ATLANTIC WOLFFISH – STEINBÍTUR
Anarhichas lupus

GENERAL INFORMATION

Atlantic wolffish is an oblong grey fish with large teeth and 10-12 stripes on each side. In the catch, common length range is 50-80 cm, but the largest one caught around Iceland was 125 cm. Atlantic wolffish is mainly found in the northwest part of the continental shelf of Iceland. At Atlantic wolffish feeding grounds, the substrate is commonly sand or clay at depth less than 100 m, but in its spawning grounds the substrate is usually coarser, with holes and crevices at depth below 100 meters.

THE FISHERY

The main fishing grounds for Atlantic wolffish are in the west and northwest part of the Icelandic shelf. From 2009, the proportion of the catch has been increasing northwest of Iceland compared to west of Iceland (Figure 1 and 2).

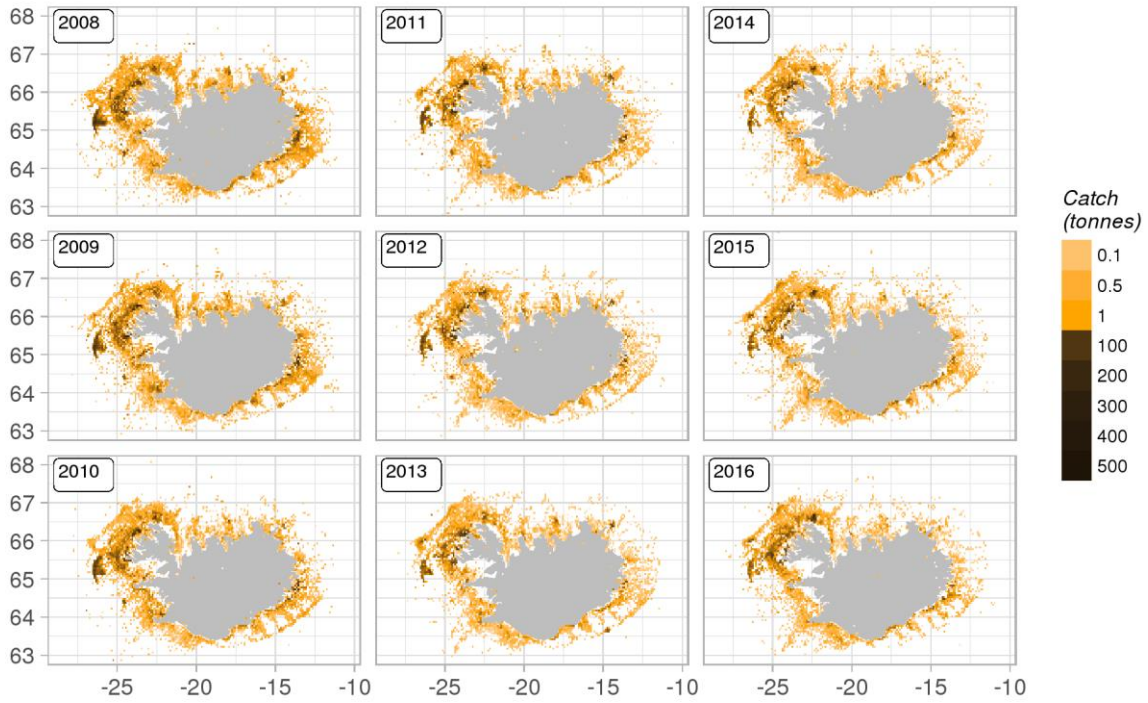

Figure 1. Atlantic wolffish. Geographical distribution of the Icelandic fishery since 2008. Reported catch from logbooks.
Mynd 1. Steinbítur. Útbreiðsla veiða á Íslandsmiðum frá 2008 samkvæmt afladagbókum.

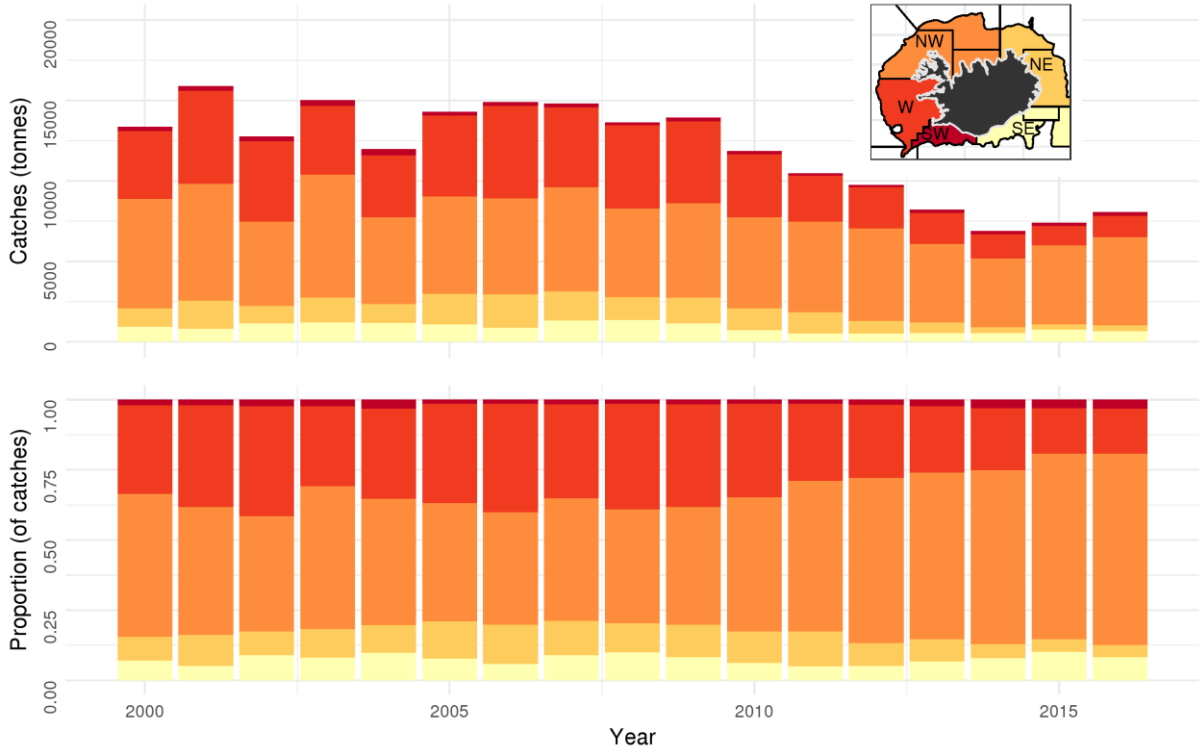

Figure 2. Atlantic wolffish. Spatial distribution of the Icelandic fishery by fishing area from 2000-2016. All gears combined.
Mynd 2. Steinbítur. Útbreiðsla veiða við Ísland árin 2000-2016. Öll veiðarfæri samanlagt.

About 80% of the catch of Atlantic wolffish is caught at depth less than 120 m. Portion of the catch at depth range 0-60 m decreased from 2003 to 2007 but since then it has been increasing. At the range 61-120 the portion of the catch has been rather stable in the years 2000-2016, at the range 121-180 m it increased from the year 2003 to 2008 since then it has generally been decreasing. At more than 180 m depth the portion of the catch was similar except in the year 2011 were it increased, but it went to a similar level the year after (Figure 3).

Most of the Atlantic wolfish landings is caught in longline fisheries (50-65%), demersal trawl (20-30%) and demersal seine (about 10%), of the total catch more than 97 % are caught by these three gear types (Figure 4). This proportion has been relatively stable through the years. However, in 2004-2008 catches in longline and demersal trawl were similar (40-50%), and for last three years catch in demersal seine has been slightly less than 14% of the total catch (Figure 4).

Since 2001, the number of longliners and trawlers reporting catches of 1000 kg/year or more of Atlantic wolffish has decreased, at the same time total catches have been decreasing. This decrease is most noticeable in the longliners fleet, where the number has dropped from almost 331 vessels in 2001, down to 145 in 2016. The number of trawlers has also decreased from 88 in 2000 to 53 last year (Table 1).

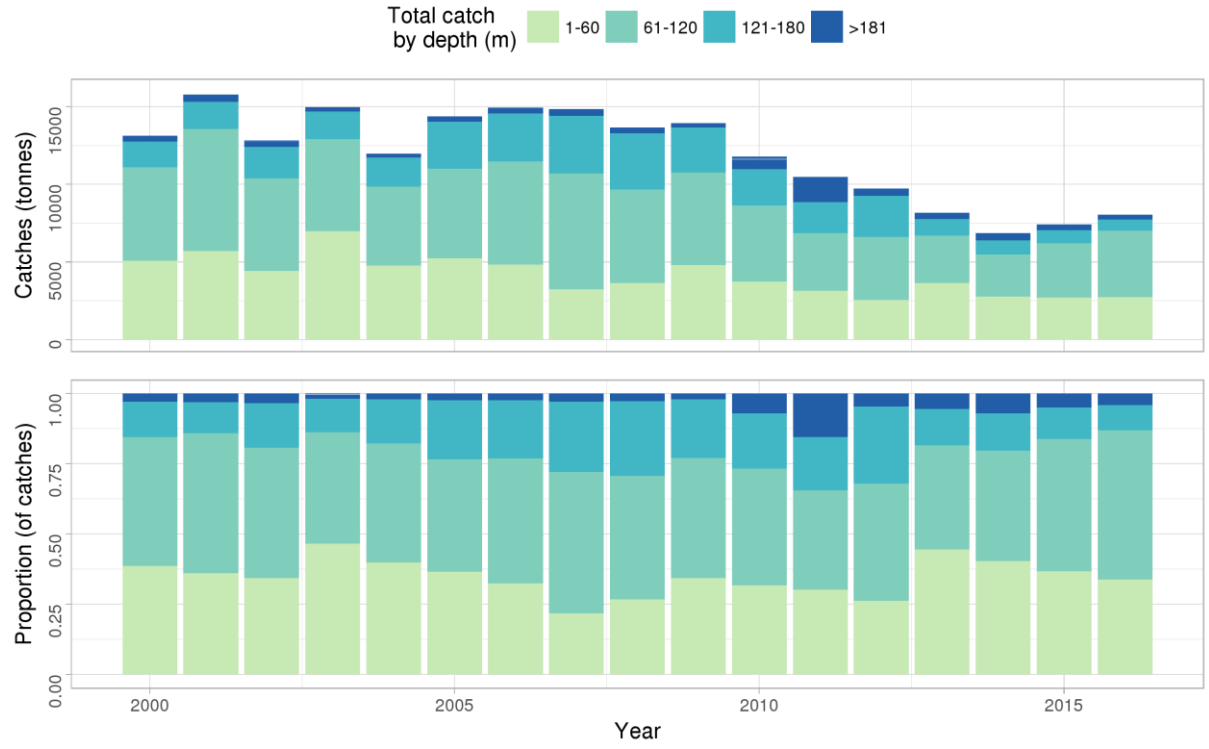

Figure 3. Atlantic wolffish. Depth distribution of demersal trawl, longline and demersal seine catches according to logbooks.
Mynd 3. Steinbítur. Afli í botnvörpu, á línu og dragnót, skipt eftir dýpi, samkvæmt afladagbókum.

