

WITCH

Glyptocephalus cynoglossus

GENERAL INFORMATION

Witch is found all around Iceland, but the highest concentration is observed in the relatively warm waters south and west of Iceland. It is a demersal flatfish species found at 25-500 m depth but is most common at 50-300 m on a sandy or muddy substrate. Females grow larger than males. Only a small proportion of males become larger than 40 cm, whereas females can get larger than 60 cm. Size at sexual maturity differs between the sexes where about half of the males reached maturity at 25 cm length, but females reach that level at 32 cm.

THE FISHERY

The geographical distribution of the witch fisheries has remained more or less unchanged in recent years (Figure 1), with main fishing grounds in the southwest of Iceland, extending along the south coast in the deeper areas. Very little catch has been reported from the northwest, north and east of Iceland. Witch is common bycatch in the *Nephrops* fishery. In 2019, one of the main *Nephrops* fishing areas, Lónsdjúp, was closed for all trawling (for both *Nephrops* and demersal trawls) to protect young *Nephrops*. There was also a closure for *Nephrops* trawling in Jökuldjúp (area already closed for all demersal trawling) and demersal trawling in Breiðamerkurdjúp and Hornafjarðardjúp (MFRI 2021). Those closures can influence the distribution of the witch catch.

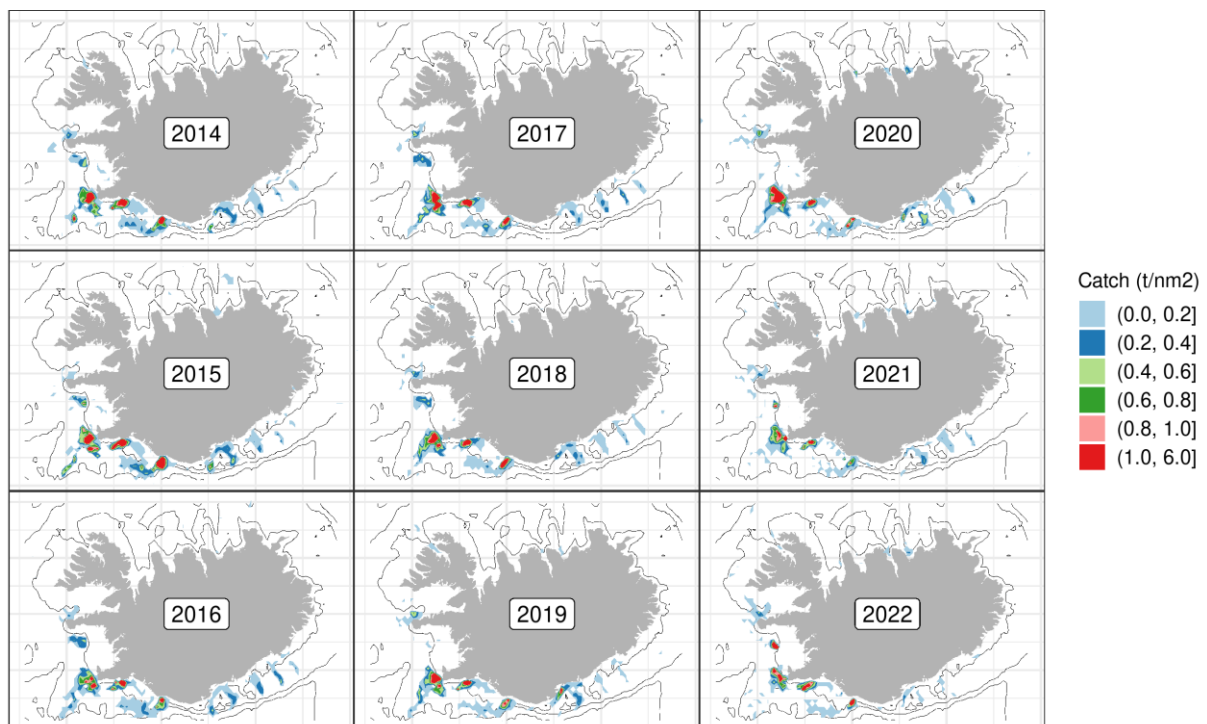


Figure 1. Witch. Geographical distribution of the Icelandic fishery since 2014. Reported catch from logbooks. 100, 300 and 1000 m isobaths are shown.

Since 2000, the main fishing grounds of witch have been in the southern and western part of the Icelandic shelf (Figure 2) according to logbook entries. Spatial distribution of the Icelandic witch fishery is considerably stable, with around 50% of the witch caught on the south-western part of the shelf.

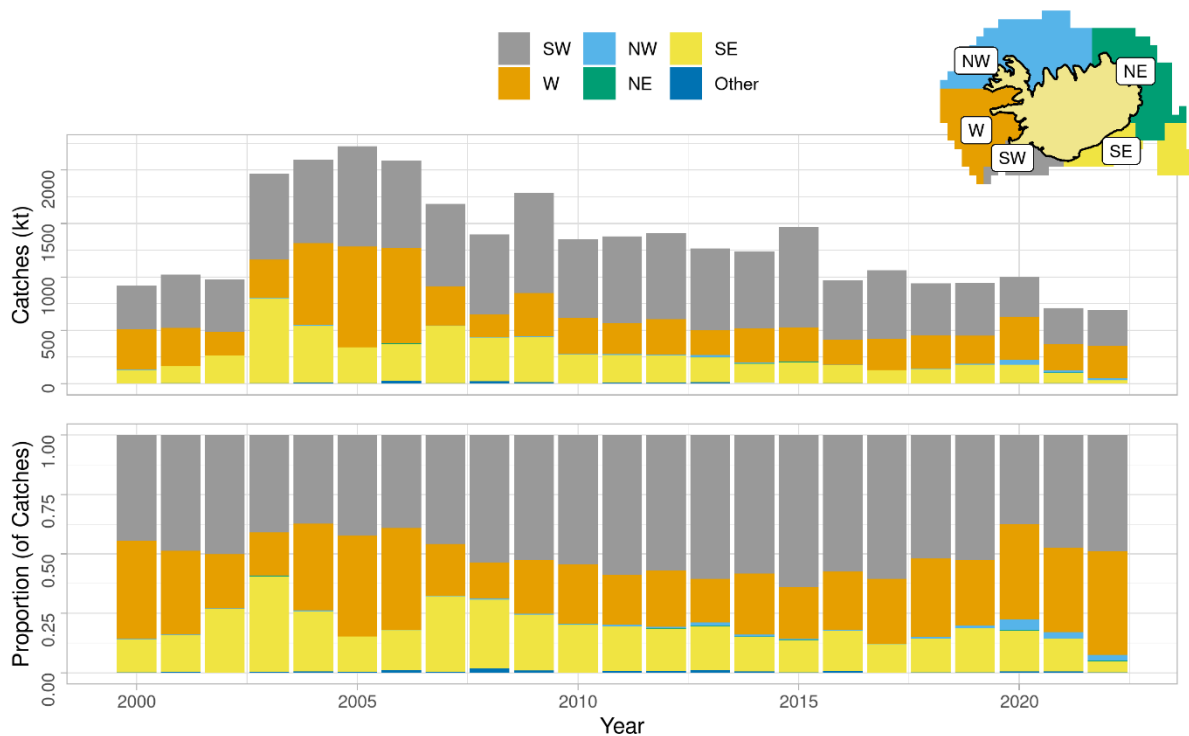


Figure 2. Witch. Spatial distribution of the Icelandic fishery by fishing area since 2000 according to logbooks. All gears combined.

Of the combined catch in demersal seine and *Nephrops* trawl, about 85-90% of witch was caught at 101-200 m depth in most years (Figure 3). In 2011-2016, that proportion had declined to about 60% while the proportion of the catch taken at 51-100 m depth increased. This was solely due to increase in demersal seine effort at that depth range. Most of the catch in demersal seine was taken at 101-150 m, but at 151-200 m depth in *Nephrops* trawl.

Witch on Icelandic fishing grounds is mainly caught in demersal seine and *Nephrops* trawl, or approximately 95% of all reported landings (Figure 4, Table 1). This proportion has been a relatively stable throughout the years. During the last nine years, however, the proportion of witch landed by seiners has decreased and reported landings from *Nephrops* trawlers increased. The drop in proportion of witch landed by *Nephrops* trawl since 2019 is most likely due to area closures in the SE and W areas mentioned previously. Since 2000, 37-83 vessels have landed over 1000 kg of witch annually (Table 1).

