

# ICELAND SCALLOP - HÖRPUDISKUR

## *Chlamys islandica*

### INTRODUCTION

Iceland scallop (*Chlamys islandica*) has been fished in several fjords and bays around Iceland since 1969 when the fisheries started in Ísafjarðardjúp with 400 tonnes caught. In the following year fishery started in Breiðafjörður which has been the major fishing area ever since. From 1970 until the closure of the fisheries in 2003, 254 thousands metric tonnes were landed from that region (Jónasson, 2007). Landings from other areas have been much lower with 18 and 14 thousand tonnes landed from Húnaflói and Ísafjörður, respectively. This report will focus only on the stock in Breiðafjörður, as no commercial fishing has taken place in other areas since 2002 (Figure 1).

The decline of the stock in Breiðafjörður between 1999 and 2003, which led to the closure of the fishery is believed to be caused by several factors (Jonasson, et al. 2007). The fishable stock consisted of few year classes and recruitment was scarce. High natural mortality caused by protozoan parasites (gray meat) was evident on all grounds, with annual mortality ratio as high as ~40 % in the main fishing ground in the southern part of the fjord. The intensity of the mortality increased with the size of the scallop and was most pronounced in the fishable part of the stock (>60 mm). Warmer waters and low levels of phytoplankton in addition to the disease caused general poor condition and smaller sizes of muscle and gonads. Total fishing mortality was also high and in combination with the above factors led to the collapse of the stock. During this period but also earlier there was a reduction in the distributional areas of the stock especially in the outer part of the fjord (Jónasson, 2007). In recent years infection levels have been low and muscle condition good.

### COMMERCIAL FISHING

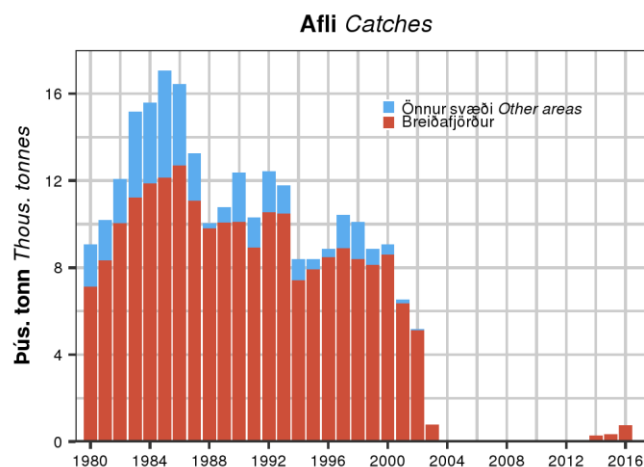


Figure 1. Total catch of Iceland scallop in Iceland and within Breiðafjörður.

Mynd 1. Heildarafli hörpudisks og afli innan Breiðafjarðar.

No fishery for Iceland scallop has been conducted in Breiðafjörður since 2003, with the exception of an experimental fishery during the last three winters (Table 1). The experimental fisheries are covered later in this report.

At the start of the fisheries in the 1970s, the catch was between 2 000 – 4 000 tonnes but reached over 10 000 tonnes in 1982 (Figure 1). The catch was greatest in 1986 when 12 700 tonnes were fished. During the period from 1996 – 2000 the average catch in Breiðafjörður was around 8 500 tonnes per year. The catch declined to 4 500 tonnes in the fishing year of 2002/03, until the fishery was closed (Table 1).

