

ANGLERFISH

Lophius piscatorius

GENERAL INFORMATION

Anglerfish (or monkfish) is a benthic "sit and wait" predator that is most abundant south and west of Iceland. It is found at depths from 20-2800 m, though most abundant between 50 and 250 m.

Females grow larger than males and can reach a size of 130 cm while males larger than 80 cm are rare. Similarly, females become sexually mature around 80 cm and males around 61 cm.

The north-western edge of the anglerfish's habitable area is found in Icelandic waters, which renders it more sensitive to environmental changes than many other species in the area.

THE FISHERY

In 2017-2021, anglerfish was caught in the southeast, southwest and, to a small extent west of Iceland as reported in logbooks (Figure 1 and 2). From 1995-2000 captures were mostly in the southeast and southwest after which it was captured more frequently in the west and in 2010-2016 also northwest and north of Iceland (Figure 1-2). Geographic distribution has changed mostly in the form of more aggregated patches because of a large reduction in catches in the southeast, south, southwest, and west areas apart from a large increase in the northwest from 2010-2016. During the past four years, spatial distribution has gradually decreased towards its previous state, before 2000 (Figure 1).

On Icelandic fishing grounds, anglerfish is mostly caught at depths between 50 and 250 m (Figure 3). In 2000-2016 it was captured to a large extent in anglerfish gillnets. Otherwise, bottom trawls and *Nephrops* trawls were most common until last year when the *Nephrops* fisheries stopped (Figure 4, Table 1). The number of boats reporting anglerfish catches peaked in 2007, with a total of 418 boats, but annual catch peaked in 2009 at 4069 t. Since then, catches have declined annually amounting to 139 t in 2022. A large reduction in catches between 2016 and 2017 can be explained by a reduction in the anglerfish gillnet fishery which accounted for 54% of the anglerfish fisheries in 2016, 14% in 2017, and 5% in 2022 (Table 1). A reduction from 411 to 159 vessels from 2021-2022, and a significant reduction in total catch, can be explained by a *Nephrops* fishing ban.

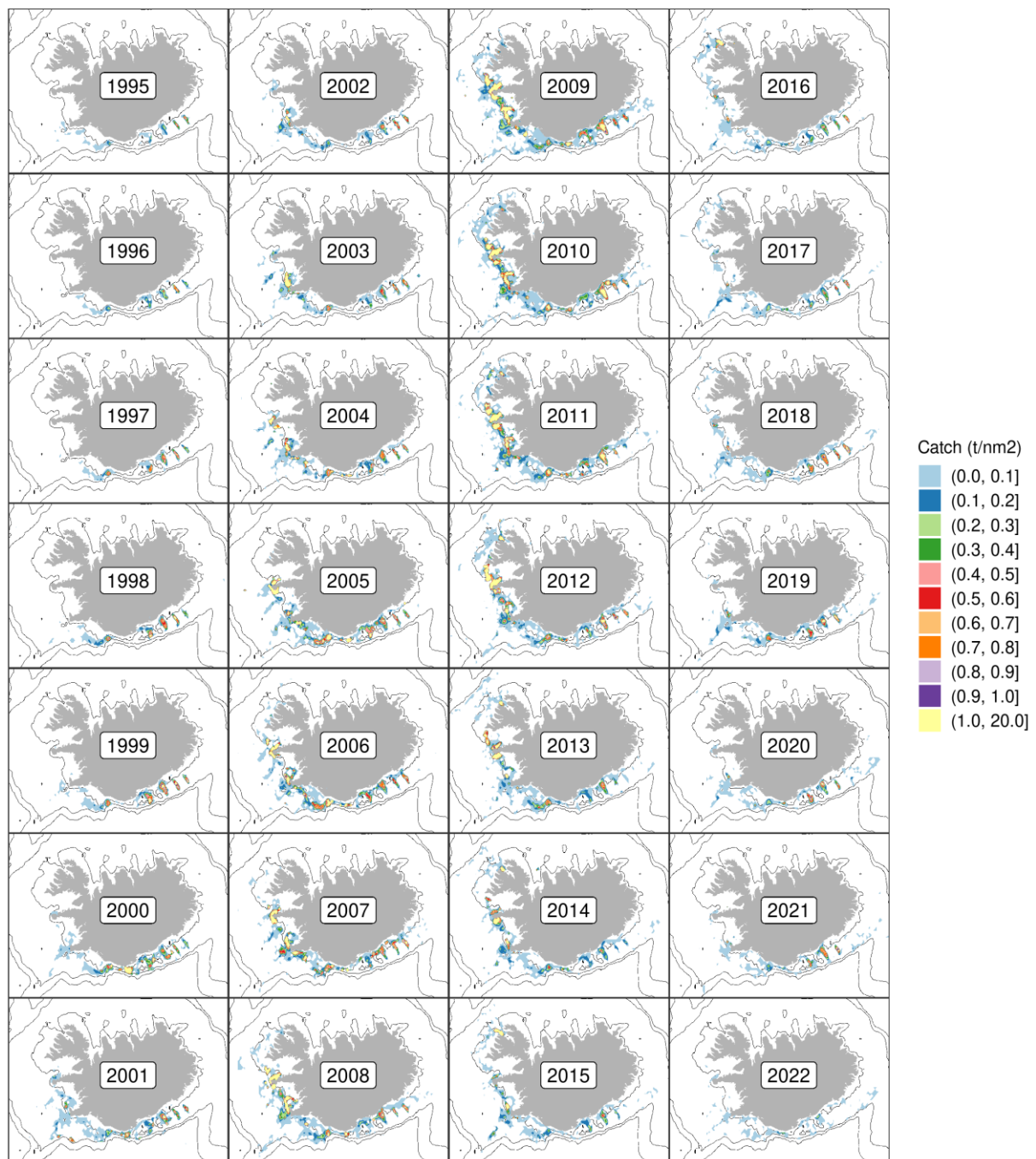


Figure 1. Anglerfish. Geographic distribution of the Icelandic fishery since 1995 as reported in logbooks.

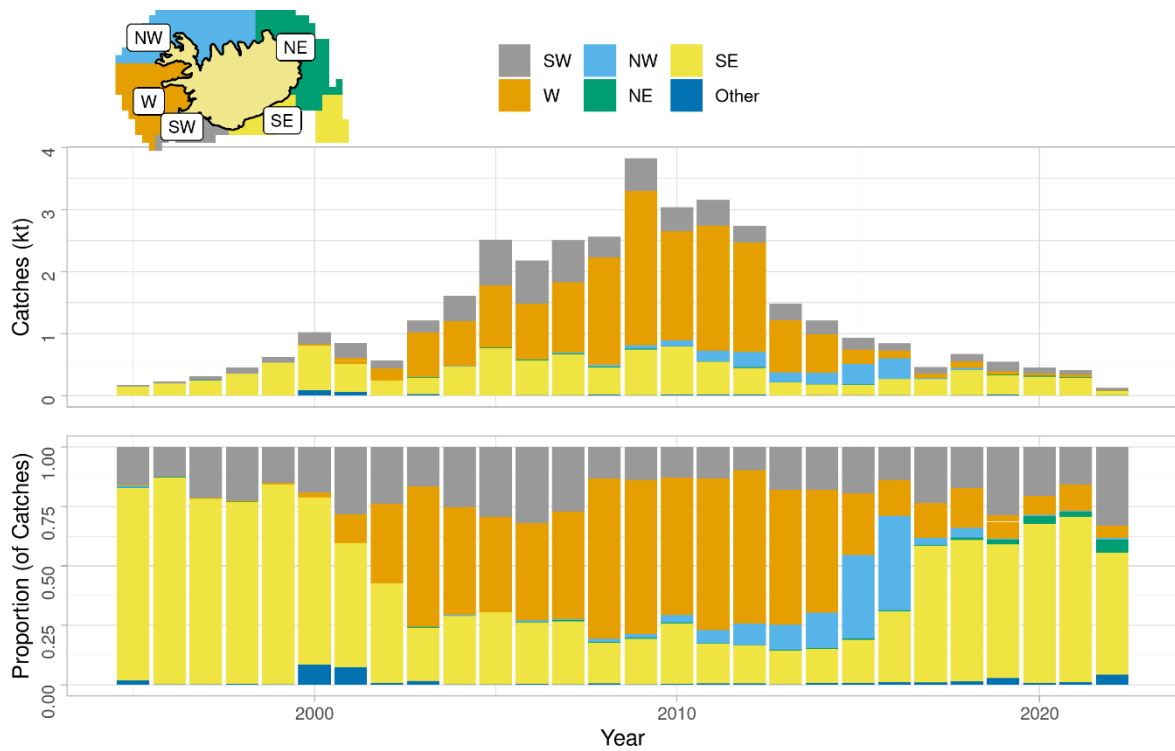


Figure 2. Anglerfish. Catch distribution and proportions by area since 1995 according to logbooks. All gears combined.

