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Converting number of barrels of lumpfish roe to ungutted landings based on logbook data / *Umreikningur á fjölda tunna af grásleppuhrognum yfir í óslægðan afla byggður á veiðdagbókum*

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Abstract

The method for converting the time series of barrels of roe produced to ungutted lumpfish was reviewed and revised due to the uncovering of errors in how the data was treated. Correcting these errors along with a slight revision of the method (reconsidering the average gonadosomatic index of lumpfish), increased estimated landings for the period 1985–2007 by approx. 10%. In addition, we now take into account the fact that the weight of landed roe was recorded as 20% lower than the actual weight (the so-called "sullprósenta") by the Directorate of Fisheries from 2008-2016. Taken together, this increased the reference value of Fproxy from 0.67 to the former value of 0.75, which would result in a corresponding increase in TAC to 5200 tonnes for the 2020 female lumpfish season. Logbook data used in the analysis have been made publicly available on https://data.hafro.is/research/lumpfish_logbooks/.

Ágrip

Umreikningur tímaraðar landana í tunnum yfir í óslægða grásleppu var endurskoðaður. Í ljós komu mistök sem ásamt lítilsháttar endurskoðun aðferðarinnar hækkuðu áætlaðar landanir tímabilsins 1985-2007 um rétt ríflega 10%. Auk þess var hætt að lækka landanir hrogna um sullprósentu (20%) eins og gert er í gagnagrunni Fiskistofu tímabilið 2008–2016. Samanlagt hækkaði viðmiðunargildi vísitölu veiðhlutfalls úr 0.67 í fyrra gildi eða 0.75, sem hefði þær afleiðingar að ráðlagður heildarafli fyrir grásleppuvertíðina 2020 hækkaði sem því næmi í 5200 tonn. Gögn úr veiðidagbókum um grásleppuveiðar sem

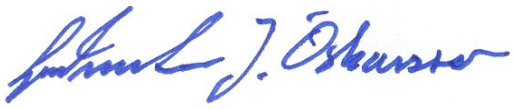
greiningin byggir á hafa verið gerð aðgengileg á https://data.hafro.is/research/lumpfish_logbooks.	
Lykilorð*: Hrognkelsi, grásleppa, landanir, umreikningur, vísitala veiðihlutfalls*	
Undirskrift verkefnisstjóra: 	**Undirskrift forstöðumanns sviðs:** 

Table of Contents

List of figures

List of tables

Introduction

Before 2008, landings data for lumpfish was not collected by Fiskistofa and the only data that is available from this period is the number of barrels of roe produced each year which was collected by the National Association of Small Boat Owners (NASBO). From 2008, Fiskistofa began collecting landings data, but as this was a roe fishery, most landings consisted of only roe as the carcasses were disposed of at sea. In 2012, it became mandatory to land the carcasses, but if the roe had been removed from the fish, only the roe was weighed. From 2012 until 2016, the proportion of landings that consisted of roe decreased while the proportion landed as ungutted fish increased. In 2017–2019, landings consisted entirely of ungutted lumpfish.

The Marine and Freshwater Research Institute began offering advice on the total allowed catch (TAC) of lumpfish in 2012. Given that data on lumpfish and their life history is limited, the general premise of the advice is that the fishery should not expand (as the consequences of doing so are unknown) and that exploitation levels should be at, or below, the long term average (MFRI 2020). For this, historical data on landings was needed (in addition to an index of stock size), thus the data on number of barrels of roe needed to be converted to weight of whole lumpfish. Up until 2014, landings of whole lumpfish were estimated using the formula "landings(kg) = barrels/2.05". In 2015, this conversion factor was revised based upon information from logbooks from 1990–2010 with the revised method described in Kennedy and Jónsson (2017). It should be noted that Kennedy and Jónsson (2017) was not about estimating historical landings per se but simply made use of them, and as part of the "Materials and Methods", how the values were obtained was described. The new conversion works by converting the number of barrels into weight of fresh roe, which is then converted to weight of ungutted fish based upon information on the percentage of fish weight made up of roe. It is thus based upon two pieces of information, the amount of fresh roe in a barrel and the amount of weight of a lumpfish that is made up of roe, otherwise known as the gonadosomatic index (GSI). In 2017, the GSI was revised from 29.8 to 30.5%. Thus in effect, from 2012–2014, 2015–2016 and 2017–2020, the weight of ungutted lumpfish per barrel was assumed to be 487, 445 and 427 kg, respectively.