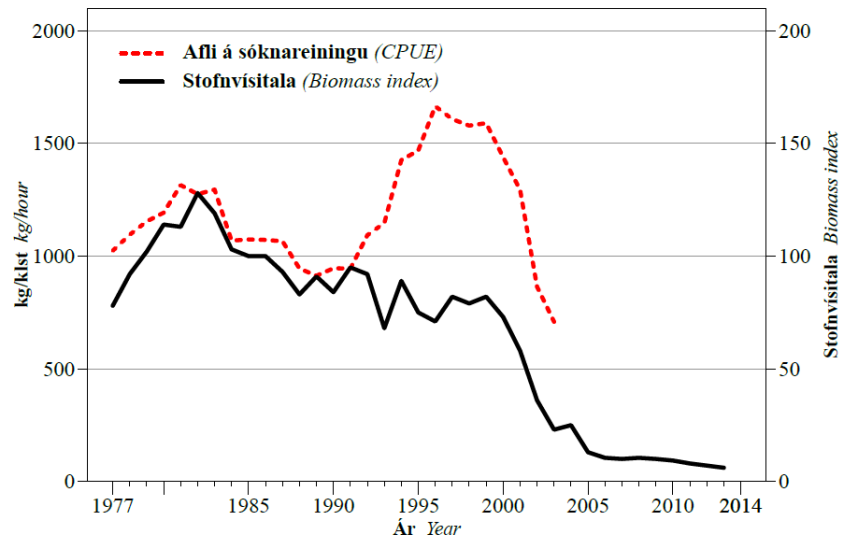


Figure 2. CPUE (kg / hour) and scallop biomass index from dredge survey in Breiðafjörður.

Mynd 2. Afli á sóknareiningu (kg / klst) og lífmassavísitala hörpudisks (mæling með plóg) úr Breiðafirði.

Catch per unit effort (CPUE, standardized to one dredge) pooled for all areas in Breiðafjörður, was relatively stable, during the period 1986–1990, but increased considerably from 1991 to 1996 (Figure 2). During the years 1996 – 1998, it was high, but it then declined sharply from 1998 to 2003. The increase in CPUE in the early 1990s coincided with changes in the scallop fishing gear, when the fleet changed from sledge dredges to the more efficient roller dredges. The decline coincided with drop in the survey index.