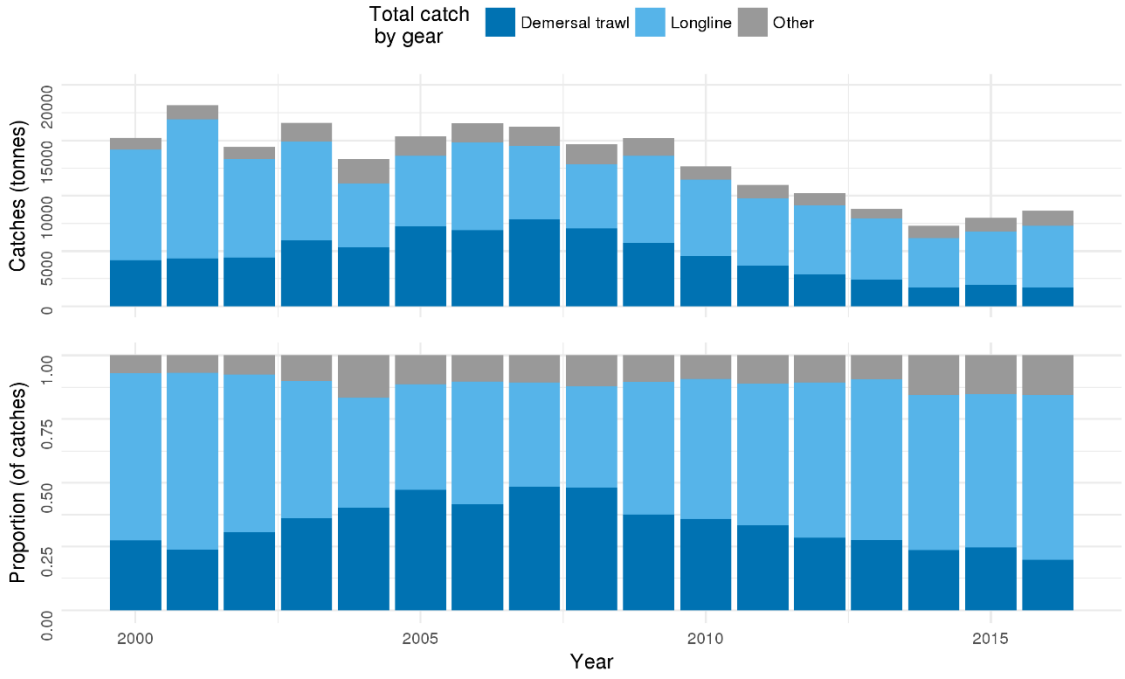

Figure 4. Atlantic wolffish. Total catch (landings) by fishing gear since 2000.
Mynd 4. Steinbítur. Landaður afli eftir veiðarfærum frá 2000.

Table 1. Atlantic wolffish. Number of Icelandic vessels reporting catch of 1000 kg/year or more of Atlantic wolffish, and all landed catch divided by gear type.

Tafla 1. Steinbítur. Fjöldi íslenskra skipa sem veitt hefur 1000 kg eða meira af steinbít yfir árið og allur landaður afli eftir veiðarfærum.

	NUMBER OF VESSELS			CATCHES (TONNES)			
YEAR	*Longliners*	*Trawlers*	*Other*	*Longline*	*Demersal trawl*	*Other*	*Sum*
2000	319	88	41	9979	4173	1075	15227
2001	331	88	58	12595	4319	1256	18170
2002	274	69	45	8897	4423	1104	14424
2003	271	70	69	8943	5960	1665	16568
2004	255	74	78	5746	5349	2226	13321
2005	246	69	76	6370	7247	1729	15346
2006	265	74	73	7962	6885	1713	16560
2007	249	75	58	6655	7857	1722	16234
2008	201	67	71	5810	7026	1794	14630
2009	209	67	69	7896	5709	1605	15210
2010	170	61	61	6923	4531	1208	12662
2011	157	59	55	6094	4062	1235	11391
2012	167	56	57	6209	2910	1095	10214
2013	170	56	51	5537	2424	831	8792
2014	165	49	52	4463	1722	1144	7329
2015	155	52	46	4828	1926	1234	7988
2016	145	53	44	5563	1713	1075	8625

CATCH PER UNIT EFFORT (CPUE) AND EFFORT.

CPUE estimates of Atlantic wolffish 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 longline (kg/1000 hooks), and demersal trawl (kg/towhour), are calculated as the total weight in sets or tows in which Atlantic wolffish was more than 10% of the catch, according to logbooks. Similar effort of demersal trawl was the number tow-hours and for longline number of hooks, in both cases data in which Atlantic wolffish was more than 10% of the catch was used.

CPUE in longline has been similar between years or around 100-140 kg/1000 hooks. CPUE of demersal trawl increased from 2000 (226 kg/h) to 2005 were it reach about 400 kg/h. Therefrom it decreased to the year 2010 (240 kg/h) and since then it has been slightly increasing (Figure 5).

Fishing effort in longline increased from 66 million hooks in 2000 to 97 million in 2001, since then it has been generally decreasing and was in 2016 around 29 million hooks. In demersal trawl fishing effort increased from about 14 thousand tow-hours in 2000 to 23 thousand in 2008, therefrom it decreased considerable and was 4.5 thousand tow-hours in 2016 (Figure 5).

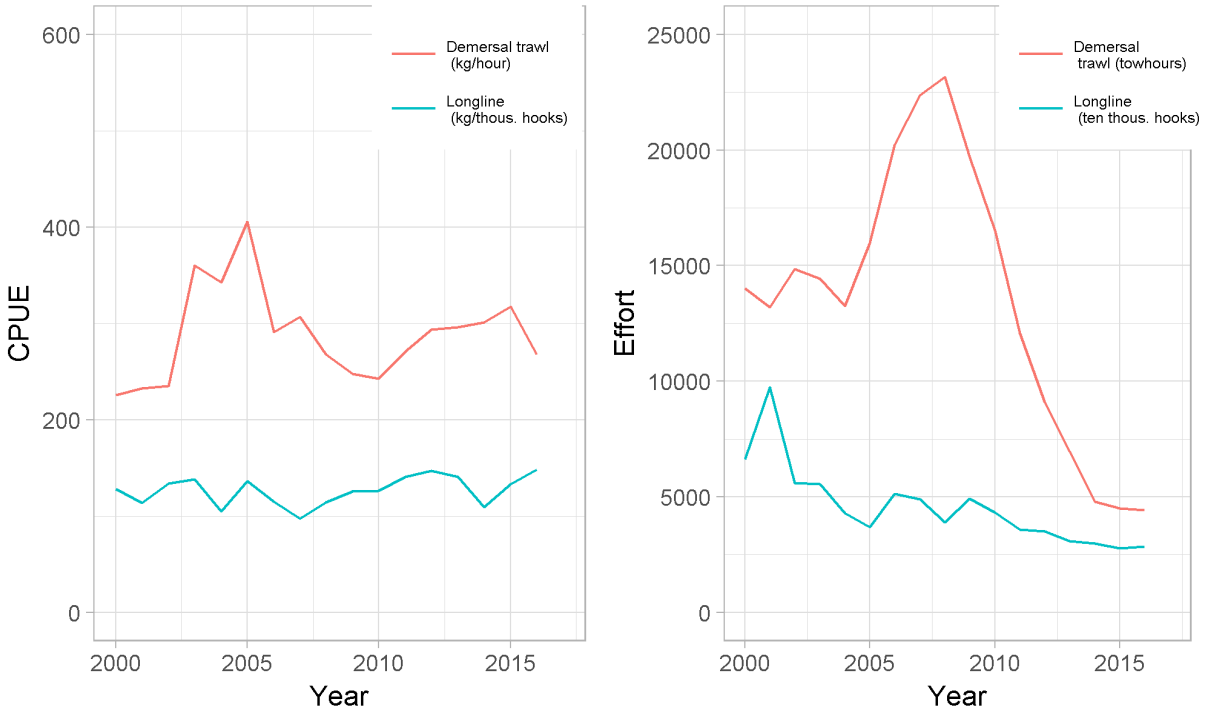

Figure 5. Atlantic wolffish. Non-standardised estimates of CPUE (left) from demersal trawl (kg/h) and longline (kg/(1000 hooks). Fishing effort (right) for longline (10000 hooks) for demersal trawl (tow hours).

Mynd 5. Steinbítur. Afli á sóknareiningu (vinstri) í botnvörpu (kg/togtími) og línu (kg/1000 krókar). Sókn (hægri) í botnvörpu (togtímar) á línu (10000 krókar)

AGE DISTRIBUTION OF LANDED ATLANTIC WOLFFISH

Analysis done in 2013 by the MFRI suggested that excessive amounts of otoliths were being taken from commercial catches of Atlantic wolffish, and as a result the amount of samples taken have been greatly reduced to save time and resources. Before this change, around 2000-2400 otoliths were being sampled yearly, but for last year 1175 otoliths were sampled in 25, 13 and 9 samples from longline, demersal trawl and demersal seine respectively. Samples were not taken from other gear, as they represent a very small proportion (~2%) of the total catch (Table 2, Figure 6).

Table 2.Atlantic wolffish. Number of samples and aged otoliths from landed wolffish catch.
Tafla 2. Steinbítur. Fjöldi sýna og aldursgreindra fiska úr lönduðum steinbítsafla.

Year	***Longline***		***Demersal trawl***		***Demersal seine***	
	Samples	Otoliths	Samples	Otoliths	Samples	Otoliths
2010	29	1669	18	1040	5	285
2011	14	750	15	778	9	550
2012	26	1300	14	700	7	350
2013	25	1249	14	692	5	249
2014	30	800	26	675	28	700
2015	25	625	19	479	19	474
2016	25	625	13	325	9	225

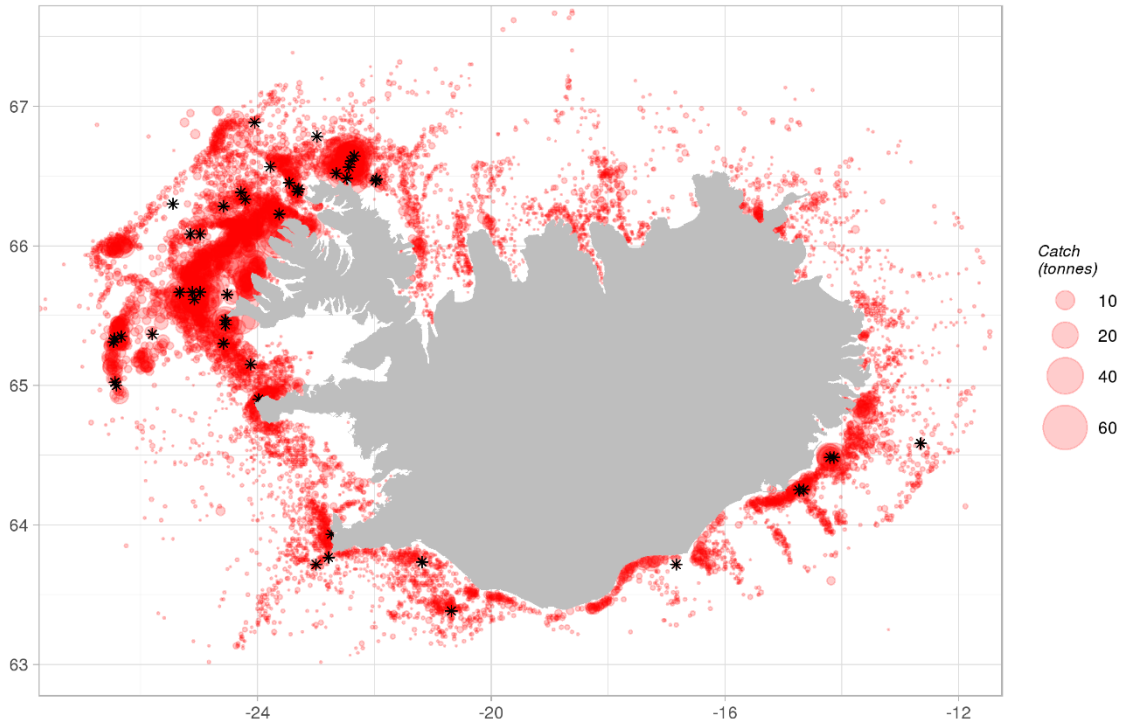

Figure 6. Atlantic wolffish. Geographical distribution of samples in 2016.
Mynd 6. Steinbítur. Svæðin (stjörnur) þar sem sýnin voru tekin úr afla árið 2016.