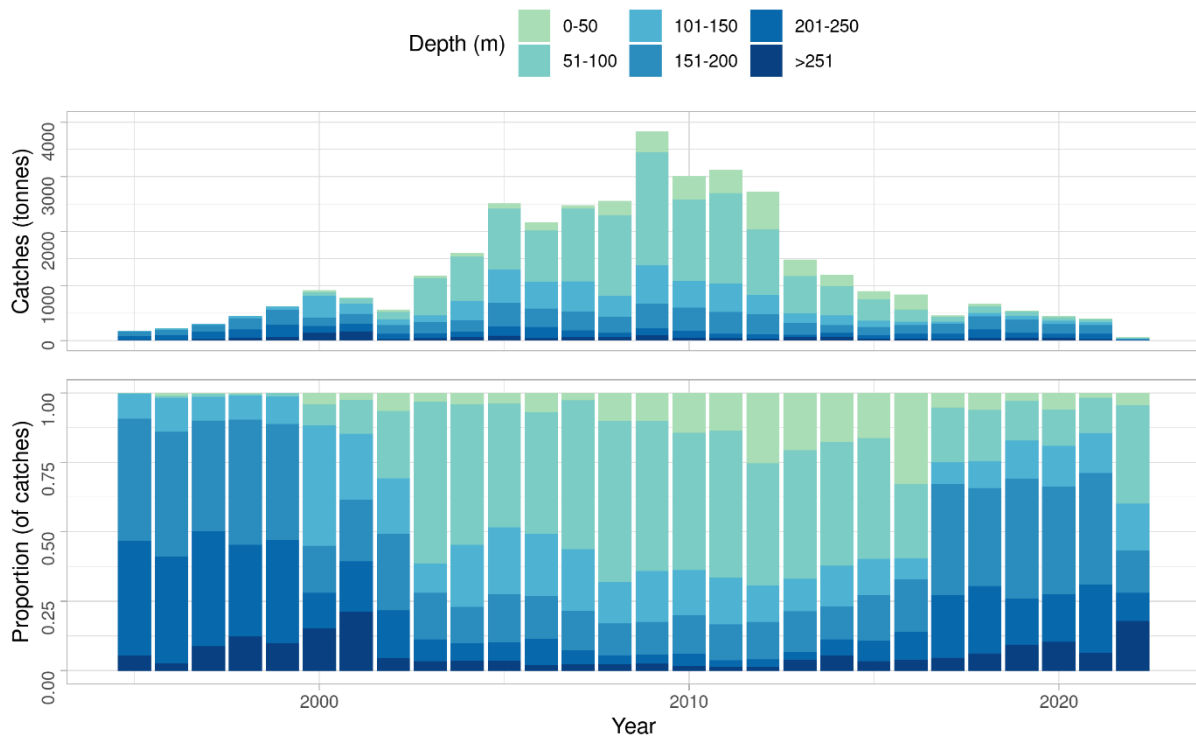


Figure 3. Anglerfish. Depth distribution of since 1995 according to logbooks.

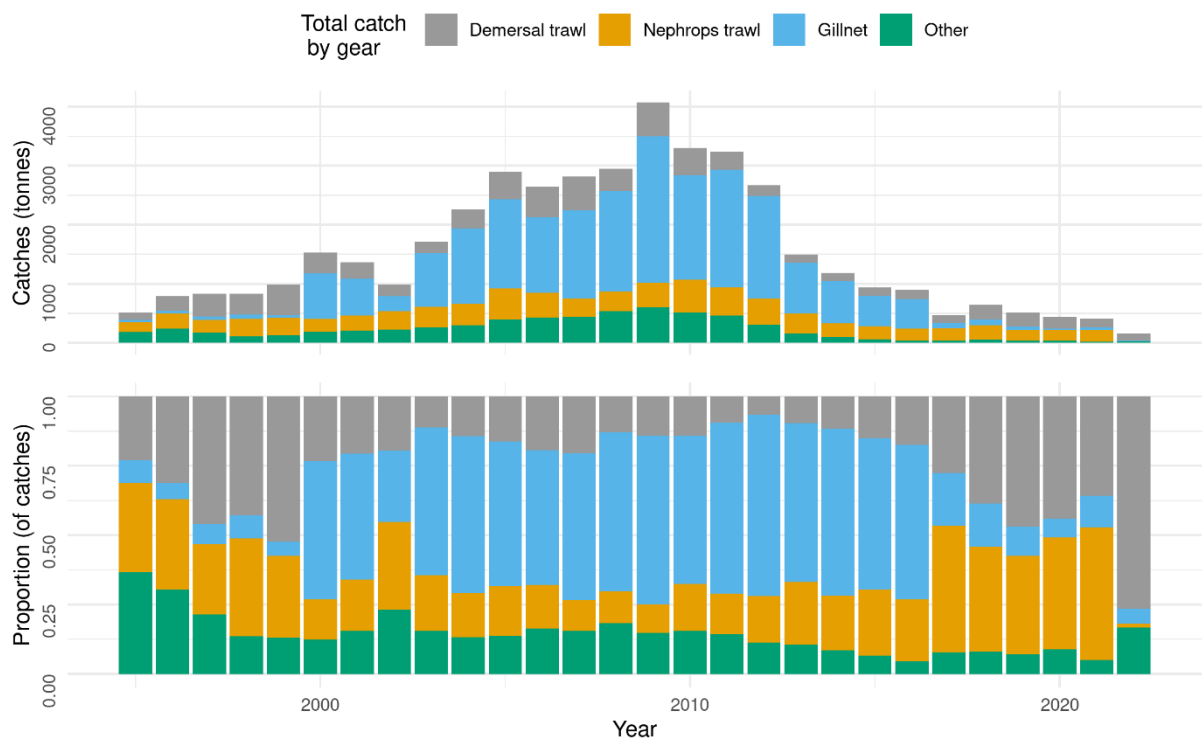


Figure 4. Anglerfish. Total catches (landings) by fishing gear from the year 1995 according to statistics from the Directorate of Fisheries.

Table 1. Anglerfish. Number of Icelandic vessels reporting captures of anglerfish, and landed catch divided by gear type.

YEAR	NUMBER OF VESSELS				CATCHES (TONNES)				
	<i>Bottom trawl</i>	<i>Gillnets</i>	<i>Nephrops trawl</i>	<i>Other</i>	<i>Bottom trawl</i>	<i>Gillnets</i>	<i>Nephrops trawl</i>	<i>Other</i>	<i>Sum</i>
1995	91	103	58	131	118	41	164	186	509
1996	87	125	58	138	248	45	259	239	791
1997	85	108	46	147	382	60	212	178	832
1998	85	128	46	129	358	69	296	112	835
1999	100	133	41	125	519	50	293	129	991
2000	94	1163	34	183	355	765	220	190	1530
2001	75	239	36	201	279	619	251	211	1360
2002	75	206	36	191	185	249	309	228	970
2003	72	186	37	225	184	900	341	260	1685
2004	74	177	29	217	307	1268	353	295	2223
2005	78	128	31	251	451	1495	514	392	2852
2006	68	103	28	269	488	1271	405	426	2591
2007	72	98	22	261	560	1489	310	436	2795
2008	63	87	22	244	381	1660	341	536	2948
2009	62	105	17	234	574	2473	419	602	4067
2010	62	165	18	227	452	1762	556	511	3281
2011	53	171	17	211	299	1991	475	463	3228
2012	54	157	18	200	175	1744	444	303	2666
2013	58	87	16	185	142	859	337	159	1496
2014	50	80	16	175	140	712	234	102	1188
2015	44	55	14	147	141	512	223	61	936
2016	49	43	12	127	156	500	200	40	896
2017	44	40	9	111	129	89	213	36	467
2018	47	35	9	93	248	100	244	51	644
2019	49	32	8	92	240	53	181	37	511
2020	48	25	8	80	192	30	177	39	437
2021	47	31	7	66	147	47	196	20	411
2022	50	21	3	65	122	9	2	26	159

LENGTH DISTRIBUTIONS FROM COMMERCIAL CATCHES

Length measurements from monkfish catches in 2001-2016 and 2019 reveal a change towards dominantly larger individuals after 2012, resulting in larger mean length (Figure 6). Data are however scarce after 2012 due to lower catches resulting in fewer length measurements as they are proportional to the catches.