## SURVEY INDICES

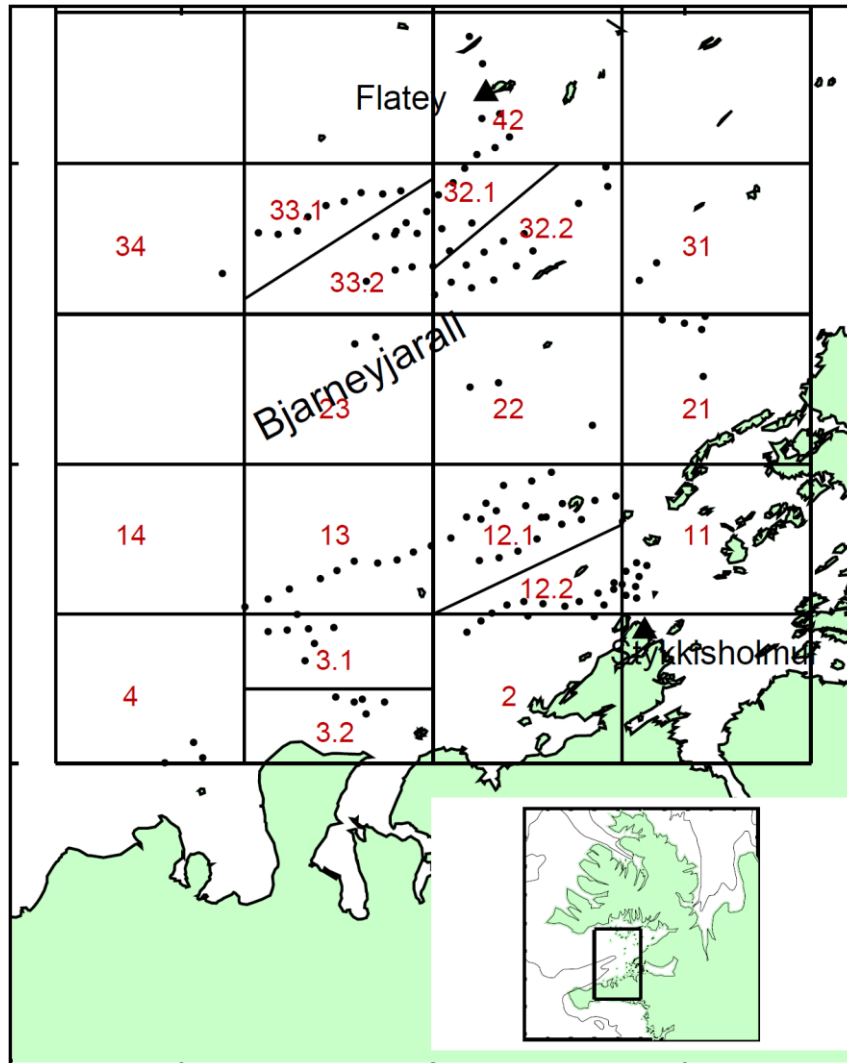


Figure 3. Overview of the dredge survey tows (dots) in Breiðafjörður, red numbers area the subareas used and the boxes the outlines of them. The town of Stykkishólmur and Flatey are marked with triangles.

Mynd 3. Yfirlitskort af stöðvum (punktar) úr plóg-leiðöngnum í Breiðafirði. Reitaskiptingin táknar undirsvæði sem notuð eru við stofnstærðarútreikninga (rauð númer). Stykkishólmur og Flatey eru merkt inn á kortið með þríhyrningum.

## DREGDE SURVEY 1977-2013

Biomass survey with dredge was conducted by the Marine Research Institute (MRI) in Breiðafjörður almost from the onset of the fishery until 2013. In each survey, usually some 120 fixed standardized tows were taken. However, in later years fewer stations were occupied with shorter tows. In 2012 the southern and in 2013 the northern part of the fjord were surveyed. Prior to 1997, a 470 kg sledge dredge 1.5 m wide was used. In 1998, the sledge dredge was substituted with an 835 kg roller dredge 1.2 m wide (Gujarro Garcia, 2006). Both dredges were equipped with 60 mm steel rings. Earlier experiments on the sledge dredge had revealed that its efficiency was 20% ( $e = 0.2$ ). Comparative experiments between the roller and sledge dredge showed that the catch of scallops in roller dredge tows was on

average 30% higher than in sledge tows, so  $e$  for the roller dredge was set at 0.26 ( $n = 46$ , MRI, unpublished data).