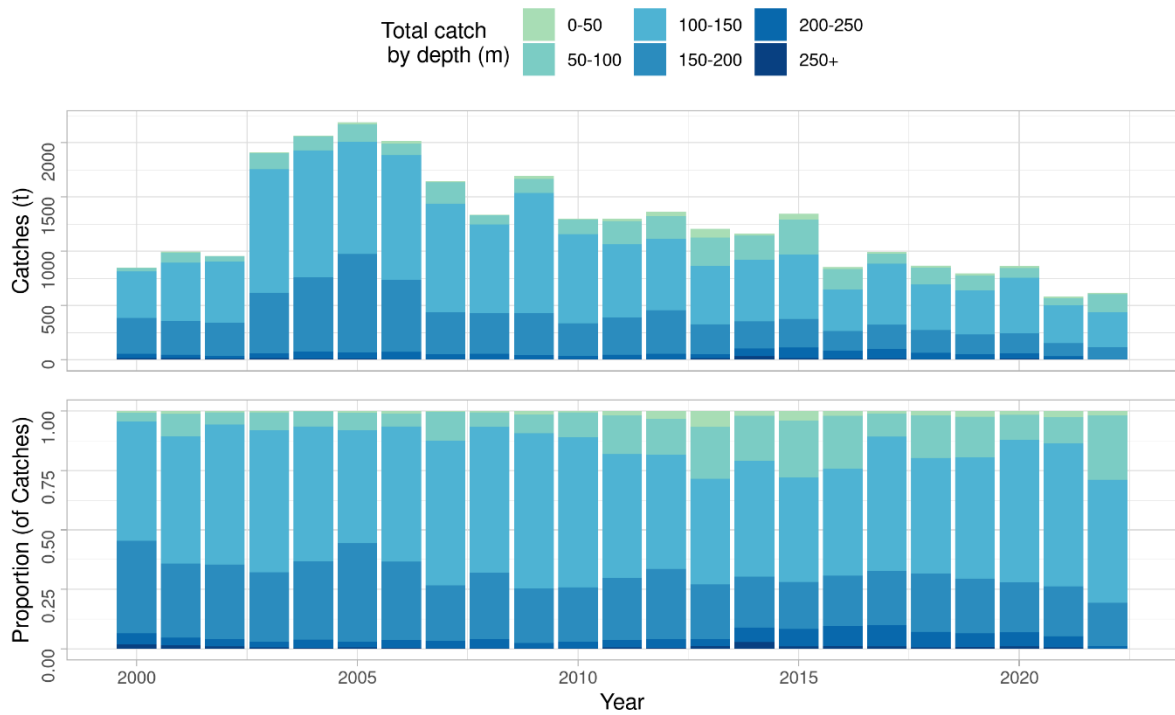


Figure 3. Witch. Depth distribution of catches from demersal seine and *Nephrops* trawl according to logbooks.

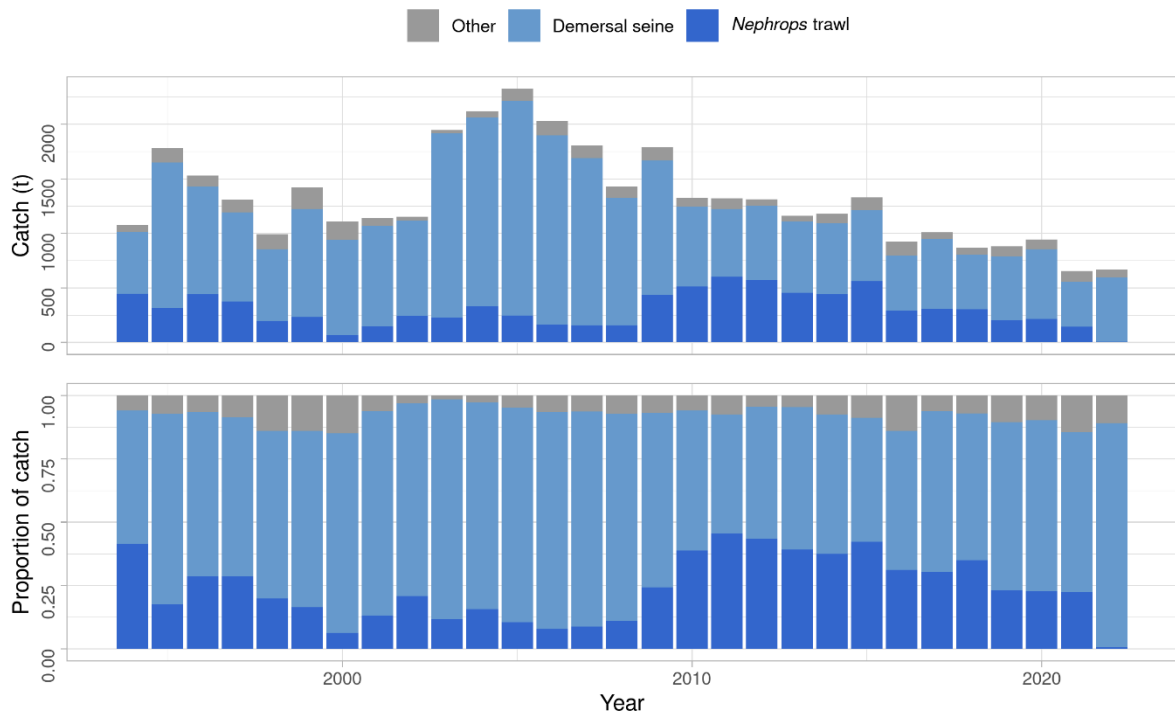


Figure 4. Witch. Total catch (landings) by fishing gear since 1994, according to statistics from the Directorate of Fisheries.

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

YEAR	NUMBER OF VESSELS			CATCHES (TONNES)			
	<i>Seiners</i>	<i>Nephrops trawl</i>	<i>Other</i>	<i>Demersal seine</i>	<i>Nephrops trawl</i>	<i>Other</i>	<i>Sum</i>
2000	30	19	34	877	56	165	1098
2001	26	24	18	920	136	77	1133
2002	22	27	7	874	236	37	1147
2003	31	22	9	1689	228	30	1947
2004	32	22	17	1731	334	59	2124
2005	32	23	24	1967	242	115	2324
2006	30	20	24	1738	170	122	2030
2007	26	14	26	1530	150	125	1805
2008	27	15	22	1166	158	103	1427
2009	32	16	23	1230	418	141	1789
2010	30	16	17	734	546	76	1326
2011	29	15	18	620	603	101	1324
2012	32	15	17	697	521	95	1313
2013	26	15	12	652	456	54	1162
2014	21	14	14	650	422	107	1179
2015	20	13	14	647	548	130	1324
2016	17	11	16	506	277	142	925
2017	18	9	10	641	309	63	1012
2018	20	10	9	502	304	61	867
2019	22	8	16	584	204	93	881
2020	23	7	15	638	216	92	946
2021	19	7	17	412	146	96	654
2022	22	3	20	590	5	67	662

The number of vessels accounting for 95% of the total catch of witch in Icelandic waters decreased from about 80 vessels in 1996-1997 to about 30 vessels in 2002, despite annual catches being at similar levels (Figure 5). In 2002-2014, the number of vessels accounting for 95% of the catches (ranging from 1200-2300 tonnes) remained relatively constant. In the last three years only about 20 vessels have accounted for 95% of the annual catch of witch.

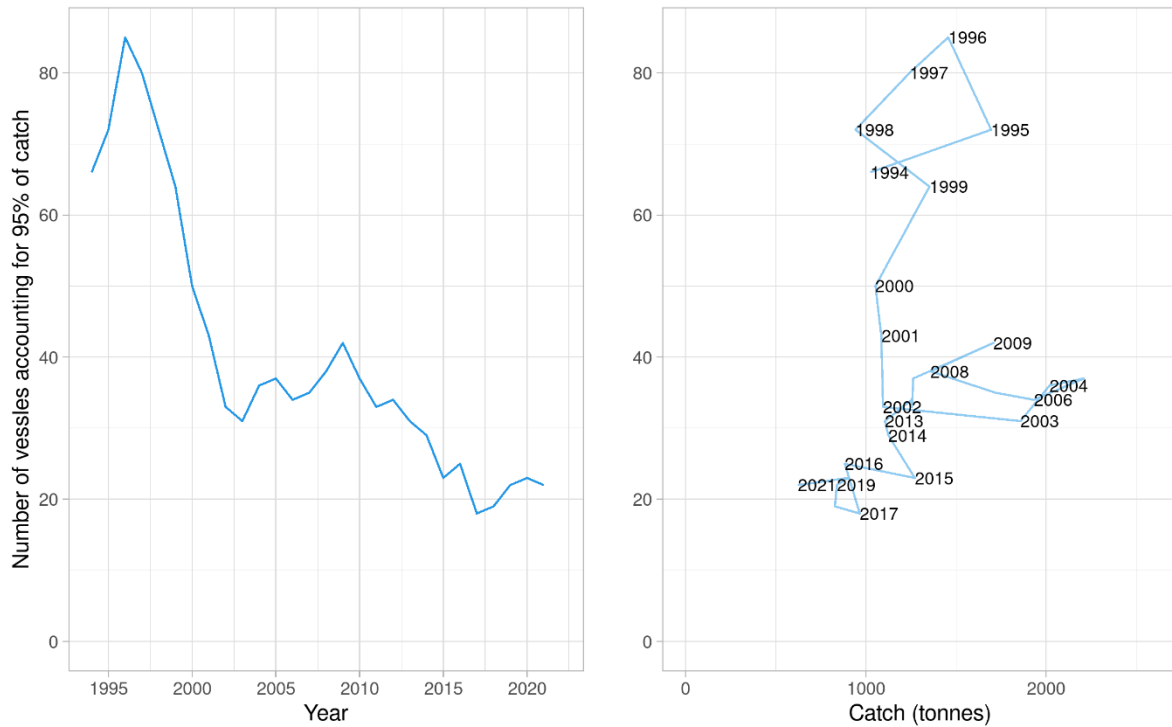


Figure 5. Witch. Number of vessels (all gear types) accounting for 95% of the total catch annually since 1994. Left: Plotted against year from 1994. Right: Plotted against total catch. Data from the Directorate of Fisheries.

CATCH PER UNIT EFFORT (CPUE) AND EFFORT.

CPUE estimates of witch 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.

CPUE in demersal seine (kg/set) sets in where witch was more than 10% of the catch have fluctuated between 200 and 550 kg/set, with highest value in 2022. CPUE for witch in *Nephrops* trawl (kg/h), in hauls where witch is more than 10% of the catch, fluctuated from 50 to 75 kg/hour in 2009-2021, but no fishing for *Nephrops* was allowed in 2022 (Figure 6).

