árin 2003-2018 ásamt meðallengdardreifingu fyrir öll árin (punktalína).*

## SURVEY DATA

The Icelandic spring groundfish survey (hereafter spring survey or IS-SMB), 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 (hereafter autumn survey or IS-SMH) was commenced in 1996. However, a full autumn survey was not conducted in 2011 due to a labour dispute. 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, a designated flatfish survey with beam trawl was started in 2016 and expanded in 2017 to cover most of the recruitment grounds of plaice and other flatfish species. The plan is to incorporate this survey in the stock assessment for plaice in the future.

Figure 10 shows both a recruitment index based on abundance of plaice smaller than 30 cm, and trends in various biomass indices. Survey length disaggregated abundance indices are shown in Figure 11 and Figure 12, abundance and changes in spatial distribution in Figure 14-17.

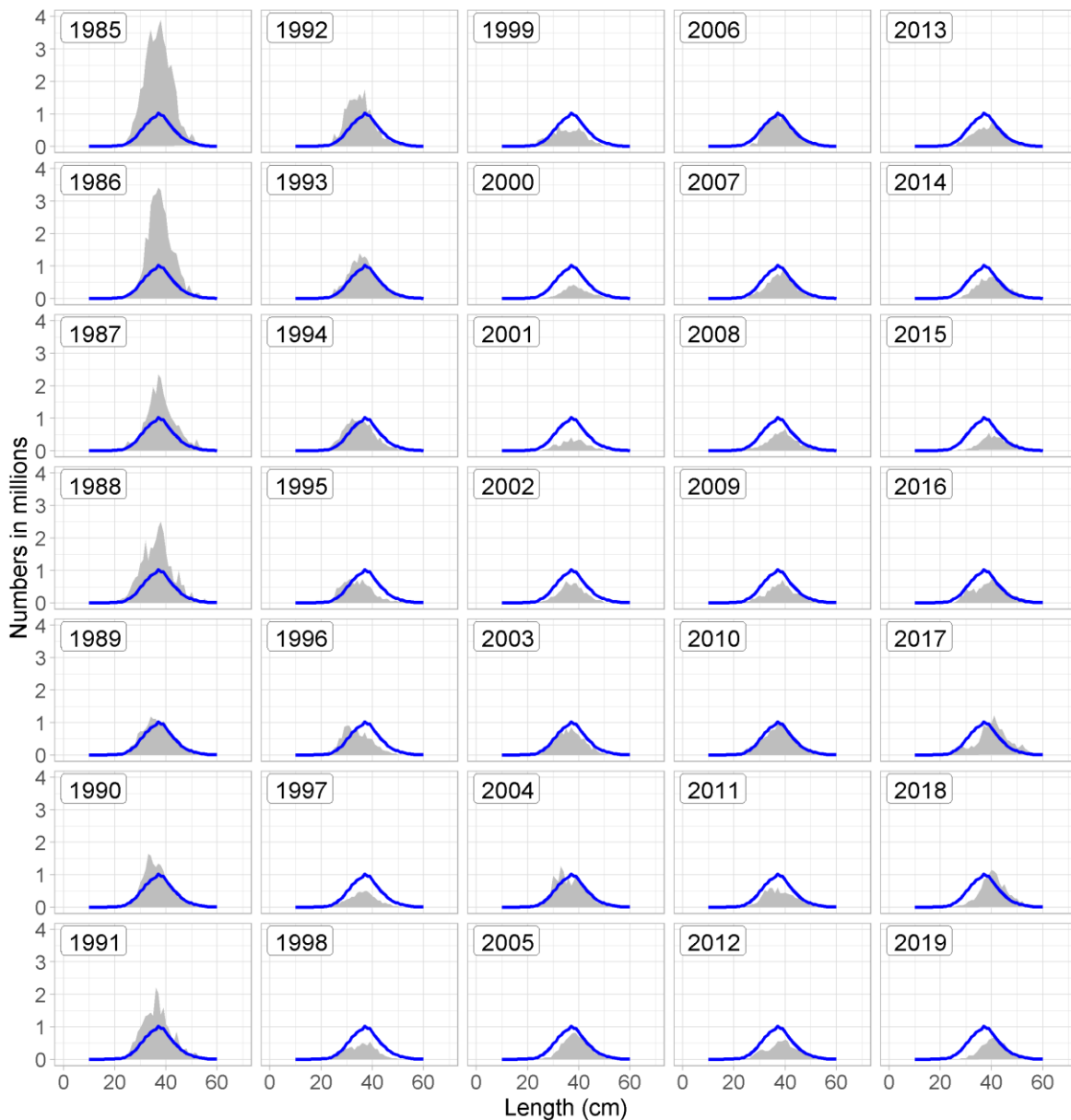
Biomass indices for the total stock of plaice, and plaice larger than 30 cm (harvestable part of the stock), have been increasing steadily since a historical low in 2001 (Figure 9). The same holds for the index of plaice larger than 50 cm, probably due to a decrease in fishing mortality. The index of juvenile abundance (<30 cm) reached an historical low in 2019. Trends in the shorter autumn survey are similar to those observed from the spring survey, but standard deviations in the measurements tend to be high.



