

LEMON SOLE – ÞYKKVALÚRA

Microstomus kitt

GENERAL INFORMATION

Lemon sole is found all around Iceland, but the highest abundance and the main fishing grounds are off the West and Southwest coast. Lemon sole is a demersal and shallow water species, mainly found on a sandy or gravel substrate and occurring mostly at 20-200 m depths.

Females grow a little larger than males, only a small proportion of males become larger than 35 cm, whereas about the same proportion of females grows larger than 40 cm. Size at sexual maturity differs between the sexes. On the main spawning grounds off the south coast, about half of the males have reached maturity at the length of 13 cm, but females reach that level at 24 cm length.

THE FISHERY

The general fishing grounds for lemon sole are on the west and south coasts (Figure 1). Hardly any catch is recorded north and east of Iceland. No obvious changes are observed in the general distribution of the fishing grounds in recent years.

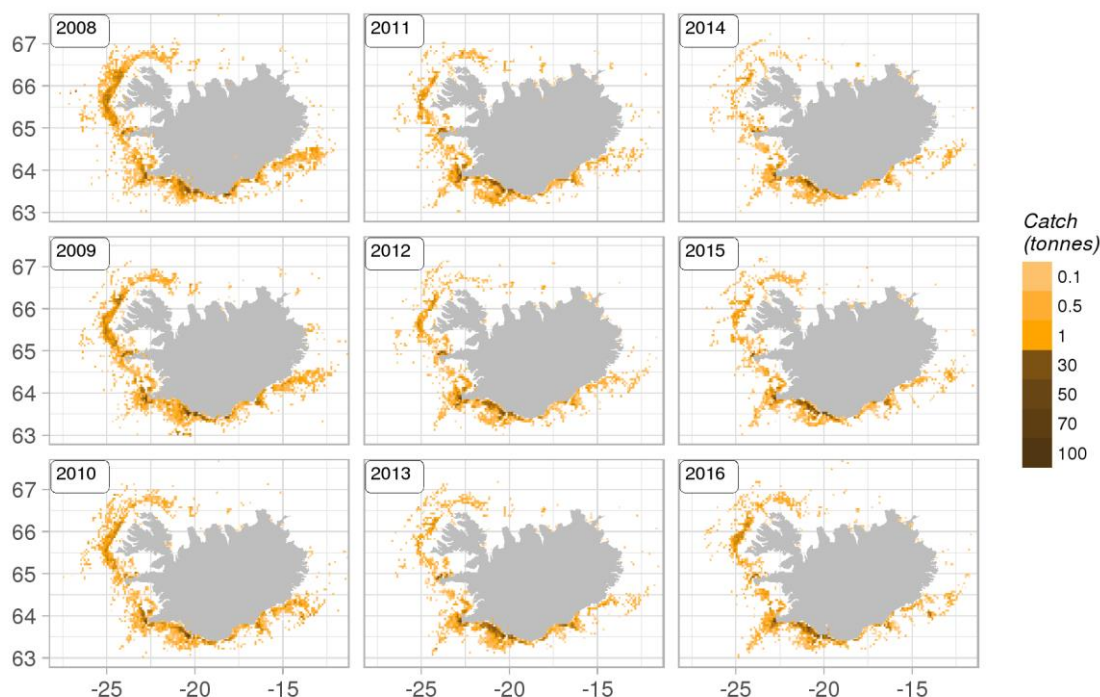


Figure 1. Lemon sole. Geographical distribution of the Icelandic fishery since 2008. Reported catch from logbooks.
Mynd 1. Þykkvalúra. Útbreiðsla veiða á Íslandsmiðum frá 2008 samkvæmt afladagbókum.

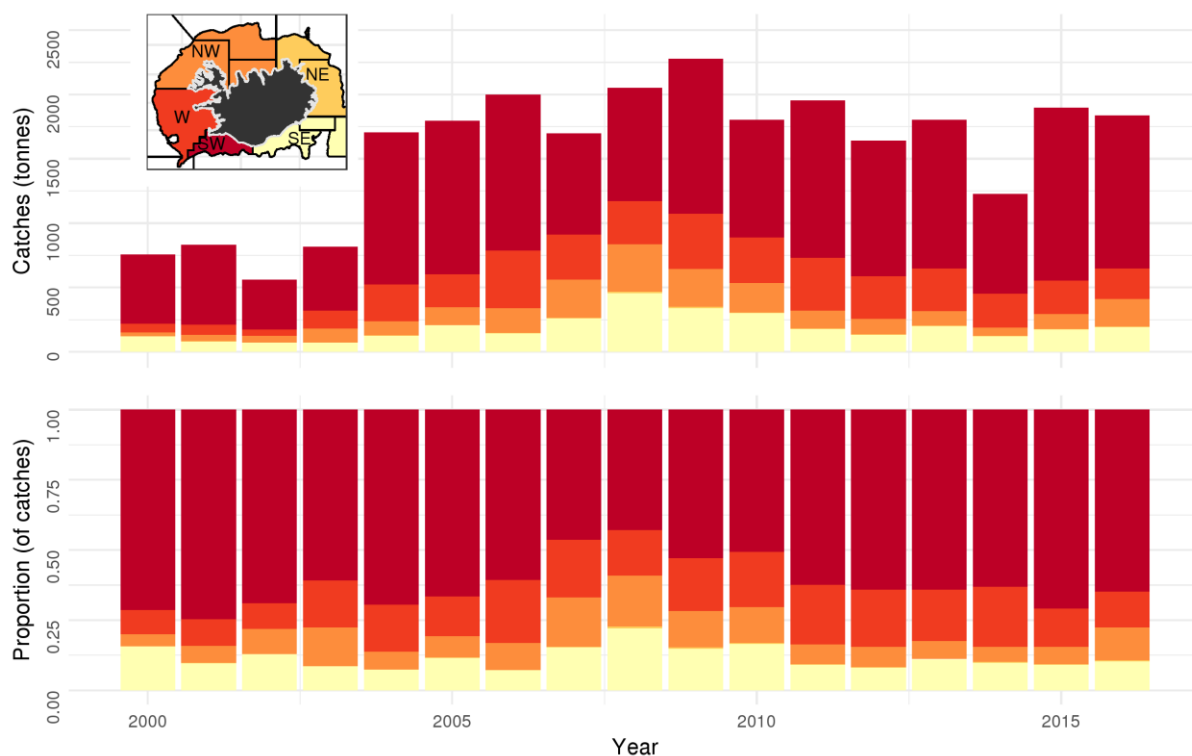


Figure 2. Lemon sole. Spatial distribution of the Icelandic fishery by fishing area from 2000-2016 according to logbooks. All gears combined.

Mynd 2. Þykkvalúra. Útbreiðsla veiða á íslensku veiðisvæði árin 2000-2016 samkvæmt afladagbókum. Öll veiðarfæri samanlagt.

Since 2000, the main fishing grounds of lemon sole have been in the southwestern part of the Icelandic shelf (Figure 2) according to logbook entries. Spatial distribution of the Icelandic lemon sole fishery is considerably stable, with around 75% caught in the southwest.

On Icelandic fishing grounds about half the catch is taken at 61-100 m depth (Figure 3). In the last four years, considerable proportion (50-70%) of demersal seine catch was taken at 41-80 m depth. More than half the catch in demersal trawl is taken in waters deeper than 80 m.

Lemon sole is mainly caught in demersal seine and bottom trawl, amounting to more than 95% of the landings in most years (Figure 4, Table 1). This proportion has been relatively stable through the years, with demersal seine taking more than half of the catches.

Since 2000, around 45-85 trawlers (demersal- and *Nephrops* trawlers) and 28-50 seiners have reported catches of lemon sole (1000 kg or more). Since 2000 the number of bottom trawlers has decreased but their numbers have remained stable since 2011, while the number of seiners have been decreasing over the entire period (Table 1).