Witch is a bycatch in the *Nephrops* fishery and reporting was poor early on. Before 2003, less than 50% of witch landings from *Nephrops* trawl were reported in logbooks. Comparison of the length composition of the witch catch in the *Nephrops* survey to the catch from the *Nephrops* trawlers indicated some discarding of the smaller witch in earlier years.

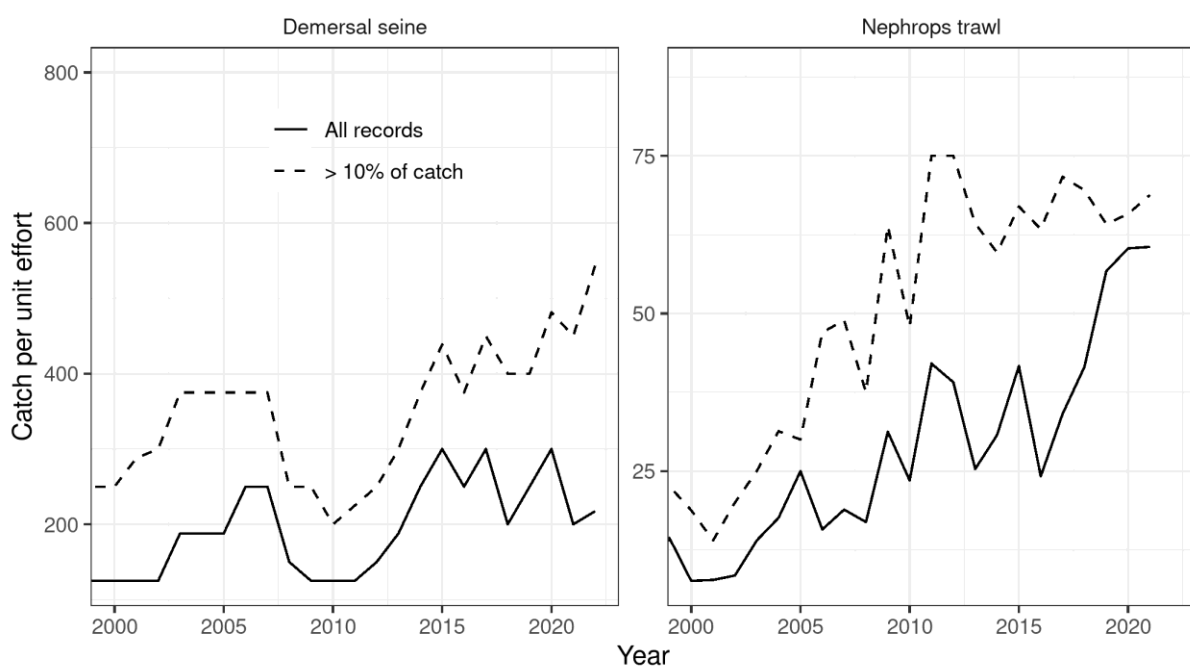


Figure 6. Witch. Non-standardised estimates of CPUE for bottom trawl (left, (kg/hour or towhours) and *Nephrops* trawl (right, (kg/hour or towhours).

AGE DISTRIBUTION OF LANDED WITCH

Table 2 shows otoliths sampling from the commercial witch catch 2010-2021. Analysis done in 2013 by the Marine Research Institute (MRI) suggested that excessive amounts of otoliths were being taken from commercial catches, and as a result the number of witch samples was reduced. Before this change, around 5000 otoliths from 100 samples were collected annually, but since 2014, annual number of samples have been between 15-60 and number of otoliths sampled between 375-1500 (Table 2, Figure 7). In general, over 95% of the otoliths sampled are age read.

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

<i>Year</i>	<i>Demersal seine</i>		<i>Nephrops trawl</i>		<i>Demersal trawl</i>	
	Samples	Otoliths	Samples	Otoliths	Samples	Otoliths
2010	45	2239	48	2400	7	350
2011	38	1900	56	2800	3	150
2012	46	2300	50	2500	1	50
2013	40	1950	28	1400	3	150
2014	26	650	18	450	3	75
2015	35	875	24	600	1	25
2016	20	500	10	250	3	75
2017	30	750	12	300	5	123
2018	19	475	8	200	4	100
2019	18	450	8	200	3	75
2020	15	375	4	100	4	100
2021	8	200	3	75	4	100
2022	19	380	0	0	3	65

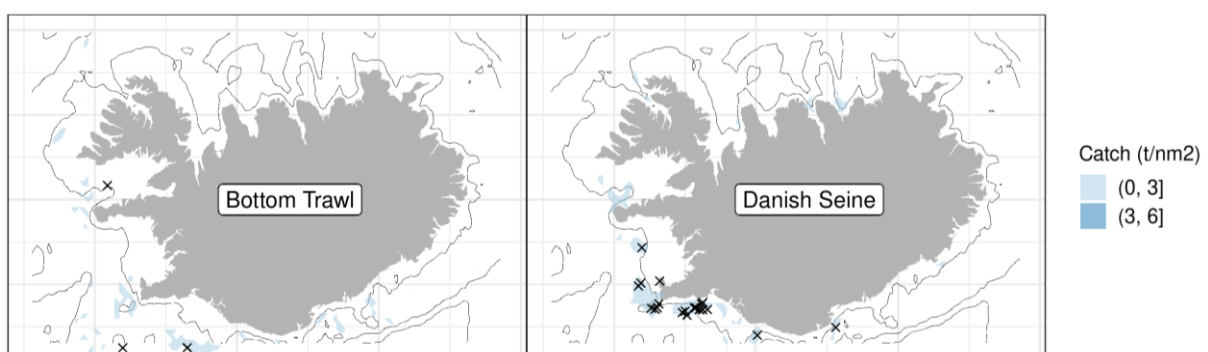


Figure 7. Witch. Fishing grounds in 2022 as reported in logbooks (colours) by gear and positions of samples taken from landings (x).

In 2002-2005, most of the witch catch was 4-7 years old (Figure 8). The proportion of these age classes has since decreased and shift towards 8-10 year old was noticeable in 2016-2018. Thus, witch in the catch has become older, and there are little signs of recruitment of younger fish into the fishery.

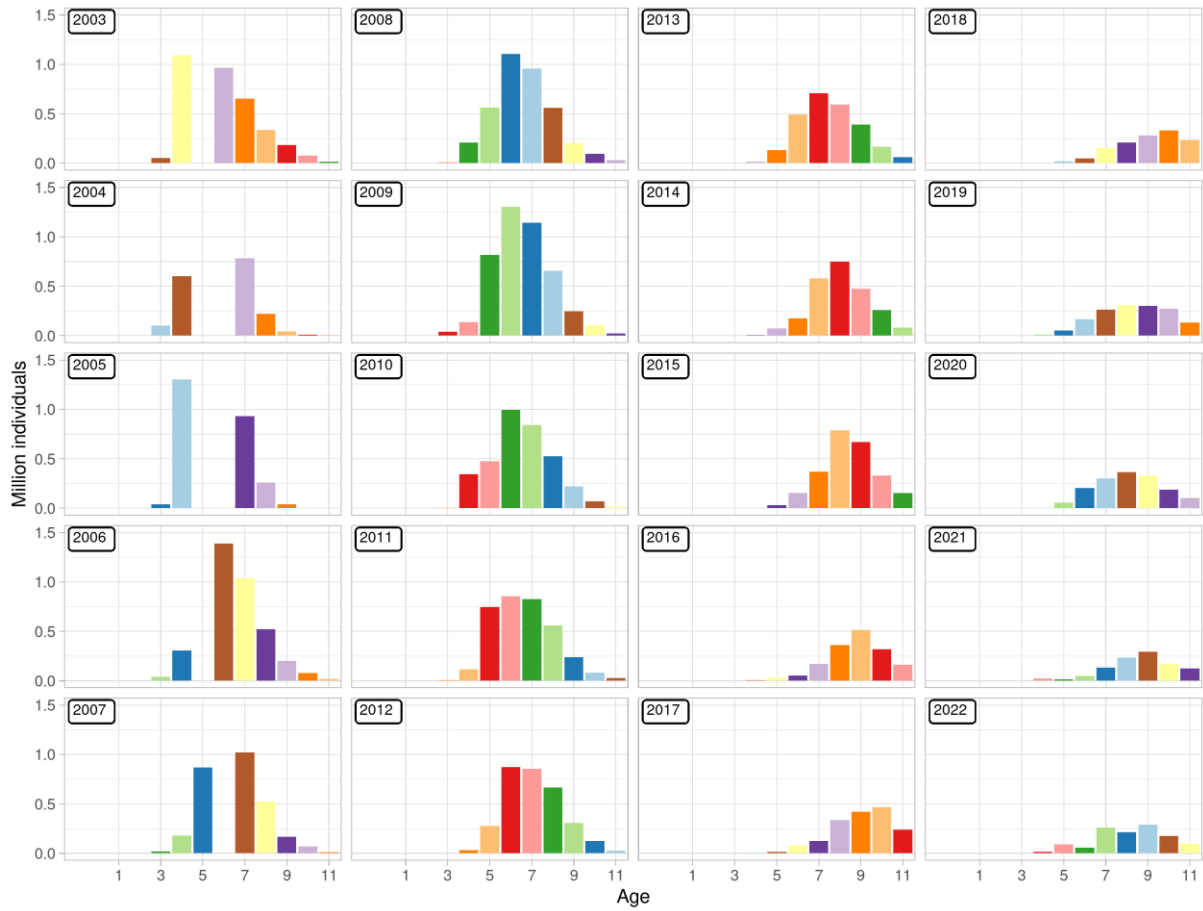


Figure 8. Witch. Estimated age distribution of landed catch based on landings and otoliths collected from landed catch.