In 2020, the assumption that roe from 427 kg of ungutted females per barrel of fully processed roe was called into question and data from a lumpfish production line was supplied to support the case (Axel Helgason, pers. comm, unpublished data). It was claimed that it would require 510–550 kg of lumpfish to fill one barrel of roe. In order to investigate this discrepancy, the conversion factor is carefully re-evaluated.

Analysis and results

In connection with this review logbooks from the female lumpfish roe fishery 1980–2016 have been made publicly available on the web data.hafro.is. After it was made compulsory in 2012 to land the lumpfish whole or the carcasses along with the roe, the lumpfish logbooks have been taken into the general logbook data base maintained by the Directorate of Fisheries and MFRI/Hafró.

Logbooks from 1990–2010 were utilised. The data recorded by the fishers could consist of weight of roe and/or number of fish. The weight of the roe could either be given as fresh weight or after having gone through one or more stages of the salting process, which affects the weight. The processing stage and weight, either measured or estimated, was given in the logbooks.

Salting process

The weight of roe reported is either fresh roe or after having gone through some of the stages of the salting process which affects the weight. These stages are:

1. Roe with all fluid.
2. Drained roe.
3. Roe ready for salting.
4. Salted roe.

In order to standardise weight of roe given in the logbooks to weight of fresh roe, a conversion factor was established for each stage in the salting process using logbook entries which contained both number of fish and weight of roe. The data was filtered to remove unrealistic values. This was done by calculating roe per fish for each entry and then removing the highest 1% of values for each stage in the salting process. A one-sided trim was performed as very high values are not possible, small values, while unlikely, are possible. The total weight of roe was divided by the number of fish giving the average amount of roe per fish for each category of roe. Ratios between the averages for the categories were divided into the weight of roe to estimate the equivalent weight of fresh roe (Table 1). The denominator for salting stage 2 differs slightly from Kennedy and Jónsson (2017), where it was 0.94, due to a coding error in the filtering.

Table 1. Conversion factors for different processing stages of roe along with number of observations.

Processing stage	Number of observations	Mean weight of roe (kg)	Denominator
1	40170	0.881	1.00
2	42297	0.815	0.92
3	33563	0.680	0.77
4	10140	0.716	0.81

Roe conversions

Using the conversion factors (Table 1), the weight of fresh roe can be estimated from the weight of roe at different stages in the salting process. If the weight of roe is missing, it can be estimated from the number of fish by multiplying the number of fish by the average weight of fresh roe per fish from Table 1, i.e. 0.881 kg.

For each year, the total weight of roe reported in the logbooks was summed across all fishing trips and boats for the given year. The number of barrels reported in the same logbooks was summed across all boats, boats which landed less than 1 tonne of roe were excluded from the analysis. The number of boats included for each year varied from 47–205 (Table 2). The relationship between barrels of roe and weight of fresh roe was then established using linear regression forced through the origin (Figure 1). In Kennedy and Jónsson (2017), an error occurred during filtering of data which occurred when fishing boats supplied a value for barrels of roe but did not include the weight of roe, in one or more entries. This let to an underestimate of the amount of roe per barrel, but has now been corrected.

According to the calculations, **139 kg of fresh roe** (roe with all fluid) are needed to fill one barrel. Data supplied by one actor in the industry gave a value of 138 kg while data from Martinsdóttir (1980) gives an average value from 11 years of data as 150 kg. Assuming a GSI of 29.4%, the amount of fish needed to fill one barrel from the calculations in this report is **472 kg**.