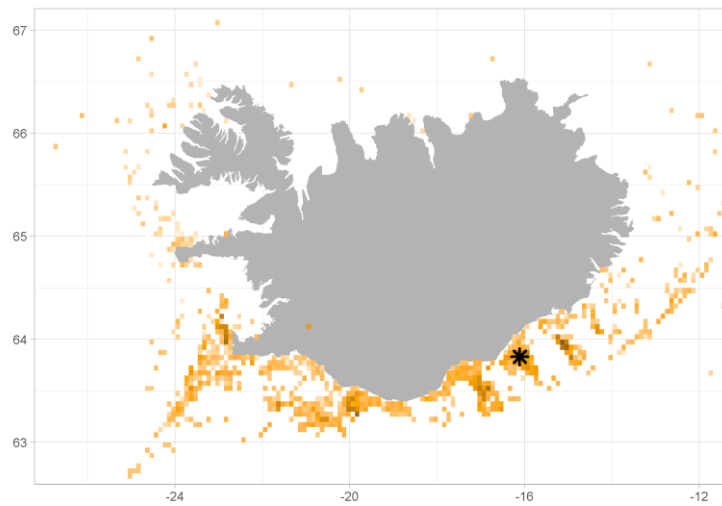


Figure 5. Anglerfish. Distribution of commercial catches 2019 and sampling location. No samples were collected in 2020-2022.

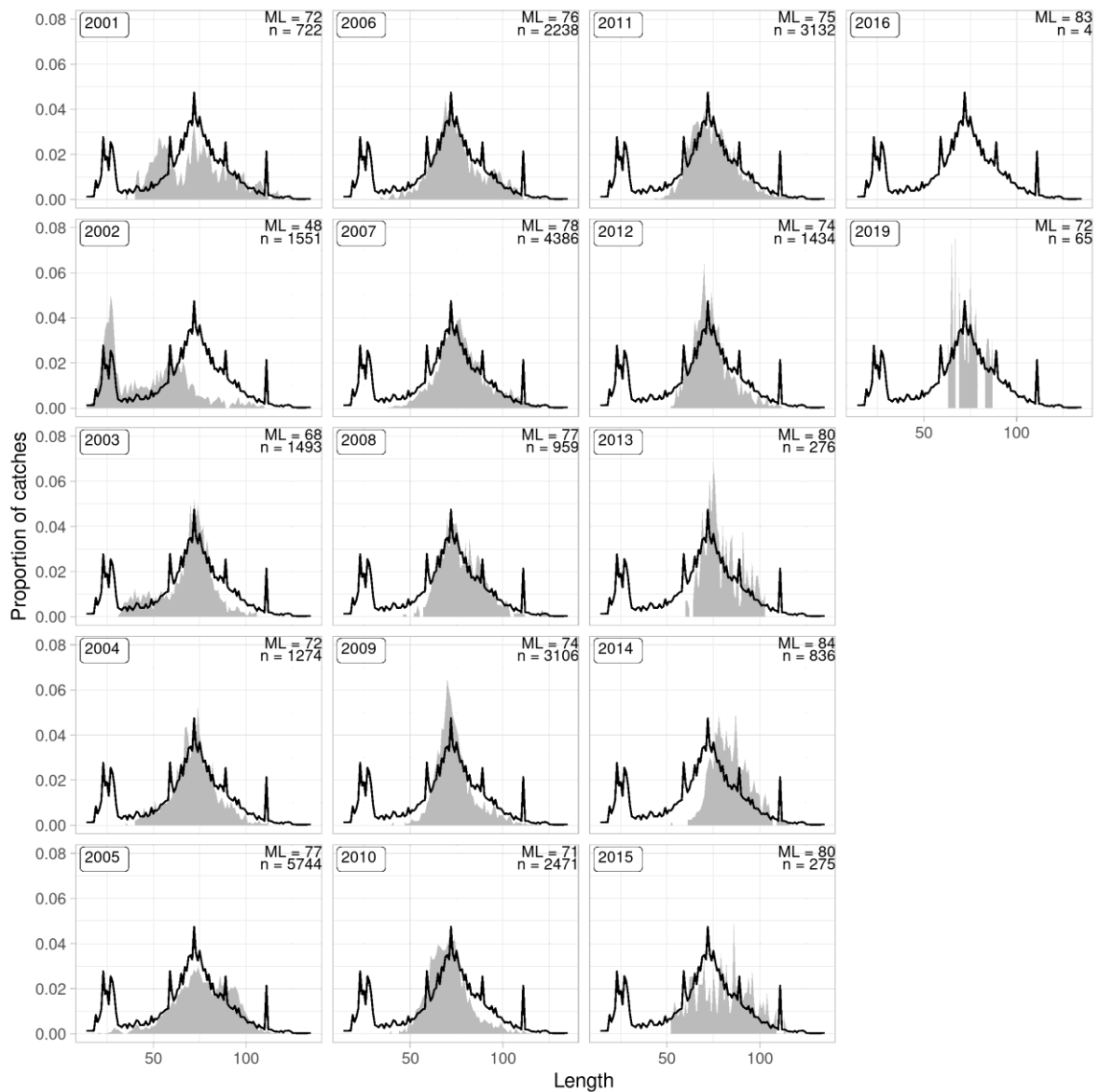


Figure 6. Anglerfish. Relative length distribution from commercial catches from the year 2001 excluding 2017-2018 and 2020-2022 due to lack of data.

SURVEY DATA

The annual Iceland spring groundfish survey (hereafter spring survey) has been conducted in March since 1985 and covers the whole Icelandic anglerfish distribution area. An additional autumn groundfish survey (hereafter autumn survey) has been conducted annually from 1996 but does not represent the anglerfish distribution and abundance as well as the spring survey. The autumn survey was not conducted in 2011.

In the surveys, harvestable biomass index is calculated as total biomass of individuals 40 cm and larger. From 1998 to 2005 the harvestable biomass index increased rapidly and remained high until 2011, followed by a sharp decline in the next five years. 2016-2019, the harvestable biomass index was relatively stable but decreased rapidly but with a small increase this year (Figure 7). The recruitment index estimated as abundance ≤ 40 cm, shows a dramatic increase, starting in 1997-1998, but a reduction in recruitment from 2008. Recruitment has since 2010 remained low (Figure 7). These changes resulted in a change in relative length distribution towards smaller mean length in 1995-2010 and larger individuals after that due to a lack of recruitment (Figure 10).