**Figure 10. Plaice. Total biomass indices (upper left), harvestable biomass indices ( $\geq 30$  cm, upper, right), biomass indices of larger individuals ( $\geq 47$  cm, lower left) and juvenile abundance indices ( $\leq 30$  cm, lower right) from the spring survey (blue) from 1985 and autumn survey (red) from 1996, along with the standard deviation.**

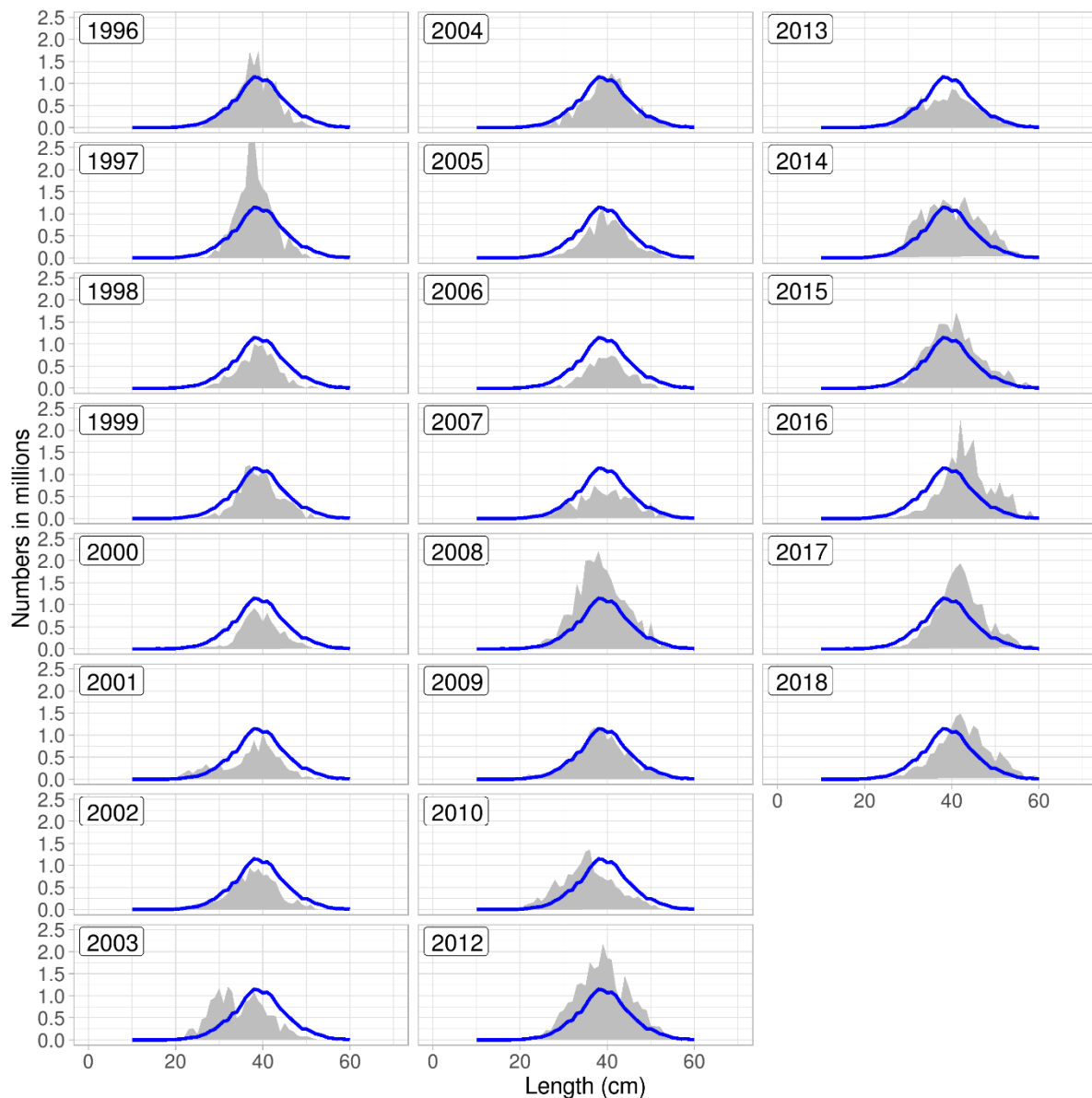
*Mynd 10. Skarkoli. Stofnvísitala (efri til vinstri), vísitala veiðistofns ( $\geq 30$  cm og stærri, efri til hægri) og vísitala stærri einstaklinga ( $\geq 47$  cm, neðri til vinstri) og nýliðunarvísitala ( $\leq 30$  cm, neðri til hægri), úr stofnmælingu botnfiska að vori (blátt) frá árinu 1985 og hausti (rautt) frá árinu 1996, ásamt staðalfrávik.*

