

LUMPFISH – HROGNKELSI

Cyclopterus lumpus

GENERAL INFORMATION

The underlying data and assumptions for the assessment and advice on fishing opportunities on lumpfish in Icelandic waters are introduced here. Juvenile lumpfish are non-shoaling, mainly pelagic and are distributed in open water throughout the Norwegian Sea, Denmark Strait and Irminger Sea. When they mature, lumpfish migrate to coastal areas around Iceland to spawn with males arriving January-February and females arriving February-March. During the migration, females exhibit a mix of pelagic and demersal behaviour. The weight of the roe close to spawning can account for 25-35% of female body weight. Lumpfish show pronounced sexual dimorphism, with the males maturing at a smaller size (~25-35 cm) than the females (~35-45 cm) and the males have an intense red colouration during the spawning season (Fig. 1). The females lay the eggs in nests in shallow water and the male will then guard the eggs until they hatch.



Fig. 1. Lumpfish Female (back) and male (front) lumpfish.

Mynd. 1. Hrognkelsi Grásleppa (aftan) og rauðmagi (framan).

COMMERCIAL FISHERY

There are two separate fisheries for lumpfish, a small scale male fishery (less than 40 tonnes per year) for the flesh and a much larger female fishery (typically 2 to 10 thousand tonnes per year) where the primary target is the roe.

The female fishery takes place from March until August, and uses gillnets with a mesh between 267 and 292 mm. More than 99% of the landings of females are from the directed female fishery. The female fishery takes place close to shore and is located in Faxaflói Bay, Breiðafjörður and along the northern coast (Fig 2). Landings from the female fishery peaked between late 1970's and 1980's (Fig. 3). Between 1980 and 2021, landings have fluctuated between 2 and 13 thousand tonnes. Pre 2008, landings have been estimated from the number of barrels of roe produced with the numbers being provided by the National Small Boat Owners Association. From 2008, it became mandatory that all

landings are recorded in a similar manner to all other fisheries in Iceland, however it was still legal to dispose of the bodies at sea so the majority of landings consisted of only roe. In 2012, it became mandatory to land the bodies but an exception has been made for 2021 and 2022 due to market conditions. As there is currently no TAC on either of these fisheries, there is no incentive to discard lumpfish, however as of 2019, it is legal to release male lumpfish caught while targeting females.

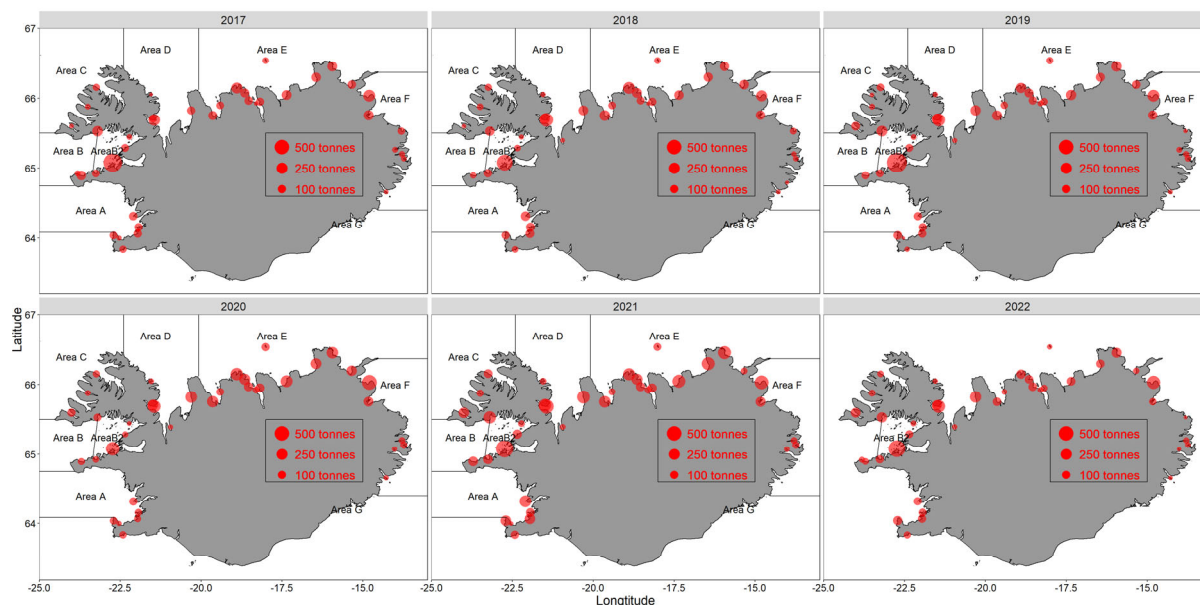


Fig. 2. Lumpfish. Landings of female lumpfish by 2017–2022. Lumpfish management areas are shown. In 2020, there were only two management areas.

Mynd 2. Hrognkelsi. Landanir á grásleppu árin 2017–2022 eftir löndunarhöfn. Stjórnunarsvæði grásleppuveiða eru afmörkuð. Árið 2020 voru stjórnunarsvæðin aðeins tvö.

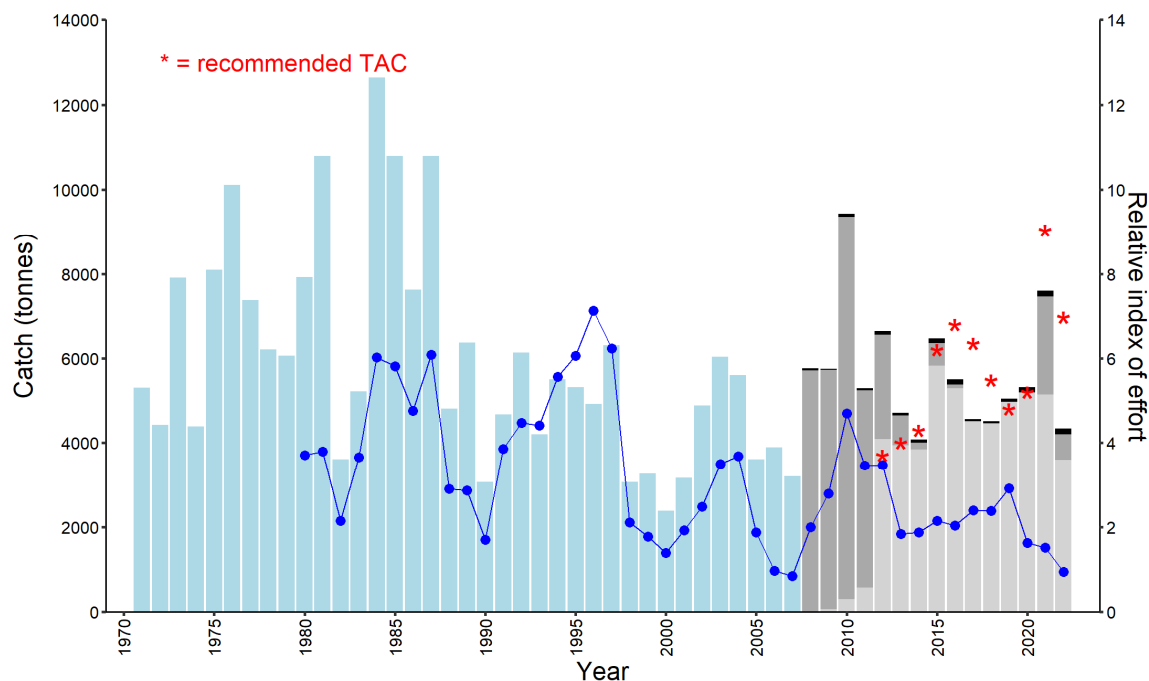


Fig. 3. Lumpfish. Landings of female lumpfish between 1970 and 2022 (bars) and lumpfish gillnet effort index for the female fishery 1980–2022 (blue line). Blue bars represent landings estimated from

barrels of roe. Dark grey represents landings of roe converted to weight of whole lumpfish, and light grey represents landings of whole lumpfish. Black represents landings of whole lumpfish and roe converted to weight of whole lumpfish from other fisheries. The recommended TAC for each year is shown with red asterisks.