LENGTH DISTRIBUTION OF LANDED WITCH

Over the past eight years, there has been a shift towards larger fish in the relative length distribution of landed catch (Figure 9). As a result, the average length in the samples taken from commercial catch has increased from 37 cm to 42 cm in the past two decades. Few smaller fish have been seen entering the fishery over the past 5 years.

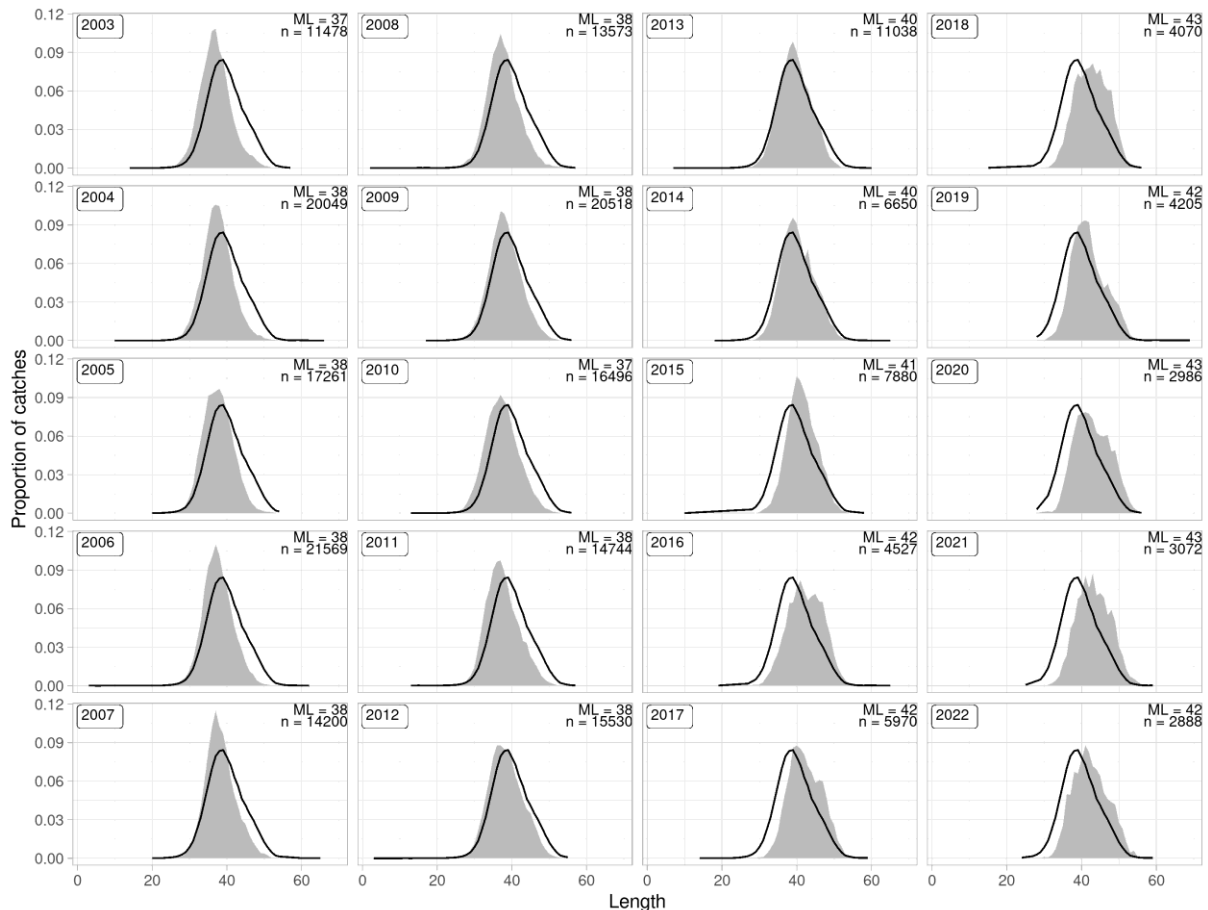


Figure 9. Witch. Relative length distribution of fish sampled from landed catch since 2003. The dotted line represents the mean length for all years.

SURVEY DATA

The Icelandic spring groundfish survey (hereafter spring survey, IS-SMB), which has been conducted annually in March since 1985, covers the most important distribution area of the witch fishery. In addition, the Icelandic autumn groundfish survey (hereafter autumn survey, IS-SMH) 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 witch that are poorly known.

Figure 10 shows trends in various biomass indices and a recruitment index based on abundance of witch smaller than 30 cm in the spring and autumn surveys. Survey length disaggregated abundance indices are shown in Figures 11-12, and abundance and changes in spatial distribution in Figures 13-16.

In both surveys, total biomass indices and biomass indices for witch larger than 30 cm (harvestable part of the stock) increased rapidly in 2004 (Figure 10) and have remained relatively high and stable since. Biomass of large fish (43 cm and larger) increased rapidly from 2010-2015 and remained at that level since. Recruitment indices (numbers below 20 cm) have decreased rapidly from quite high numbers in the beginning of the spring survey 1985 and stayed at that level through the period with small recruitment pulses occasionally. In 2011-2019, the recruitment indices from both surveys were at an all-time low. Recruitment increased in the spring survey in 2021 and is at a similar level this year.

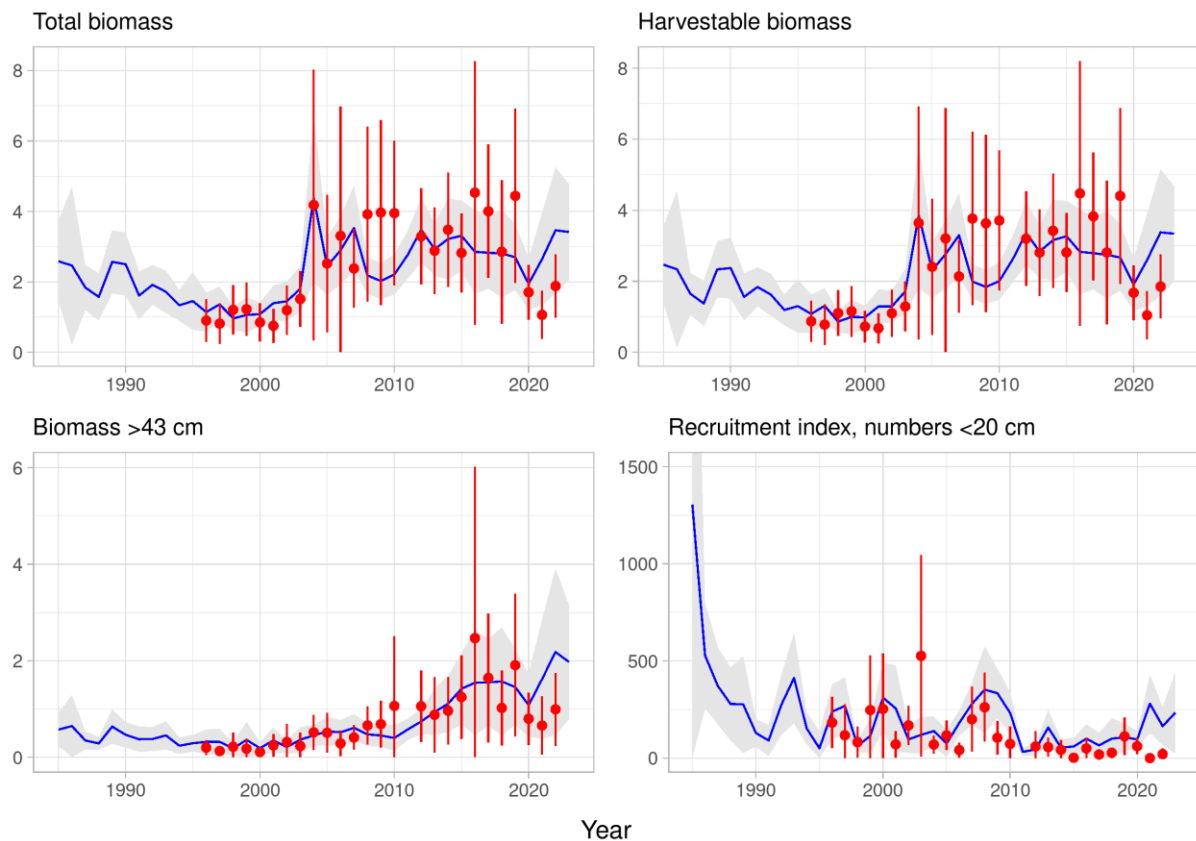


Figure 10. Witch. Total biomass indices (upper left), harvestable biomass indices (≥ 30 cm, upper, right) and biomass index of larger individuals (≥ 43 cm, lower left), juvenile abundance indices (≤ 20 cm, lower right), from the spring survey (blue) and autumn survey (red), along with the standard deviation.

Relative length distribution of witch in the spring survey has shifted towards larger fish (Figure 11). The average length of witch increased from 31 cm in 1988 to 38-39 cm in 2016-2023. Data from the autumn survey tells a similar story, with a marked increase in average size of witch (Figure 12).