Like in samples from the commercial catch, there has been a slight shift towards larger fish in the length distribution of measured individuals from the spring survey (Figure 11). The average length of plaice in the survey samples has increased from 37 cm in 2002 to 40 cm in 2019. Data from the autumn survey tells a similar story, with a marked increase in average size of plaice caught (Figure 12).



**Figure 11. Plaice. Length disaggregated abundance indices from the spring survey. The blue line shows the mean for all years.**

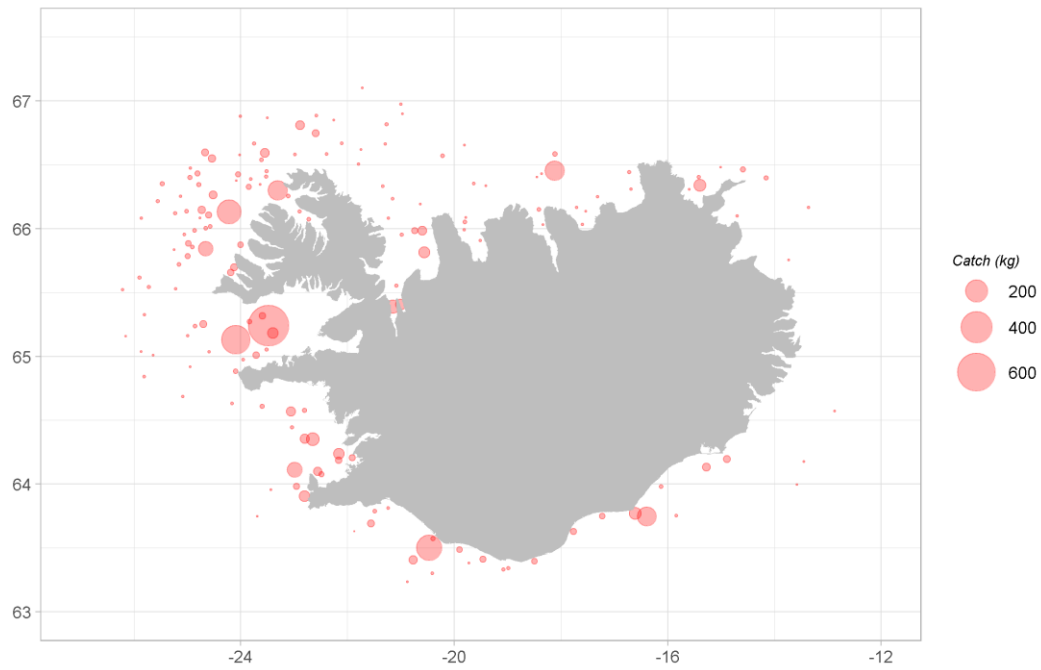
*Mynd 11. Skarkoli. Lengdarskiptar vísitölur úr stofnmælingu botnfiska að vori frá 1985 ásamt meðaltali allra ára (blá lína).*



**Figure 12. Plaice. Length disaggregated abundance indices from the autumn survey. The blue line shows the mean for all years.**