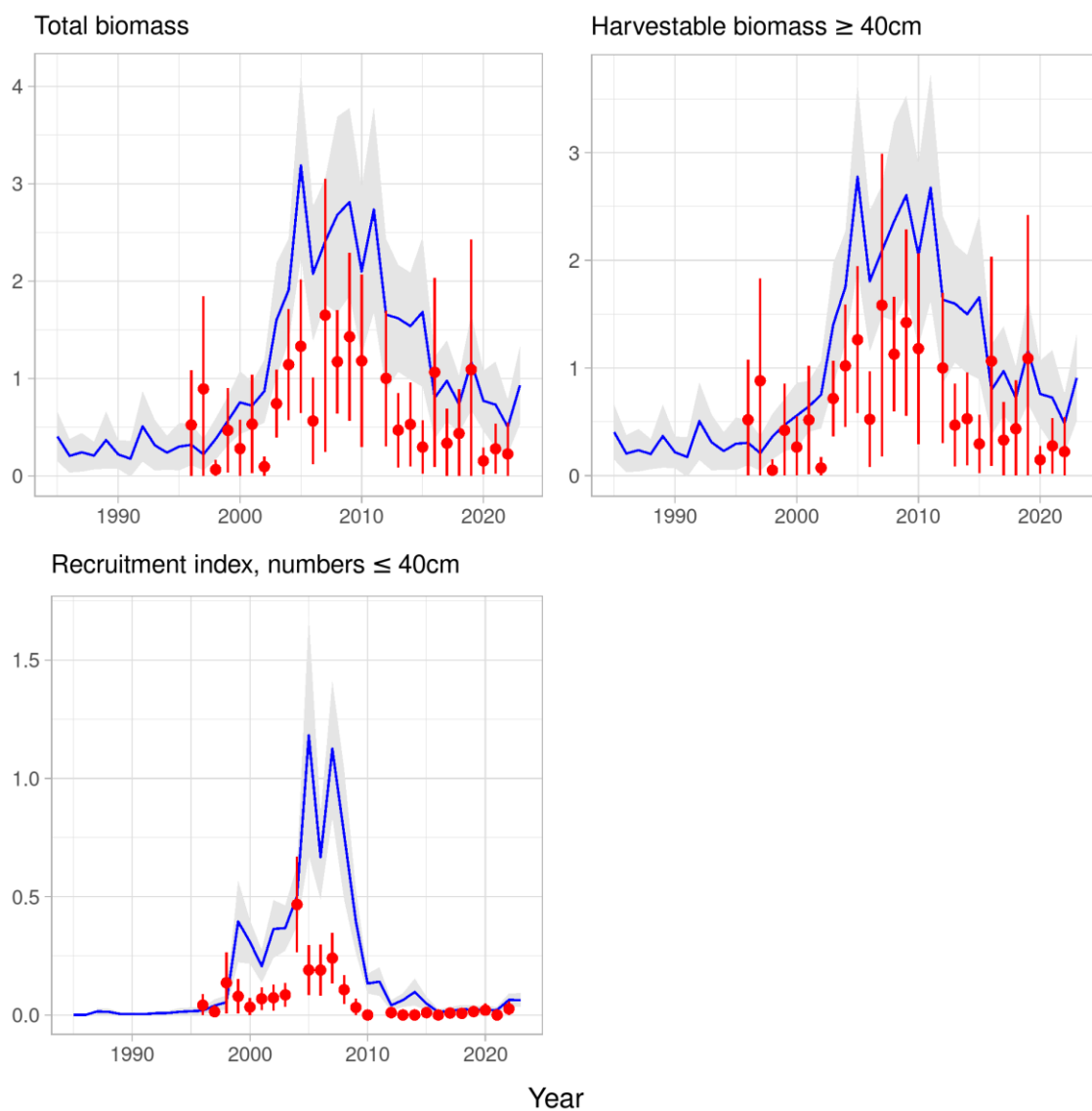


Figure 7. Anglerfish, Total survey biomass index, harvestable biomass index (≥ 40 cm) and juvenile abundance index (≤ 40 cm). Blue lines indicate spring survey and red dots indicate autumn survey. Shaded areas and error bars indicate 95% CI.

Anglerfish is caught in the spring survey mainly to the southeast, southwest, and west of Iceland (Figures 8 and 9). The cold waters northeast and east of Iceland are almost completely void of anglerfish. Monkfish in the northeast are usually caught in the southernmost part. Until 1999, anglerfish was caught almost exclusively south of Iceland after which it was captured in greater numbers in the west and northwest. Since 2016-2017, the relative abundance has decreased in the northwest and west (Figure 9).

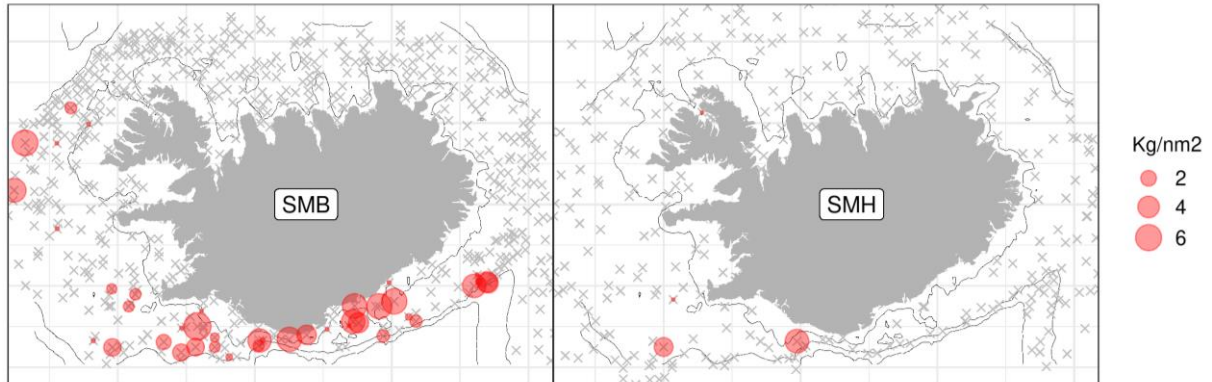


Figure 8. Anglerfish. Spatial distribution in the spring survey in 2023 and the autumn survey in 2022.

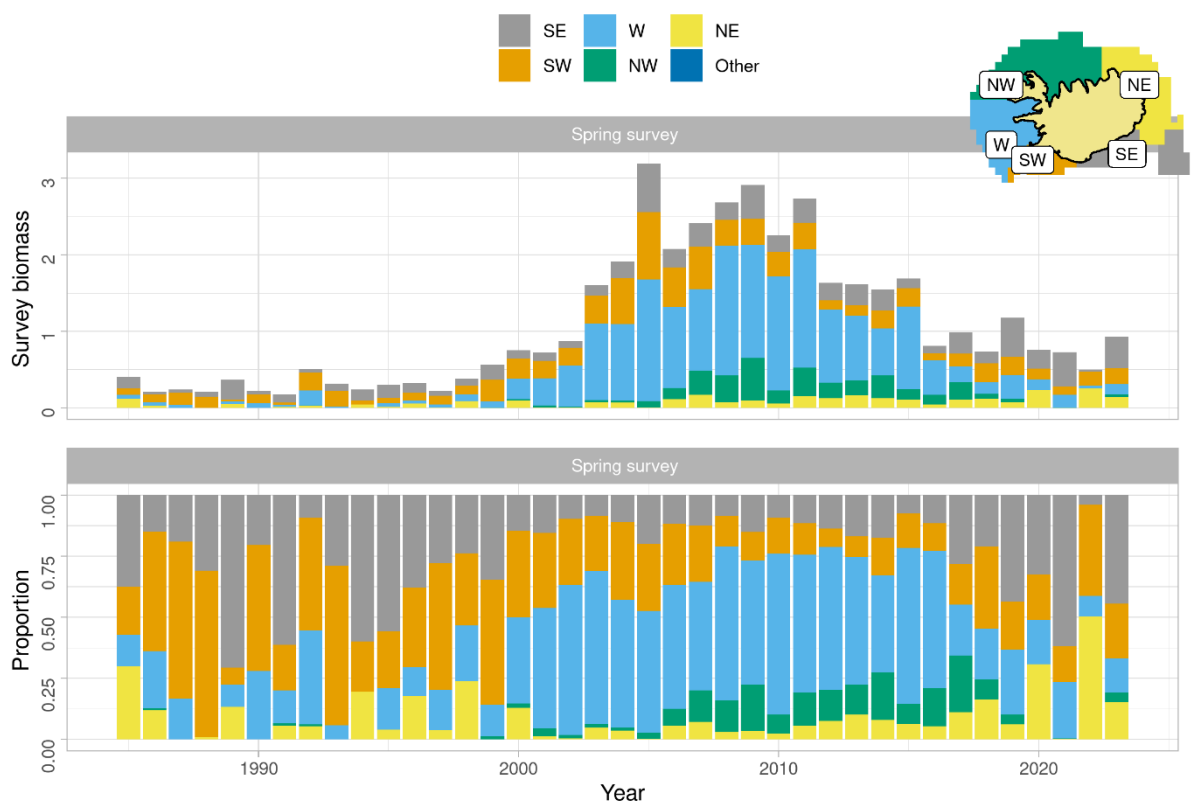


Figure 9. Anglerfish. Spatial distribution of biomass index from the spring survey since 1985.