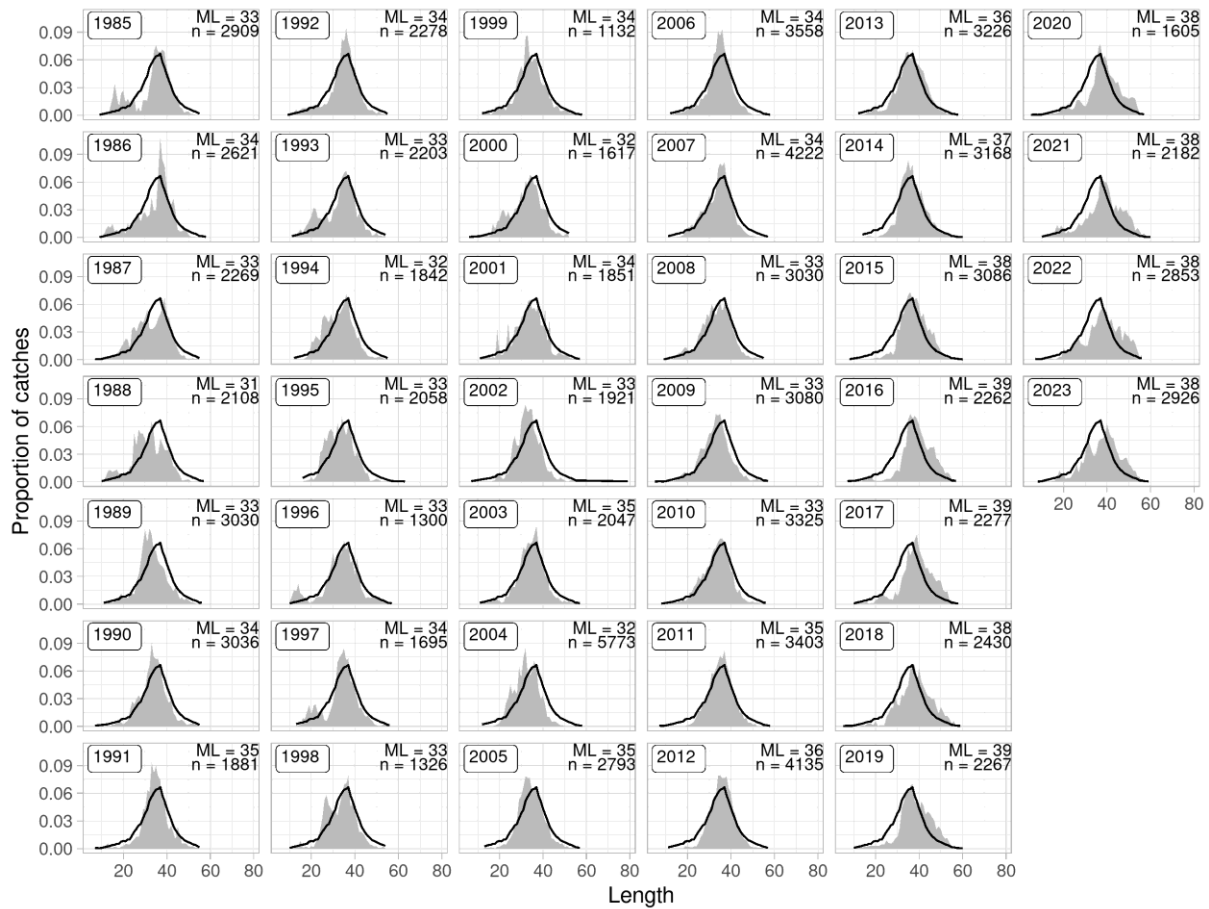


Figure 11. Witch. Relative length disaggregated abundance indices from the spring survey. The black line shows the mean for all years.

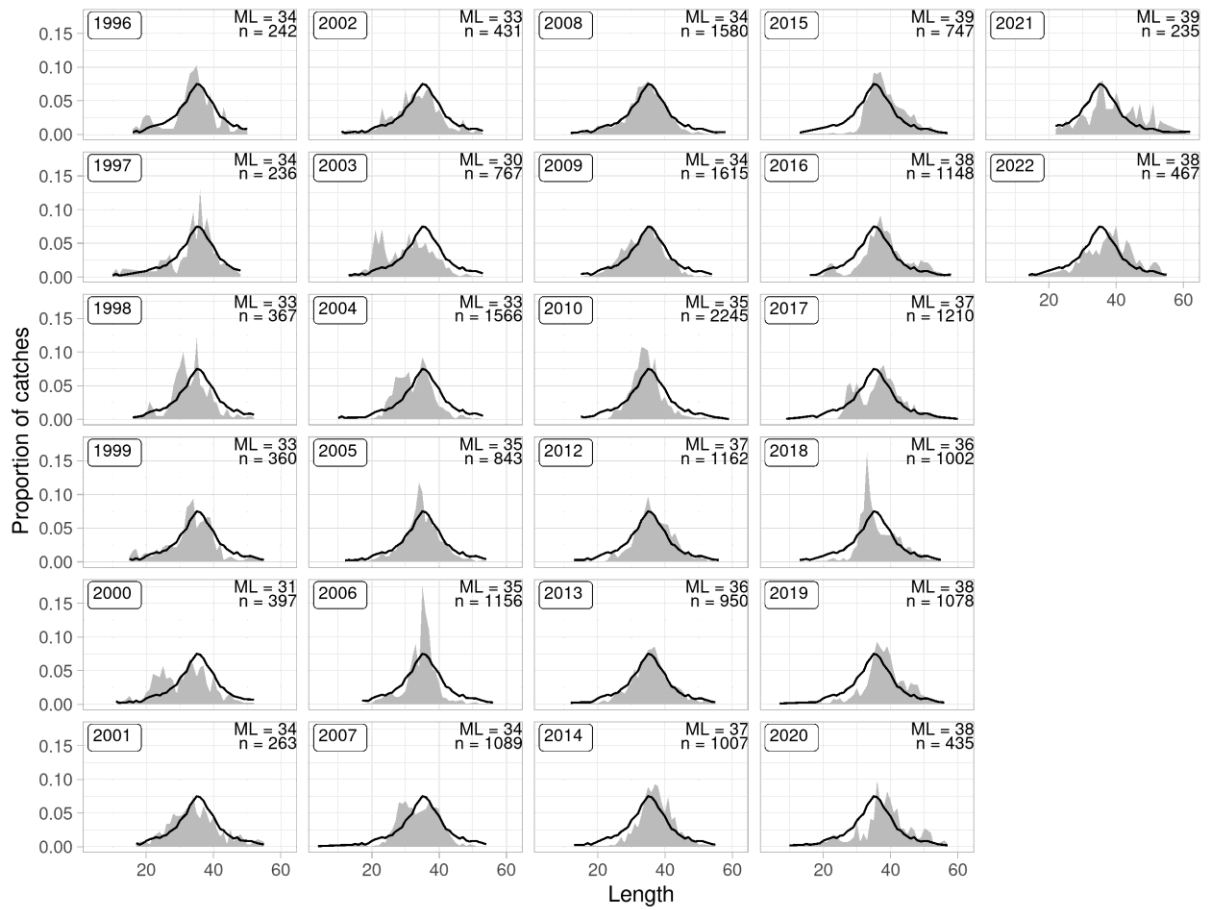


Figure 12. Witch. Relative length-disaggregated abundance indices from the autumn survey since 1996. The black line shows the mean for all years.

Witch is caught all around Iceland in the spring survey, but only in very small quantities off the east coast (Figures 13-14). Abundance of witch is highest and quite stable in the SW and W areas. Abundance in the SE area is quite low except for years 2002-2012. In the northern areas abundance has increased in 2008 and remained stable since. The autumn survey shows a similar trend (Figures 15-16).

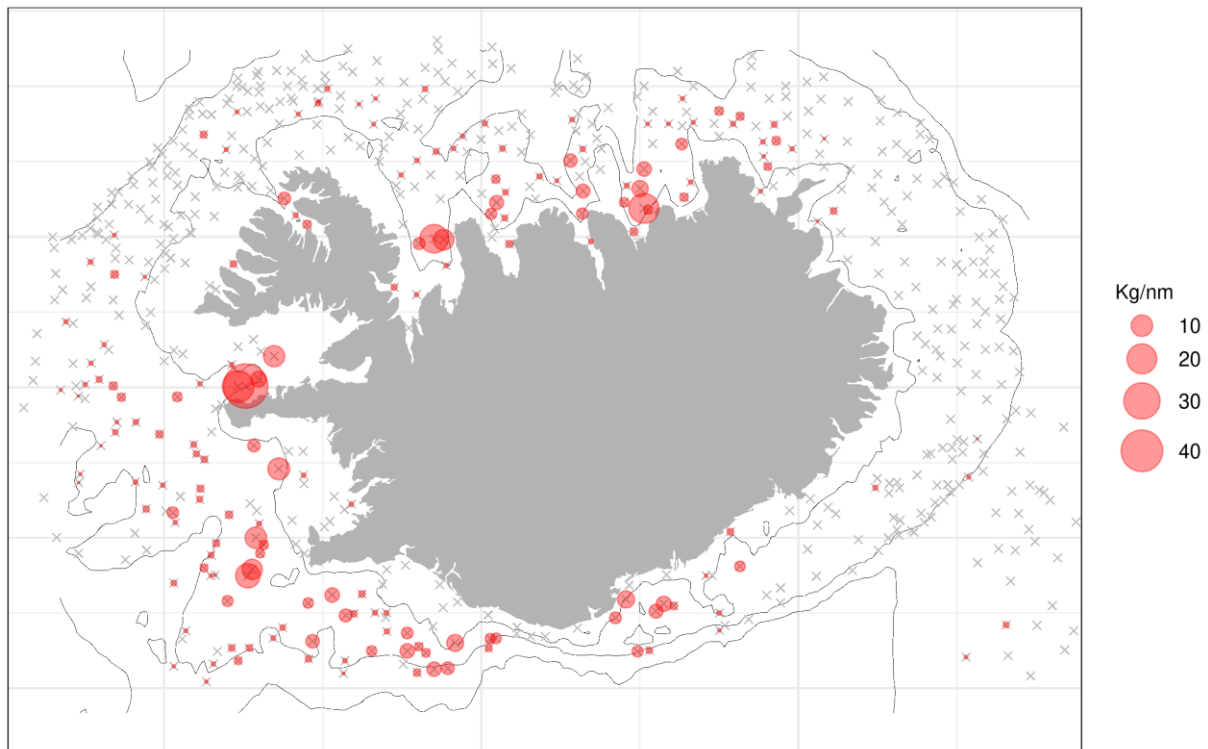


Figure 13. Witch. Spatial distribution in the spring survey in 2023.