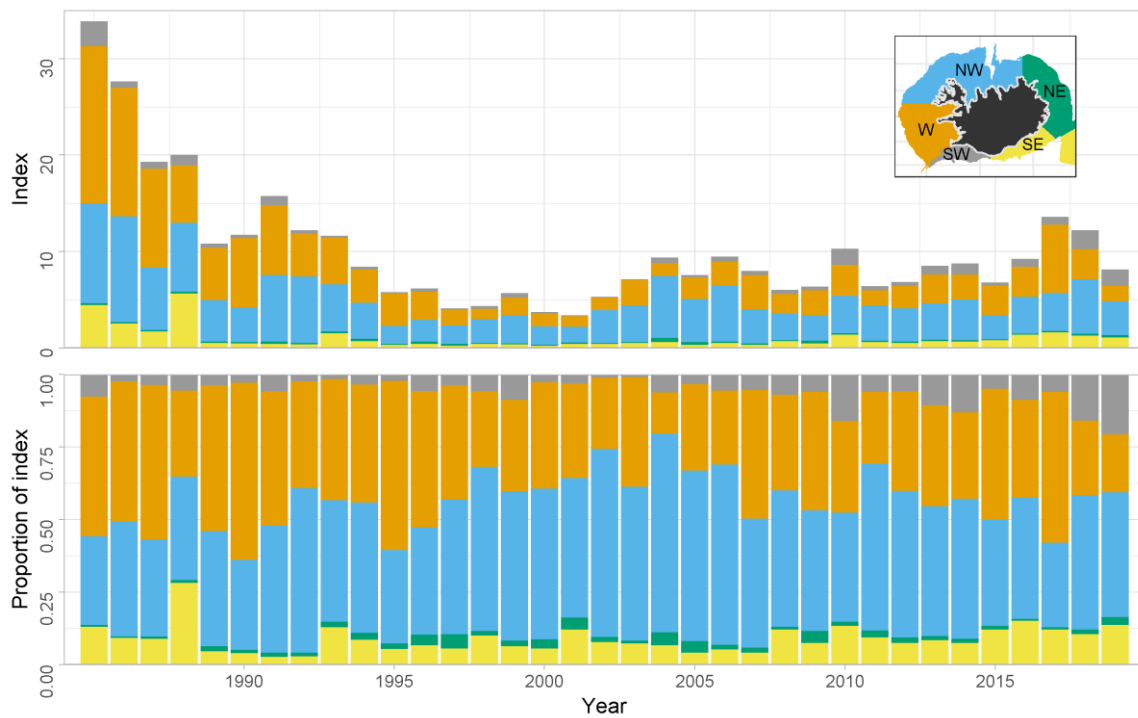
*Mynd 12. Skarkoli. Lengdarskiptar vísitölur úr stofnmælingu botnfiska að hausti frá 1996 ásamt meðaltali allra ára (blá lína).*

Plaice were mostly caught in the northwestern area as well as on the main spawning grounds off the western part of the country in the spring survey in 2019 (Figure 13). Spatial distribution of the catch of plaice in the spring survey shows some temporal changes, particularly between catches taken in west and northwest areas (Figure 14). 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 13. Plaice. Spatial distribution in the spring survey in 2019.**

*Mynd 13. Skarkoli. Útbreiðsla í stofnmælingu botnfiska að vori 2019.*



**Figure 14. Plaice. Spatial distribution of biomass index from the spring survey.**

*Mynd 14. Skarkoli. Dreifing lífmassavísitölu í stofnmælingu botnfiska að vori.*

Plaice were mainly caught in the main feeding grounds for plaice in the northwest of the country in the autumn survey 2018 (Figure 15). The majority of plaice in the autumn survey has been caught on the traditional feeding grounds in the northwest. However, there has been a slight increase in the relative abundance of plaice in the western part in recent years, from around 10% in 2004 and 2005 up to 25% in 2010-2015 (Figure 16). In 2018, however, vast majority of the plaice was caught in the northwest area.