In samples from commercial landings, the mean age of Atlantic wolffish was around 11 years in 1999-2009, from that time to 2015 it was around 12 years and in 2016 it was 13 years. There are many years' classes in commercial landings, most of them seems to be similar in size (figure 7). The year classes 1989, 1990, 1997 and 2000 seems to be stronger than average and 1991 weaker.

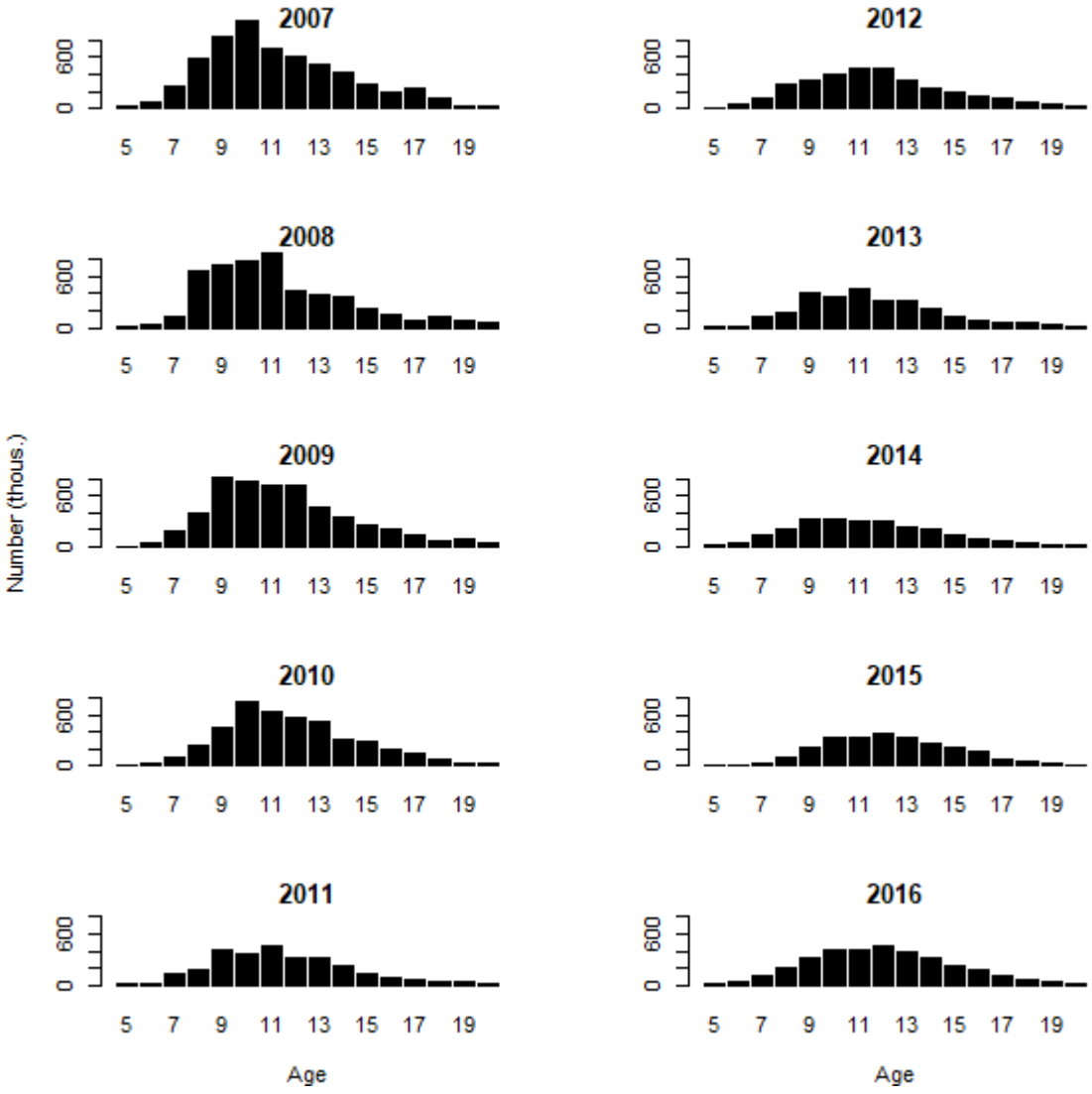

Figure 7. Atlantic wolffish. Estimated age distribution of landed catch based on landings and otoliths collected from landed catch.
Mynd 7. Steinbítur. Áætluð aldursdreifing landaðs afla byggð á aldursgreiningum á fiskum úr afla.

LENGTH DISTRIBUTION OF LANDED ATLANTIC WOLFFISH

The length distribution of landed Atlantic wolffish catch has been relatively stable since 2001 (Figure 8). The average length in the commercial catch was around 70 cm for last 16 years.

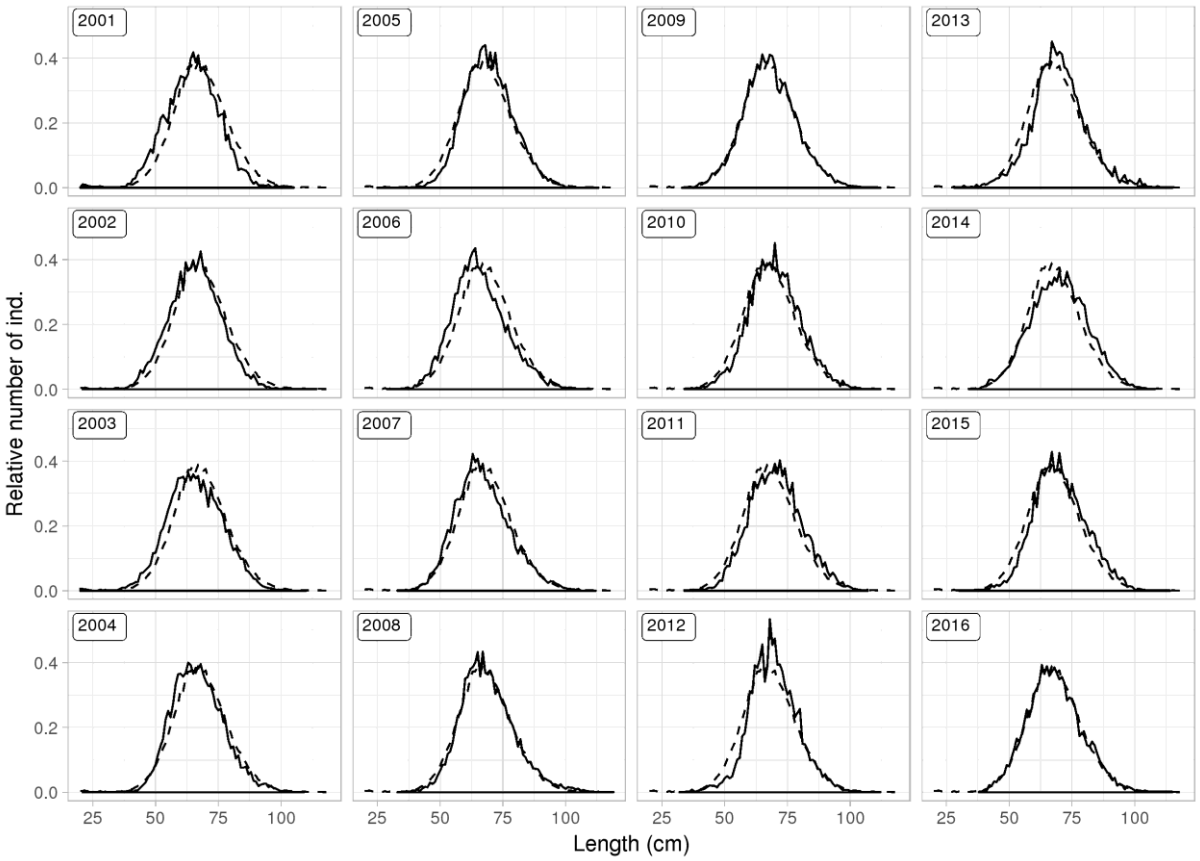

Figure 8. Atlantic wolffish. Length distribution of fish sampled from landed catch. The dotted line represents the mean length for all years.
Mynd 8. Steinbítur. Lengdardreifing aflasýna frá árinu 2001 með meðallengd fyrir öll árin (punktalína).

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 Atlantic wolffish in Icelandic waters. In addition, the Icelandic autumn groundfish survey (hereafter autumn survey, IS-SMH) was commenced in 1996 and expanded in 2000. However, a full autumn survey was not conducted in 2011 due to a labour dispute and therefore the results for 2011 are not presented. The spring survey is considered to measure changes in abundance/biomass better than the autumn survey.

Total biomass and harvestable biomass indices decrease from 1985 to 1995. In 1996 the biomass index increased to 1998 but from that time it decreased to a historical low level in 2010-2012 since then it has been increasing (Figure 9). The harvestable biomass has generally been increasing from 1995 with considerable oscillators. The recruitment index was high in the years 1992-2003, since 1999 it has been decreasing, which coincide with increasing effort and catch of trawlers at its main spawning ground west of Iceland (Látragrunn) during its spawning and incubation time. The recruitment index reached a historical low level in 2011 since then it has been rather stable or increased slightly. Which coincides with that the closed spawning/incubation area on Látragrunn was enlarged from 500 km^2 (from 2002) to 1000 km^2 in 2011.