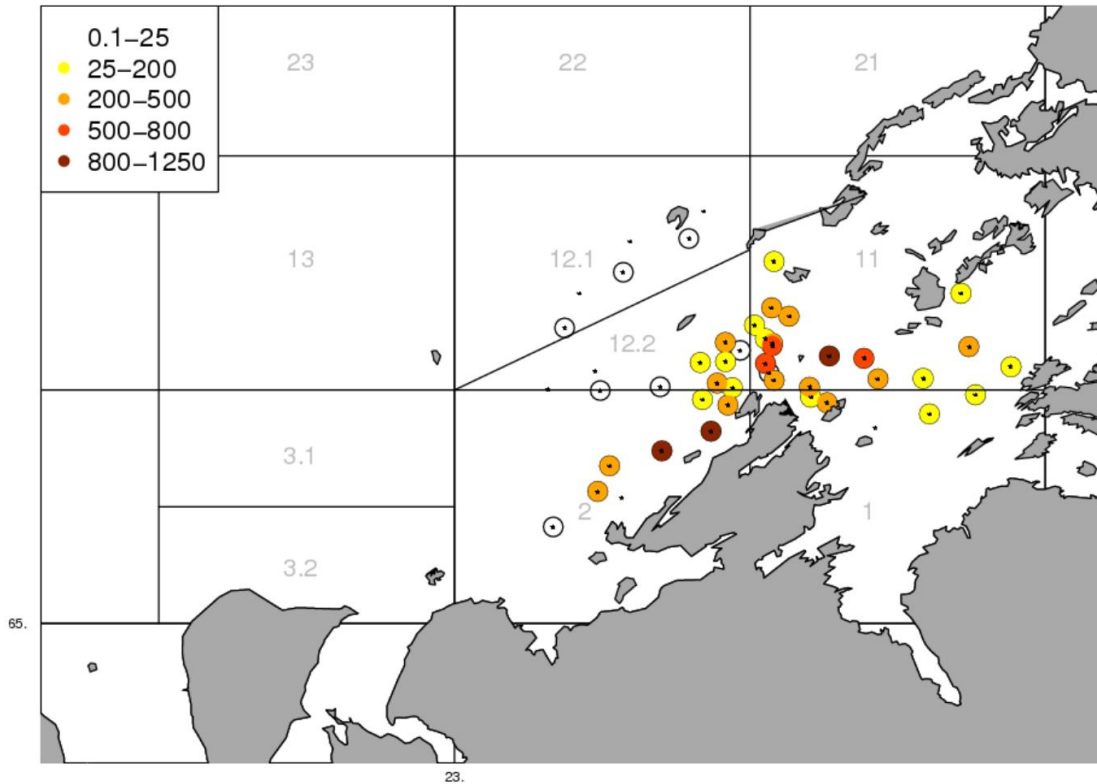


Figure 4. Catch of scallops (kg) per towed mile during dredge survey of the southern part of Breiðafjörður in 2012. Small dots represent stations with zero scallops but rings show stations with scallop catch according to the color scale. Black grids are the subareas marked with grey numbers.

*Mynd 4. Afli hörpudisks (kg) á hverja dregna sjómílu í plógleiðangri í suðurluta Breiðafjarðar árið 2012. Litlir punktar sýna stöðvar með engum hörpudisk og litir innan hringja tákna magn skv. kvarða. Reitaskipting er sýnd og heiti reita (gráar tölur).*

Each survey tow covered approximately 0.4 nautical miles and the tow speed was 4 knots. For each tow, the total catch was weighed and a random subsample of approximately 25 kg taken. In each subsample, all live scallops were weighed and the height of about 100 specimens was recorded. The remaining scallops were counted and the numbers of cluckers (dead scallops attached on their hinges, both damaged and whole shells) were recorded.