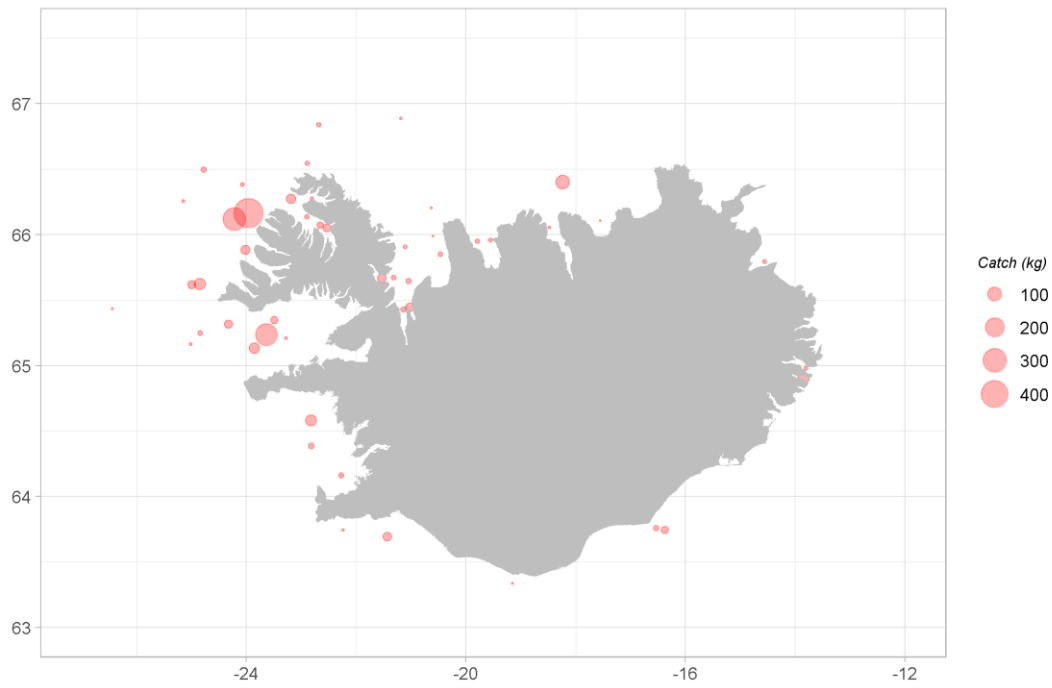


Figure 15. Plaice. Spatial distribution of plaice in 2018 in the autumn survey.

*Mynd 15. Skarkoli. Útbreiðsla í stofnmælingu botnfiska að hausti árið 2018.*

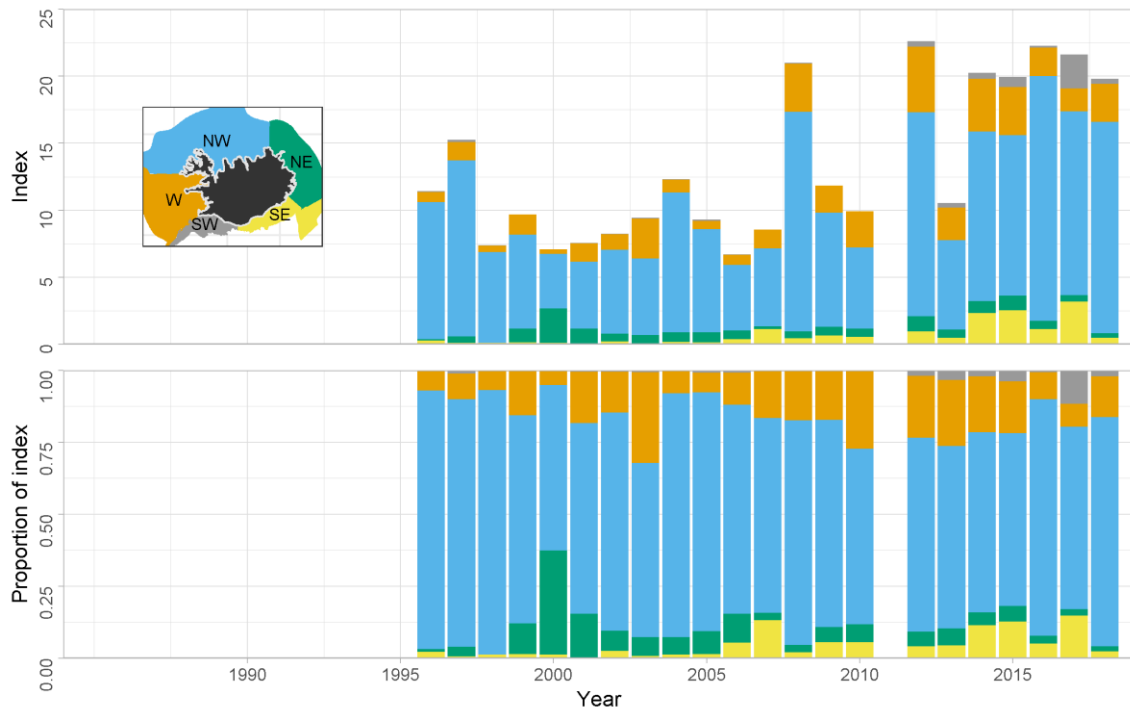
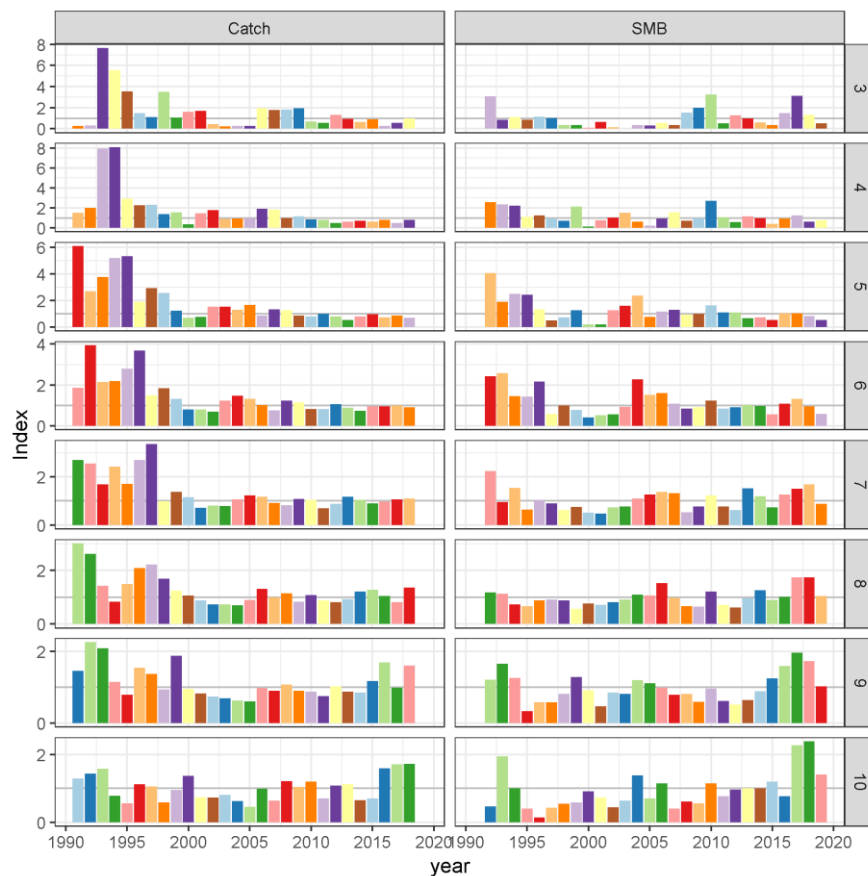