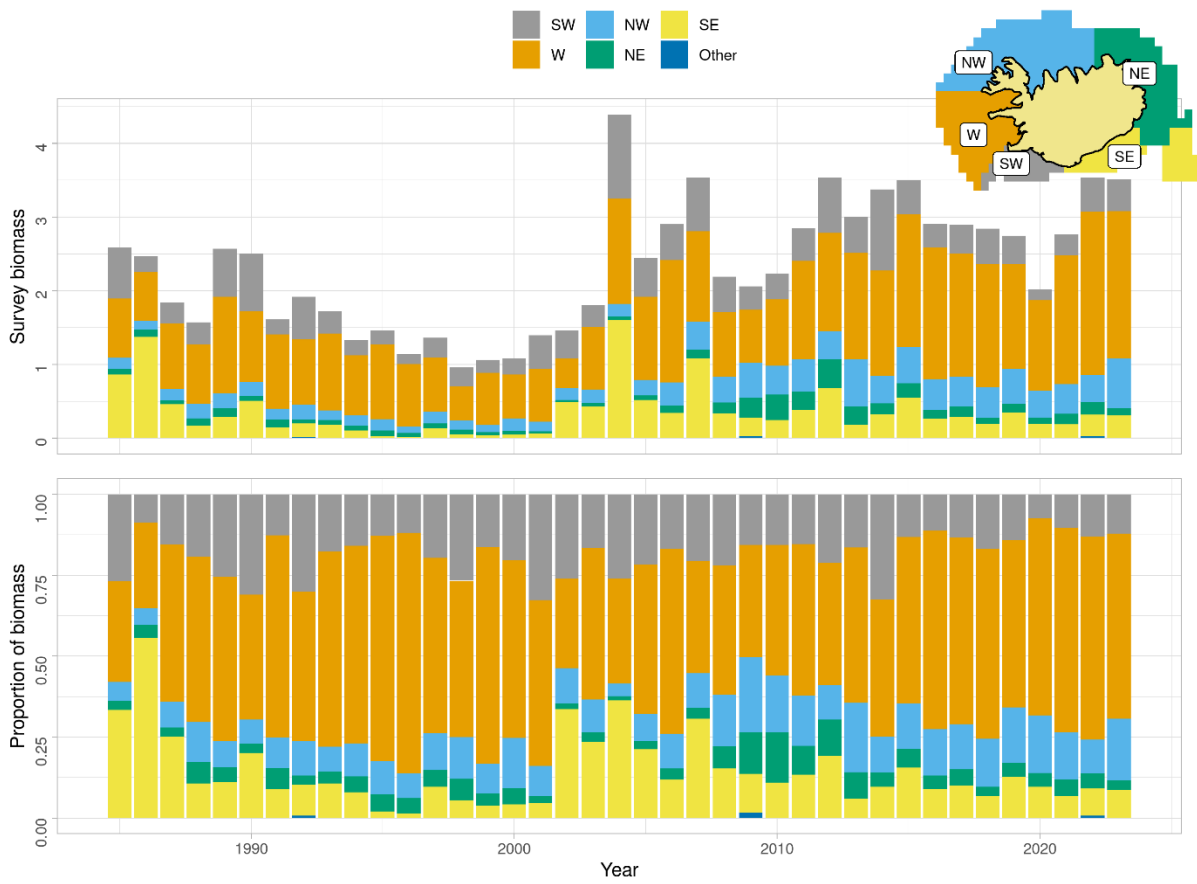


Figure 14. Witch. Spatial distribution of biomass index from the spring survey since 1985.

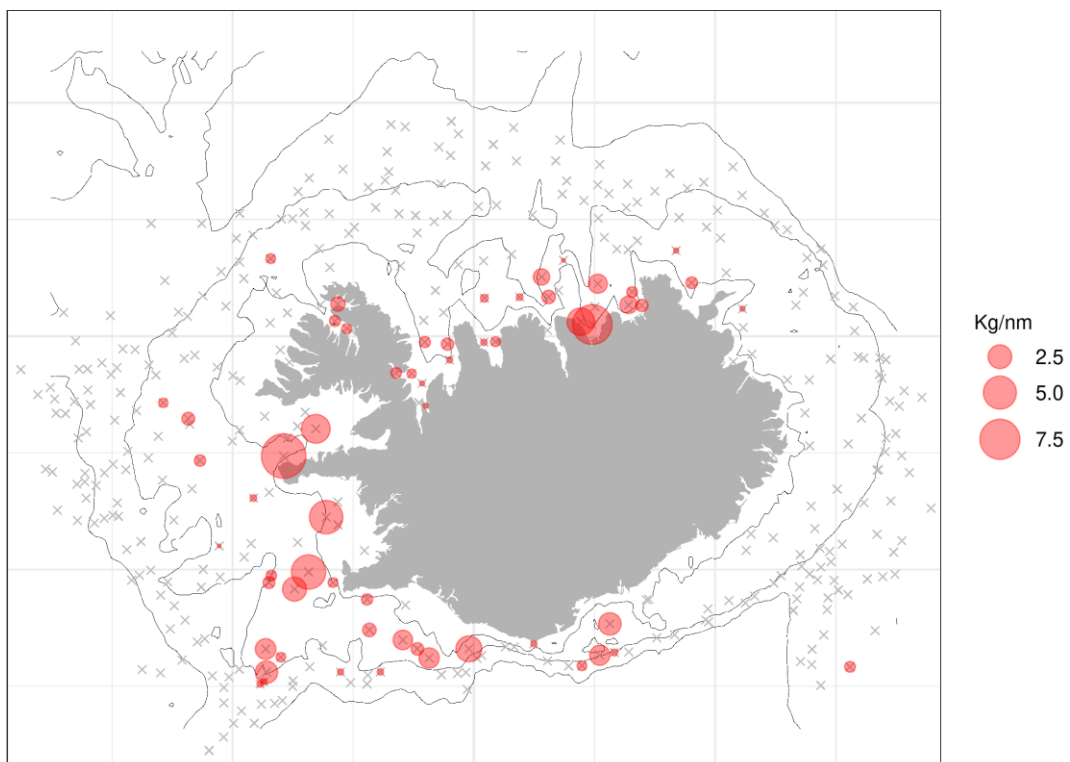


Figure 15. Witch. Spatial distribution in the autumn survey in 2022.

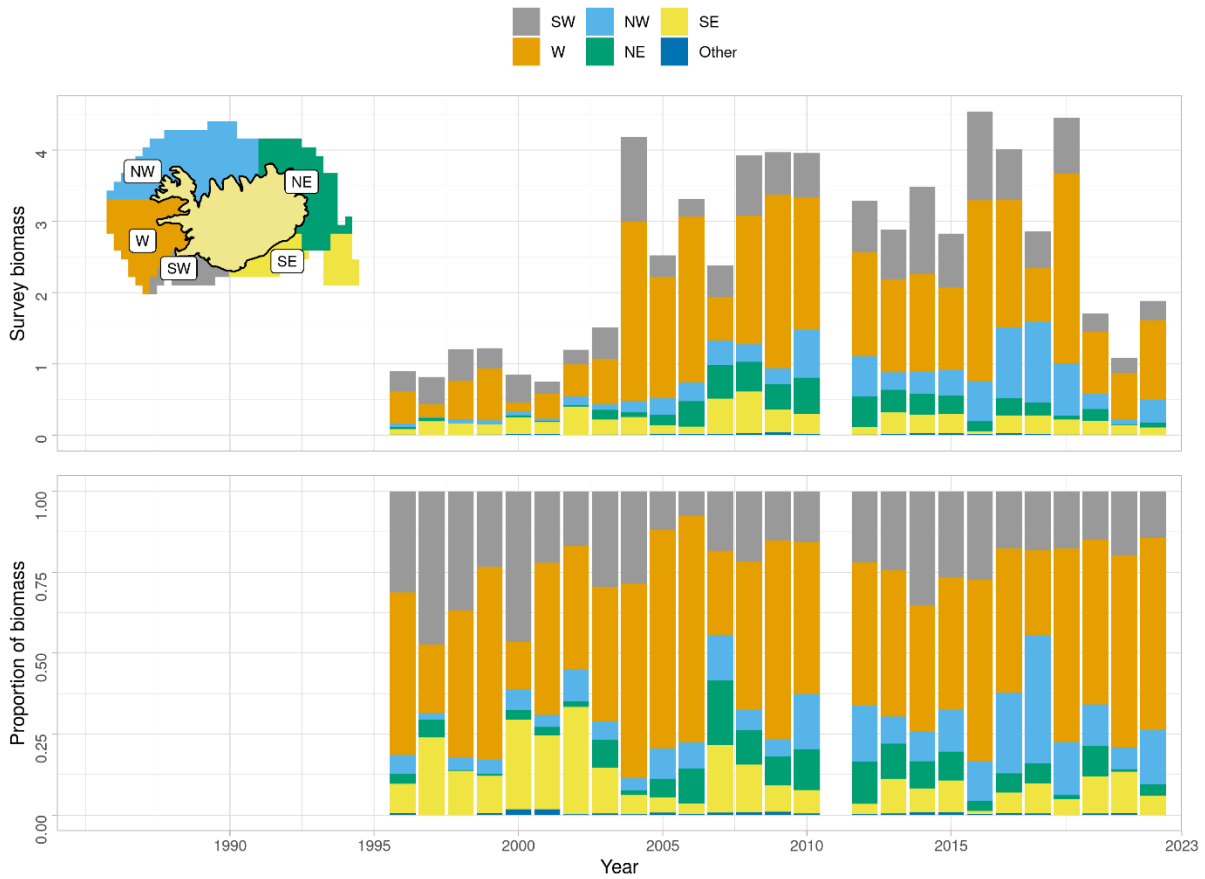


Figure 16. Witch. Spatial distribution of biomass index from the autumn survey.