Mynd 3. Hrognkelsi. Landanir á grásleppu 1970-2022 (súlur) og sóknarvísitala grásleppuneta (blá lína) árin 1980-2022 Ljósbláar súlur sýna ár þar sem afli var metinn út frá fjölda tunna af hrognum, dökkgráar súlur sýna landanir hroga umreiknaðar í heila grásleppu, ljósgráar súlur landanir heillar grásleppu úr grásleppuveiðum, svartar úr öðrum veiðum. Ráðlögð heildarveiði er sýnd með rauðum stjörnum.

The male fishery takes place in only a few locations along the coast (Fig. 4) from January to March and uses gillnets with a mesh of between 178 and 203 mm. Approximately 20-60 tonnes of male lumpfish are landed each year with the directed fishery making up between 2 and 56% of the total landings per year between 2003 and 2021 (Fig. 5). Other landings of males come from the female fishery and from other gears (cod gillnets, demersal seine and bottom trawls). The effort in the cod-gillnet fishery increased from 2002-2006 and then decreased from 2006-2020 which is reflected in the landings of male lumpfish. This decrease of landings from the cod gillnet fishery partially accounts for the wide range in the percentage of total landings from the male fishery.

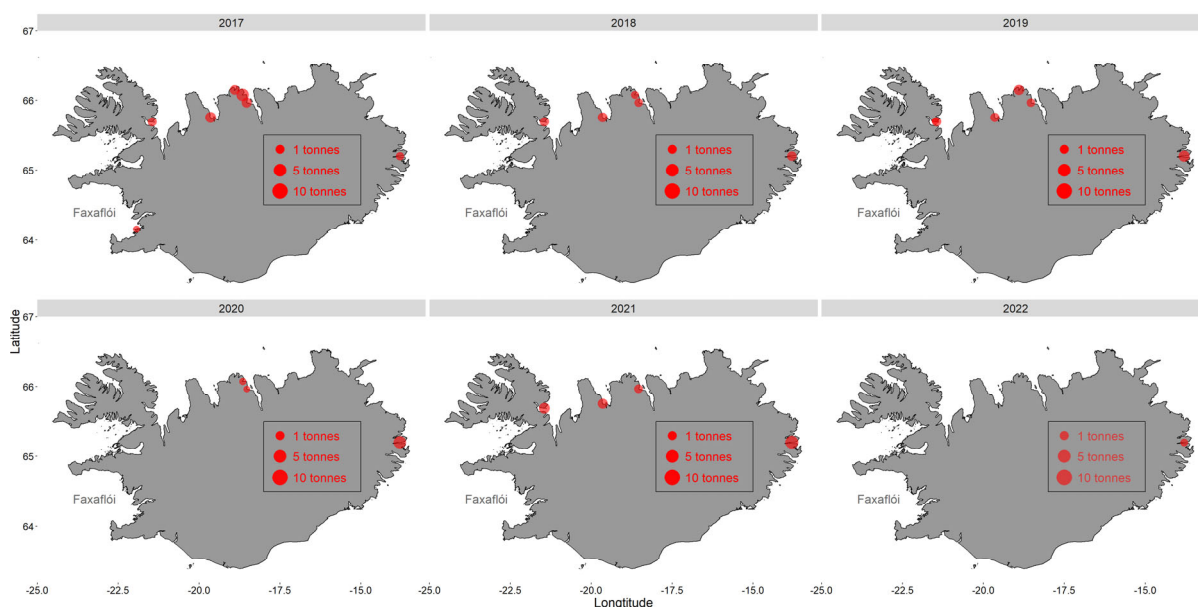


Fig. 4. Lumpfish. Landings of male lumpfish from the directed male fishery by harbour 2017-2022.

Mynd 4. Hrognkelsi. Landanir á rauðmaga úr rauðmaganetum árið 2017-2022.

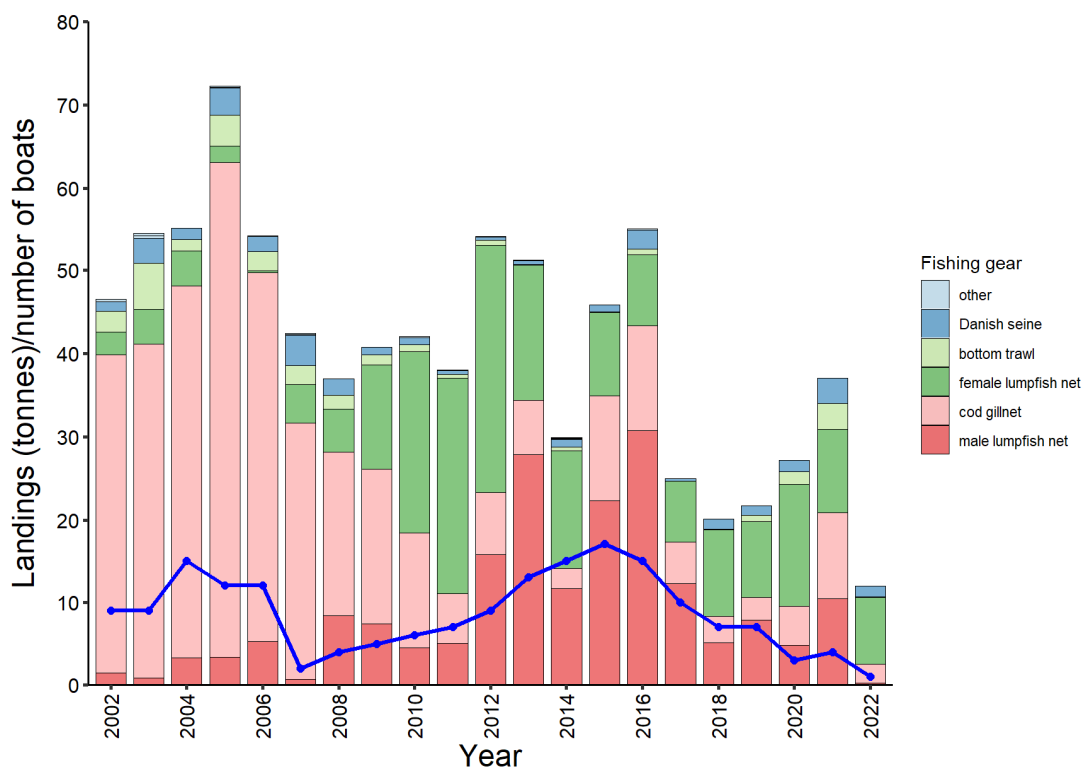


Fig. 5. Lumpfish. Landings of male lumpfish between 2002 and 2022 by gear type. Blue line shows the number of boats which participated in the male fishery.

Mynd 5. Hrognkelsi. Landanir á rauðmaga 2002-2022 úr rauðmaganetum og öðrum veiðfærum. Bláa línan sýnir fjölda báta sem tóku þátt í rauðmaganetaveiðum hvert ár.