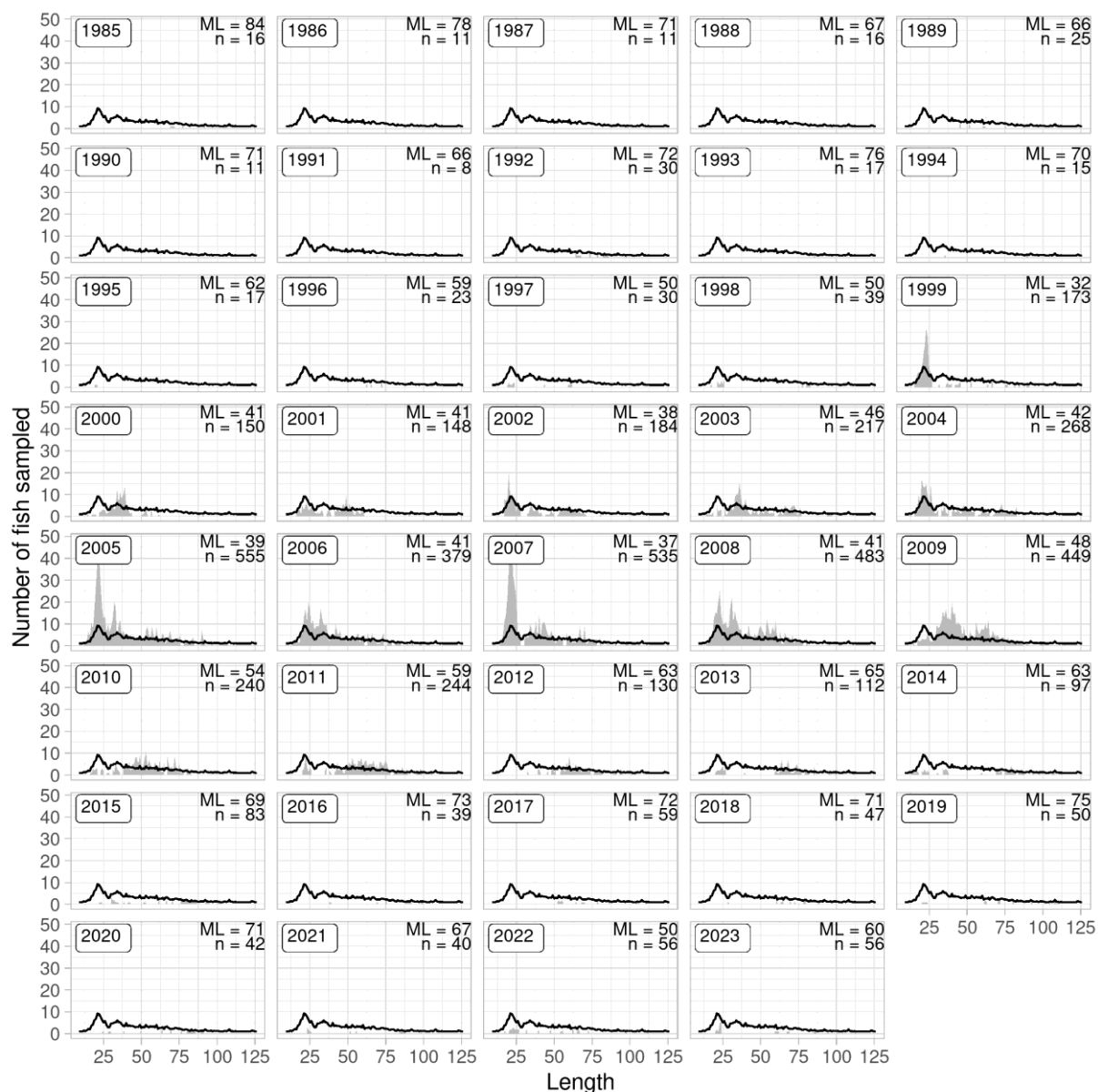


Figure 10. Anglerfish. Length distribution in the spring survey since 1985. The line shows the mean for all years.

In the autumn survey anglerfish is mainly caught south of Iceland (Figures 8). Relative abundance in the NW area was usually high in 2005-2017, in accordance with the spring survey (Figure 11).

Since 2017, a beam trawl survey has been conducted annually to improve the plaice and dab assessment (Figure 12). A 4-m beam trawl is used at depths of <50 m around the country, apart from the northeast in 2017. As in both the spring and autumn surveys, monkfish distribution is mostly limited to the south of Iceland (Figure 12 and 13). The length distribution, however, was rather evenly distributed in 2017-2018, rather low catches in 2019-2020 but an increase in both number of juveniles and total number in 2021 (Figure 14).

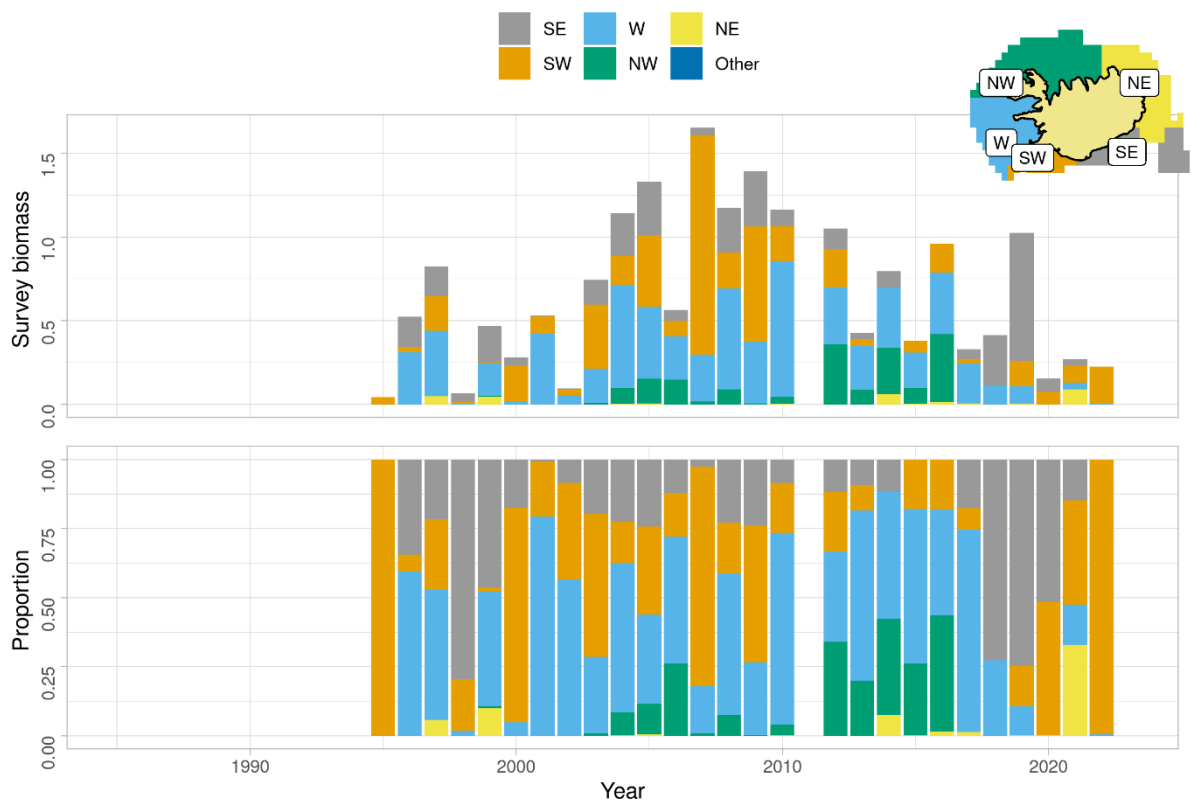


Figure 11. Anglerfish. Spatial distribution of biomass index from the autumn survey since 1996. The survey was not conducted in 2011.