STOCK ASSESSMENT

COMMENTS ON THE ASSESSMENT AND ADVICE

The assessment is for this stock based on ICES *rfb*-rule for data limited stocks for the first time in 2023, where life history traits, exploitation characteristics and other relevant parameters for data-limited stocks are considered (ICES 2021). The *rfb*-rule has the following form:

$$A_{y+1} = A_{y-1} r f b m$$

where A_{y+1} is the advised catch, A_{y-1} is last year's advice, r corresponds to the trend in biomass index (as in the current ICES "2 over 3" rule), f is a proxy for the exploitation (mean catch length divided by an MSY reference length) and b a biomass safeguard (reducing the catch when biomass index drops below a trigger value).

r is the ratio of the mean of the last two survey indices and the mean of the three preceding values or:

$$r = \frac{\sum_{i=y-2}^{y-1} I_1 / 2}{\sum_{i=y-3}^{y-5} I_1 / 3}$$

f is the length-ratio component where:

$$f = \frac{\bar{L}_{y-1}}{L_{F=M}}$$

where \bar{L} is the mean catch length above $L_{F=M}$.

$L_{F=M}$ is calculated as:

$$L_{F=M} = 0.75L_c + 0.25L_\infty$$

where L_c is the length where frequency is half that of the modal value (Figure 20), and L_∞ is von Bertalanffy L_∞ .

b is the biomass safeguard and is used to reduce catch advice when index falls below trigger,

$$b = \min(1, I_y - 1/I_{trigger})$$

where $I_{trigger} = I_{loss\omega} * 1.4$

m is a multiplier based on stock growth. K for witch is 0.15 and therefore m is 0.95.

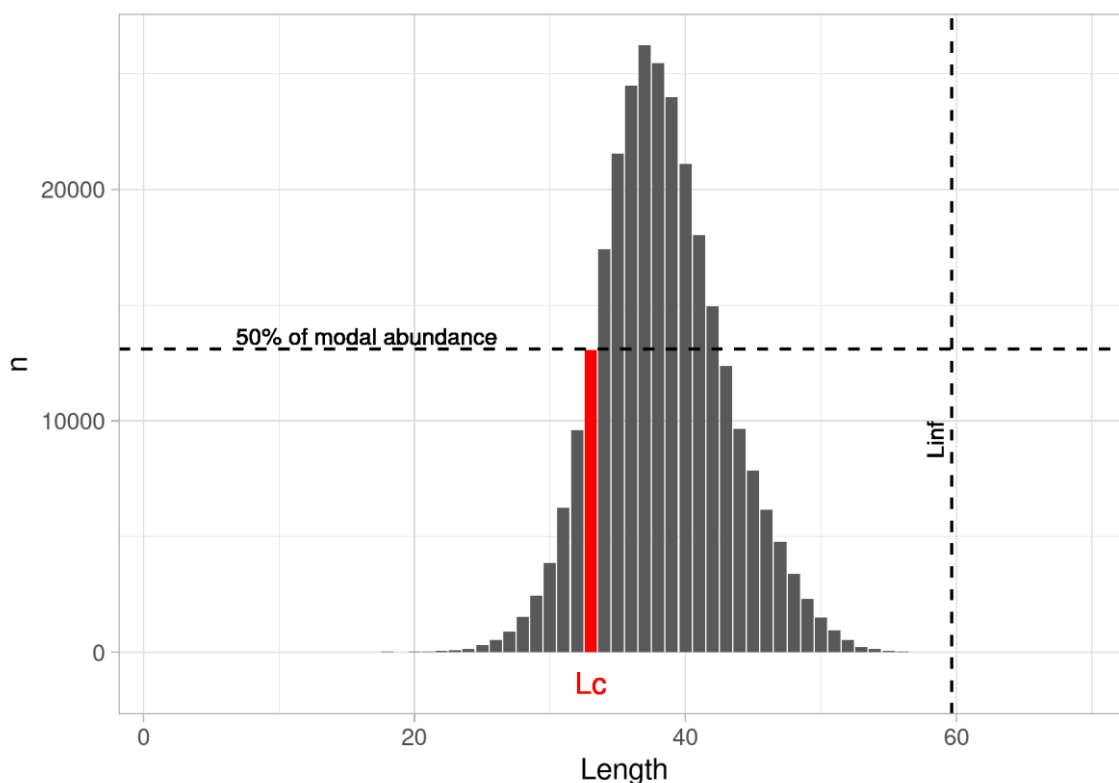


Figure 20. Witch. Length frequency distribution from catches. Red line is the length at first capture.

ANALYSIS ON THE ASSESSMENT AND ADVICE

The assessment is based on the rfb-rule for ICES category 3 data-limited stocks and is applied for lemon sole for the first time this year and is applied for the next two fishing years (2023/2024 and 2024/2025). The Icelandic spring trawl survey (IS-SMB) was used as the index for the stock development. The advice is according to $A_{y+1} = A_{y-1} r f b m$ or $1230 \text{ t} * 1.4 * 1.07 * 1 * 0.95$ which calls for the use of the stability clause, since the advice would increase more than 20%. This results in advice for 2023/2024 set at 1476 t (20% increase from last year's advice) (Table 3). In 2019-2021, the advice was based on the ICES framework for data limited stocks (Category 3.2) where the ratio of the mean of the last two survey indices (Index A) to the mean of the three preceding values (Index B) is multiplied by the last year's advice. This method is no longer considered precautionary and hence, the new rule.

Table 3. Witch. Comparison between the *r*fb-rule and the “2 over 3” rule.

	rfb-rule	Old 2-over-3 rule
Previous	1230	1230
Index A	3358	3358
Index B	2391	2391
Ratio (A/B)	1.4	1.4
Length ratio	1.07	
Biomass	1	
Multiplier	0.95	
Initial advice	1750	1722
Stability	20%	20%
Precautionary	-	-
Final advice	1476	1476
Advice	+20%	+20%

*Last applied in 2022.

APPLICATION OF THE RFB-RULE

- *r* is calculated as the average of last two years values, divided by average of three preceding years values which results in $r=1.4$ (Figure 21, Table 3)

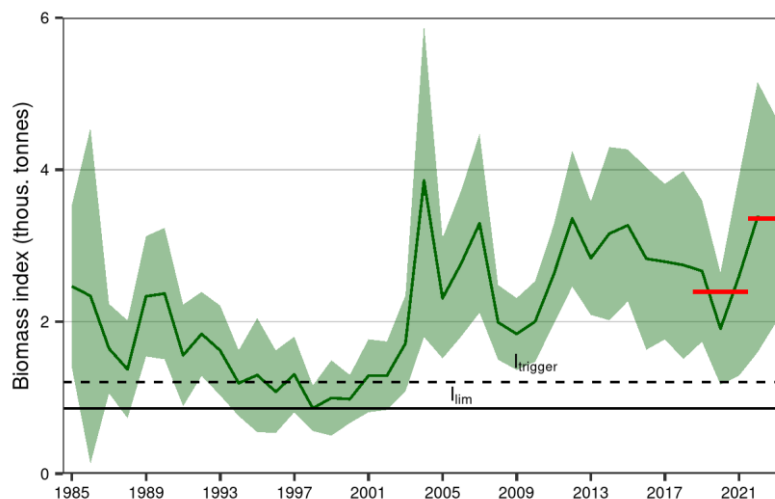


Figure 21. Witch. IS-SMB biomass index since 1985. The red lines show the average of last two years values and the three preceding years used to calculate *r*.

- *f* is the length-ratio component. The mean length from the previous year’s catches was 42 cm and the target reference length (L_c , the length where frequency is half that of the modal value $\times 0.75 + L_\infty \times 0.25$) is **40** (Figure 22).

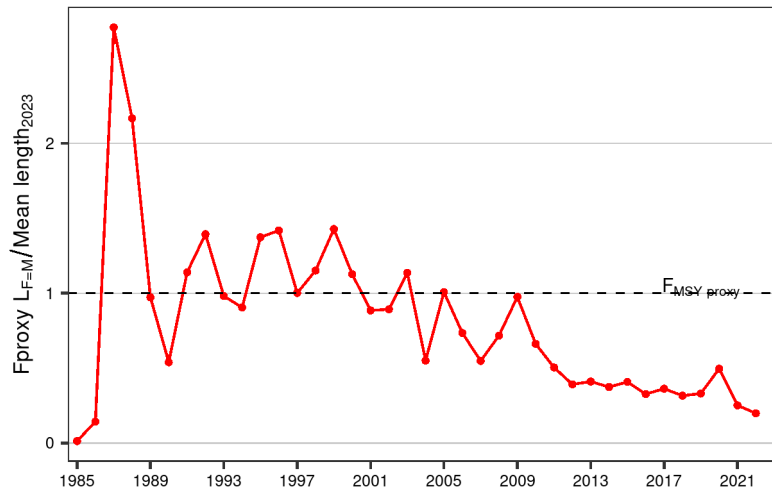


Figure 22. Witch. Annual Fproxy for years for which sufficient data was available.