ESTIMATION OF HISTORICAL LANDINGS

As landings data was not routinely collected before 2008, the landings before this period are estimated from number of barrels of roe produced with this data being provided by the National Association of Small Boat Owners. The method used to do this is described in Kennedy and Jónsson (2020). In summary, information from fisher logbooks is used to estimate the average weight of roe in a fish and the amount of fresh roe that is needed to fill one barrel of roe. The values currently used are 29.4% of the weight for the average amount of roe per fish and that it takes 139 kg of fresh roe to fill one barrel. This equates to 472 kg of ungutted lumpfish per barrel of roe, thus the weight of the landings of lumpfish (tonnes) = $0.472 \times \text{number of barrels}$.

Landings of roe that are recorded by the Directorate of Fisheries are converted to weight of whole lumpfish using the formula

$$W_{\text{lump}} = \text{roe} \cdot 1.25 \cdot \frac{100}{29.4}$$

where W_{lump} = weight of whole lumpfish and roe = weight of landed roe. When roe is landed, 20% of the weight is deducted to account for the fluids and this is the weight recorded by the directorate of fisheries. It is assumed the roe accounts for an average of 29.4% of the weight of the fish.

MANAGEMENT AND PREVIOUS ADVICE

The female lumpfish fishery is an effort controlled fishery with limits placed on the total length of nets, total number of fishing days and total number of boats. The total number of boats is limited as boats must have, in addition to a valid commercial fishing licence, "Grásleppuréttindi", a permit which allows the boat to fish for lumpfish. In March 2023 there were 437 boats with Grásleppuréttindi. No new permits are issued, and a permit can only be obtained by transferring it from one boat to another. However, there is currently no system which can prevent all boats with a valid permit taking part in the fishery of one particular year. To participate in the fishery for the current year, a boat with a permit to fish lumpfish must inform the Directorate of Fisheries that they will activate the license for that year.

Up until 2020, the coastline around Iceland was divided into 7 areas (Fig. 2), each area was open for lumpfish fishing for approximately 2.5 months. Each boat had to select an area for that year and could not fish in another. The licence allowed fishing for female lumpfish for an allocated number of days within the time period in which that area was open, each boat choosing a continuous period within the open season. The area system was abolished in 2020 and boats were free to move between areas, except for the inner Breiðafjörður area (B2) which opens later (20th May) than the other areas. The area system was reinstated in 2021. There are a number of areas which are closed for lumpfish fishing to lower the bycatch of marine mammals (Fig. 6).

The primary method to limit catches of female lumpfish is by altering the total number of days that each boat can fish for. The number of days is set annually by the Minister of Fisheries and Agriculture and is based upon an advised TAC for female lumpfish from MFRI and discussions with stakeholders. MFRI have been advising on a TAC since 2012 (Table 2), which is given in tonnes (see Advice section below).

The only restrictions on the male fishery are the period in which a male lumpfish net can be used (1st January – 15th June) and the mesh size and height of the net. There is no TAC and MFRI does not issue advice on a TAC.

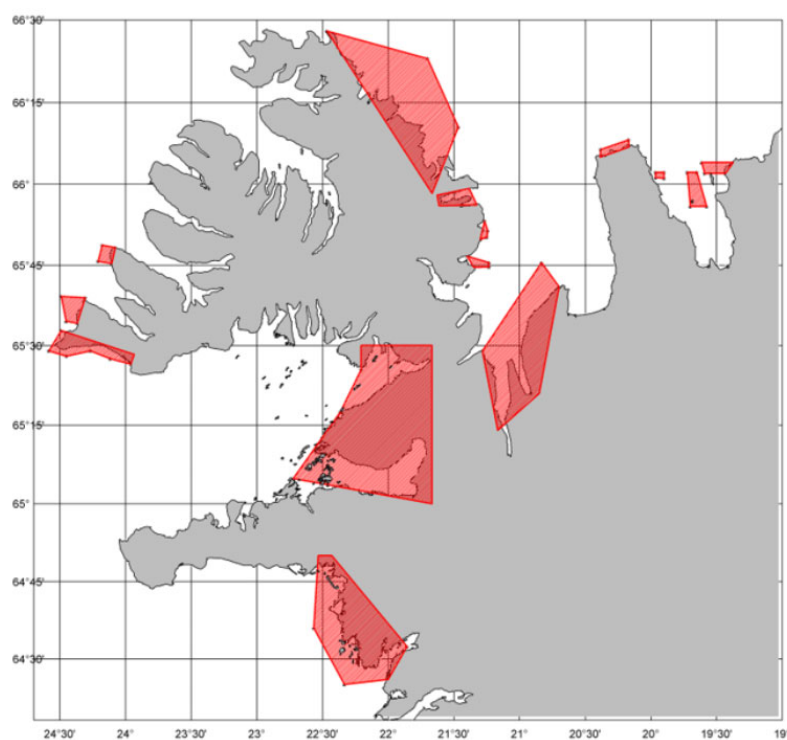


Fig. 6. Lumpfish. Areas closed to lumpfish fishing from 2020 to reduce the risk of marine mammal bycatch.

Mynd 6. Hrognkelsi. Kort sem sýnir svæðin sem lokuð verða fyrir veiðum með hrognkelsanetum vertíðina 2020 til að draga úr meðafla sjávarspendýra.

EFFORT AND CATCH PER UNIT EFFORT (CPUE)

The number of boats participating in the female fishery is influenced, alongside other factors, by the market price of the roe. Pre-1996, the number of boats participating in the fishery was higher, varying approximately between 290 and 450 per year (Table 2). Post 1996, the number of boats has varied from 144 to 363. However, the number of nets per boat has increased between these two periods, while the number of days for which each boat can fish has decreased (Table 2). The number of boats participating in the male fishery has varied between 2 and 17 between 2001 and 2021 (Fig. 3).

The CPUE is estimated from fisher logbooks and is calculated as the weight of catch divided by the number of nets (Fig. 7). The CPUE of the female fishery has varied over time and is influenced both by the biomass of the population and by the effort itself.