Table 2. Number of boats included in the analysis per year.

Year	Number of boats
1990	100
1991	145
1992	162
1993	133
1994	57
1995	166
1996	174
1997	149
1998	101
1999	84
2000	66
2001	62
2002	40
2003	76
2004	87
2005	47
2006	66
2007	57
2008	80
2009	85
2010	75

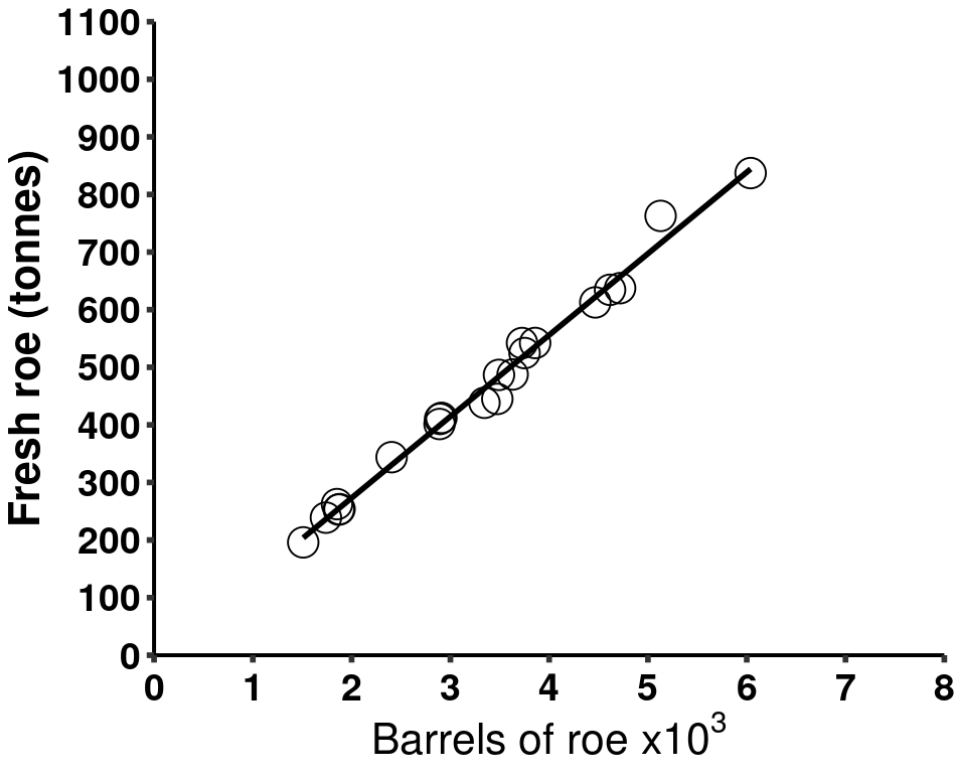


Figure 1. Amount of fresh roe versus number of barrels for each year from 1990 to 2010. The slope of the regression line is 0.139 (SE = 0.001, $p < 0.001$).

Sensitivity to GSI

The calculations of roe needed to fill one barrel are sensitive to the value used for GSI, increasing the value used by 1% decreases the weight of fish needed to fill a barrel by 14–22 kg (Table 3). In Kennedy and Jónsson (2017), a value of 30.5% was used based upon a rounded median. More samples collected from the commercial fishery are now available (Figure 2), taking this data into consideration,the average value from the logbook data (assuming an average fish weight of 3 kg, thus 100*(881/3000)), 29.4%, is considered to be a more appropriate value.