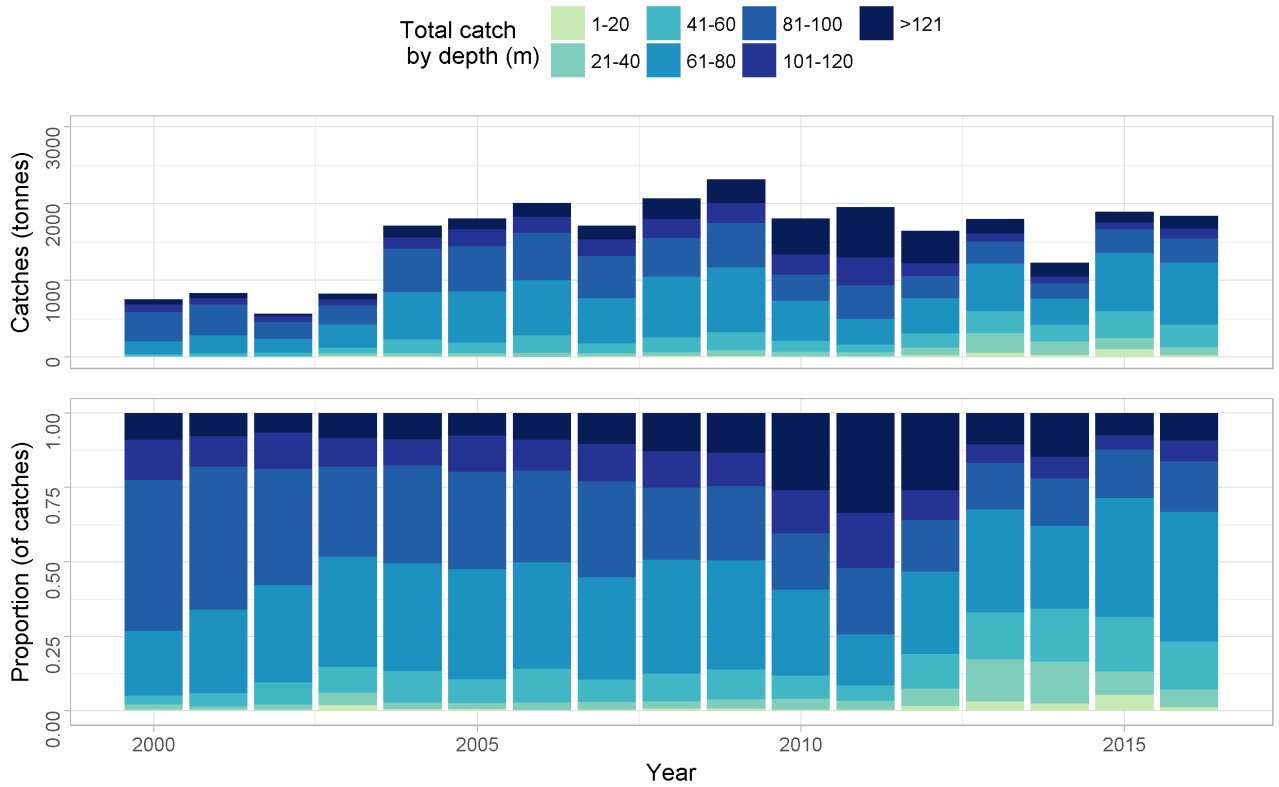


Figure 3. Lemon sole. Depth distribution of catches according to logbooks.
Mynd 3. Þykkvalúra. Afli samkvæmt afladagbókum, skipt eftir dýpi.

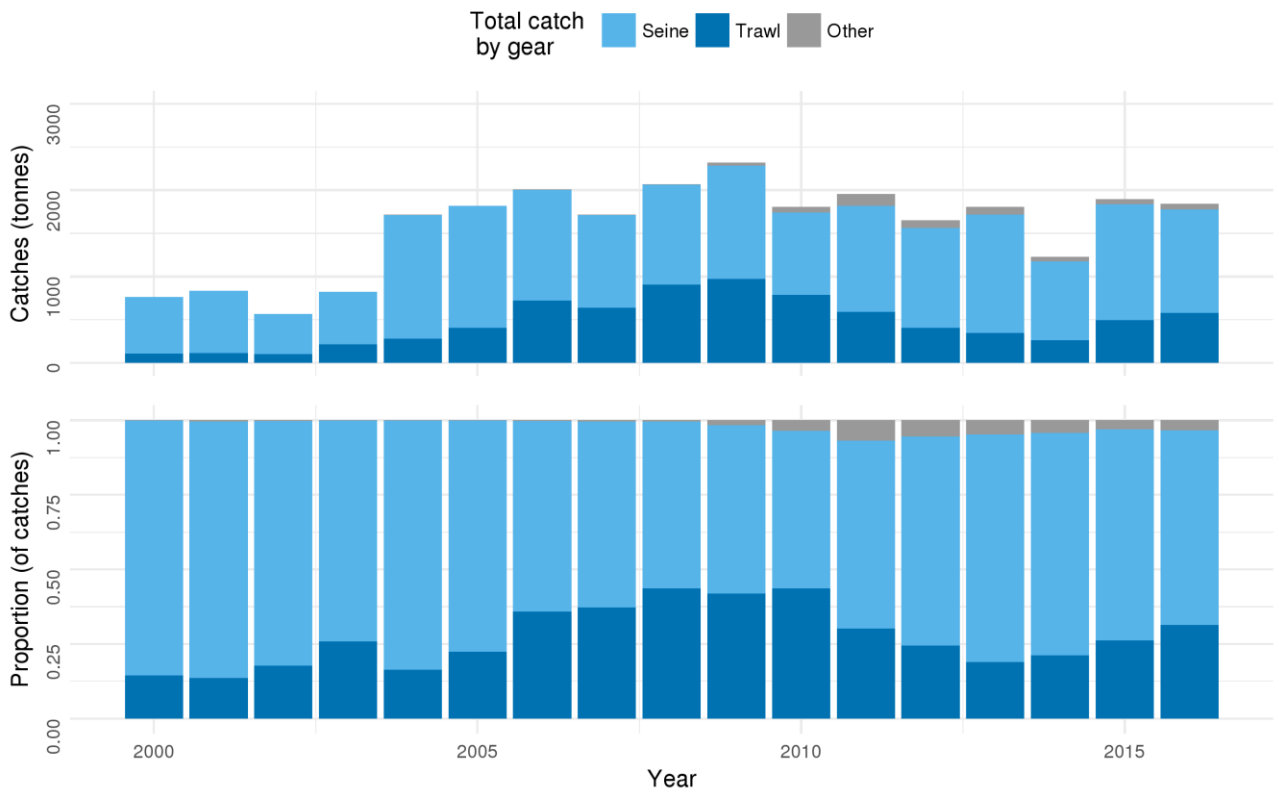


Figure 4. Lemon sole. Total catch (landings) by fishing gear since 2000.
Mynd 4. Þykkvalúra. Landaður afli eftir veiðarfærum frá 2000.

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

Tafla 1. Þykkvalúra. Fjöldi íslenskra skipa sem landað hafa 1000 kg af þykkvalúru 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	85	50	7	591	815	32	1438
2001	70	46	4	483	861	27	1371
2002	60	37	10	370	552	28	950
2003	66	46	5	446	782	18	1246
2004	65	56	9	608	1565	36	2209
2005	66	50	11	868	1608	29	2505
2006	71	49	10	1220	1446	22	2688
2007	74	44	11	1450	1194	18	2662
2008	69	41	9	1318	1282	34	2634
2009	66	47	11	1143	1437	49	2629
2010	59	39	15	894	995	81	1970
2011	42	38	13	611	1164	124	1899
2012	38	39	12	435	1099	79	1614
2013	38	35	14	378	1304	82	1765
2014	31	30	13	290	860	52	1202
2015	38	28	12	473	1237	62	1772
2016	45	28	11	562	1108	65	1735

CATCH PER UNIT EFFORT (CPUE) AND EFFORT.

CPUE estimates of lemon sole 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-standardized CPUE in demersal seine (kg/set) is calculated as the total weight in sets in which lemon sole was more than 10% of the catch. In the years 2000-2014, according to logbooks, lemon sole CPUE gradually increased from 200 to around 400 kg/set (Figure 5). In the years 2015 and 2016, however, the CPUE was 600 and 550 kg/set, respectively. CPUE of lemon sole in demersal trawl has been slowly increasing since 2002.