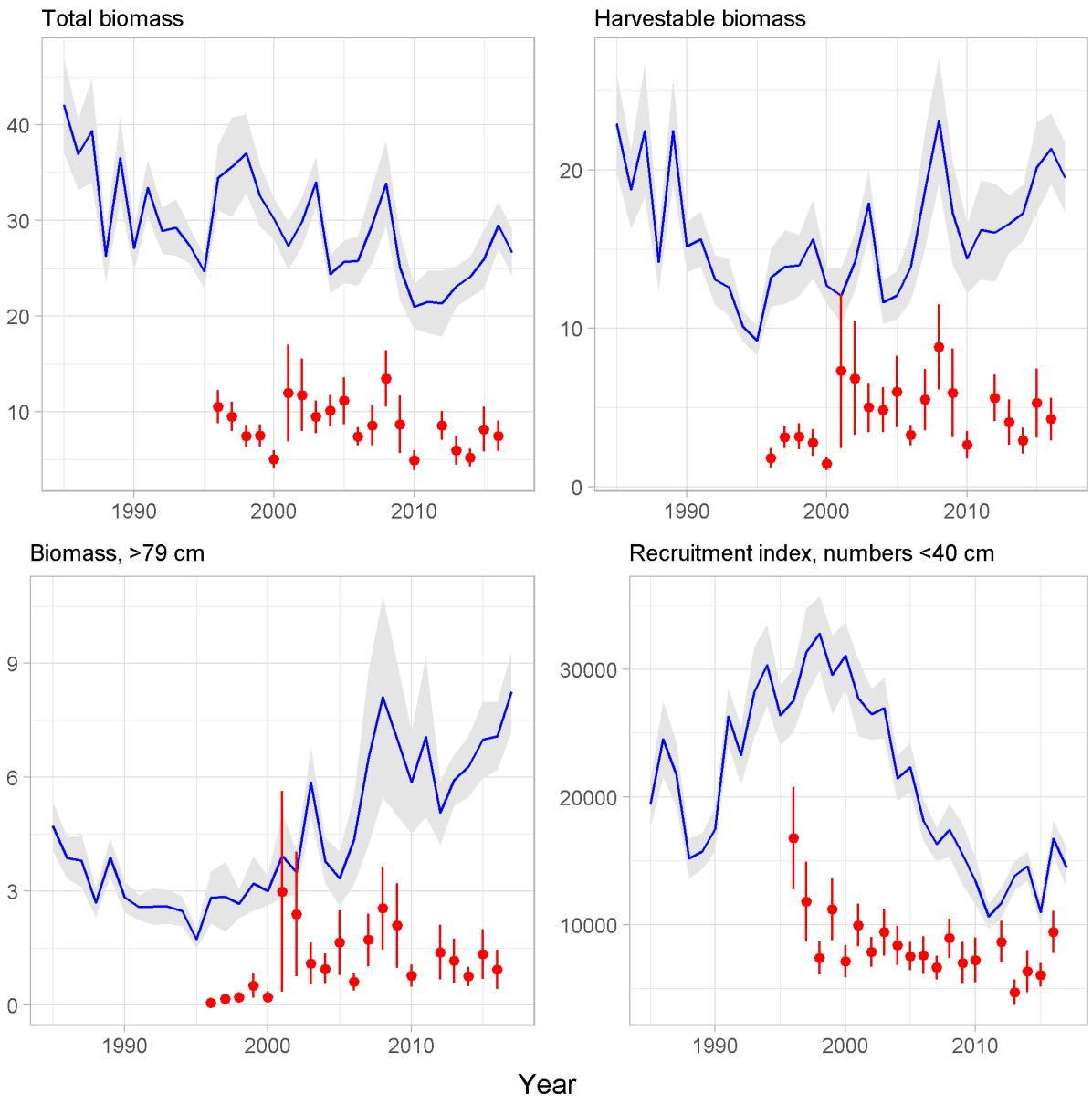

Figure 9. Atlantic wolffish total biomass indices (upper left) and harvestable biomass indices (>60 cm) (upper, left), large fish biomass indices (> 79 cm) (lower left) and juvenile abundance indices (< 40 cm) (lower right), from the spring survey (blue) from 1985 and autumn survey (red) from 1996, along with the standard deviation.

Mynd 9. Stofnvísitala steinbíts (efri til vinstri), vísitala veiðistofns (60 cm og stærri, efri til hægri), vísitala fiska stærri en 79 cm (neðri til vinstri) og nýliðunarvísitala (efri til hægri) úr stofnmælingu botnfiska að vori (blátt) frá árinu 1985 og hausti (rautt) frá árinu 1996, ásamt staðalfráviki.

The length distribution in the spring survey was unimodal and skewed to the right from 1985 to 2007. Since then the shape of the distribution has been bimodal because of more decrease in number in catch of fish at 40-60 cm than other lengths. The mean length of Atlantic wolffish has been similar between years it was however lowest in the years 1994-2004, but in these years the recruitment index was high. During decreasing recruitment index from 2004 the mean length increased and was in the years 2007 to 2017 on the average about 41 cm (Figure 9 and 10). The number of fish caught in spring survey increased from14 thousand in 1988 to 24 thousand in 1996, from then the number was rather stabile to 2003, wherefrom it decreased steadily between years to 2011-2012 were 9 thousand fish were caught. Since then the number has increased a little and in 2017, 11 thousand fish were caught.

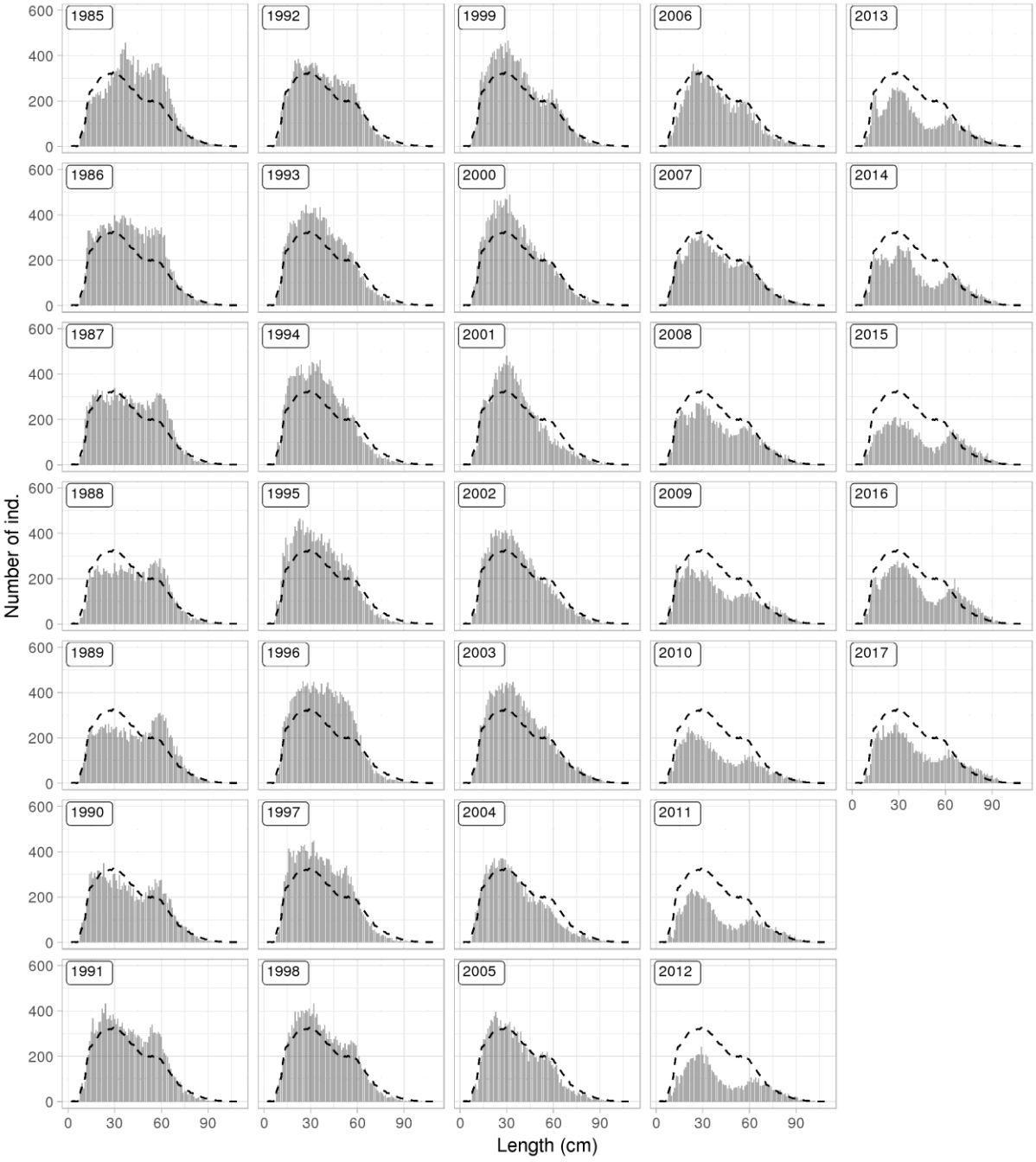

Figure 10. Atlantic wolffish. Length distribution from the spring survey. The dotted line shows mean length for all years combined.

Mynd 10. Steinbítur. Lengdardreifing úr stofnmælingu botnfiska að vori frá 1985 ásamt meðallengd allra ára (punktalína).

In the spring survey, Atlantic wolffish are mainly caught in shallow waters in northwest of Iceland (Figure 11). When the spring survey is conducted the Atlantic wolffish are on its feeding grounds which are commonly in shallow waters. In the spring survey, most of the catch has always been in the north-west area. However, in the years 2010-2012 there was more caught in the west area than usually and in 1995 to 1998 more in north east area than usually (Figure 12).

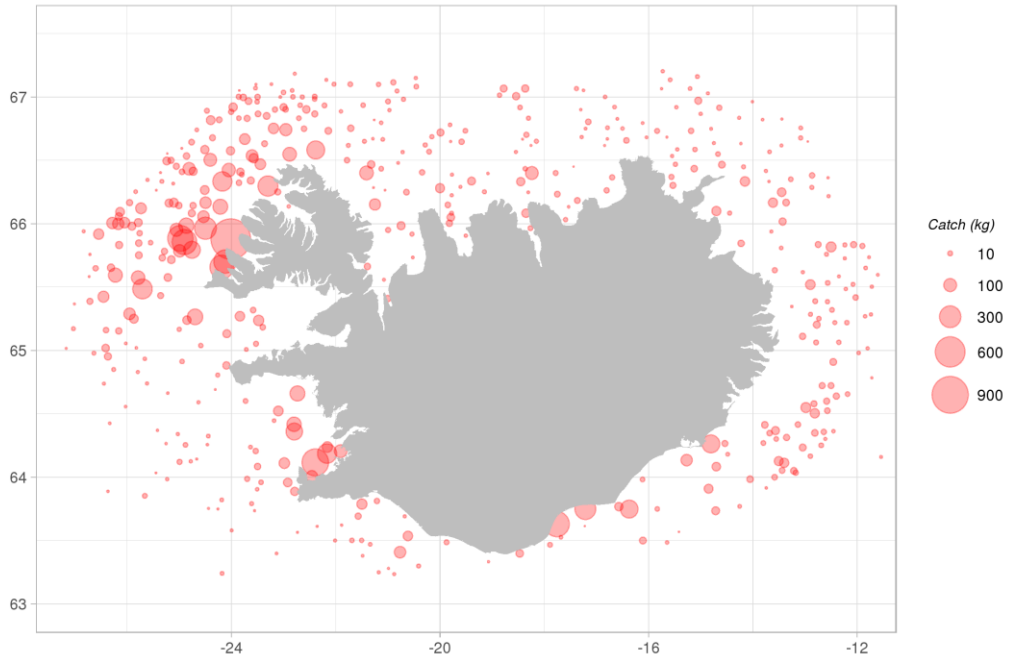

Figure 11. Atlantic wolffish. Spatial distribution in the spring survey in 2017.
Mynd 11. Steinbítur. Útbreiðsla í stofnmælingu botnfiska að vori 2017.