Figure 16. Plaice. Spatial distribution of biomass index from the autumn survey.

*Mynd 16. Skarkoli. Dreifing lífmassavísitölu í stofnmælingu botnfiska að hausti.*

## STOCK ASSESSMENT

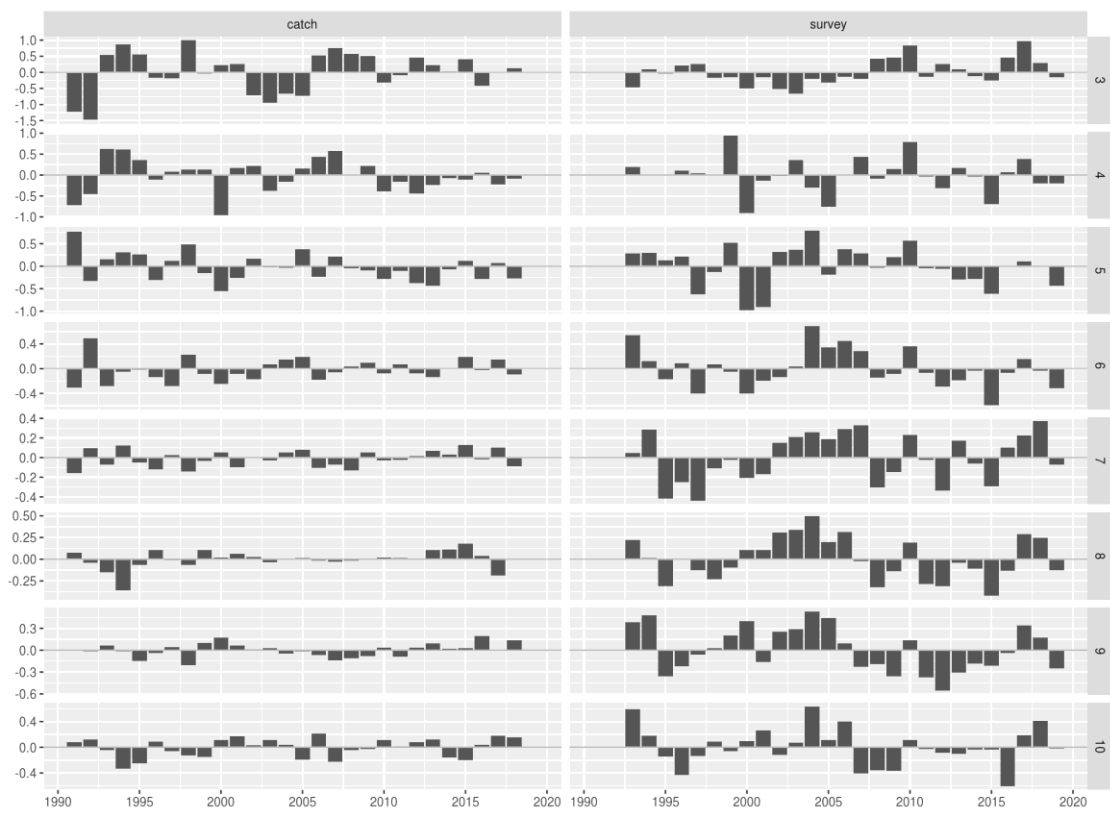


**Figure 17. Plaice. Year class strength of 3-10 year old fish in catch (1991-2018) and IS-SMB spring survey (1999-2019). Input data for the stock assessment.**

*Mynd 17. Skarkoli. Árgangar 3-10 ára fiska í afla (1991-2018) og vorralli (1999-2019). Inntaksgögn fyrir stofnmatíð.*

Strong year classes that are now 8, 9 and 10 year old fish are seen in the catch (Figure 17). Most of the harvestable biomass in 2018 is made up from strong year classes of old (9-10 year old) fish.

Analytical age-based stock assessment model using catch in numbers and age disaggregated indices from the spring survey was used for the first time in 2016, and that same model was used this year. Considerable uncertainty is present in the model due to limited information on recruitment, and