Total fishing effort for lemon sole in demersal seine is estimated as the number of sets where lemon sole was more than 10% of the total catch. The fishing effort fell to a low in 2002 and rose to a peak in 2004. After 2004 it has been decreasing more or less continuously. This is both due to the fact that fewer seiners are fishing and catch per unit effort is higher. For demersal trawl, fishing effort during the last 16 years was highest in 2006-2011 (Figure 5).

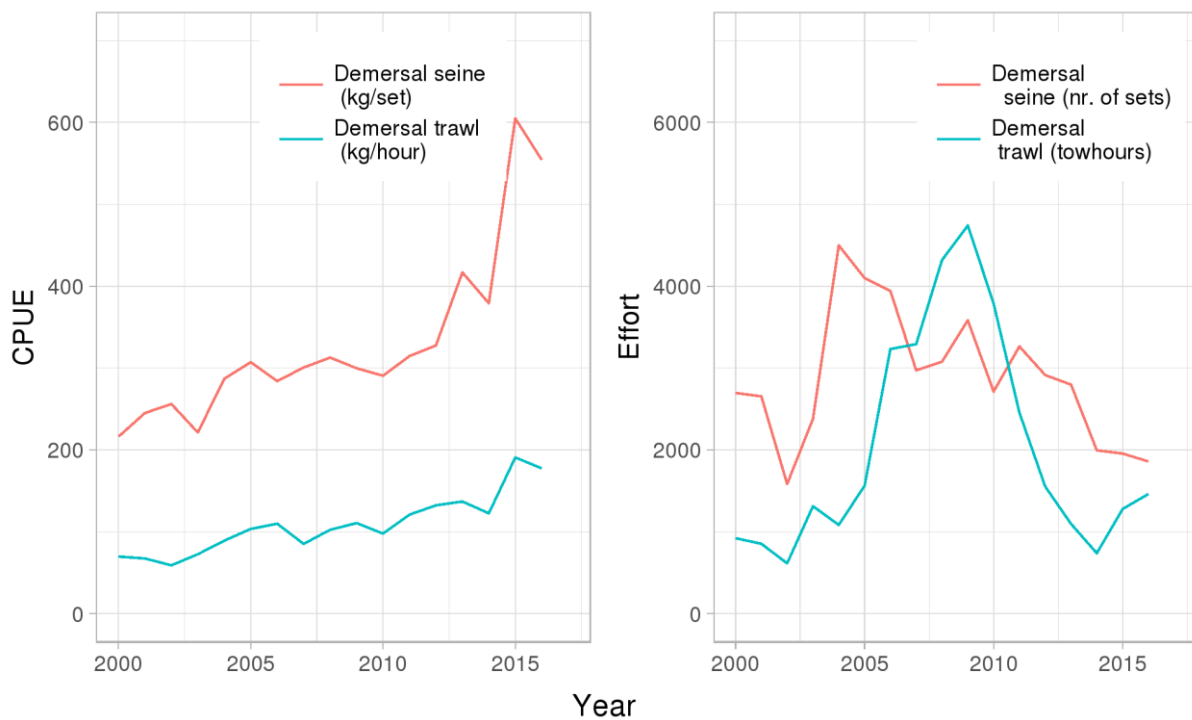


Figure 5. Lemon sole. Raw CPUE (left) and fishing effort (right) from demersal seine (kg/set or nr. of sets) (in red) and demersal trawl (kg/hour or towhours) (in blue).

Mynd 5. Þykkvalúra. Afli á sóknareiningu (vinstri) og sókn (hægri) með dragnot (kg í kasti eða fjöldi kasta) (rautt) og botnvörpu (kg/klst eða tog tímar) (blátt).

AGE DISTRIBUTION OF LANDED LEMON SOLE

Otoliths have been collected from commercial catches since 1999. Annually 11-38 samples have been collected from demersal seine and 3-21 samples from demersal trawl, or a total of 275-1100 and 100-500 otoliths respectively (Table 2, Figure 6). Samples were not taken from other gears, as they represent a small proportion (~5%) of the total catch.

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

Tafla 2. Þykkvalúra. Fjöldi sýna og aldursgreindra fiska úr lönduðum aflu.

Year	Demersal seine		Demersal trawl	
	Samples	Otoliths	Samples	Otoliths
2010	23	575	21	506
2011	36	875	12	300
2012	37	925	14	361
2013	36	899	8	200
2014	20	500	8	200
2015	28	700	17	420
2016	27	675	17	425

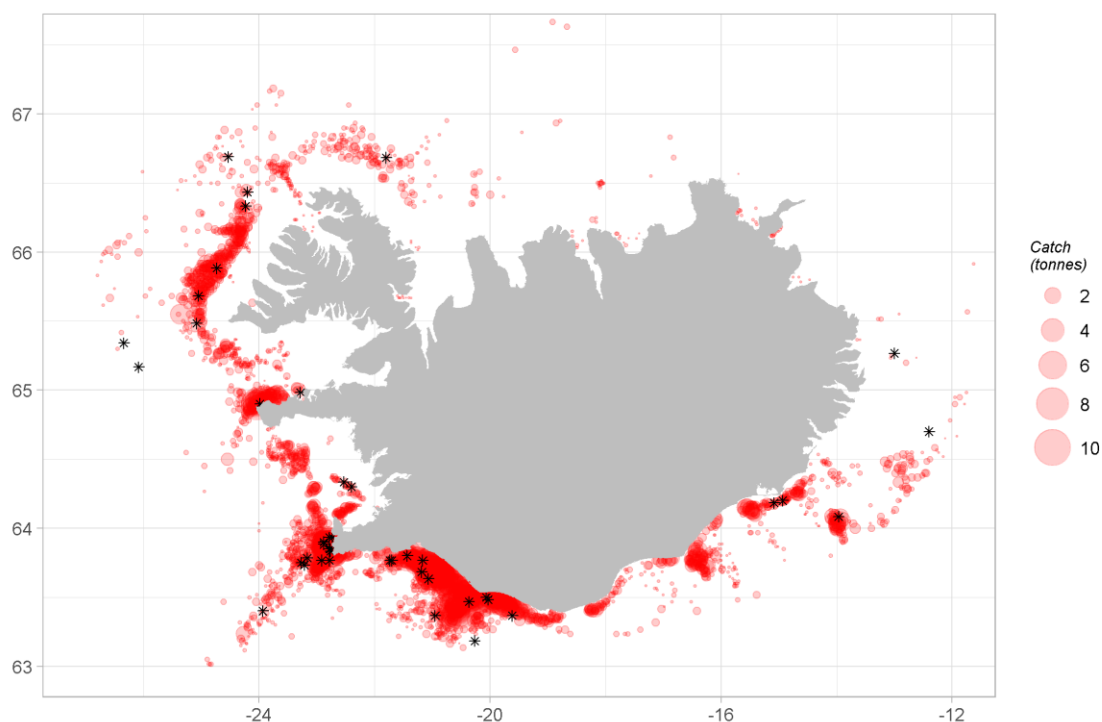


Figure 6. Lemon sole. Fishing grounds in 2016 as reported in logbooks (red) and positions of samples taken from landings (asterisks).

Mynd 6. Þykkvalúra. veiðisvæði við Ísland árið 2016 samkvæmt afladagbókum (rautt) og staðsetningar sýna úr lönduðum aflu (stjörnur).

In 2010-2015 the majority of the catch was 6-8 years old lemon sole, or about 70% of landings in numbers (Figure 7). The proportion of these age classes in the catch then decreased in 2016, when 8 and 9 year old fish were the majority of the catch.