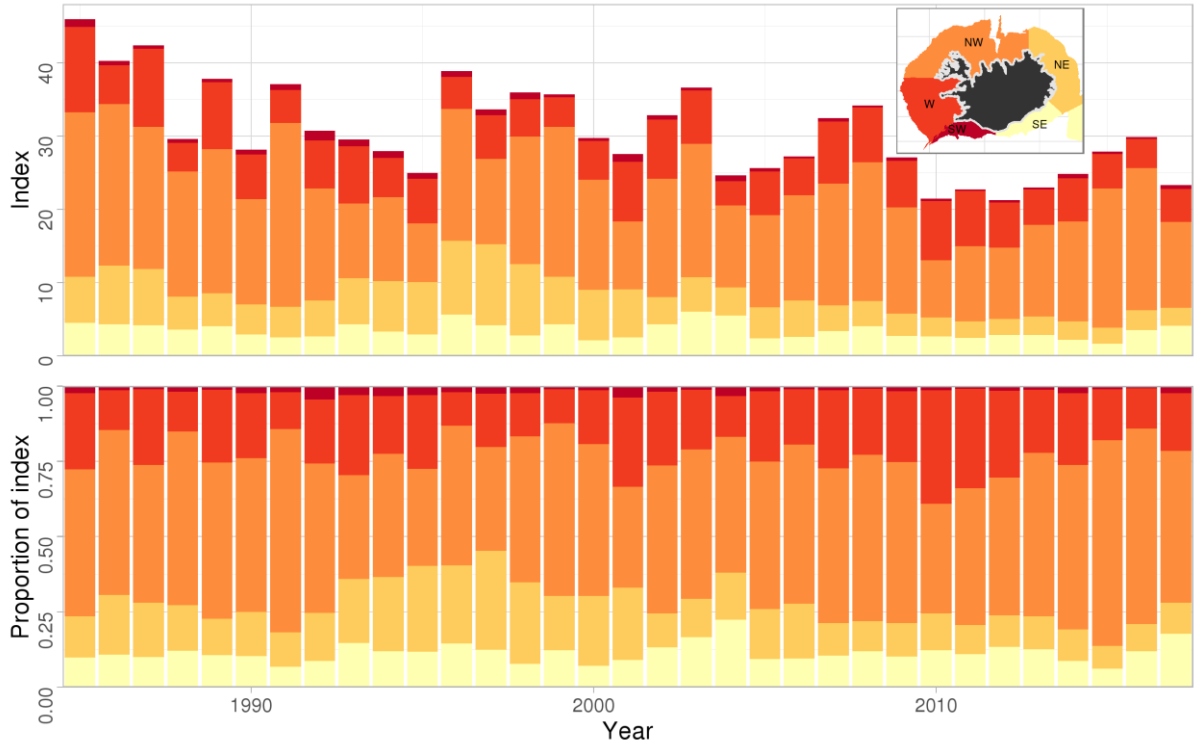

Figure 12. Atlantic wolffish. Spatial distribution of biomass index from the spring survey in 1985-2017.
Mynd 12. Steinbítur. Dreifing lífmassavísitölu í stofnmælingu botnfiska að vori árin 1985-2017.

The mean length in the autumn survey has been oscillating from 34 cm to 40 cm in the years 1996 to 2016 with no trend. The number caught however has similar trend as in spring survey, in 2002 the number was 1578 fishes, wherefrom it decreased almost constantly between years to 2013 were 777 fishes were caught, since then the number has increased and was in 2016 1148 fishes (Figure 13).

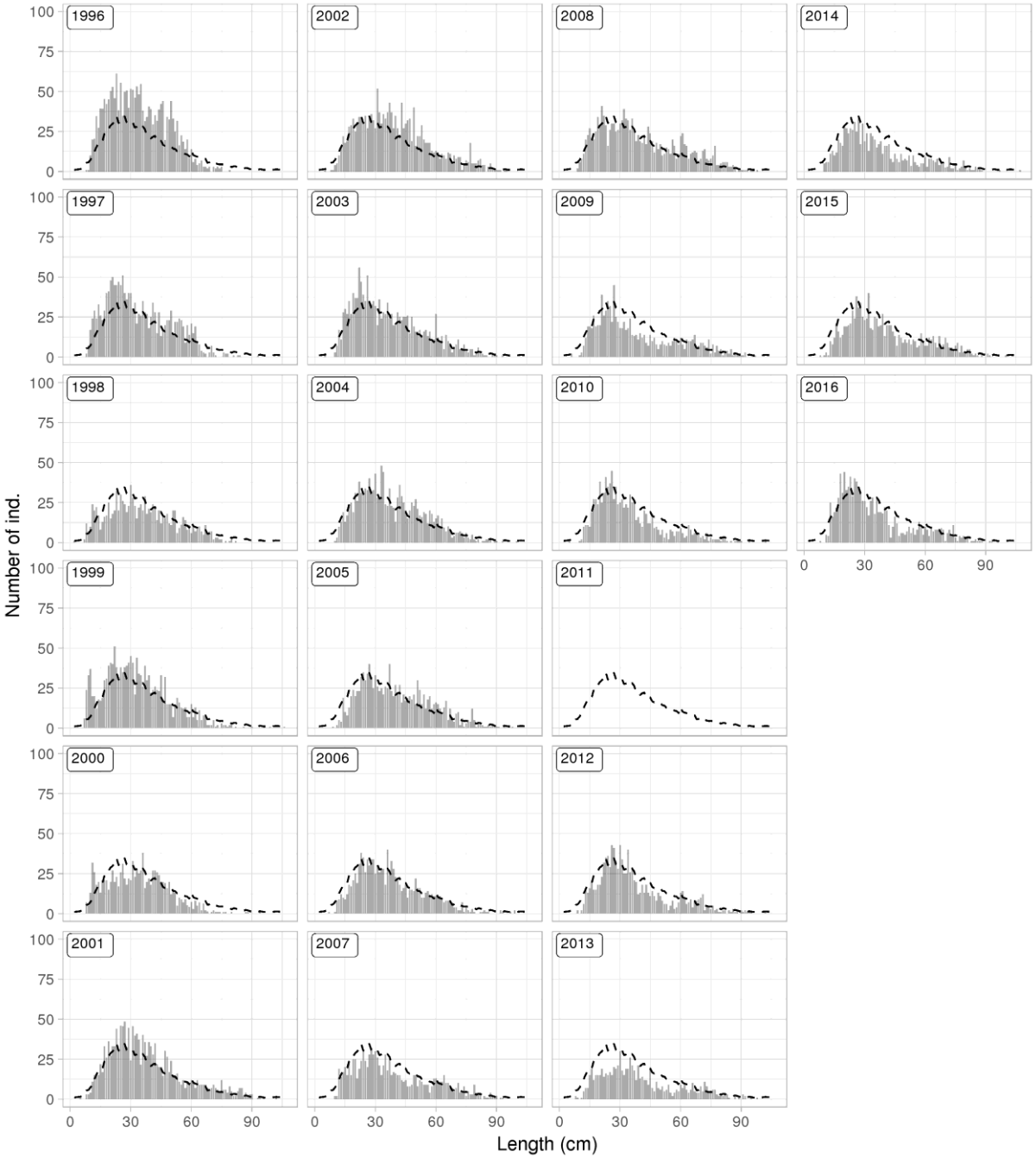

Figure 13. Atlantic wolffish. Length distribution from the autumn survey. The dotted line shows mean length for all years combined.

Mynd 13. Steinbítur. Lengdardreifing úr stofnmælingu botnfiska að hausti frá 1996 ásamt meðallengd allra ára (punktalína).

In the autumn survey, Atlantic wolffish are more often caught in deeper waters than in the spring survey. The autumn survey is conducted when Atlantic wolffish is spawning, and the spawning grounds are usually deeper than the feeding grounds. The west area is the main spawning area of Atlantic wolffish, and from 2000 the highest biomass was measured in the northwest and west areas (Figure 14 and 15).

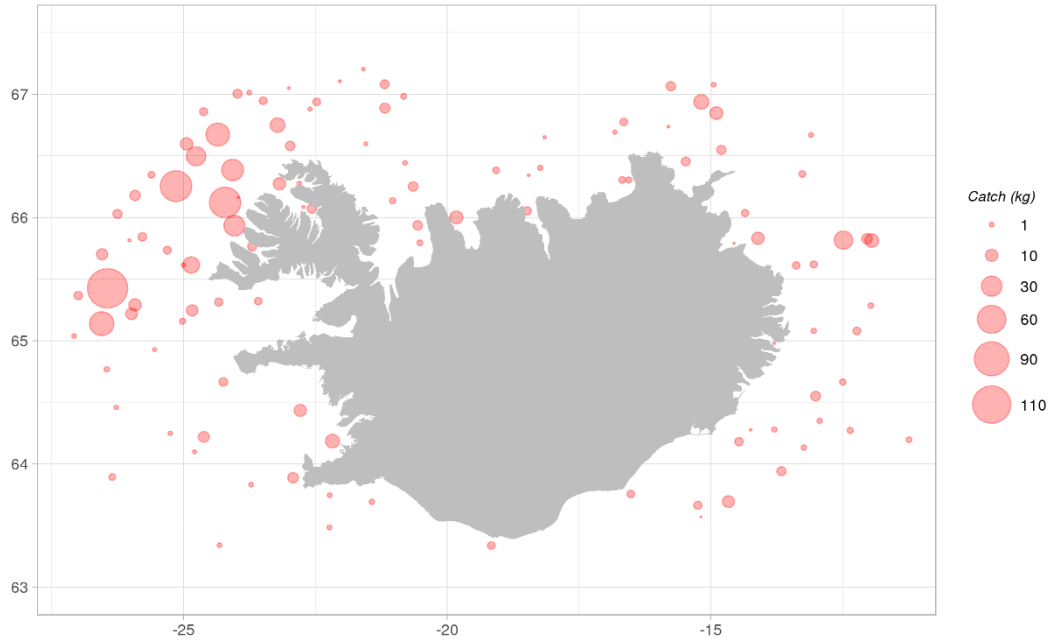

Figure 14. Atlantic wolffish. Spatial distribution in the autumn survey in 2016.
Mynd 14. Steinbítur. Útbreiðsla í stofnmælingu botnfiska að hausti árið 2016.