the model has large residuals, in particular for the survey data (Figure 18). Maximum sustainable yield is the basis for the advice, and the reference point is set as  $F = 0.22$ .



**Figure 18. Plaice. Residuals of the stock assessment model, both for catch and IS-SMB indices by age.**

*Mynd 18. Skarkoli. Frávik stofnmatslíkans, bæði fyrir aldurskiptan afla og stofnvísitölur.*



## MANAGEMENT

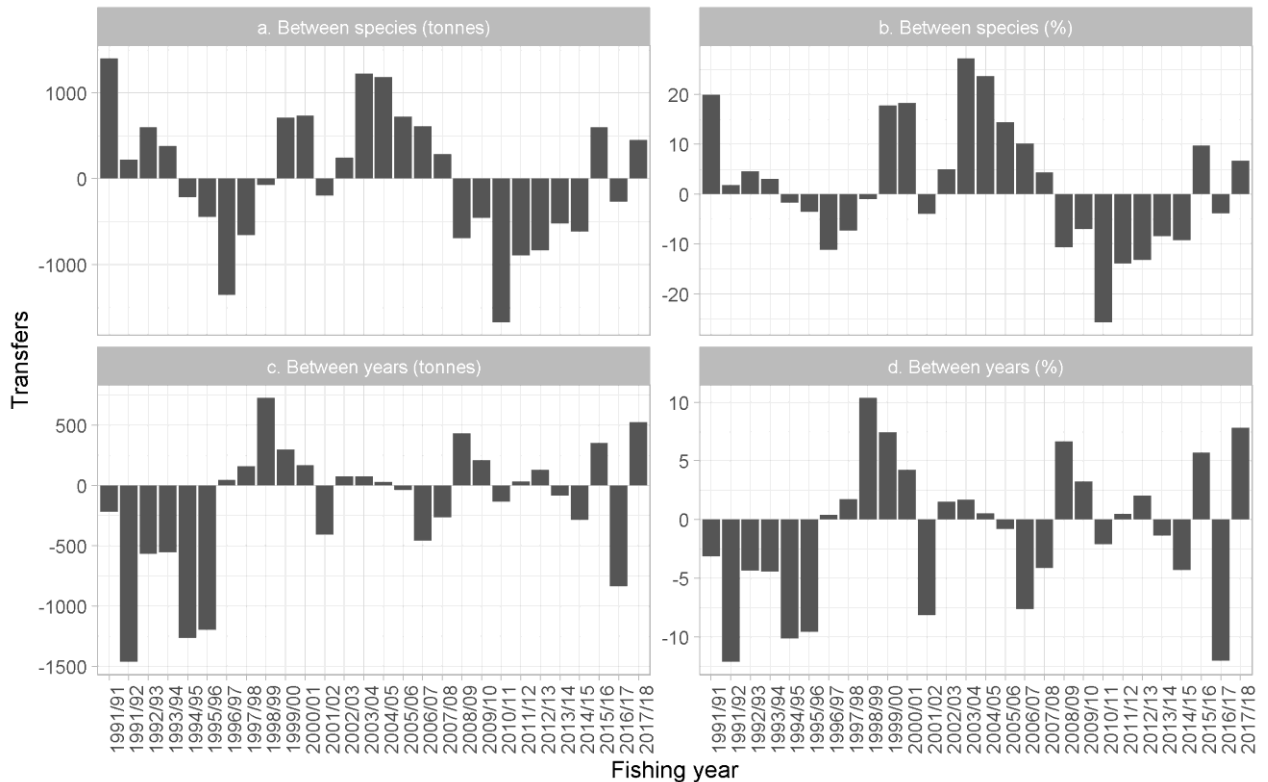
The Ministry of Industries and Innovation is responsible for management of the Icelandic fisheries and implementation of legislation. Plaice was included in the ITQ system in the 1991/1992 quota year and as such subjected to TAC limitations. For the first six years, the TAC was set higher than recommended by Marine Research Institute (MRI), but this practice stopped in the 2010/2011 quota year. One reason is that no formal harvest rule exists for this stock. In some recent quota years, landings have been lower than the advised TAC (Table 6).