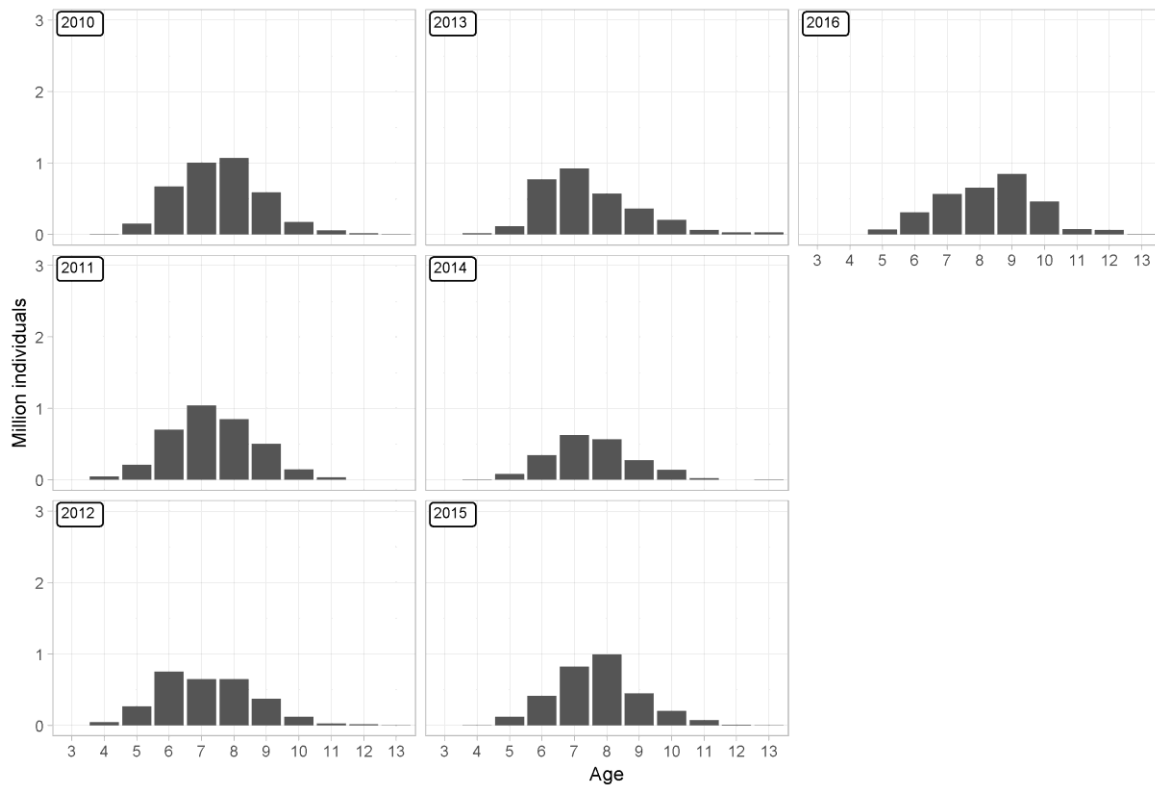


Figure 7. Lemon sole. Estimated age distribution of landed catch based on landings and otoliths collected from landed catch.

Mynd 7. Þykkvalúra. Áætluð aldursdreifing landaðs afla byggð á aldursgreiningum á fiskum úr afla.

LENGTH DISTRIBUTION OF LANDED LEMON SOLE

Length distribution of landed lemon sole have remained stable since 2001, however there has been a slight shift towards larger fish since 2014 (Figure 8).

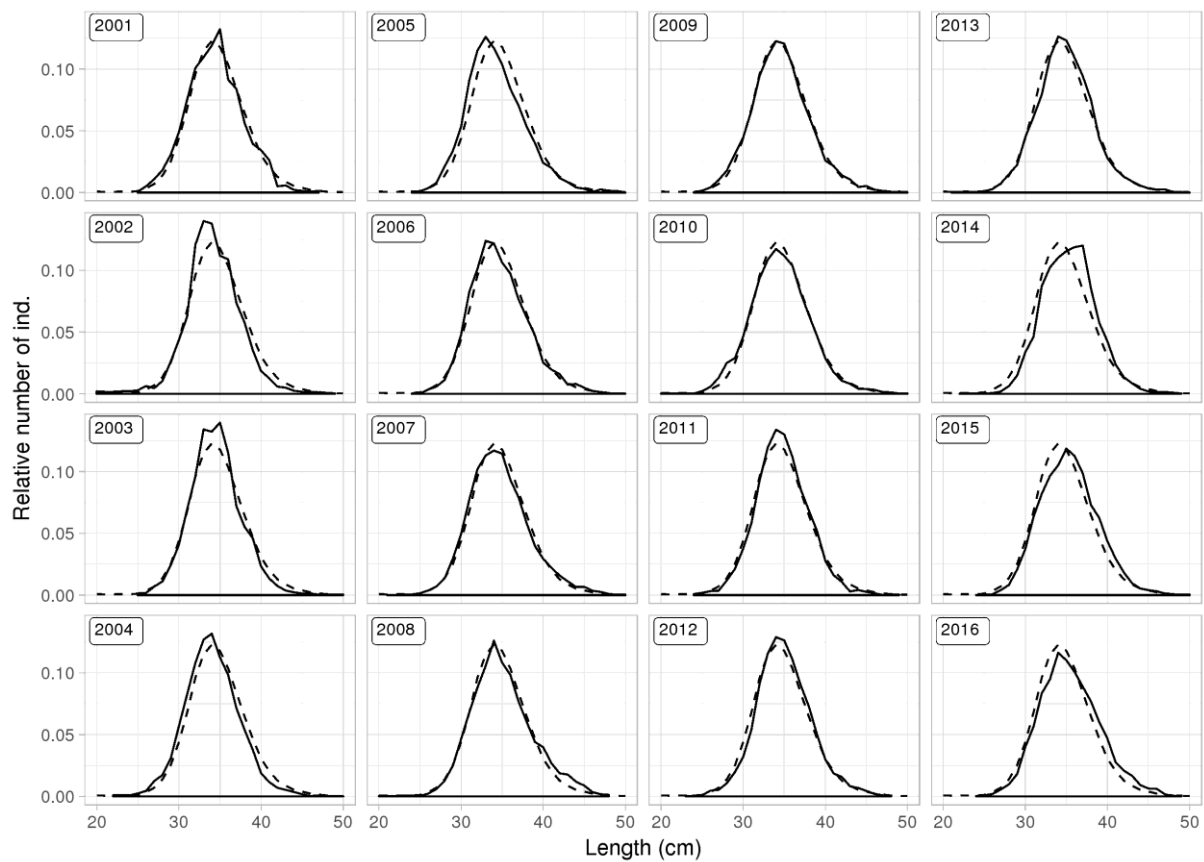


Figure 8. Lemon sole. Length distribution from landed catch. The dotted line represents the mean length distribution for all years.

Mynd 8. Pykkvalúra. Lengdardreifing aflasýna frá árinu 2001 með meðallengdardreifing 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 the lemon sole. In addition, the Icelandic autumn groundfish survey (hereafter autumn survey, IS-SMH) was commenced in 1996. 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. It may not, however, adequately cover the main recruitment grounds for lemon sole as the main nursery areas are thought to be 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 will be expanded in 2017 to cover most of the recruitment grounds of lemon sole and other flatfish species. The plan is to incorporate this survey in the stock assessment for lemon sole in the future.

Figure 9, shows both a recruitment index based on abundance of lemon sole smaller than 20 cm, and trends in various biomass indices. Survey length distributions are shown in Figure 10 and Figure 11, abundance and changes in spatial distribution in Figure 12 - Figure 15.

Total biomass index and the biomass index for lemon sole larger than 30 cm (harvestable part of the stock) has been variable in recent years, with large fluctuations between years (Figure 9). The index for lemon sole larger than 39 cm has been increasing recently. The index of juvenile abundance (<20 cm) has decreased in the last six years after large peak in 2011 which was observed only in spring survey. The result from the shorter autumn survey are by and large similar to those observed from the spring survey, except for the juvenile abundance index that shows a different pattern than the spring survey.