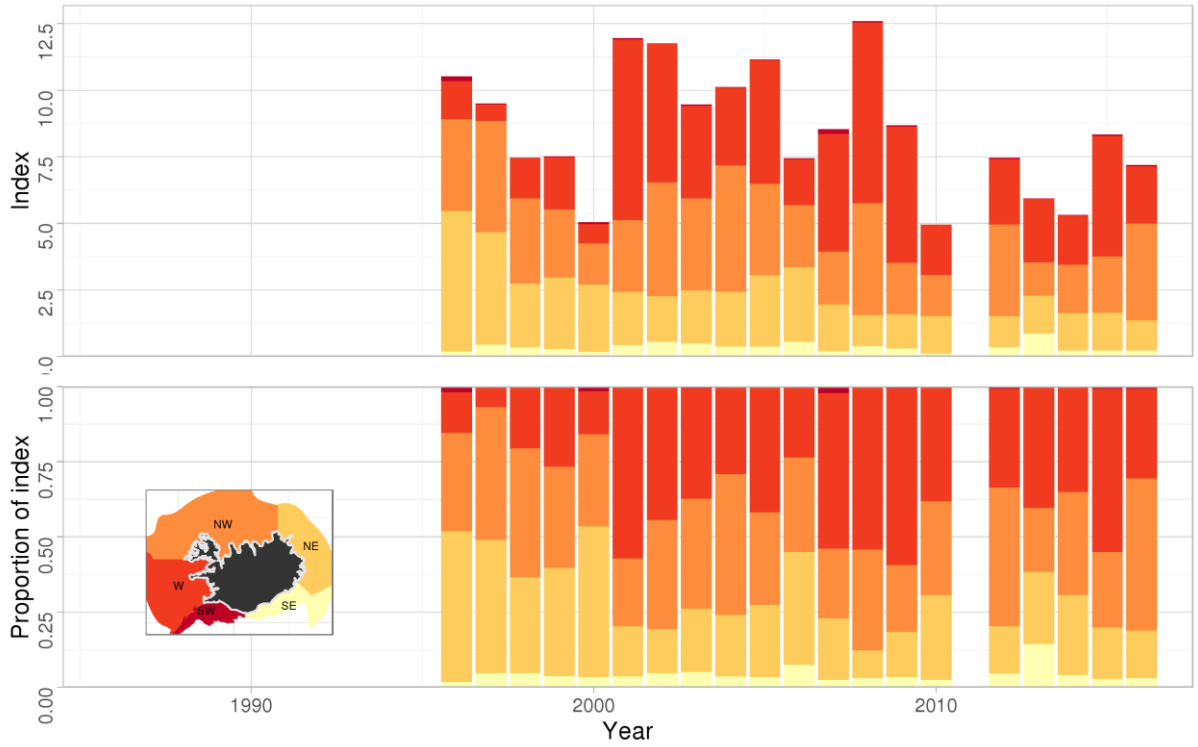

Figure 15. Atlantic wolffish. Spatial distribution of the biomass index from the autumn survey in 1996-2016.
Mynd 15. Steinbítur. Dreifing lífmassavísitölu í stofnmælingu að hausti árin 1996-2016.

MANAGEMENT

The Ministry of Industries and Innovation (MII) is responsible for management of the Icelandic fisheries and implementation of legislation. Atlantic wolffish was included in the ITQ system in the 1996/1997 quota year and as such subjected to TAC limitations. From that time to the fishing year 2004/2005 the catch was sometimes more than recommended by the MFRI and sometimes lower, the catch were on the average 5% more that advised in this years. In the fishing years 2005/2006 to 2008/2009 the catch was around 25% more than the advised TAC. The reasons for this is that the TAC was set higher than the advice and that on average about 3000 tonnes of other species quota were being transferred to Atlantic wolffish quota (Table 3, Figure 16).

Table 3. Atlantic wolffish. Recommended TAC, national TAC set by the Ministry, and landings (tonnes).
Tafla 3. Steinbítur. Tillögur Hafrannsóknastofnunar um hámarksafla, ákvörðun stjórnvalda um aflamark og landaður afli (tonn).

FISHING YEAR	REC. TAC	NATIONAL TAC	CATCH
1996/97	13000	13000	11523
1997/98	13000	13000	11689
1998/99	13000	13000	13051
1999/00	13000	13000	14906
2000/01	13000	13000	18094
2001/02	13000	16100	13667
2002/03	15000	15000	16953
2003/04	15000	16000	13253
2004/05	13000	16000	14208
2005/06	13000	13000	16473
2006/07	12000	13000	15796
2007/08	11000	12500	15159
2008/09	12000	13000	15453
2009/10	10000	12000	13096
2010/11	8500	12000	12122
2011/12	7500	10500	10607
2012/13	7500	8500	8953
2013/14	7500	7500	7531
2014/15	7500	7500	7861
2015/16	8200	8200	8858
2016/17	8811	8811	
2017/18	8540		

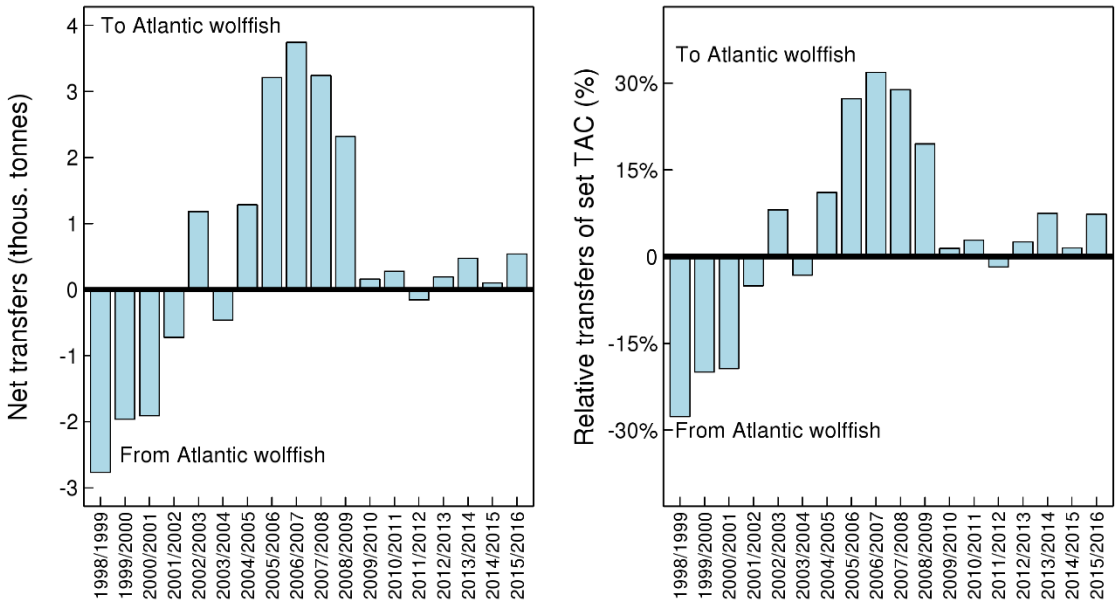

Figure 16. Atlantic wolffish. Net transfers of Atlantic wolffish quota to other species in the Icelandic ITQ system by fishing year. Positive values indicate that other species are being transferred to Atlantic wolffish but negative mean that Atlantic wolffish quota is being converted to other species.

Mynd 16. Steinbítur. Tilfærsla á kvóta milli steinbíts og annarra tegunda í kvótakerfinu eftir fiskveiðiárum. Jákvæð gildi tákna að kvóta annara tegunda er breytt í steinbít, en neikvæðar að steinbítskvóta sé breytt í aðrar tegundir.

ASSESSMENT

SETTINGS

The advice for Atlantic wolfish has since 2001 been based on a Gadget model. In 2001-2010 natural mortality (M) was set at 0.15 and the advice based on $F_{0.1}$ but since 2011 natural mortality has been set as M=0.10 and advice based on F_{msy} (F_{max}). Weights of different likelihood components were estimated in the 2011 assessment and again in the 2013 and 2015 assessments. The weights in the final run have been kept unchanged since 2013.

The parameters estimated in the model are:

- Initial numbers at age
- Recruitment at age 1 every year
- Size of recruits
- Selection pattern of the commercial fleet and survey.

Data used in the estimation are:

- Length distributions from survey and catches.
- Length disaggregated abundance indices from survey in 6 groups. 5-13cm, 14-19cm, 29-29cm, 30-55cm, 56-74cm and 75-109cm.
- Age data from survey and catches used as age-length keys.

Selection pattern of the fisheries and the survey are size based.

RESULTS

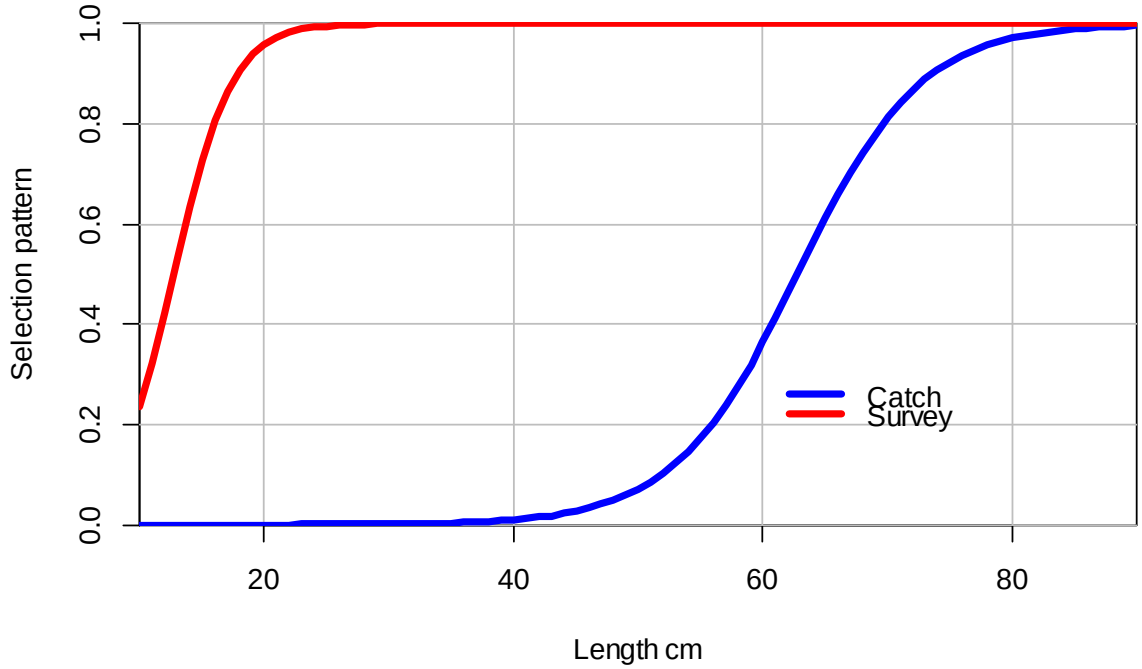

Figure 17. Atlantic wolffish. Estimated selection pattern from the catch and the survey.
Mynd 17. Steinbítur. Metið veiðimynstur hjá flotanum og í stofmælingunni í mars.