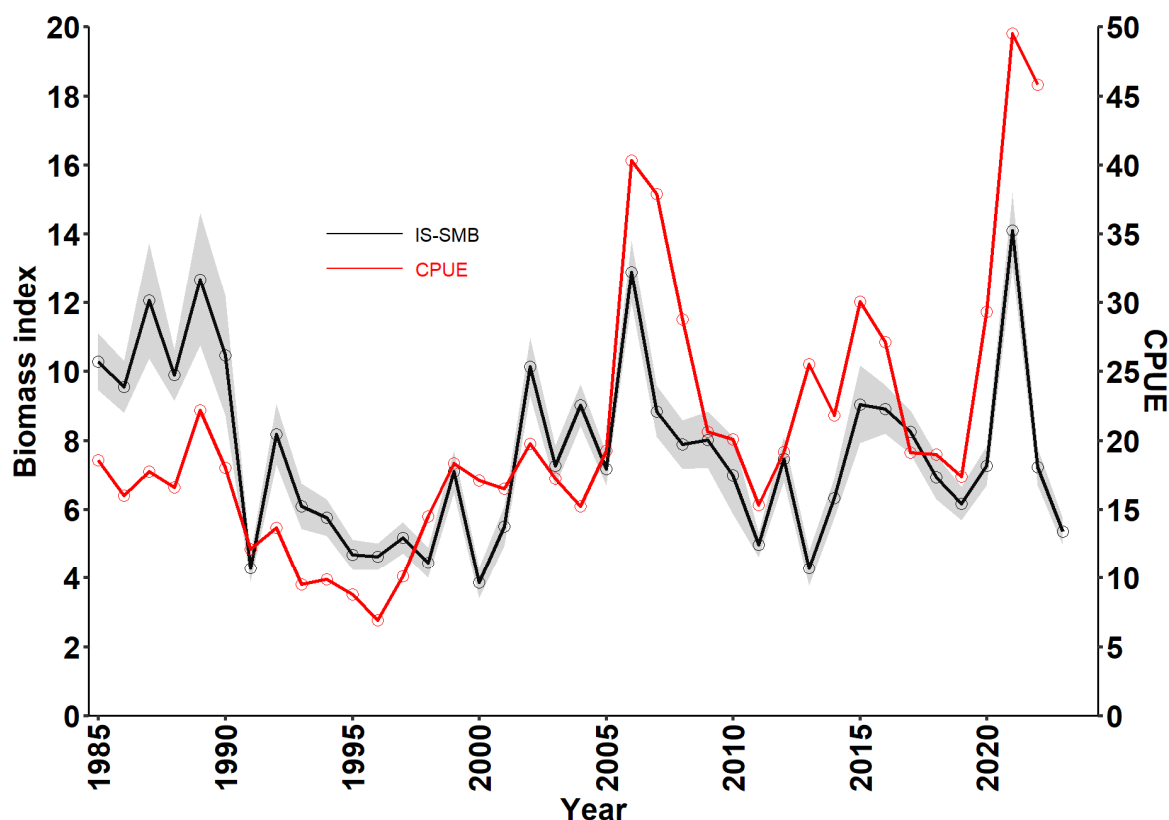


Fig. 7. Lumpfish. Biomass index of female lumpfish in March from the IS-SMB and CPUE from the female fishery.

Mynd 7. Hrognkelsi. Lífmassavísitala grásleppu í stofnmælingu í mars (IS-SMB) og afli á sóknareiningu (CPUE) við grásleppuveiðar.

LENGTH COMPOSITION OF LANDINGS

Pre 2012, obtaining length measurements from the female fishery was difficult due to the removal of roe before landing and disposing of the bodies at sea. Due to a change in regulations in 2012, the

majority of landings consist of ungutted lumpfish. The landings are aggregated at a small number of locations for processing making it more straightforward to sample from the fishery. Mean length of fish caught in the female fishery is around 38-41 cm with limited variation between years (Fig.8), this is primarily due to the limited length range in the population and the selectivity of the gillnets.

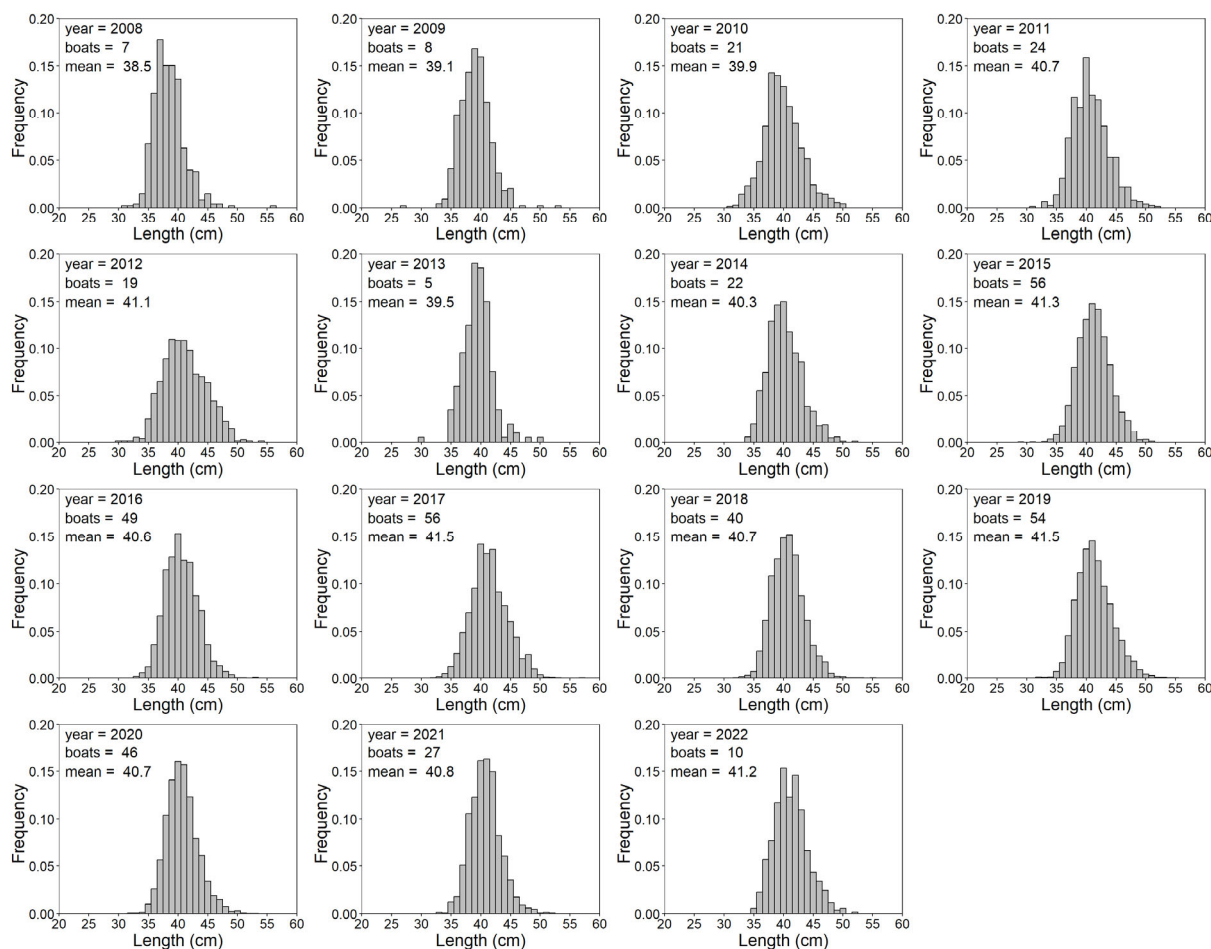


Fig. 8. Lumpfish. Length distribution of females from the female fishery from 2008-2022. The number of boats sampled and mean length is given. Forty fish are measured from each boat sample.

Mynd 8. Hrognkelsi. Lengdardreifing grásleppu í afla árin 2008-2022, ásamt fjölda báta og meðallengd hvert ár. Fjörutíu fiskar eru mældir í sýni úr afla hvers báts.

BIOMASS INDICES

Data from the IS-SMB is currently used as the basis for tracking trends in biomass of the female lumpfish population (Fig. 9). This survey covers a large part of the temporal and depth distribution of mature female lumpfish. Data from the annual gillnet survey is also taken into account as supporting information (Fig. 10). In general, the biomass index for females from the IS-SMB was high between 1985-1990, low during the 1990's and at roughly intermediate levels during the 2000's. It decreased during the early 2010's but has recently increased to intermediate levels. The length distribution has changed over time (Fig. 11), with females ≥ 45 cm being more abundant during 1985-1990 than in the years post 1990. The abundance of large females reached a minimum in 1997 but has gradually increased since then, with the abundance in 2017 being the highest since 1990 (Fig. 9).

Catchability of male lumpfish in the IS-SMB seems to be very poor and the trends are not considered to reflect the real changes in the population (Fig. 12). There has been little change in the length composition of males over time (Fig. 13).