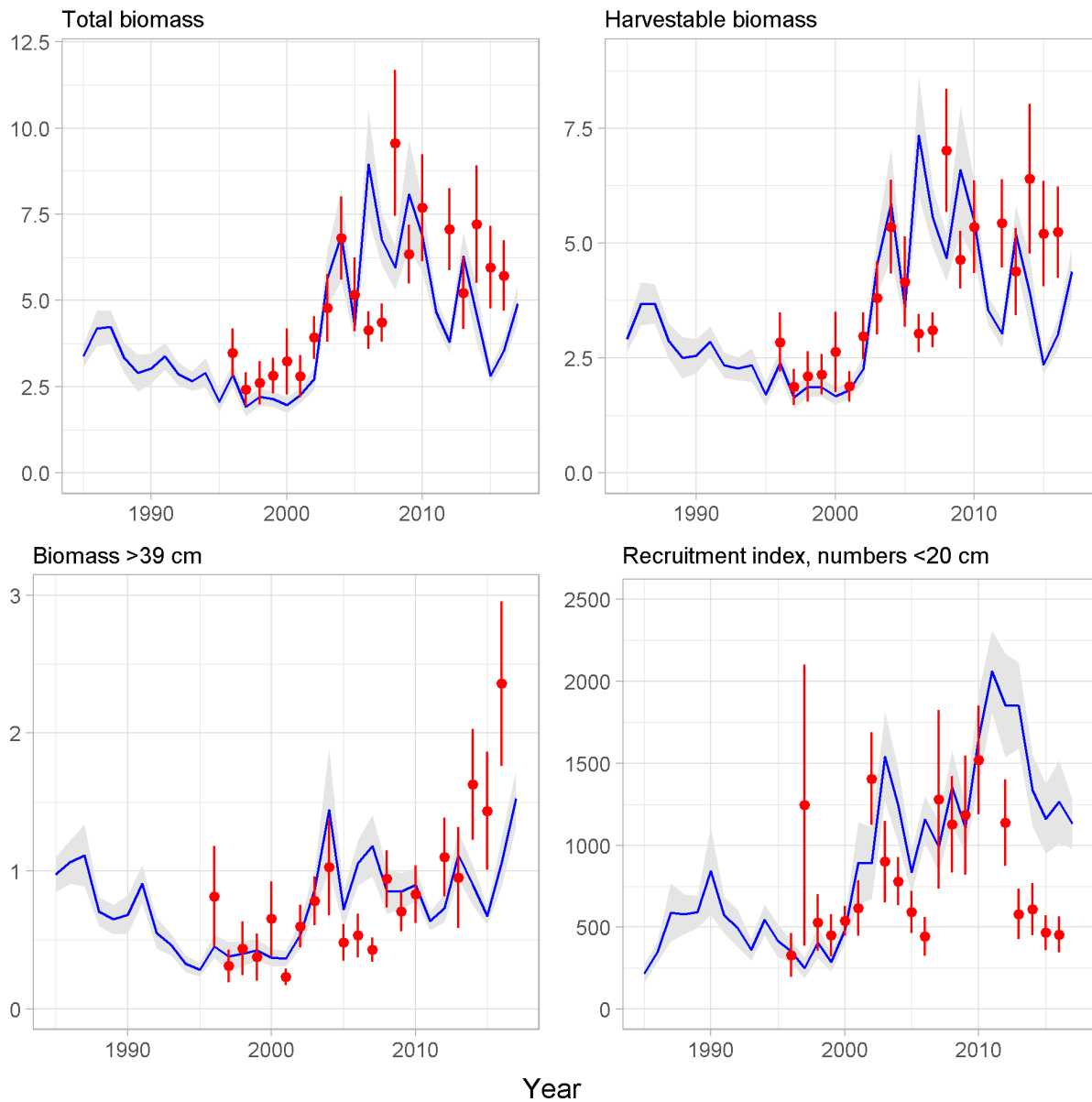


Figure 9. Lemon sole total biomass indices (upper left) and harvestable biomass indices (>30 cm) (upper, right), biomass indices of larger ind. (>39 cm) (lower left) and juvenile abundance indices (<20 cm) (lower right) from the spring survey (blue) from 1985 and autumn survey (red) from 1996, along with the standard deviation.

Mynd 9. Stofnvisitala þykkvalúru (efri til vinstri), vísitala veiðistofns (30 cm og stærri, efri til hægri) og vísitala stærri einstaklinga (39 cm og stærri, neðri til vinstri) og nýliðunarvísitala (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, the size distribution in the spring survey has been stable, with little variation over time (Figure 10). Data from the autumn survey tells a similar story (Figure 11).

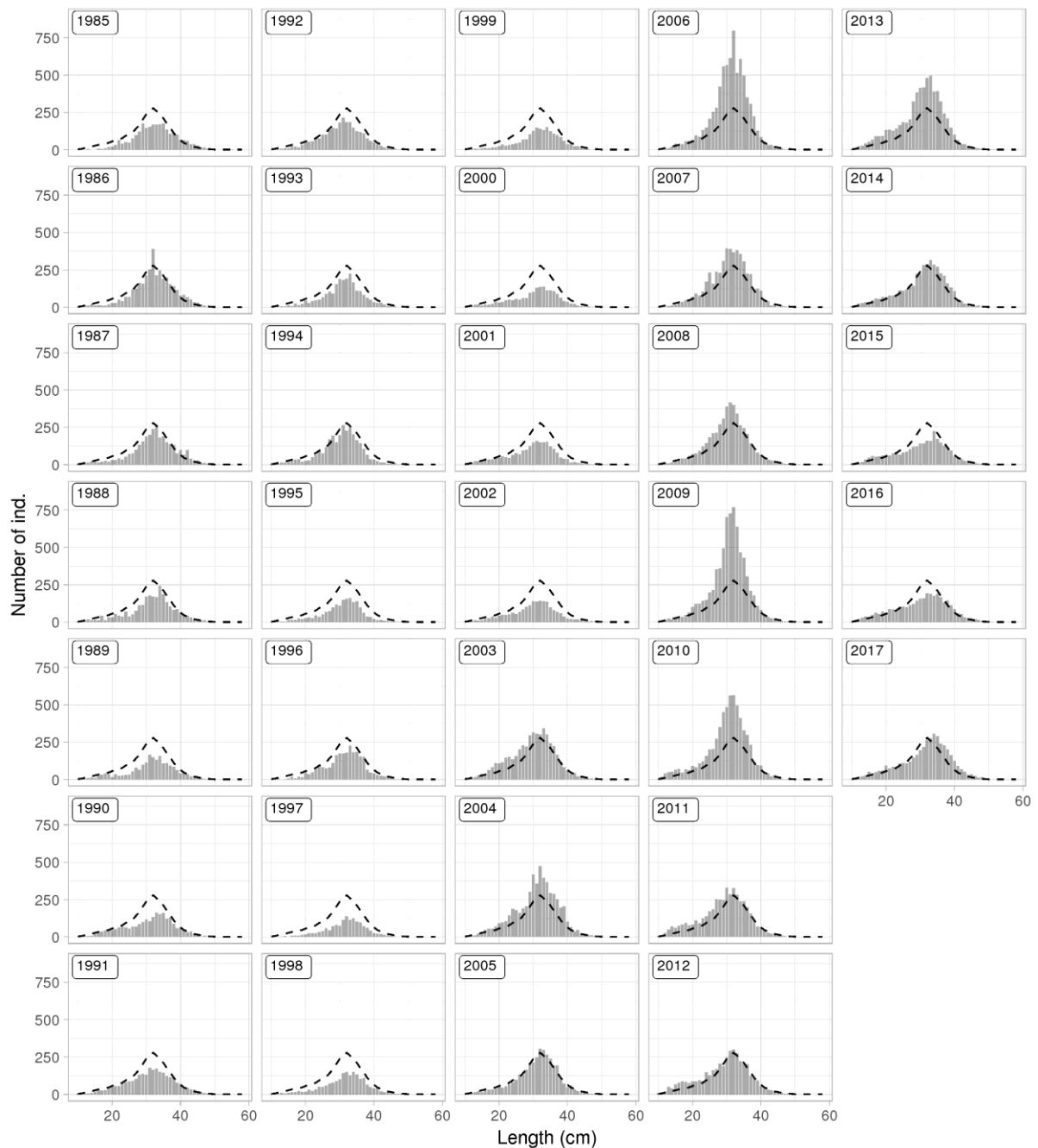


Figure 10. Lemon sole. Length distribution from the spring survey. The dotted line shows mean length for all years combined.