Figure 17 shows the estimated selection pattern from the model. L50 in the selection pattern of the commercial fleet is 62 cm that corresponds to 13 years old fish (Figure 18). The selection pattern is used to calculate fishable biomass that is the sum of the estimated biomass in each length group multiplied by the selection pattern shown in Figure 17

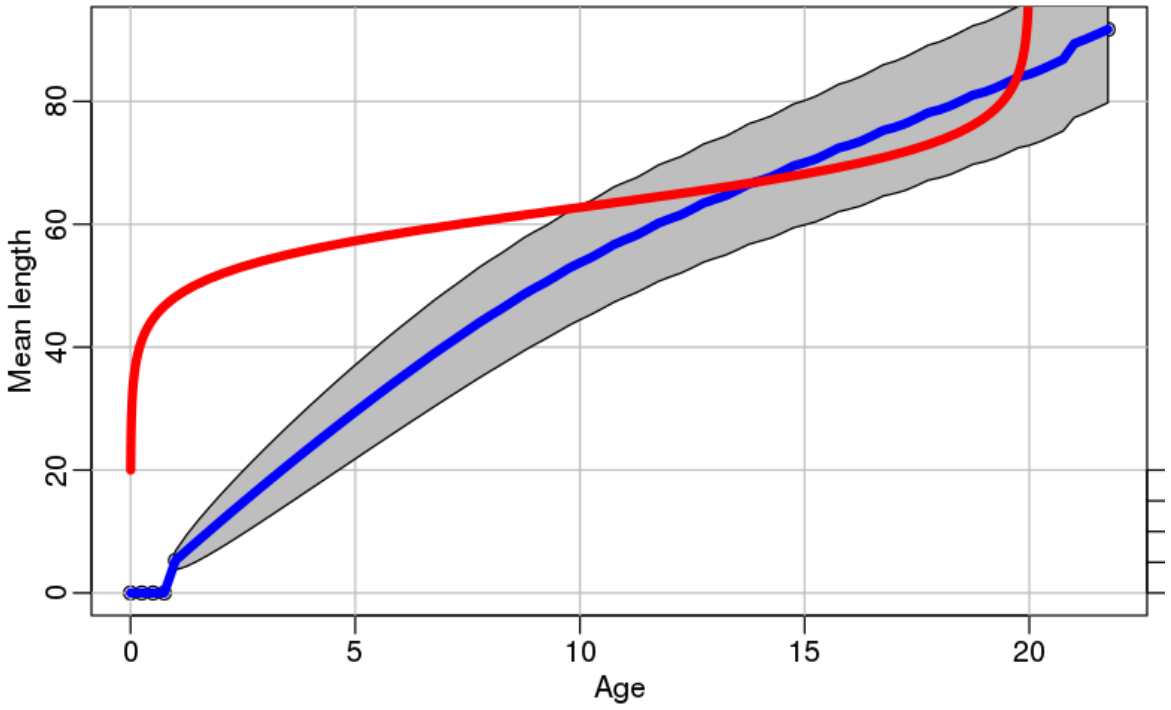

Figure 18. Atlantic wolffish. Estimated mean length and selection pattern as function of age.
Mynd 18. Steinbítur. Meðallengd og veiðimynstur sem fall af aldri.

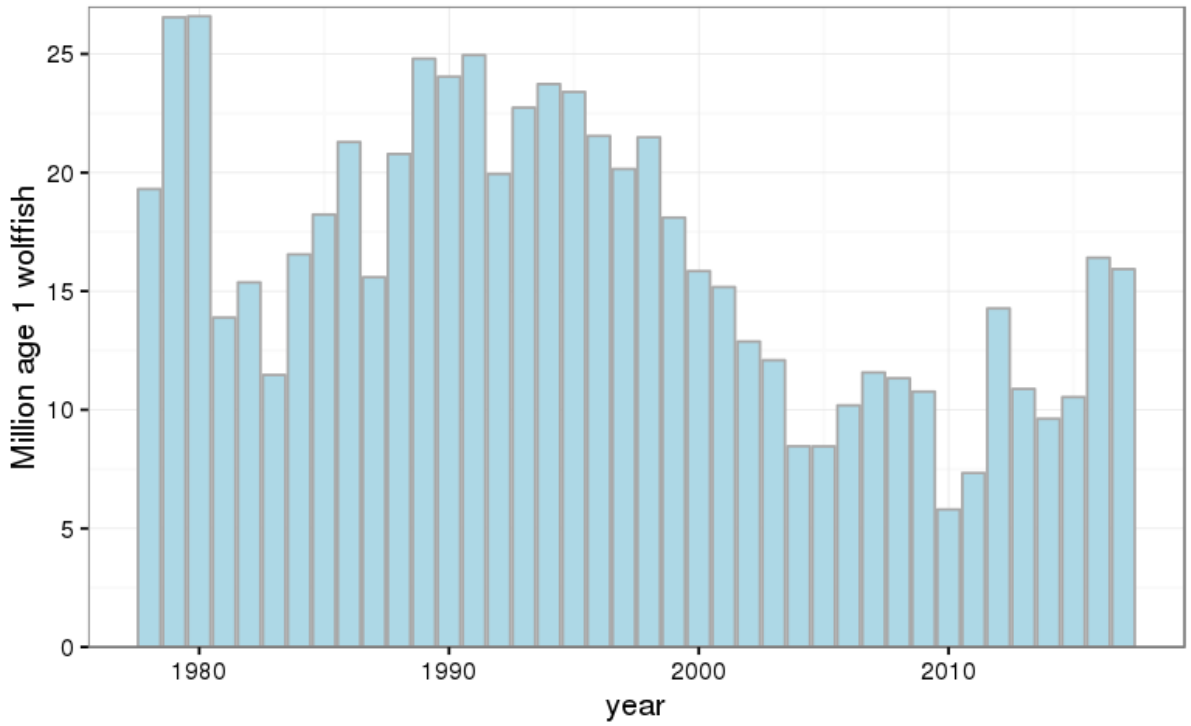

Figure 19. Atlantic wolffish. Estimated recruitment at age 1.
Mynd 19. Steinbítur. Metin nýliðun eins árs skv. stofnmatinu 2017.

The fishable stock (called harvestable biomass in the advice report) has not changed much since 2010 (Figure 19), mostly due to decreased fishing mortality (Figure 20) and is not expected to change much in coming years with annual catches thus expected to range between 7 and 8 thous. tonnes.

The advice is based on F=0.3. This F applies to fully recruited fish and is equivalent to F_{15} = 0.23 (F_{15} is shown in Figure 20). The advice for next fishing year is 8500 tonnes.

The assessment has been conducted using the same settings since 2013. There has been a tendency for upward revision of fishable biomass in this period (Figure 21). The assessment does though seem to be reasonably consistent. Fishing mortality is low so a longer time than 5 years is required to conclude much about the consistency.

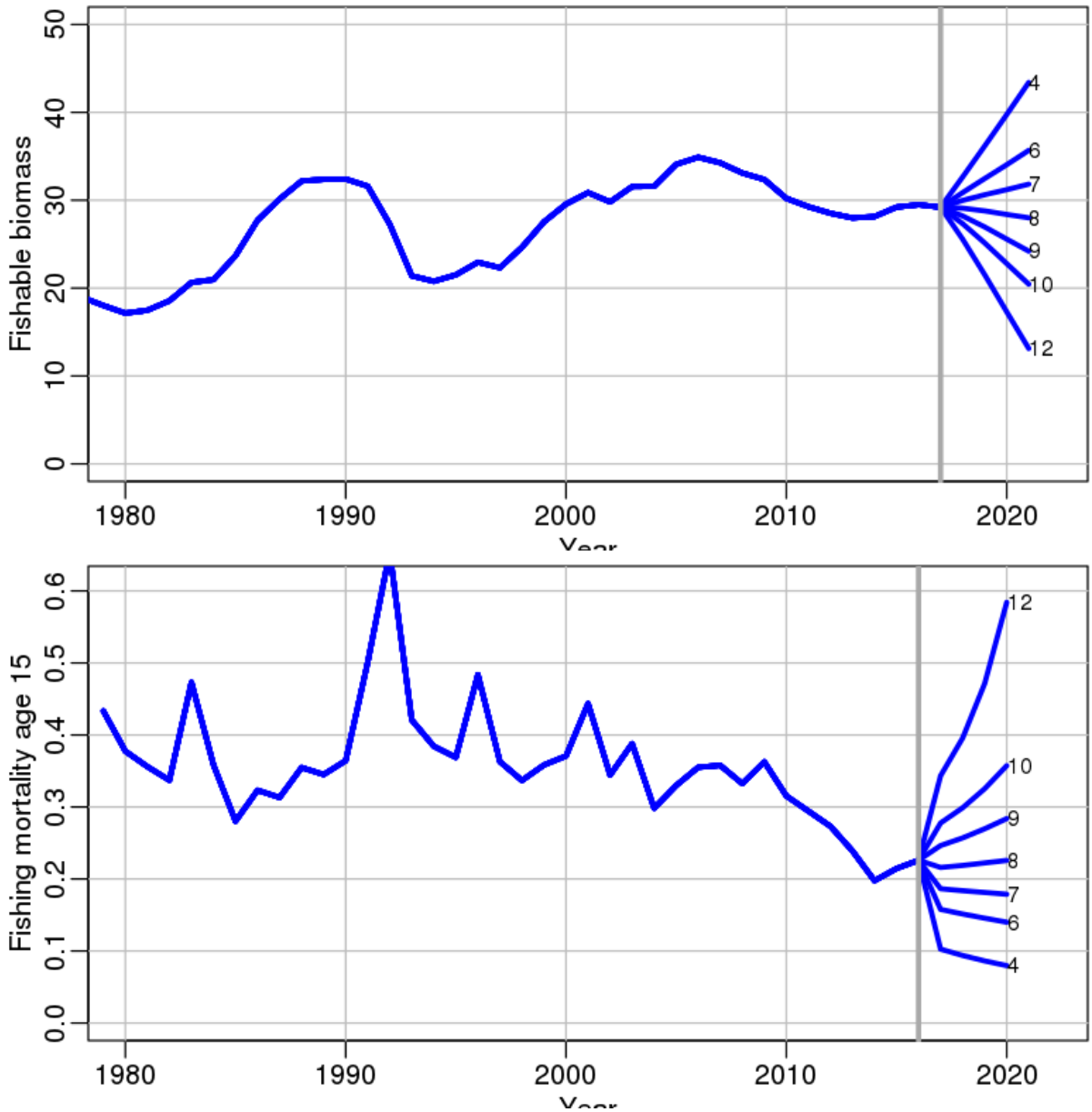

Figure 20. Atlantic wolffish. Fishable biomass and fishing mortality of age 15 wolffish. The figures shows historical values and prediction based on different annual catch next years.

Mynd 20. Steinbítur. Veiðistofn og fiskveiðidauði 15 ára steinbíts. Myndin sýnir söguleg gildi og þróun fyrir mismunandi árlegan afla næstu ár.

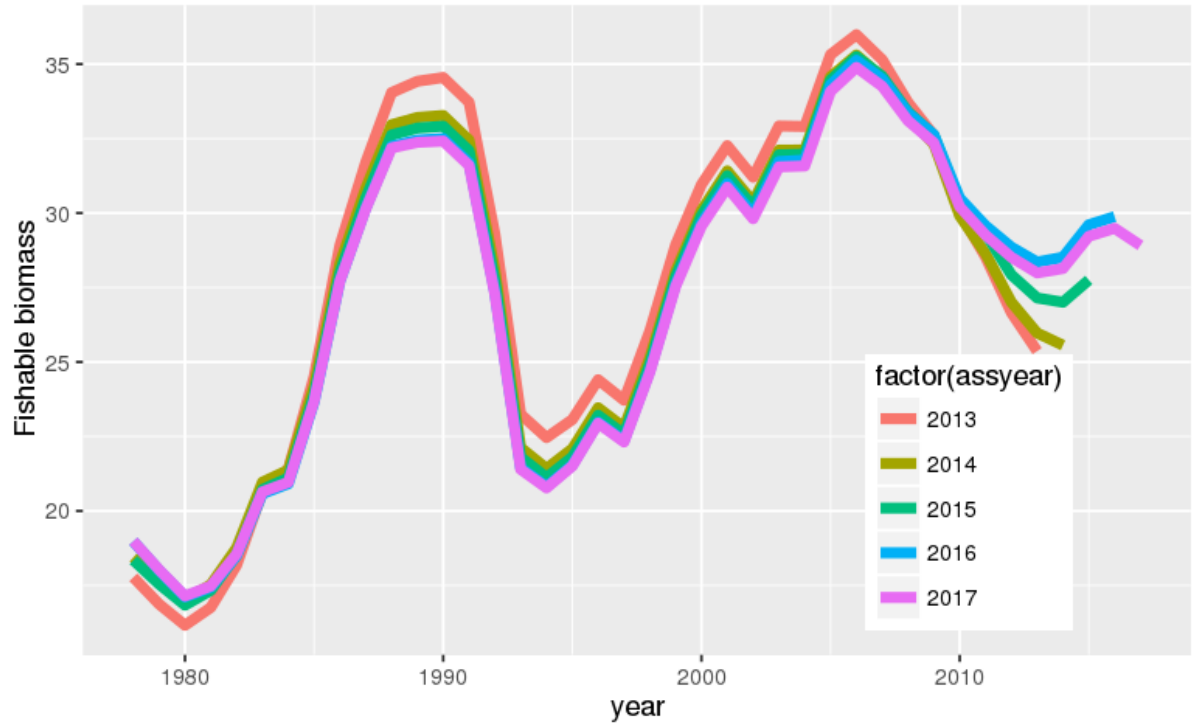

Figure 21. Atlantic wolffish. Estimated fishable biomass in the assessments 2013-2017.
Mynd 21. Steinbítur. Metinn veiðistofn í stofnmatinu 2013-2017.