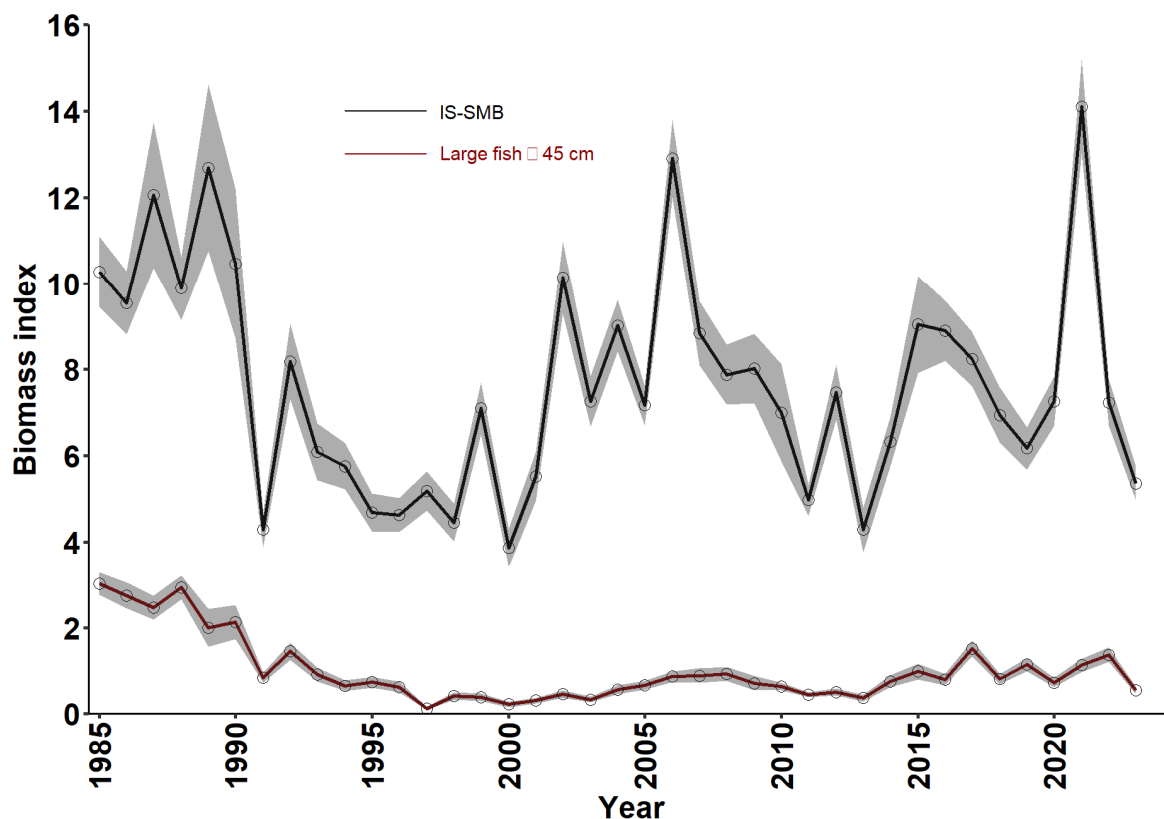


Fig. 9. Lumpfish. Biomass index of female lumpfish and biomass index of large lumpfish ≥ 45 cm in March from the IS-SMB.

Mynd 9. Hrognkelsi. Lífmassavísitölur grásleppu og grásleppu ≥ 45 cm í stofnmælingu í mars (IS-SMB).

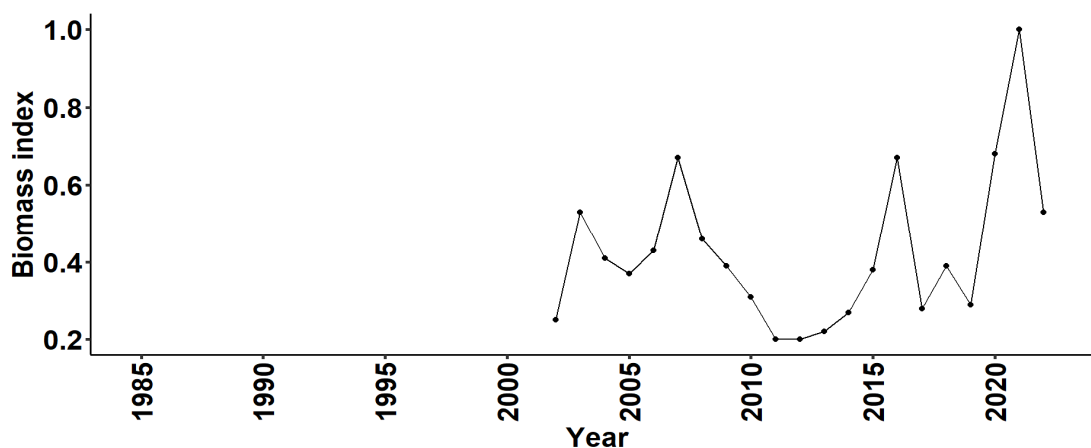


Fig.

10. Lumpfish. Biomass index of lumpfish from the gillnet survey (SMN). Note that it is not separated by sex.

Mynd 10. Hrognkelsi. Lífmassavísitala hrognkelsi í stofnmælingu með netum (SMN). ATH vísitalan er fyrir bæði kynin.