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

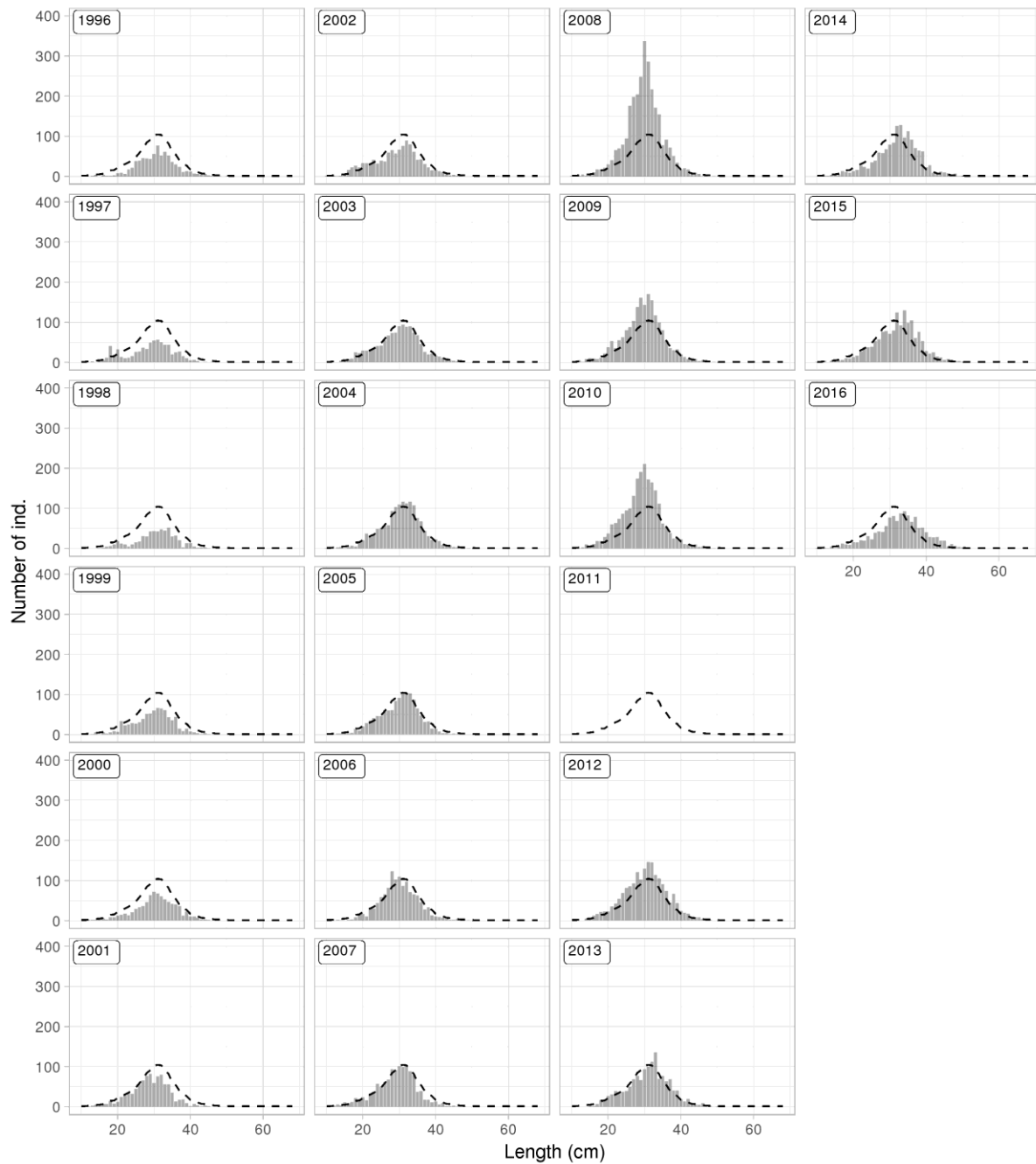


Figure 11. Lemon sole. Length distribution from the autumn survey. The dotted line shows mean length for all years combined.

Mynd 11. Pykkvalúra. Lengdardreifing úr stofnmælingu botnfiska að hausti frá 1996 ásamt meðallengd allra ára (punktalína).

Lemon sole were mostly caught on the main fishing grounds in the southwest and west part of the country in the spring survey in 2017, while considerable amount was also caught deep of the southeast coast (Figure 12). The coldest waters off the northeast and east coast are almost devoid of lemon sole. Spatial distribution of lemon sole in the spring survey has been relatively stable since the survey was started in 1985 (Figure 13). The increase in estimated biomass after 2002 occurred more or less evenly in all areas, although in years with exceptionally high biomass estimates (i.e. 2006 and 2009) the increase was mostly in the SW area.

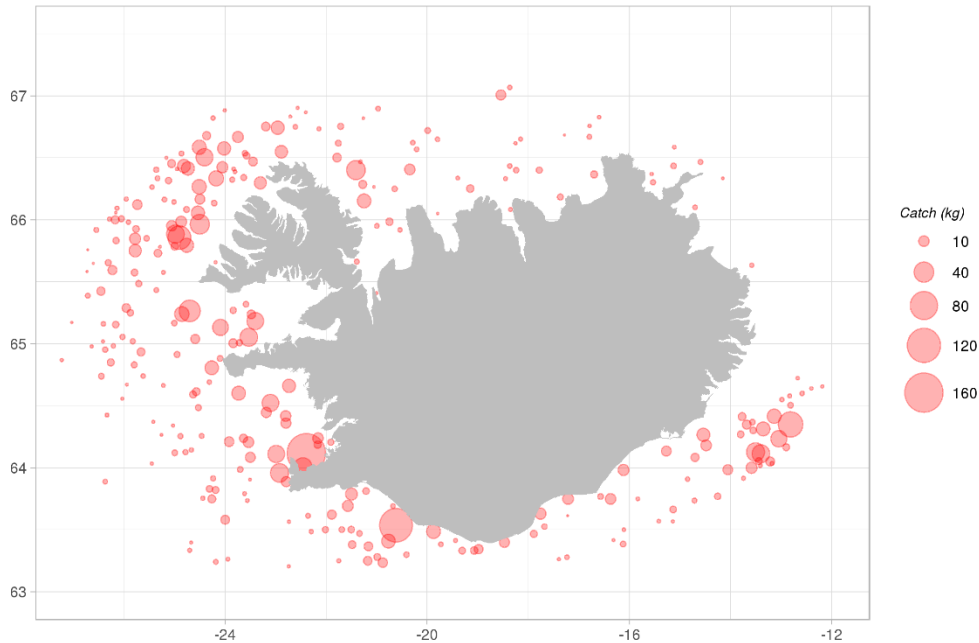


Figure 12. Lemon sole. Spatial distribution in the spring survey in 2017.
Mynd 12. Þykkvalúra. Útbreiðsla í stofnmælingu botnfiska að vori 2017.