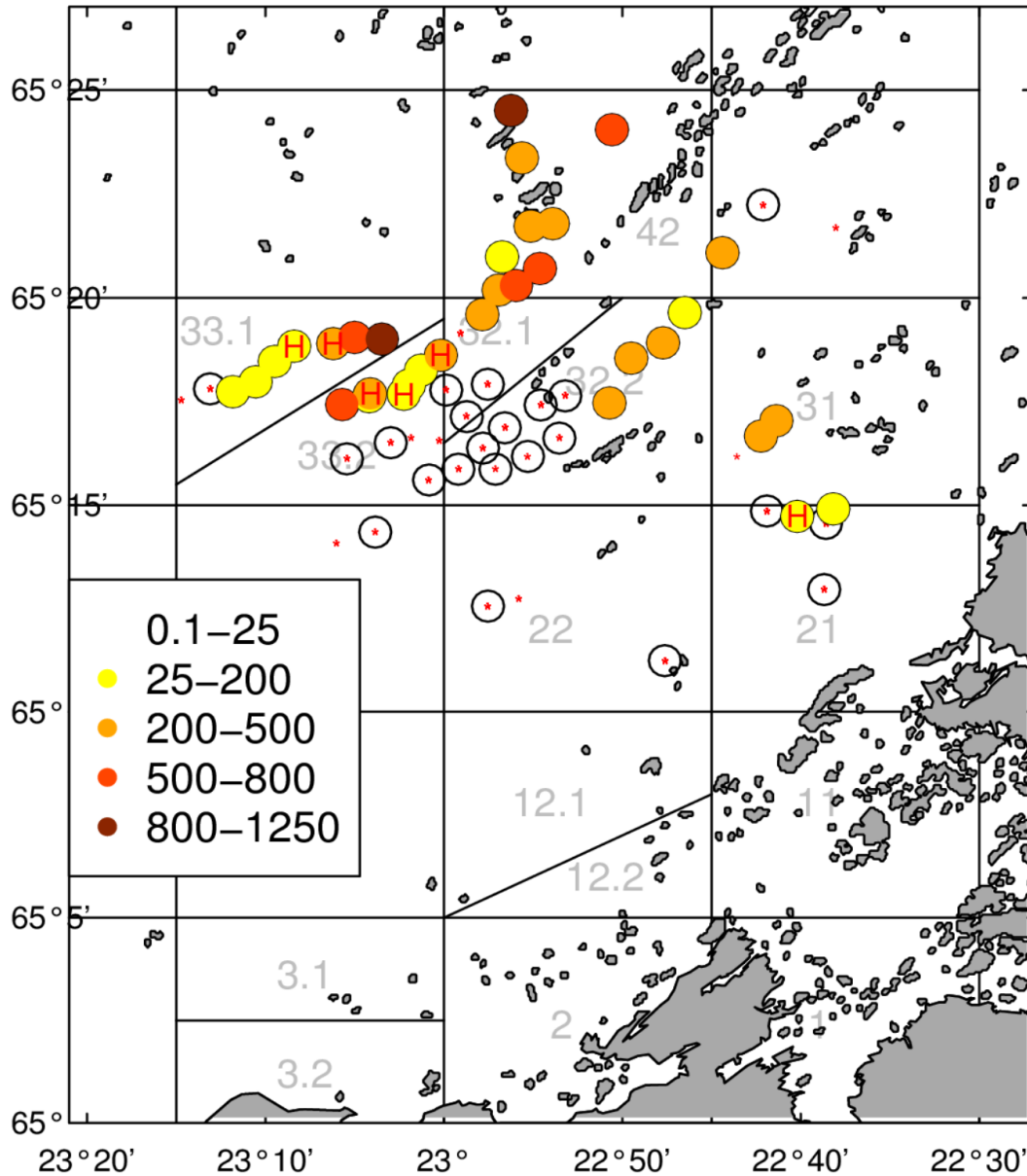


Figure 5. Catch of scallops (kg) per towed mile during dredge survey of the northern part of Breiðafjörður in 2013. Small dots represent stations with zero scallops but rings show stations with scallop catch according to the color scale. Black grids are the subareas marked with grey numbers. Red H marks stations with more than 10 % cluckers/scallop ratio.

*Mynd 5. Afli hörpudisks (kg) á hverja dregna sjómílu í plógleiðangri í norðurhluta Breiðafjarðar árið 2013. Litlir punktar sýna stöðvar með engum hörpudisk og litir innan hringja tákna magn skv. kvarða. Reitaskipting er sýnd og heiti reita (gráar tölur). Rautt H stendur fyrir stöðvar með meira en 10% af skeljum á hjör.*

The survey area was divided into subareas, based on a grid of squares of equal size. Squares positioned on the main scallop grounds were split into two subareas (Figure 3). The total region fished was divided into a northern area (subareas 31–42), north of Bjarneyjaáll (a trench bisecting the fjord from west to east), and a southern area (subareas 2–14), south of the trench. The size of the scallop beds in each subarea was based on estimates conducted at the beginning of the surveys in the early 1970s, where the total area was estimated to be 72 km<sup>2</sup>. See further information of the calculation of the stock index in Jonasson, *et al.* (2007).