- b is the biomass safeguard and is used to reduce catch advice when index falls below trigger. I_{loss} for witch is 861 and was based on the lowest biomass index. $I_{trigger}$ is $I_{loss} * 1.4$ or 1205 (Figure 21). The biomass index this year is 3340, which is above $I_{trigger}$ and hence, b is 1.
- m is the tuning parameter and for slow growing species (with von Bertalanffy $K < 0.2$), m equals 0.95.

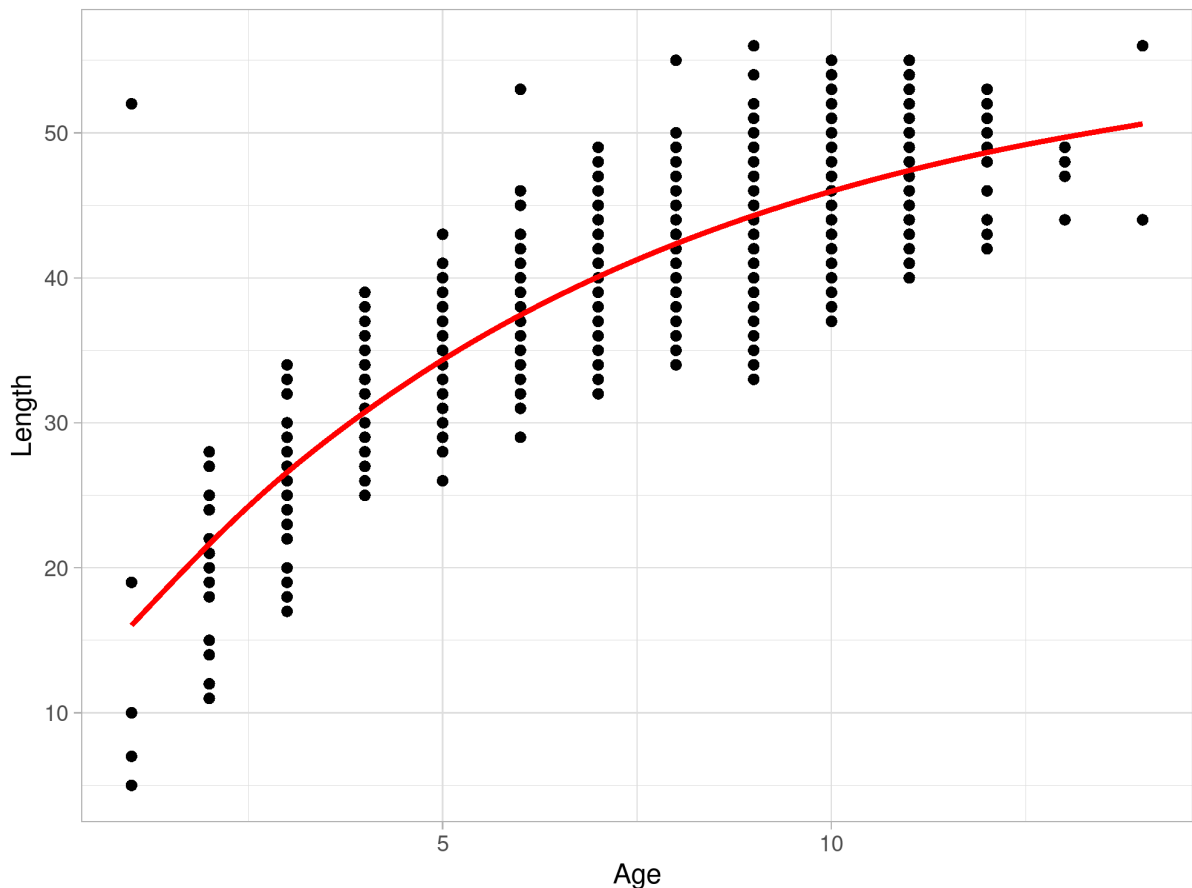


Figure 23. Witch. The von Bertalanffy growth curve (red line) fitted to age and length data from the beam trawl survey and the spring survey in the last 5 years.

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. Witch was included in the ITQ system in the 1996/1997 fishing year and as such subjected to TAC limitations. For the fishing years 2005/2006 to 2009/2010 the TAC was set higher than recommended by Marine Research Institute (MRI), but since the 2010/2011 fishing year TAC has been the same as recommended TAC (Table 4).

For most fishing years the net transfers between witch and other species in the Icelandic ITQ-system are less than 15% of the national TAC (Figure 24). The main exception from this was during the fishing years 2008/2009 and 2009/2010 when the national TAC was set considerably higher than recommended, and considerable proportion of witch quota was transferred to other species (Figure 24, Table 4). For the last five fishing years there has been a net transfer from witch to other species in the quota system. Transfer of witch quota between fishing years is usually within 10% but was over 20% last year (Figure 24).

Table 4. Witch. Recommended TAC, national TAC set by the Ministry, and landings (tonnes).

FISHING YEAR	REC. TAC	NATIONAL TAC	CATCH
1994/95	1500	-	1760
1995/96	1400	-	1660
1996/97	1200	1200	1260
1997/98	1100	1100	960
1998/99	1100	1100	1160
1999/00	1100	1100	1110
2000/01	1100	1100	1160
2001/02	1350	1350	1220
2002/03	1500	1500	1530
2003/04	1500	1500	2000
2004/05	2000	2000	2250
2005/06	2200	2400	2190
2006/07	2000	2400	2200
2007/08	2000	2400	1540
2008/09	1600	2200	1700
2009/10	1600	2200	1300
2010/11	1300	1300	1220
2011/12	1100	1300	1450
2012/13	1100	1100	1180
2013/14	1100	1100	1170
2014/15	1100	1100	1220
2015/16	1100	1100	1140
2016/17	1110	1100	1090
2017/18	1116	1116	885
2018/19	1100	1100	844
2019/20	1067	1067	940
2020/21	854	854	733
2021/22	1025	1025	603
2022/23	1230	1230	

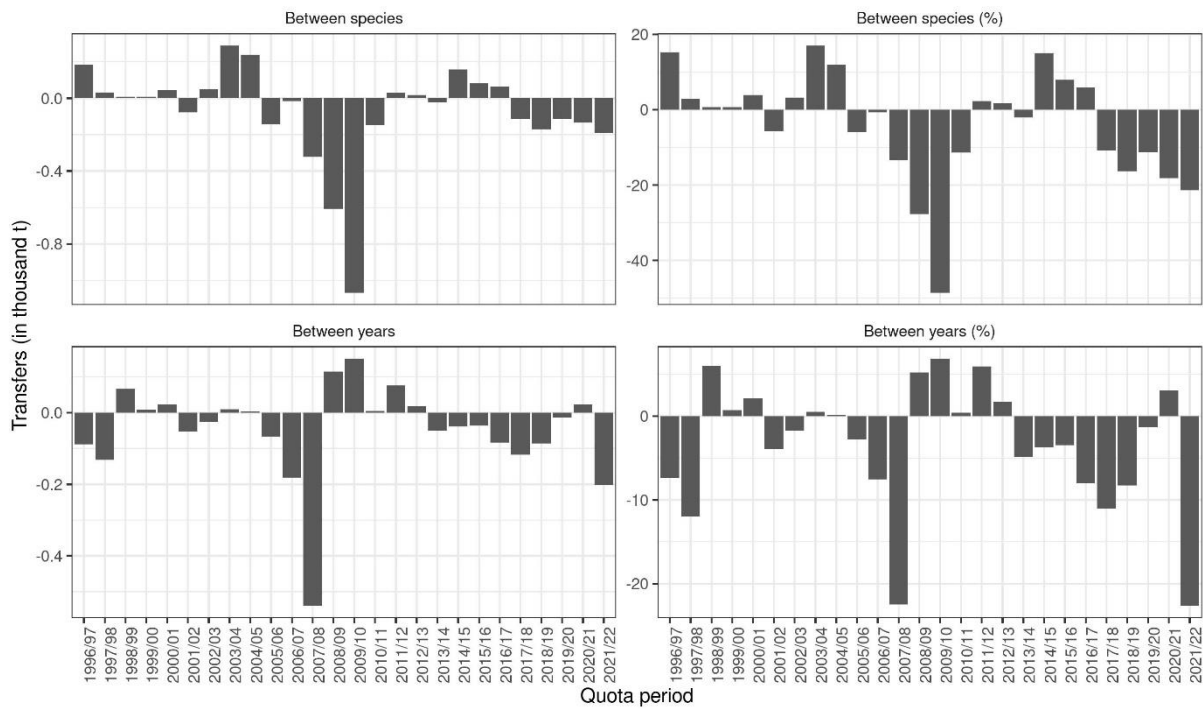


Figure 17. Witch. Net transfers of quota to and from witch in the Icelandic ITQ system by fishing year. Between species (upper): Positive values indicate a transfer of other species to witch, but negative values indicate a transfer of witch quota to other species. Between years (lower): Net transfer of quota in a given fishing year.

REFERENCES

MFRI 2022. MFRI Assessment Reports 2023. Witch. 21 pp.

<https://www.hafogvatn.is/static/extras/images/040-humartr1235185.pdf>