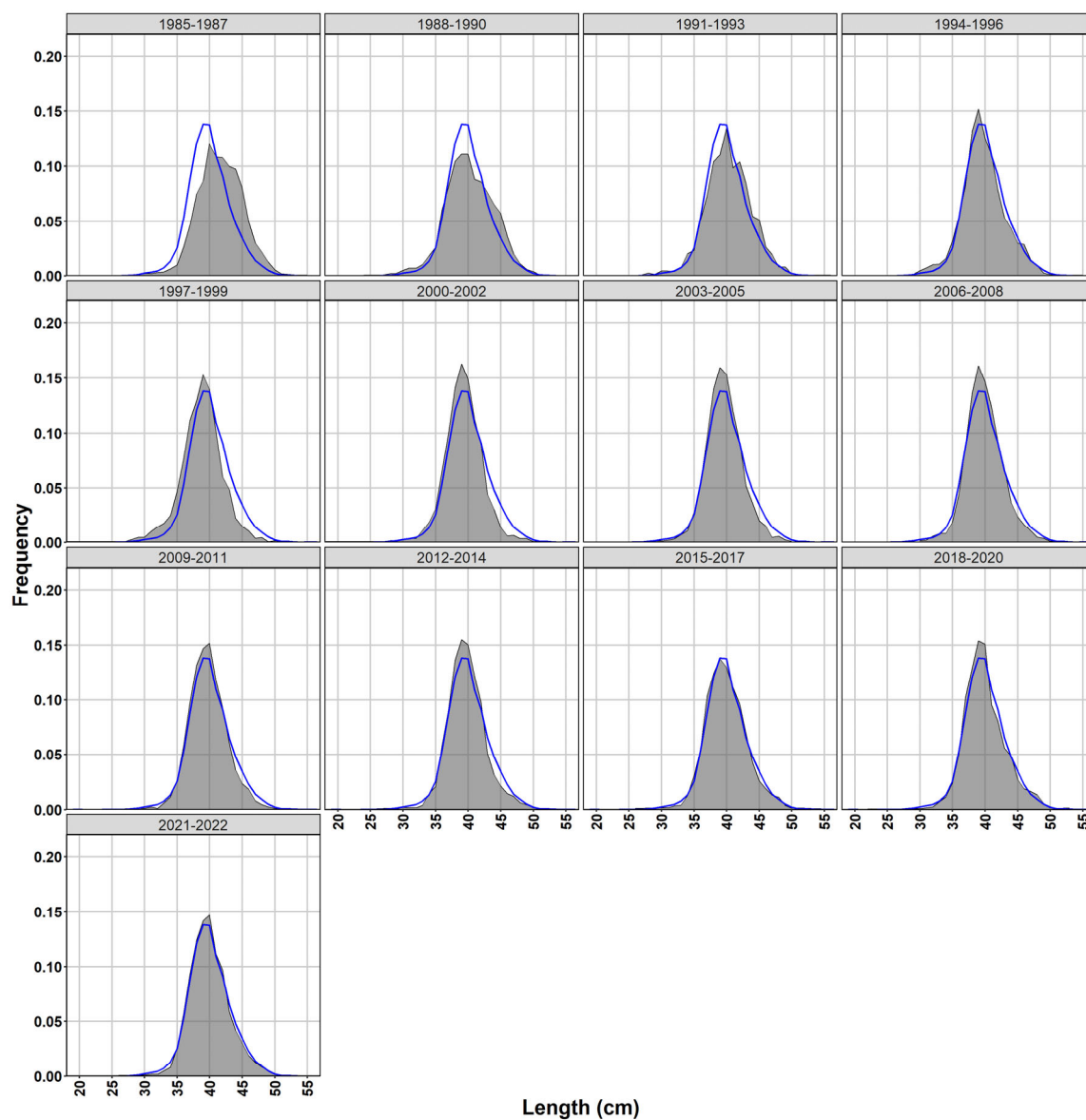


Fig. 11. Lumpfish. Length distribution of female lumpfish caught in the IS-SMB grouped into three year periods for 1985-2022. Lines represent the average length distribution for the whole study period.

Mynd 11. Hrognkelsi. Lengdardreifingar grásleppu í IS-SMB, skipt í 3 ára tímabil. Línurnar sýna meðaltal fyrir allt tímabilið.

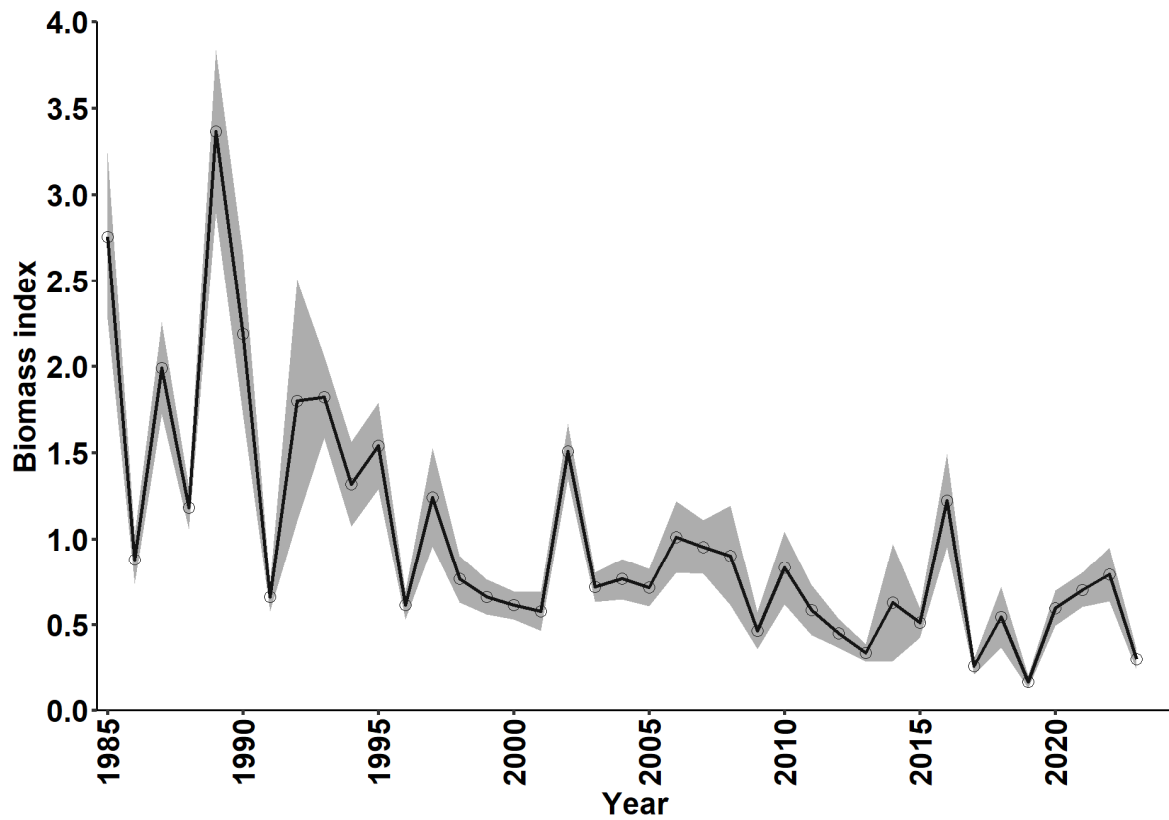


Fig. 12. Lumpfish. Biomass index of males from the IS-SMB.

Mynd 12. Hrognkelsi. Lífmassavísitala rauðmaga í stofnmælingu í mars (IS-SMB).