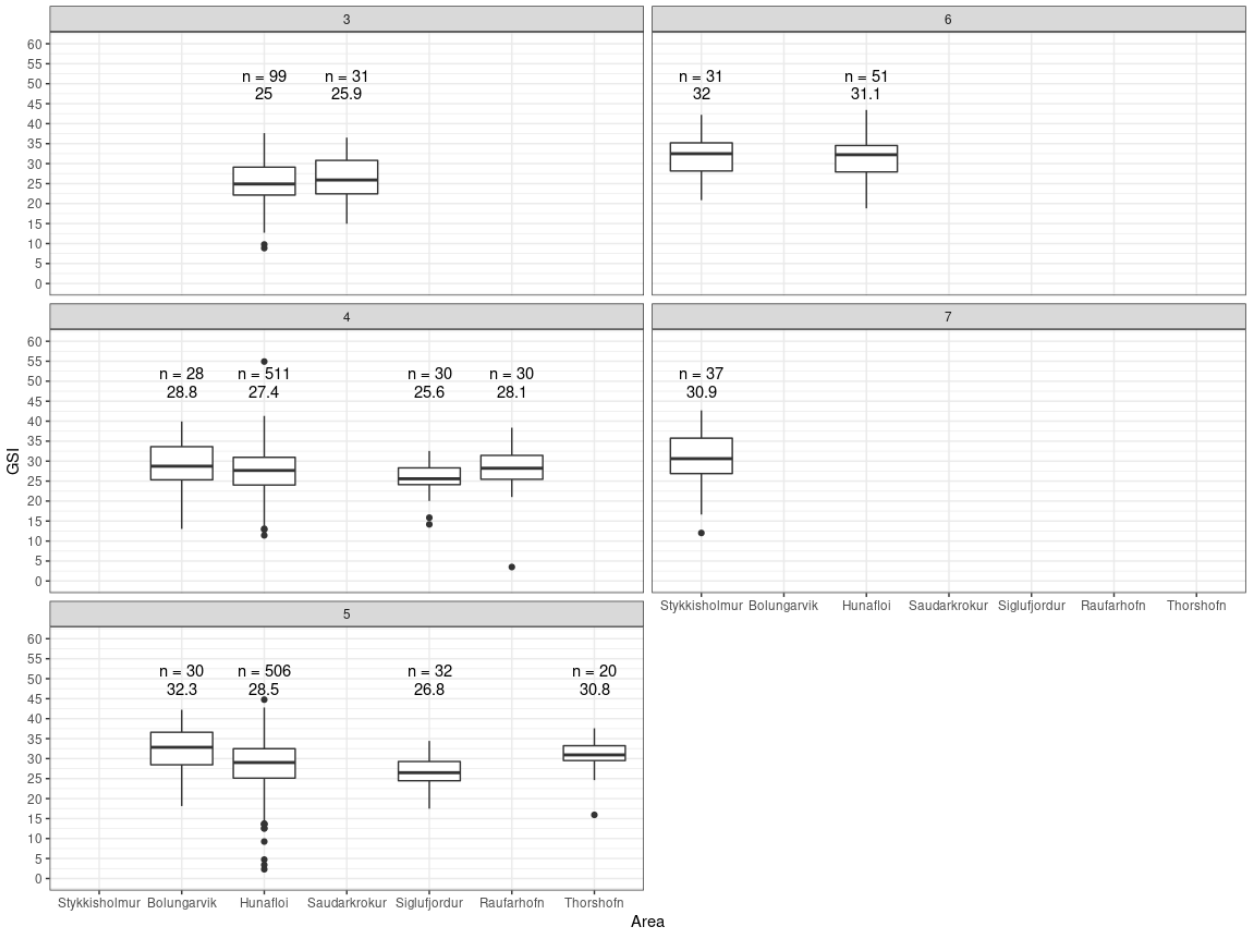


Figure 2. Range of GSI values by area and month collected 2009–2019, number of samples and average is shown.

Table 3. Estimates of kg of fish needed per barrel at different values of GSI.