**Table 6. Plaice. Recommended TAC, National TAC set by the Ministry, and landings (tonnes).**

*Tafla 6. Skarkoli. Tillögur Hafrannsóknastofnunar um hámarksafla, ákvörðun stjórnvalda um aflamark og landaður afli (tonn).*

<b>FISHING YEAR</b>	<b>REC. TAC</b>	<b>NATIONAL TAC</b>	<b>CATCH</b>
<b>1991/92</b>	10000	11000	10200
<b>1992/93</b>	10000	13000	12400
<b>1993/94</b>	10000	13000	12300
<b>1994/95</b>	10000	13000	11100
<b>1995/96</b>	10000	13000	11000
<b>1996/97</b>	10000	12000	10345
<b>1997/98</b>	9000	9000	8083
<b>1998/99</b>	7000	7000	7452
<b>1999/00</b>	4000	4000	4907
<b>2000/01</b>	4000	4000	4921
<b>2001/02</b>	4000	5000	4402
<b>2002/03</b>	4000	5000	5402
<b>2003/04</b>	4000	4500	5844
<b>2004/05</b>	4000	5000	6184
<b>2005/06</b>	4000	5000	5647
<b>2006/07</b>	5000	6000	6149
<b>2007/08</b>	5000	6500	6620
<b>2008/09</b>	5000	6500	6361
<b>2009/10</b>	5000	6500	6389
<b>2010/11</b>	6500	6500	4843
<b>2011/12</b>	6500	6500	5822
<b>2012/13</b>	6500	6500	5932
<b>2013/14</b>	6500	6500	6030
<b>2014/15</b>	7000	7000	6237
<b>2015/16</b>	6500	6500	7619
<b>2016/17</b>	7330	7330	6369
<b>2017/18</b>	7103	7103	8208
<b>2018/19</b>	7132	7132	
<b>2019/20</b>	6985		

Figure 19, shows the net transfers in the Icelandic ITQ-system. From 2002-2008 (positive values in Figure 19) there was a net transfer of other species being transferred to plaice quota. 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. Net transfer of plaice quota between fishing years has varied between years, and ranges from -10 to 12% (Figure 19).



**Figure 19. Plaice. Net transfers of quota to and from plaice in the Icelandic ITQ system by quota year. Between species (upper): Positive values indicate a transfer of other species to plaice, but negative values indicate a transfer of plaice quota to other species. Between years (lower): Net transfer of quota for a given fishing year.**

*Mynd 19. Skarkoli. Nettó tilfærsla á kvóta eftir fiskveiðiárum. Tilfærsla milli tegunda (efri myndir): Jákvæð gildi tákna tilfærslu á kvóta annarra tegunda yfir á skarkola en neikvæð gildi tilfærslu skarkolakvóta á aðrar tegundir. Tilfærsla milli ára (neðri myndir): Nettó tilfærsla kvóta á viðkomandi fiskveiðiári.*