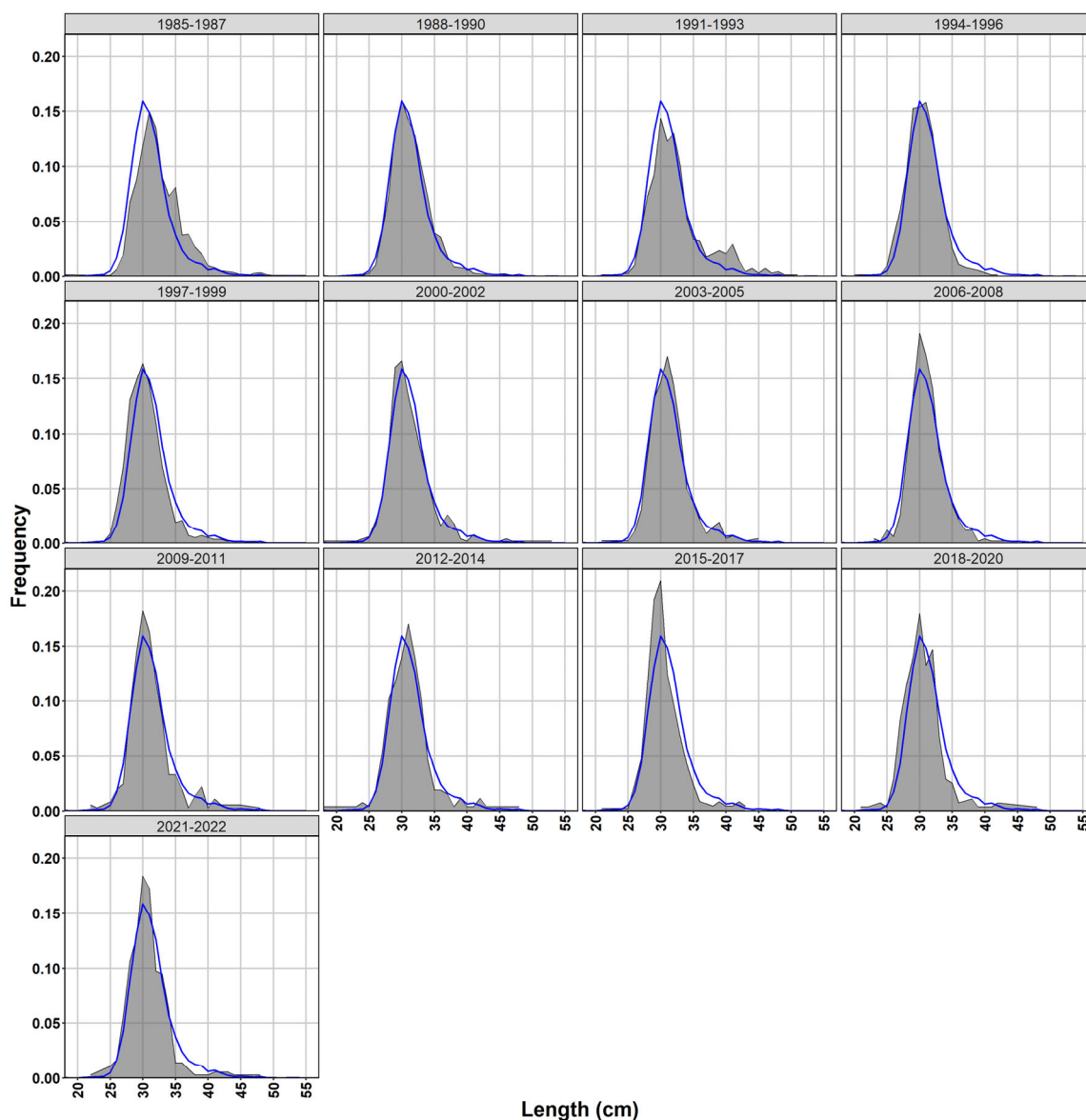


Fig. 13. Lumpfish. Length distribution of male lumpfish caught in the IS-SMB grouped in three year periods. Lines represent the average length distribution for the whole study period.

Mynd 13. Hrognkelsi. Lengdardreifingar rauðmaga í IS-SMB, skipt í 3 ára tímabil. Línurnar sýna meðaltal fyrir allt tímabilið.

F_{PROXY}

An index of relative fishing mortality for lumpfish is derived from the IS-SMB and landings of whole lumpfish ($F_{\text{proxy}} = \text{Yield}/\text{Survey biomass index}$) (Fig. 14, Table 1).

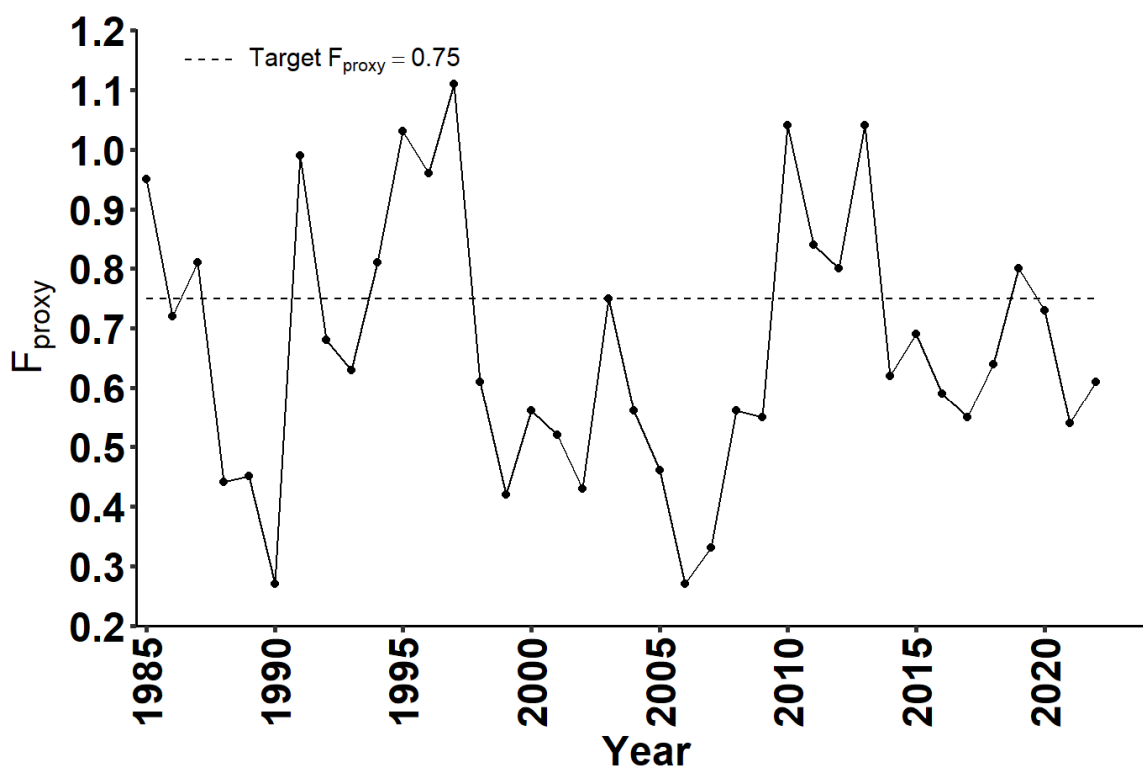


Fig. 14. Lumpfish. F_{proxy} of female lumpfish 1985-2022. Average F_{proxy} for the reference period (1985-2019) is shown (dashed line).

Mynd 14. Hrognkelsi. Vísitala veiðihlutfalls hrygna 1985-2021. Sýnt er meðaltal viðmiðunarára (1985-2019).

ADVICE

In 2020, the lumpfish assessment went through a benchmark assessment (Kennedy et al. 2021) together with representatives from the Ministry of Fisheries (Fiskistofa), the fishing and processing industry. It was concluded that historical catches estimated from the number of barrels reported to the NASBO on an annual basis pre-2008 was not suited for input into the assessment. A new harvest plan was agreed which came into force in the 2021 assessment.

The results of the benchmark concluded that the use of a constant exploitation rate is appropriate for this stock and that recent historical catches (2008-2020) suggest an exploitation level of 0.75, the exploitation level used in setting the advice from (2013-2020), is likely sustainable.

The lumpfish biomass index fluctuates considerably between years, therefore, the index from the current fishing year is taken into account when considering the advice. To compensate for uncertainty in the measurements, the previous year's index is also taken into account. The current year's and previous year's survey are giving a weighting of 70 and 30% respectively. The advice from the MFRI based on target F_{proxy} is thus given in two stages, an initial TAC based upon the biomass index of the preceding year and a final TAC based upon the current biomass index.

The advisory rule (Fig. 15) now includes a biomass safeguard which entails the application of a linear reduction in the target F_{proxy} when the biomass index (I) falls below the level of a precautionary trigger I_{trigger} set at $1.4 \cdot I_{\text{lim}}$. As the advice is made up of two components, calculated from I from the current year and the previous year, then, if I is equal to or below I_{lim} , in the current year or previous year, then

that year will represent a value of zero in the calculation of TAC. I_{lim} was set at the historical minimum of the biomass index in the reference period 1985-2020 (Table 1).

On the basis of the SMB biomass indices in 2022 (7233) and 2023 (5352), the advice for the 2023 fishing season comes to 4411 tonnes. MFRI further advises that the initial TAC for the fishing year 2023/2024 should be 1193 tonnes.

Table 1. Summary of reference points for the lumpfish in Icelandic waters and their basis.

Tafla 1. Gátmörk fyrir hrognkelsi og grunnur þeirra.