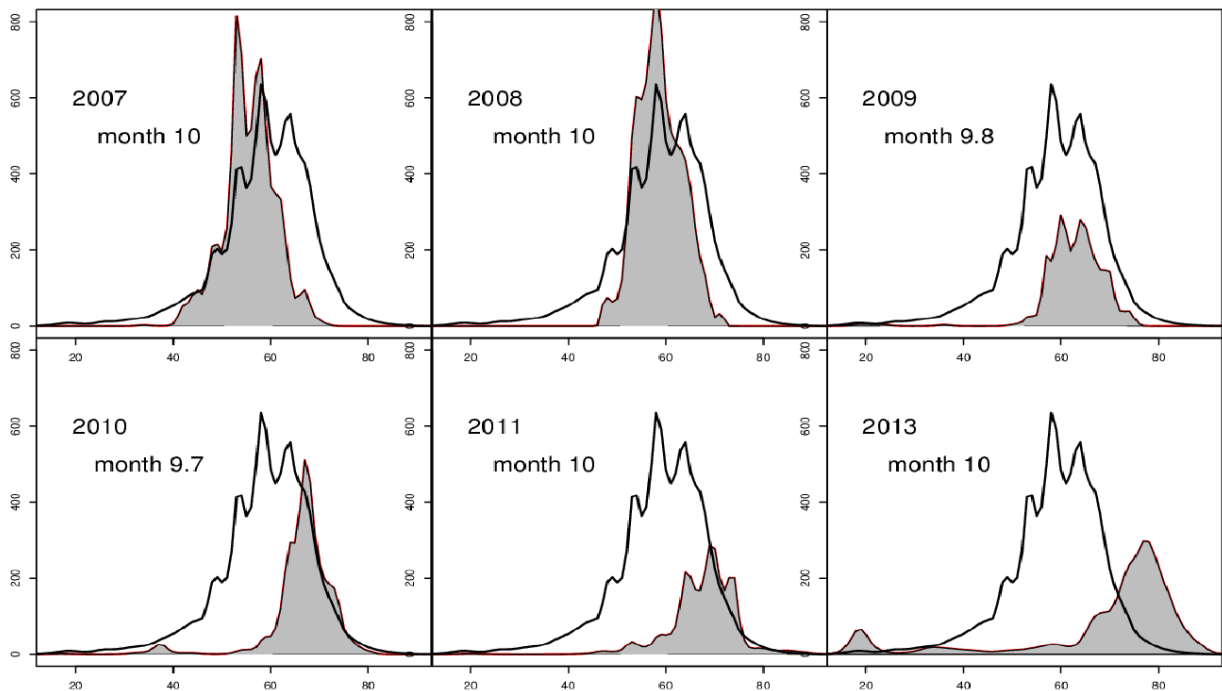


Figure 6. Frequency distribution of scallop shell height (mm), mean numbers per towed mile, from subarea 33.1 (south of Oddbjarnarsker) during 2007 – 2011 and in 2013. Grey filled area is the distribution of individual year and the black line is the mean of 1993 – 2013.

*Mynd 6. Hæðardreifing (mm) hörpudisks frá reit 33.1 (suður af Oddbjarnarskeri) frá 2007 – 2011 og 2013. Tölurnar eru meðalfjöldi skelja á togmílu. Gráa svæðið er umrætt ár og svartar línur eru meðaltal árunna 1993 – 2013.*

The stock index of Iceland scallop in Breiðafjörður was relatively stable from 1993 to 1999, but it declined sharply from 2000 to 2003. In 2003 (23 000 t), it was at a historically low level or at 30% of the average stock size during the 1990s. This declining trend continued until 2006 and since then the index slowly decreased until the last value of combined surveys of 2012 and 2013 (Figures 2, 4 & 5).

The trend in shell height frequency has been that the ratio of scallop above 65 mm has increased and in 2013 there was high proportion of scallops above 80 mm (Figure 6). Small scallops were hardly seen until the year 2012 in the southern part of the fjord (Figure 7). Year-classes from 2004 – 2009 are poorly visible in the stock.