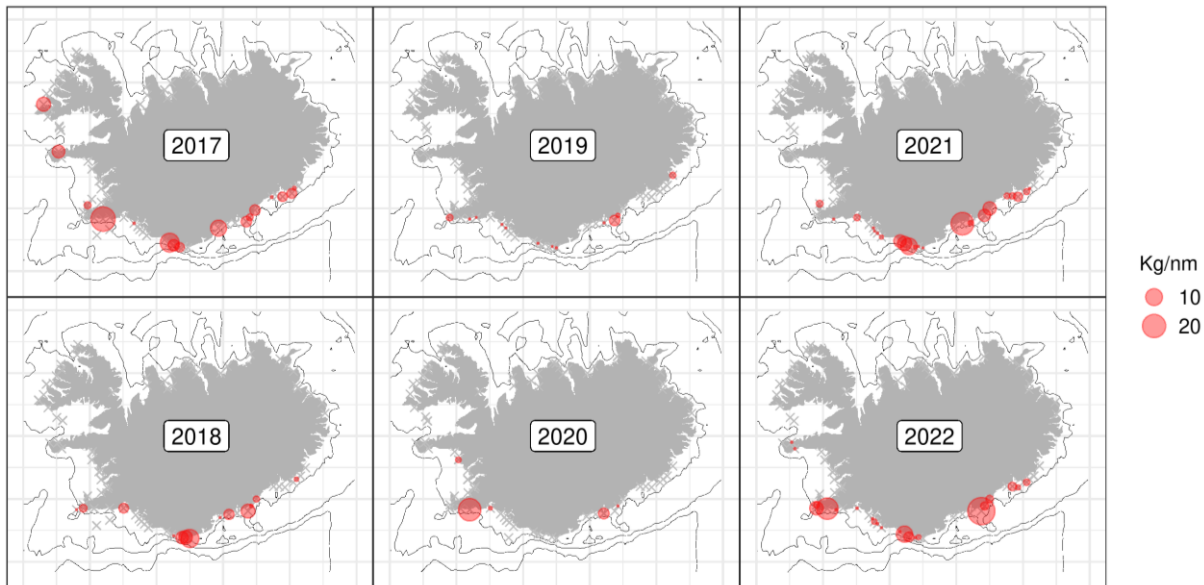


Figure 12. Anglerfish. Spatial distribution in the beam trawl survey 2017-2022. The northeast was not surveyed in 2017.

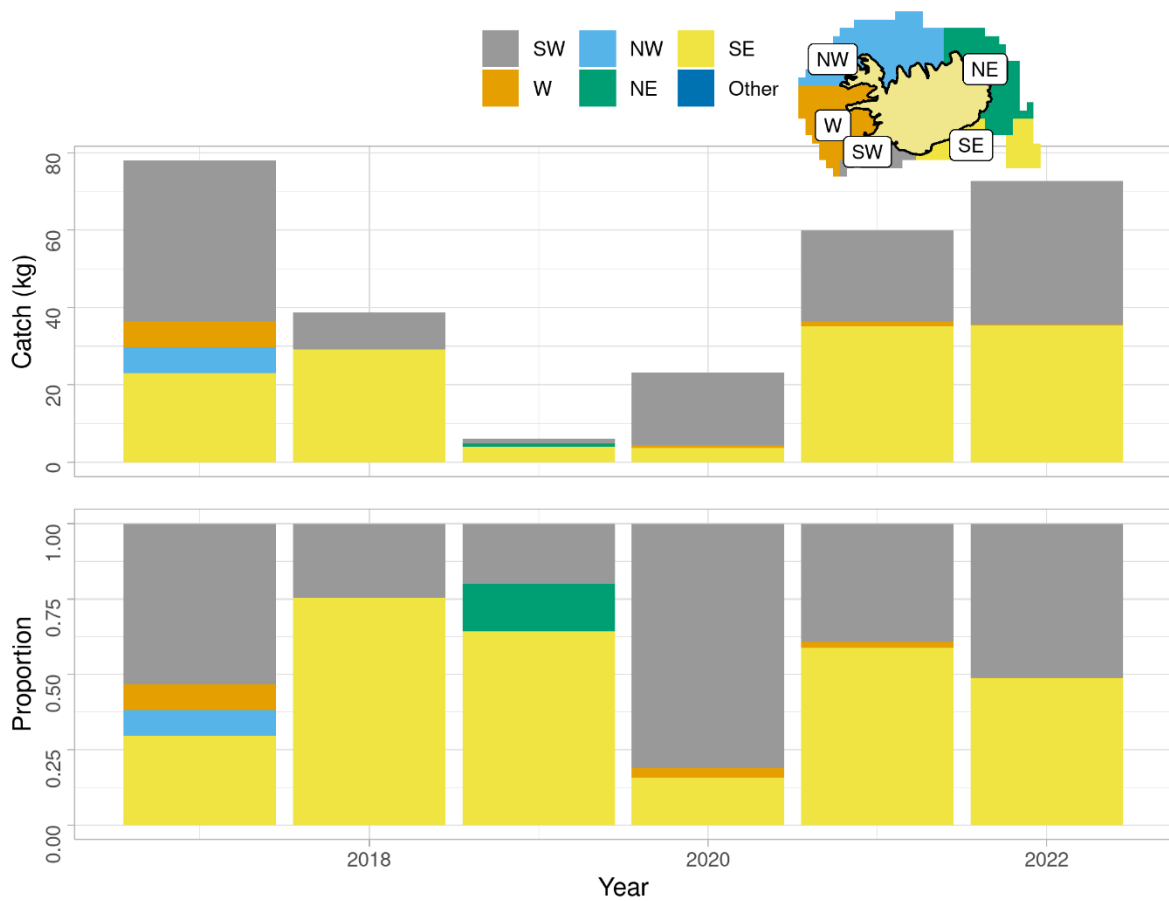


Figure 13. Anglerfish. Spatial distribution of biomass index from the beam trawl survey 2017-2022.

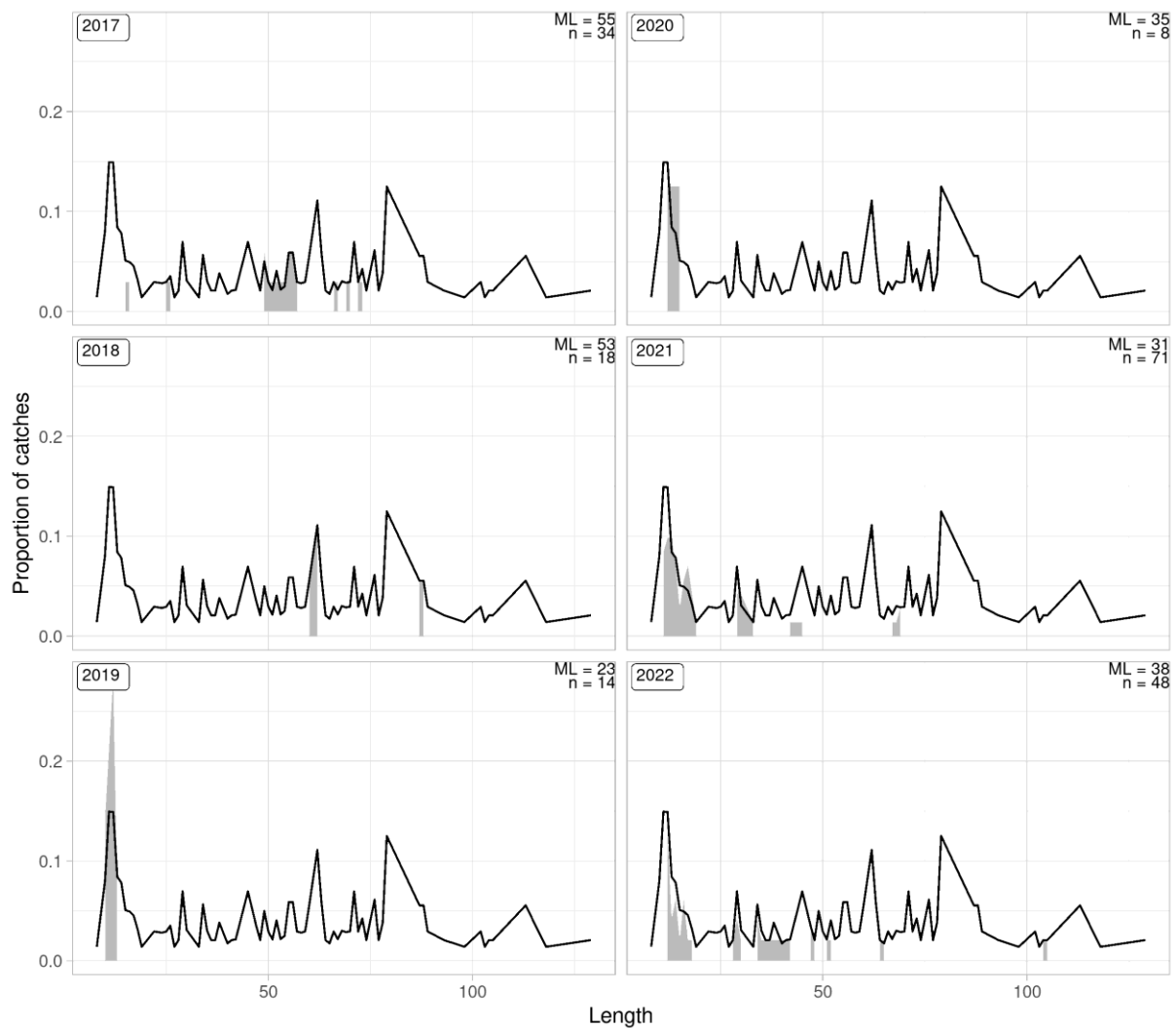


Figure 14. Anglerfish. Length distribution in the beam trawl survey 2017-2022.