Nálgun <i>Framework</i>	Viðmiðunarmörk <i>Reference point</i>	Gildi <i>Value</i>	Grundvöllur <i>Basis</i>
Varúðarnálgun <i>Precautionary approach</i>	Target $F_{MSY\ proxy}$	0.75	Meðaltal F_{proxy} árin 2014-2020 <i>Mean F_{proxy} for 2014-2020</i>
	I_{lim}	3859	Lægsta sögulega gildi <i>Historical minimum</i>
	$I_{trigger}$	5403	$I_{lim} \times 1.4$

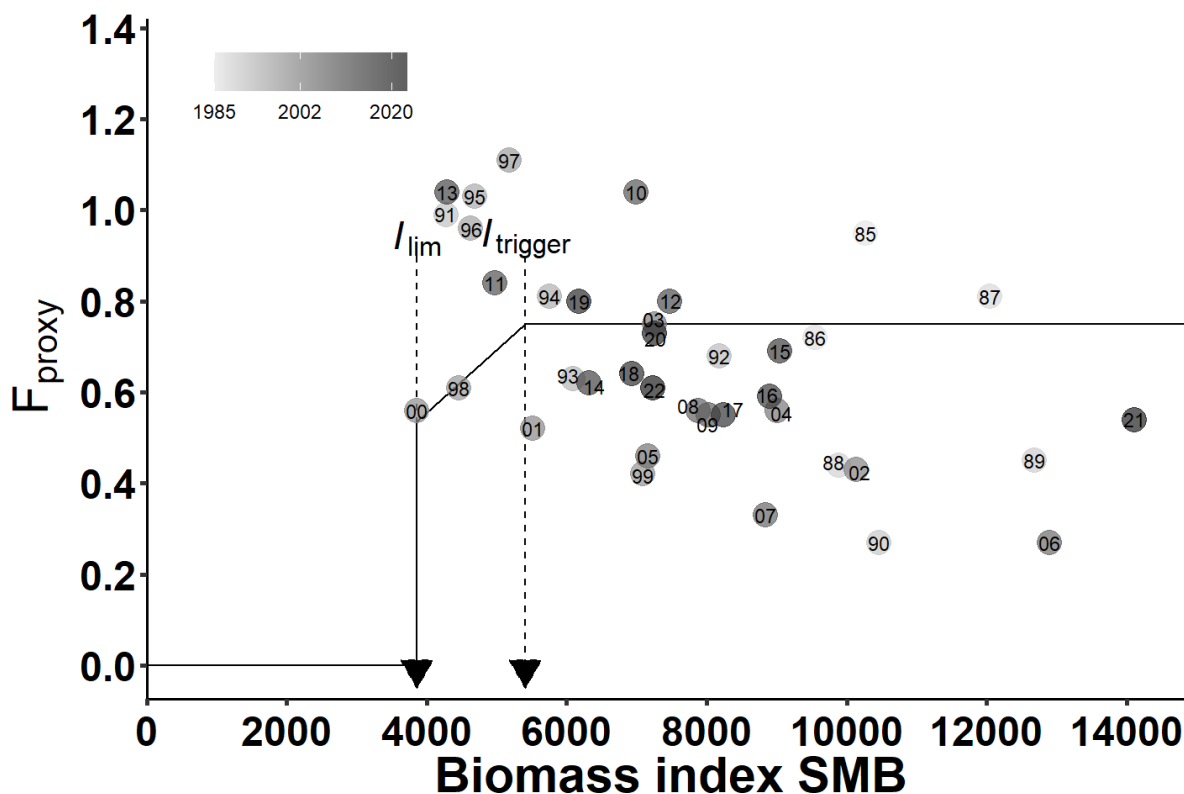


Fig. 15. Change in F_{proxy} (line) used in calculation of advised TAC versus the biomass index from the spring groundfish survey. The biomass index and actual F_{proxy} of previous years are shown.

Fig. 15. Breytingar í markgildi veiðihlutfalls (F_{proxy}) notað í útreikningum á veiðiráðgjöf miðað við lífmassavísitölu frá SMB. Vísitala og raun veiðihlutfall fyrri ára er sýnt með punktum.

Table 2. The number of boats which participated in the female lumpfish fishery, the maximum number/total length of nets (the maximum number per crew member and the maximum per boat, in brackets, is shown for years 1980-2012), the maximum number of consecutive fishing days for each boat, the biomass index of female lumpfish from the IS-SMB, the advised TAC and total catch from the directed female fishery (Landings.DF) and from other fisheries (Landings.other) between 1980-2019. In 2017, the number of fishing days was increased from 36 to 46 days during the season. In 2020, the season was halted before all boats could complete the allocated number of days.

Tafla 2. Yfirlitstafla fyrir árin 1980-2020 um fjölda báta á grásleppuveiðum, hámarks fjöldi/heildarlengd neta (hámarksfjöldi neta á áhafnarmeðlim og á bát, innan sviga, er gefin fyrir árin 1980-2012), hámarksfjöldi veiðidaga á bát, lífmassavísitölur grásleppu IS-SMB, ráðlagður afli, heildarafli í beinum veiðum og heildarafli í óbeinum veiðum.

Year	Boats	Nets	Fishing.days	SMB.index	Advice	Landings.DF	Landings.other
1980	343	50 (150)				7926	0
1981	347	50 (150)				10798	0
1982	219	50 (150)				3615	0
1983	292	50 (150)				5214	0
1984	384	50 (150)				12637	0
1985	401	50 (150)		10273		10798	0
1986	298	50 (150)		9546		7624	0
1987	350	50 (150)		12052		10798	0
1988	334	50 (150)		9887		4815	0
1989	353	50 (150)		12680		6372	0
1990	234	50 (150)		10461		3068	0
1991	356	50 (150)		4283		4673	0
1992	393	50 (150)		8180		6137	0
1993	326	50 (150)		6092		4200	0
1994	401	100 (300)		5756		5504	0
1995	417	100 (300)		4682		5315	0
1996	447	100 (300)		4628		4922	0
1997	372	100 (300)		5177		6313	0
1998	277	100 (300)		4454		3065	0
1999	258	100 (300)		7091		3266	0
2000	266	100 (300)		3859		2380	0
2001	197	100 (300)		5513		3167	0
2002	222	100 (300)		10132		4887	0
2003	272	100 (300)		7259		6033	0
2004	353	100 (300)		9012		5599	0
2005	256	100 (300)	60	7163		3613	0

Year	Boats	Nets	Fishing.days	SMB.index	Advice	Landings.DF	Landings.other
2006	163	100 (300)	50	12896		3898	0
2007	144	100 (300)	50	8841		3196	0
2008	205	100 (300)	50	7879		5764	47
2009	265	100 (300)	62	8020		5753	27
2010	338	100 (300)	62	6995		9428	71
2011	363	100 (300)	50	4970		5290	50
2012	334	100 (300)	50	7467	3700	6641	83
2013	282	200	32	4285	4000	4709	57
2014	221	200	32	6322	4300	4074	63
2015	316	7500m	32	9041	6200	6474	117
2016	239	7500m	32	8901	6800	5504	119
2017	246	7500m	36	8241	6350	4565	52
2018	218	7500m	46	6937	5487	4516	48
2019	240	7500m	44	6173	4805	5044	77
2020	202	7500m	44	7260	5200	5315	122
2021	173	7500m	40	14108	9040	7601	136
2022	175	7500m	25	7233	6972	4335	138
2023				5352	4411	0	0

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ICES 2020. 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. 2:98. 72 pp. <http://doi.org/10.17895/ices.pub.5985>

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