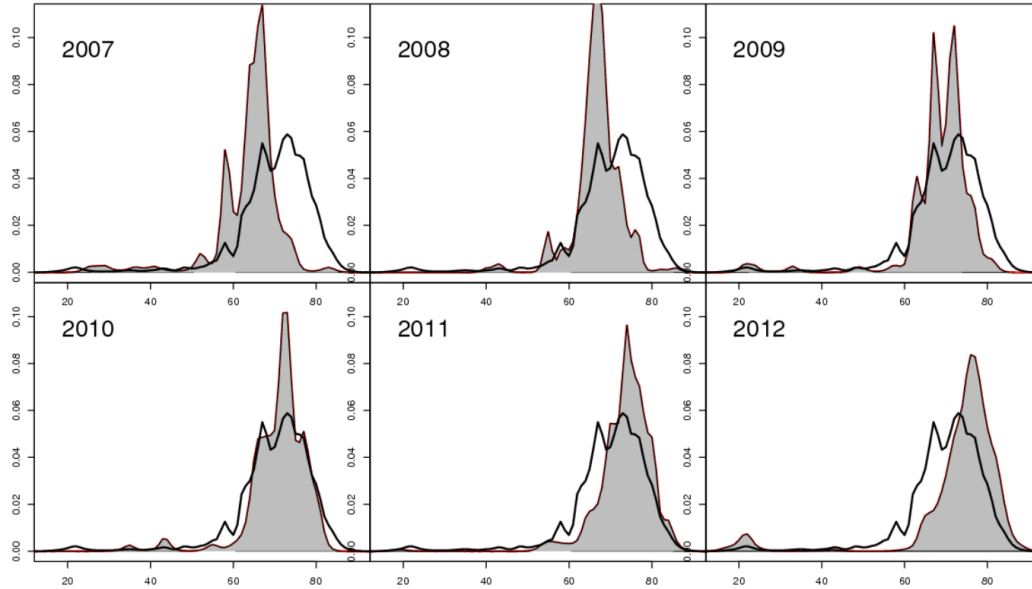


Figure 7. Relative size frequency distribution (%) of scallops from subarea 2 (west of Stykkishólmur) during 2007 – 2012. Grey filled area is the distribution of individual year and the black line is the mean of 1993 – 2012.

*Mynd 7. Hlutfallsleg hæðardreifing (mm) hörpudisks frá reit 2 (vestur af Stykkishólmi) frá 2007 – 2012. Gráa svæðið er umrætt ár og svartar línur eru meðaltal árunna 1993 – 2012.*

## CAMERA SURVEY 2014 – 2016

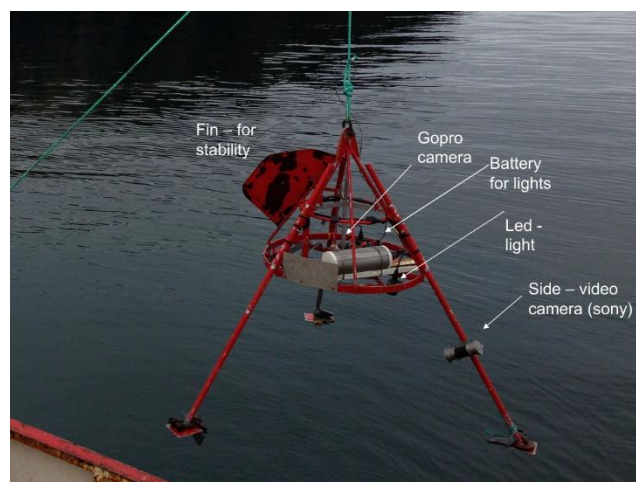


Figure 8. The first camera drop frame used for mapping scallop populations in Breiðafjörður.

*Figure 8. Mynd af fyrsta þrífótnum sem notaður var við kortlagningu hörpudisks í Breiðafirði.*

A drop frame camera survey has been conducted on scallop grounds in Breiðafjörður for the last three years (Figure 8). Stokesbury (2012) discussed some of the advantages that the video/camera survey technique has over conventional dredge survey and states that the new method is a direct measure of absolute abundance versus a semi-quantitative one. It is more precise, rather fast and nonintrusive. That are the main reasons why the MFRI is exploring to change from the dredge-to a camera survey.