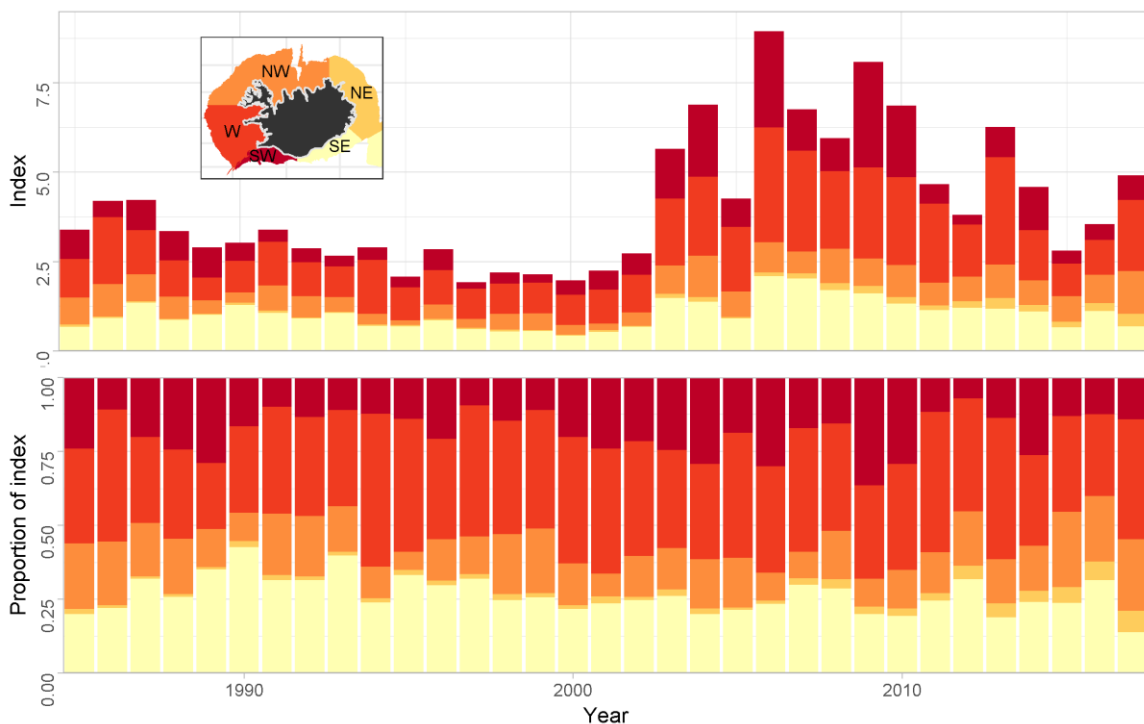


Figure 13. Lemon sole. Spatial distribution of biomass index from the spring survey in 1985-2017.
Mynd 13. Þykkvalúra. Dreifing lífmassavísitölu í stofnmælingu botnfiska að vori, árin 1985-2017.

Lemon sole were mainly caught in the west and northwest of the country in the autumn survey in 2016 with some lemon sole also caught in the southeast (Figure 14). The majority of lemon sole in the autumn survey has been caught in the west and northwest of the country. In the last two years of the survey, there has been a slight increase in the abundance of lemon sole in the W and NW areas, but decrease in the SE area (Figure 15).

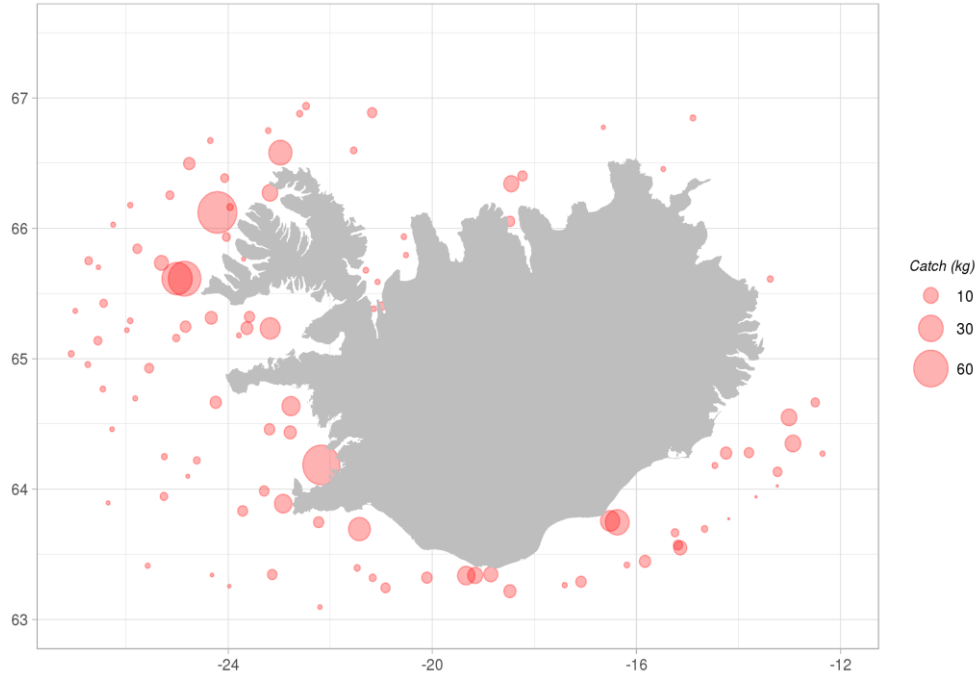


Figure 14. Lemon sole. Spatial distribution in the autumn survey in 2016.
Mynd 14. Pykkvalúra. Útbreiðsla í stofnmælingu botnfiska að hausti árið 2016.

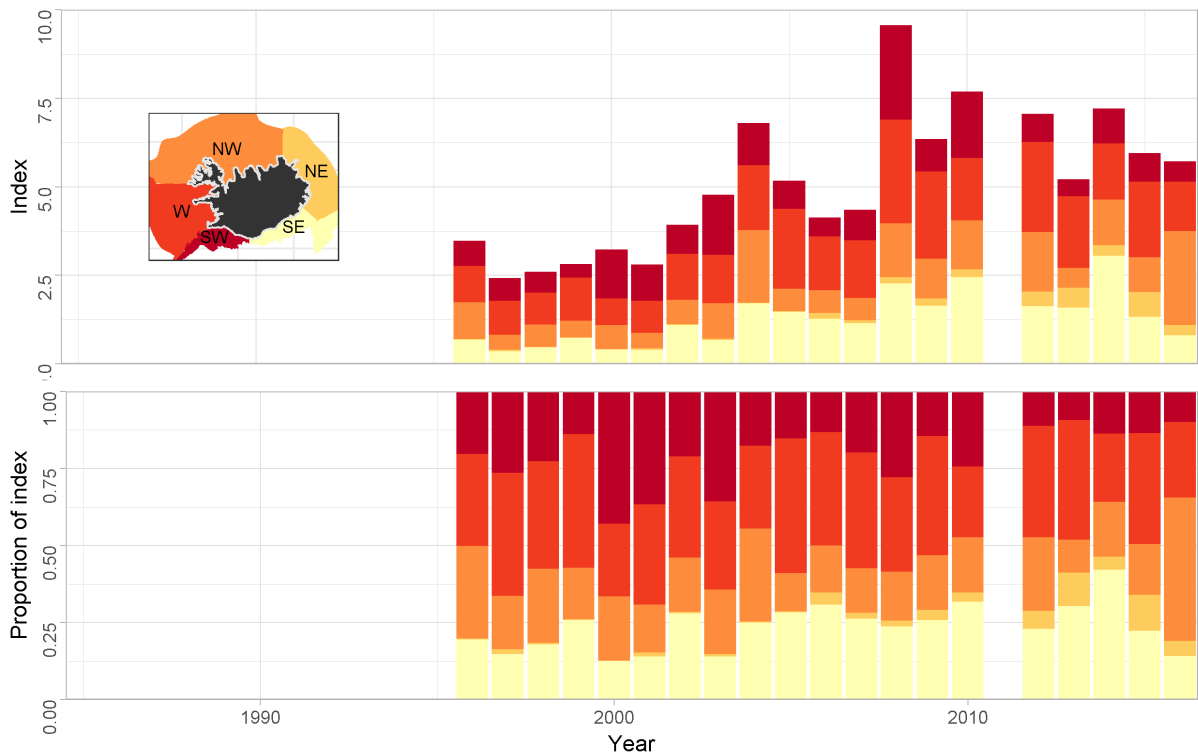


Figure 15. Lemon sole. Spatial distribution of biomass index from the autumn survey in 1996-2016.
Mynd 15. Pykkvalúra. Dreifing lífmassavísitölu í stofnmælingu botnfiska að hausti, árin 1996-2016.