STOCK ASSESSMENT

COMMENTS ON THE ASSESSMENT AND ADVICE

The assessment is based on ICES *rfb*-rule for data limited stocks for the first time in 2022, 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 15), 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 $I_{trigger} = i_{loss\omega}$

m is a multiplier based on stock growth. K for anglerfish is <0.2 and therefore m is 0.95 .

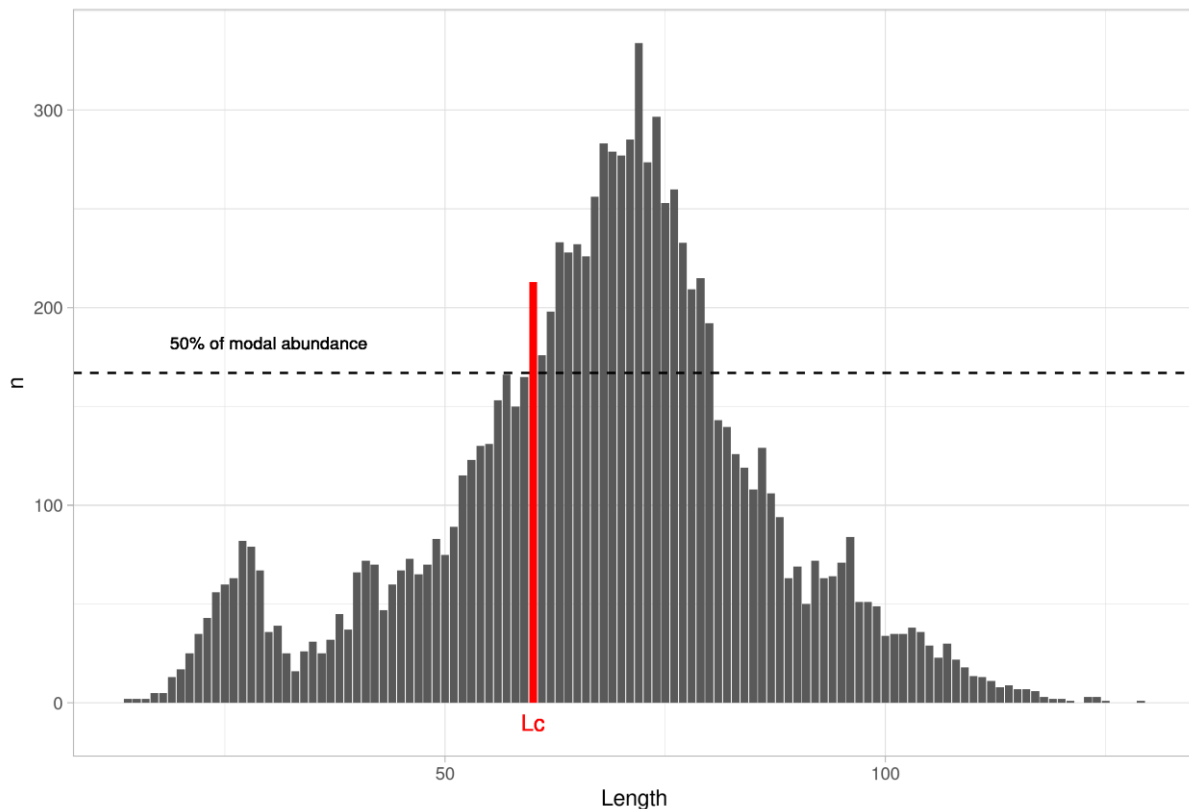


Figure 15. Anglerfish. Length frequency distribution from catches. Red line is the length at first capture.

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 anglerfish 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 $258 \text{ t} * 0.788 * 0.99 * 1 * 0.95$ which result in advice for 2023/2024 set at 191 t (26% reduction 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. Anglerfish. Comparison between the *rfb*-rule and the “2 over 3” rule.

	<i>rfb</i> -rule	Old 2-over-3 rule
Previous advice	258	258
Index A	695	695
Index B	882	882
Ratio (A/B)	0.788	0.788
Length ratio	0.99	-
Biomass safeguard	1	-
Multiplier	0.95	-
Initial advice	191	203
Stability clause applied	-	0.8
Precautionary buffer*	-	-
Final advice	191	207
Advice change	-26	-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 $r=0.833$ (Figure 16, Table 2)

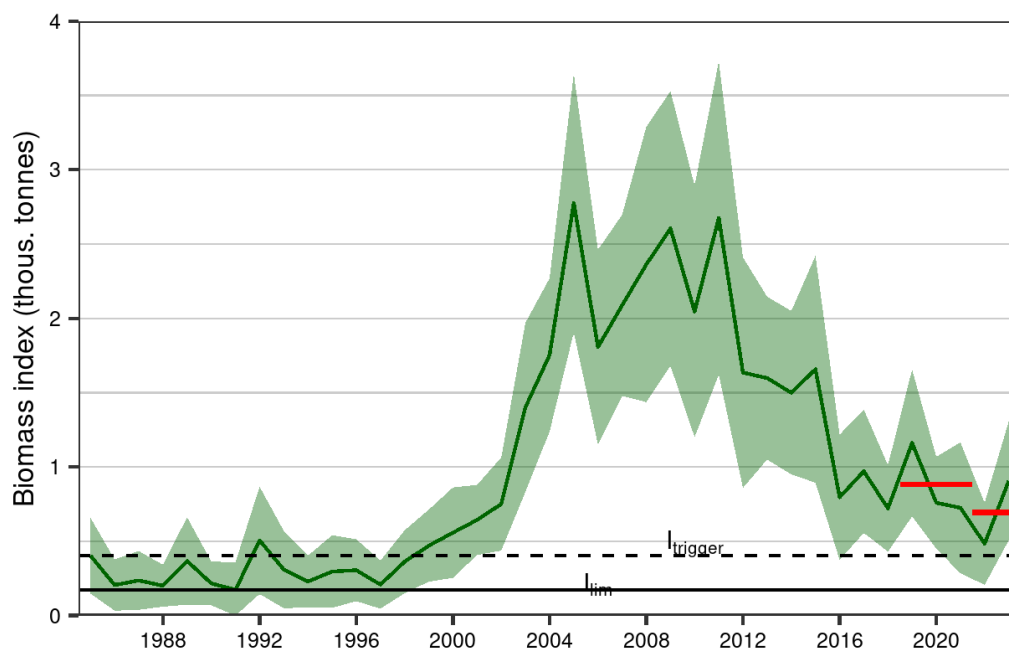


Figure 16. Anglerfish. Biomass index since 1985. The red lines show the average of last two years values and the three preceding years used to calculate *r*.

- *f* is the length-ratio component. The mean length from catches 2019, the last year that length was measured from catches, was 74.22 cm and the target reference length (L_C , the length where frequency is half that of the modal value $* 0.75 + L_{\infty} * 0.25$) is **75** (Figure 17).