GSI	Kg lumpfish per barrel
25.0	555
25.4	547
25.8	538
26.2	530
26.6	522
27.0	514
27.4	507
27.8	499
28.2	492
28.6	485
29.0	479
29.4	472
29.8	466
30.2	460
30.6	454
31.0	448
31.4	442
31.8	437

Effect on Fproxy and advised TAC

Increasing number of fish in each barrel impacts the estimated landings for the years 1985–2007. In addition, we have begun to account for the "sullprósenta" in the landings data recorded by the Directorate of Fisheries. From 2008, the weight of the landed roe was recorded as 20% lower than the actual weight to account for ovary fluid. Thus, in the present report, the landings of roe recorded by Directorate of Fisheries from 2008-2016 were multiplied by 1.25 to bring them to the original weight of roe, then multiplied by 3.4 to bring this to the weight of ungutted lumpfish. These changes have consequences for the average Fproxy for 1985–2019 which in turn has consequences for the advised TAC (Table 4). Taken together, this increased the reference value of Fproxy from 0.67 to the former value of 0.75, which would result in a corresponding increase in advised TAC to 5200 tonnes for the 2020 female lumpfish season.

Table 4. The effect of estimated amount of lumpfish needed to fill a barrel on the average Fproxy for 1985–2019 and the resultant advice for a biomass index of 6934. The value 6934 is based upon a 70/30 weighting of the current (2020) and previous years (2019) female lumpfish biomass index from the ground fish survey (MFRI/Hafró (2020)).

Kg lumpfish per barrel	Average Fproxy	Advice (tonnes)
542	0.819	5679
535	0.812	5630
528	0.805	5582
521	0.798	5533
514	0.791	5485
507	0.784	5436
500	0.777	5388
493	0.770	5339
486	0.763	5291
479	0.756	5242
472	0.749	5194
465	0.742	5145
458	0.735	5096
451	0.729	5055
444	0.722	5006

Discussion

In the previous analysis, that described in Kennedy and Jónsson (2017), two errors occurred:

- A typo in a script resulted in incorrect filtering which led to the higher conversion factor.
- Incorrect filtering which led to the underestimation of the roe landed by several boats.

The impact of the first filtering was small and had an insignificant impact on the estimations, correcting the error increased the kg of fish per barrel by ~1kg. Correction of the second error had a greater influence and led to an increase in the estimated amount of roe in a barrel, from 427 to 455 kg, when using a GSI value of 30.5%.

Revision of the GSI value also affected the final value of fish per barrel and the trial of different values shows that the result is sensitive to this value. Data collected from the fishery show that

GSI is variable from area to area and between months and that an average value of 30.5% for the fishery is unlikely. The variation in GSI is greater between the catches of different boats than within the catch of single boats, thus to get an accurate picture of GSI from the fishery, measurements need to be taken from many boats.

Our final values still differ from the values supplied from one producer of lumpfish roe in Iceland (Axel Helgason, pers. comm.). The fish from the producers had a an average GSI of 26.4%, this is in the lower range of GSI values seen in the fishery. The fish from the producer were caught in April, and the GSI increases from month to month. From 1980–1997, the peak of the fishery occurred in mid May, whereas from 1998, it would peak in the beginning of May (Kennedy and Ólafsson (2019)), thus fish would tend to be caught later in the season than they do currently, thus, there would have been a higher average GSI value than currently.

In Martinsdóttir (1980), it is reported that an average of 150 kg of fresh roe is needed for each barrel, but they also report that the average GSI is 31.4 (weighted average of reported values), this would equate to 512 kg of fish per barrel. The GSI value from Martinsdóttir (1980) is in the upper range of GSI values from the fishery, in addition, the data from Martinsdóttir (1980) gives a higher amount of roe than indicated from the logbook data and from the above mentioned producer of roe. This indicates some variability between producers and(or) time. Thus values, for the amount of roe needed for each barrel, and the amount of roe in a fish, which are representative of the whole fishery/industry are needed to get an accurate picture of the weight of fish needed to fill one barrel of roe. The present study achieves this in that it takes data from many fishers/fishing companies over a 20 year period so it should be representative of the industry during this period.

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