MANAGEMENT

The Ministry of Industries and Innovation (MII) is responsible for management of the Icelandic fisheries and implementation of legislation. Lemon sole was included in the ITQ system in the 1999/2000 quota year and as such subjected to TAC limitations.

Between 2005 and 2009, the TAC was set higher than recommended by Marine Research Institute (MRI), but this practice stopped in the 2010/2011 quota year (Table 3). No formal management plan exists for this stock.

Figure 16 shows the net transfers in the Icelandic ITQ-system. From 2003-2008 (positive values in Figure 16) there was a net transfer of other species being transferred to lemon sole quota. However, from 2009-2015, there was little lemon sole quota transferred to other species until two years ago when there was a considerable amount transferred to lemon sole from other species quota.

Table 3. Lemon sole. Recommended TAC, national TAC set by the Ministry, and landings (tonnes).

Tafla 3. Þykkvalúra. Tillögur Hafrannsóknastofnunar um hámarksafli, ákvörðun stjórnvalda um aflamark og landaður afli (tonn).

FISHING YEAR	REC. TAC	NATIONAL TAC	CATCH
1999/00	1400	1400	1400
2000/01	1400	1400	1400
2001/02	1400	1400	1000
2002/03	1600	1600	1100
2003/04	1600	1600	2100
2004/05	1600	1600	2600
2005/06	1600	1800	2500
2006/07	1600	2000	2900
2007/08	1600	2200	2600
2008/09	1800	2200	2700
2009/10	1800	2200	2000
2010/11	1800	1800	1740
2011/12	1800	1800	1800
2012/13	1400	1400	1460
2013/14	1600	1600	1430
2014/15	1600	1600	1760
2015/16	1300	1300	1720
2016/17	1087	1087	
2017/18	1304		

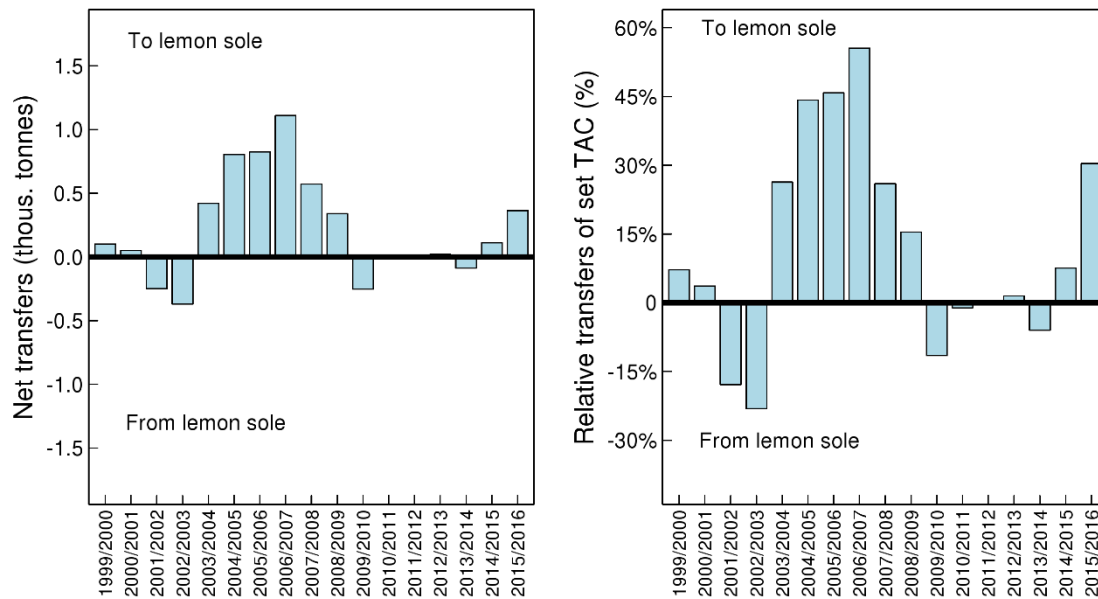


Figure 16. Lemon sole. Net transfers of quota to/from lemon sole in the Icelandic ITQ system by fishing year. Positive values indicate that other species are being transferred to lemon sole but negative mean that lemon sole quota is being converted to other species.

Mynd 16. Þykkvalúra. Tilfærsla á kvóta milli þykkvalúru og annarra tegunda í kvótakerfinu eftir fiskveiðiarum. Jákvæð gildi tákna að kvóta annara tegunda var breytt í þykkvalúru, en neikvæðar að þykkvalúrukvóta var breytt í aðrar tegundir.

ADVICE 2017

This advice follows the ICES framework for stocks where reliable stock biomass indices are available, but analytical age-length assessments are not feasible (Category 3 stocks). Spring survey biomass index of lemon sole 30 cm and larger, along with catch, is used to calculate F_{proxy} (catch/survey biomass). The target F_{proxy} was defined based on the mean of the reference period of 2010-2015 (Figure 17). Analysis of age disaggregated catch data from the reference period in 2016 suggested that fishing mortality was too high and the average fishing mortality needed to be lowered by at least 20%. The advice from 2016 and onwards is therefore based on multiplying the most recent index value with target F_{proxy} that is average F_{proxy} of the reference period reduced by 20%. The advice for the 2017/2018 is therefore the spring survey biomass index, 4382 * target F_{proxy} 0.38 or 1665, but since that is more than 20% increase from last year, an uncertainty cap is applied, bringing the recommended TAC down to 1304 tonnes (Table 4).

Table 4. Lemon sole. Advice calculations

Tafla 4. Þykkvalúra. Útreikningur ráðgjafar

Index 2017	4382
Target F_{proxy}	$0.8 * 0.48 = 0.38$
Advice 2016	1087
Index 2017 x Target F_{proxy} / Advice 2016	1.53
Uncertainty cap	Applied 20%
Catch advice	$1087 * 1.20 = 1304 \text{ t}$

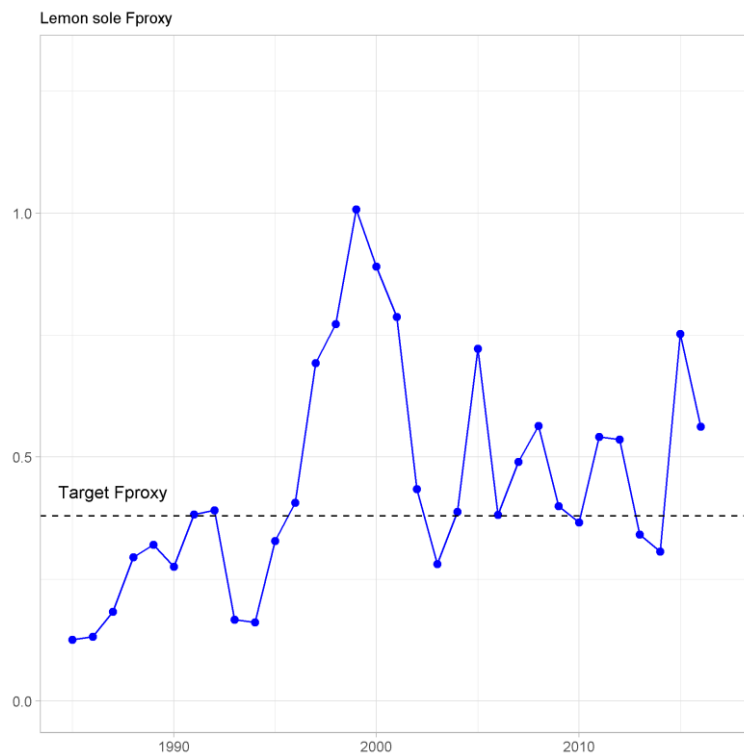


Figure 17. Lemon sole. F_{proxy} (catch/survey biomass). The F_{proxy} is set as 80% of the mean of the reference period of 2010-2015.

Mynd 17. Þykkvalúra. Vísitala veiðihlutfalls ($F_{\text{proxy}} = \text{afli/vísitala}$). Markgildi F_{proxy} byggir á 80% meðaltali árána 2010-2015, en á þeim tíma voru vísitölur veiðihlutfalls og lífmassa tiltölulega stöðugar.