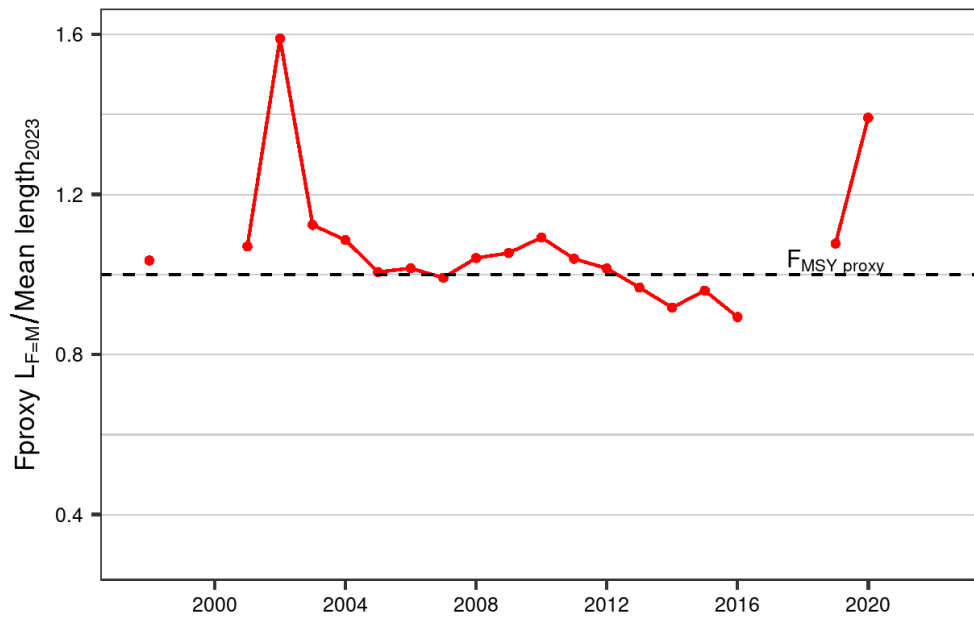


Figure 17. Anglerfish. Annual Fproxy for years for which sufficient data was available. .

- b is the biomass safeguard and is used to reduce catch advice when index falls below trigger. I_{loss} for anglerfish is 287 and was based on biomass indices in the years 1985-1999. $I_{trigger}$ is $I_{loss} * 1.4$ or 402. The biomass index this year is 907, 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 to 0.95 (Figure 19).

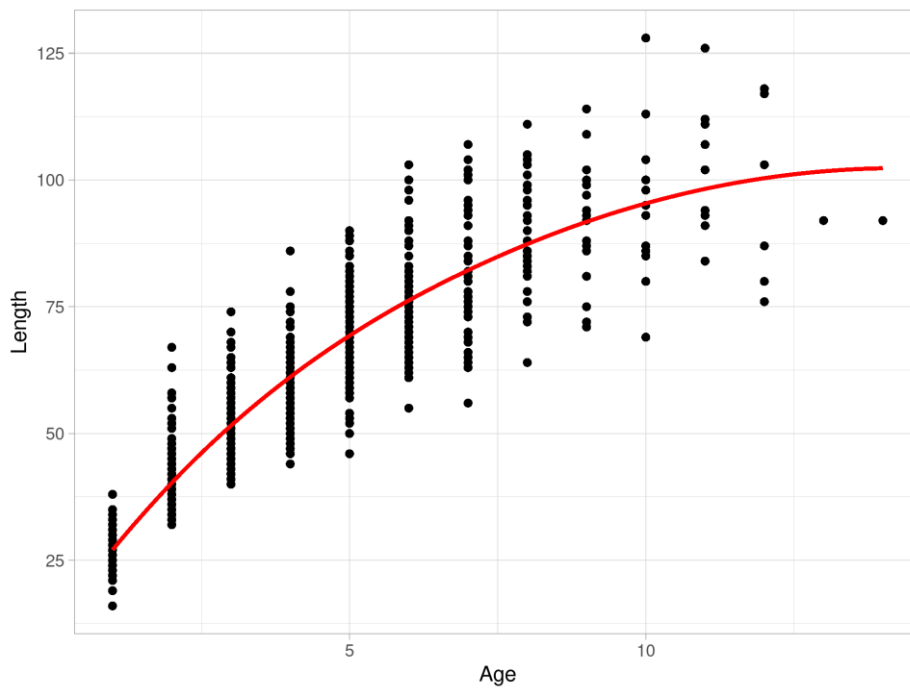


Figure 18. Anglerfish. The von Bertalanffy growth curve (red line) fitted to age and length data for anglerfish age read in the years 2000-2003. K for anglerfish according to available data is 0.16.

MANAGEMENT

The Ministry of Industries and Innovation is responsible for management of the Icelandic fisheries and implementation of legislation. Anglerfish has been subject to TAC limitations from the 2001/2002 quota year. From the quota year 2003/2004 to 2012/2013, TAC limitations were set higher than recommended by the Marine Research Institute and, additionally, catches were sometimes higher than the TAC. Since 2015/2016 however, catches were 5-9% lower than the set TAC until 2017/2018 when they were 23% lower (Table 4). In the last fishing year, less than 50% of the set TAC was caught (Table 4).

Figure 20 shows the net transfer of quota to and from anglerfish in the Icelandic ITQ system. During years with high catches, quota from other species was transferred to anglerfish. Since the population started declining, anglerfish quota has been transferred to other species, which amounted up to 13% in the quota years 2010/2011 to 2020/2021 and 22% in the last fishing year. Transfer of anglerfish quota to the next fishing year has usually been under 13% but exceeded 30% in the most recent fishing year (Figure 19).

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

Fishing year	Rec. Tac	National TAC	Catch
2001/02	-	1500	1001
2002/03	-	1500	1363
2003/04	1500	2000	1903
2004/05	1500	2000	2420
2005/06	2200	3000	2832
2006/07	2200	3000	2672
2007/08	2200	2500	2962
2008/09	2500	3000	3436
2009/10	2500	3200	3598
2010/11	2500	3000	3376
2011/12	2500	2850	3006
2012/13	1500	1800	1930
2013/14	1500	1500	1398
2014/15	1000	1000	1080
2015/16	1000	1000	913
2016/17	711	711	677
2017/18	853	853	653
2018/19	722	722	565
2019/20	441	441	429
2020/21	503	503	437
2021/22	402	402	199
2022/23	258	258	

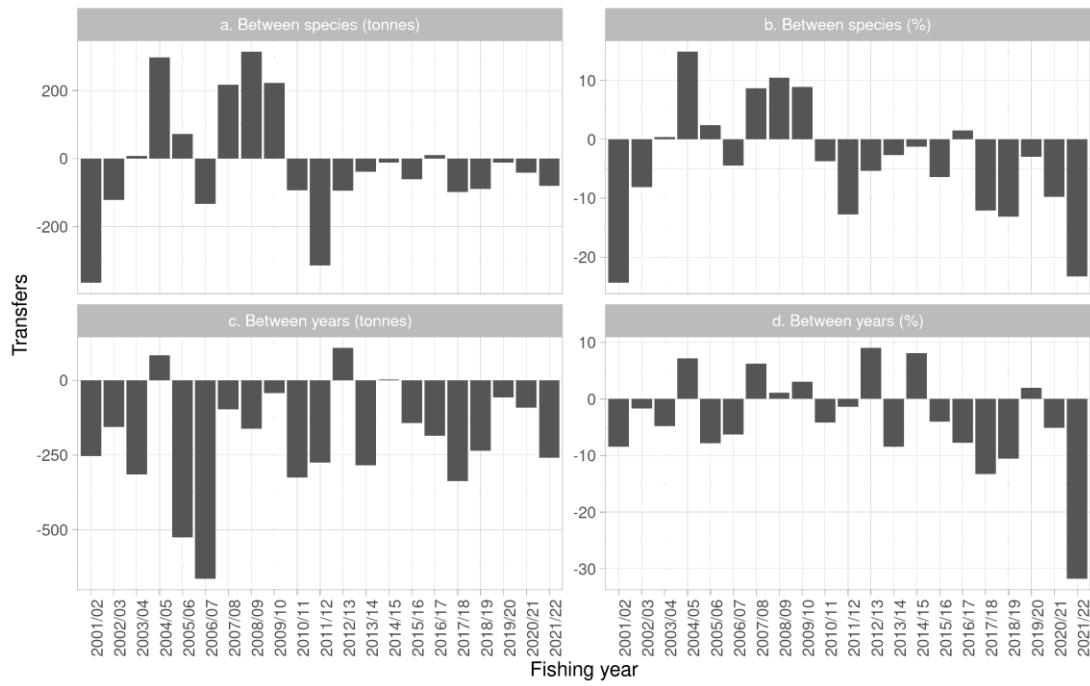


Figure 19. Anglerfish. Net transfers of quota in the Icelandic ITQ system by quota year. Between species (upper): Positive values indicate a net transfer of other species’ quota to anglerfish, but negative values indicate a net transfer of anglerfish quota to other species. Between years (lower): Net transfer of quota in a given quota year.

REFERENCES

ICES. 2021. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports. Report <https://doi.org/10.17895/ices.pub.5985>