Indices from the spring survey vs. estimated number in stock, show a reasonable correlation (figure 22) except for the size group 56-74 cm, which is the size accounting for largest part of the biomass. Part of the low correlation in the 56-74 cm group could is small dynamic range of the stock (12-18 million fish). The setup of having the same catchability all years for this size group could also be a problem, the catchability might vary depending on which part of the range 56-74 cm is most heavily populated. Current values (intersection of the green lines) shows that the current survey indices are according to predictions except for 75-109 cm length group where they are above prediction and 5-13 cm where they are below.

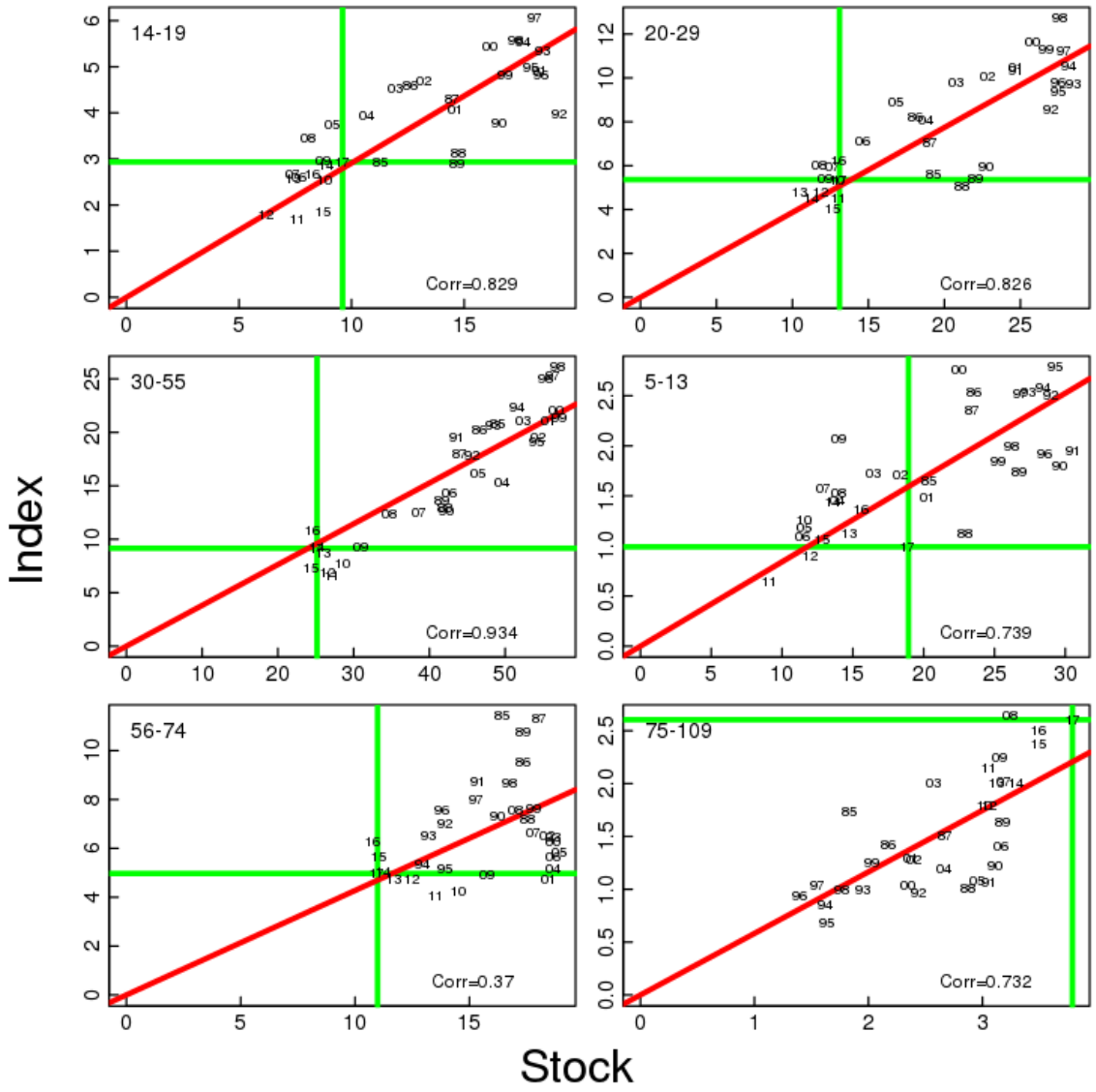

Figure 22. Atlantic wolffish. Survey abundance indices vs. number in stock for the 6 length groups shown used in tuning. The labels indicate years and the most recent values are shown by the overlap of the horizontal and vertical green lines.

Mynd 22. Steinbítur. Vísitölur úr stofnmælingu á móti fjölda í stofni fyrir þá 6 lengdar hópa sem eru notaðir í samstillingu. Textinn á myndinni sýnir á og nýjustu gildin sjást sem skurðpunktur láréttu og lóðréttu grænu línanna.

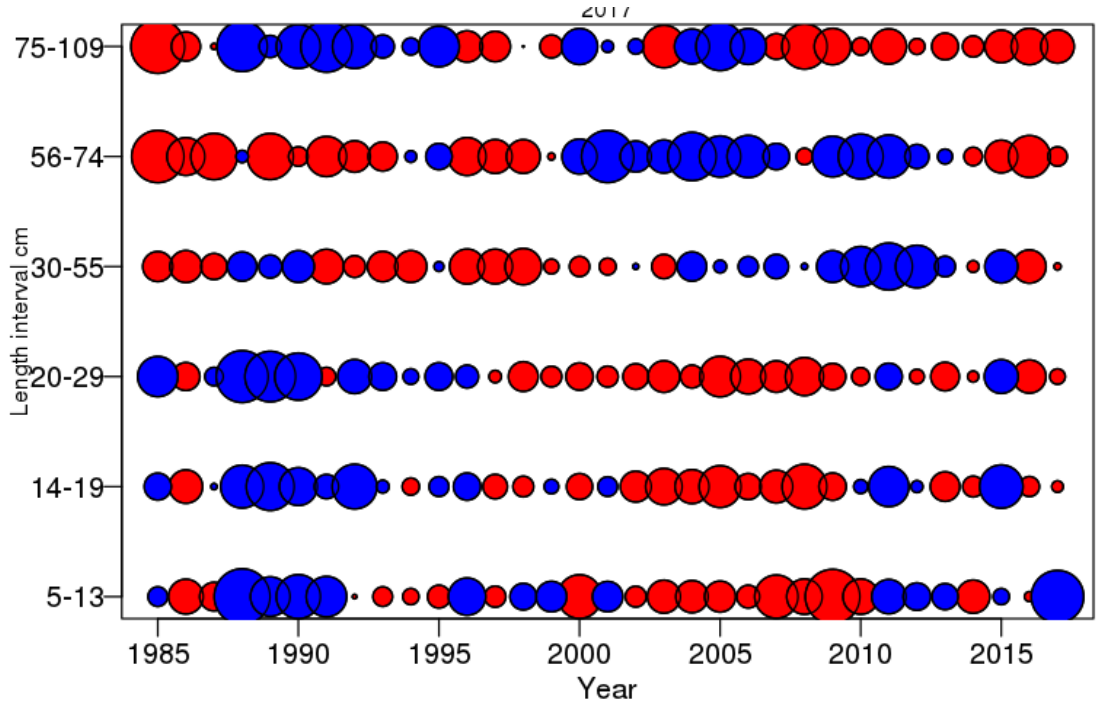

Figure 23. Atlantic wolfish. Log-residuals from the survey. Red circles indicate positive residuals (observed > predicted).

Mynd 23. Steinbítur. Frávik í sambandi milli líkans og rallvísitalna. Rauðir hringir sína jákvæð frávik, þ.e. rallvísitala > spágildi ralllvísitölu úr líkani.

Advice for Atlantic wolfish is based on F=0.3 where the fishing mortality F refers to fully recruited fish. Fully recruited fish is either 90cm (figure 17) or 20 years old (figure 19). Figure 20 does on the other hand show fishing mortality of age 15 fish. The growth and selection pattern are fixed for all the simulation period. Still the size at age can changed as the fisheries are modelled to target the largest fish of each cohort leading to lower mean length of the survivors and some change in selection by age if fishing mortality varies much.

The F used for advice is F_{max} from yield per recruit analysis of the stock. The model is size based and M is relatively low so F_{max} is expected to be precautionary harvesting stragety. Formal HCR evaluation is expected to take place in the winter 2017/18.

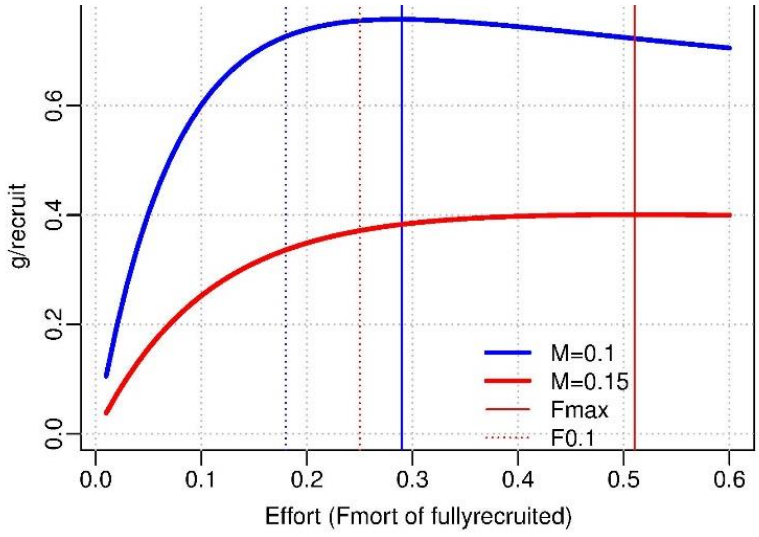

Figure 24. Atlantic wolfish. Yield per recruit as function of fishing mortalty of fully recruited wolfish.

Mynd 24. Steinbítur. Afraskstur á nýliða sem fall af fiskveiðidauða steinbíts sem er að fullu kominn inn í veiði.

ADVICE