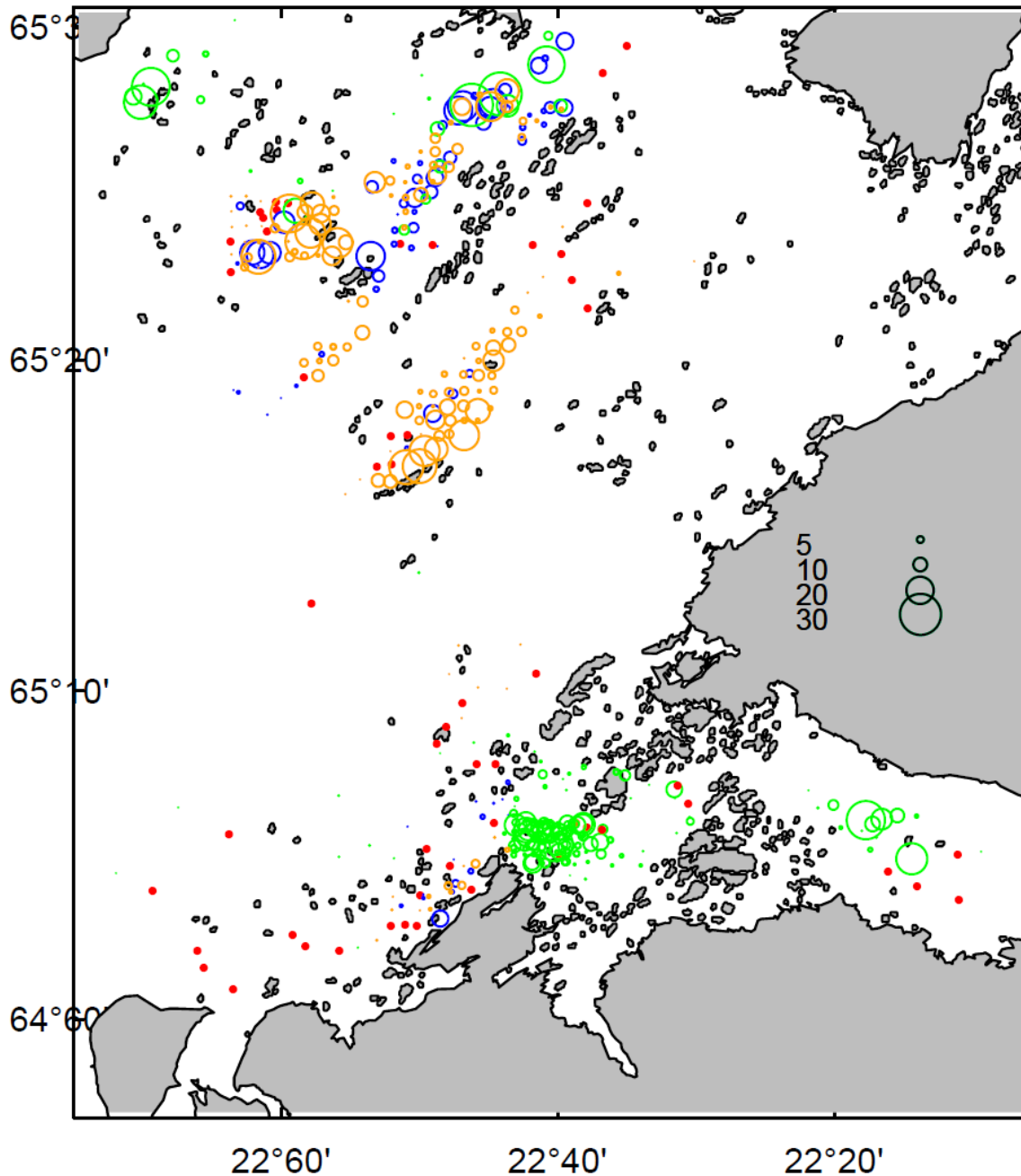


Figure 9. Camera surveys stations in Breiðafjörður, during 2014 (green), 2015 (blue) and 2016 (orange). The size of the circles represent the number of scallops ( $m^2$ ). Red dots are stations with no scallop.

Mynd 9. Stöðvar í myndavélaleiðöngnum árin 2014 (grænt), 2015 (blátt) og 2016 (appelsínugult). Stærð hringja táknar fjölda hörpudiska ( $m^2$ ) skv. kvarða. Rauðir punktar eru þar sem enginn hörpudiskur sást.



Several tows with dredge are also carried out to get information on shell height and biological samples. Ten camera “drops” are completed on each station and the general rule is to count every other drop or 5 drops in total. In the camera survey all animals are counted, and the area of the image is known.

In April 2014, a pilot camera survey focused mainly on the Breiðasund area in the southern part of the fjord, where experimental fishing had been planned. (Figure 9). There were also stations on conventional fishing grounds in the southern area, Sundin (subarea 12.2), and the area between Höskuldsey and Elliðaey (subarea 12.1). In total 146 station were completed. New grounds and grounds that were not covered with the older dredge survey were also surveyed. Those were in Hvammsfjörður, south of Skálmarnes, west of Látralönd and around Sauðeyjar in northwestern part of the fjord. Large numbers of scallops were found on many of the “new” grounds. Another survey was conducted in December 2014 and covered the area that was fished in the experimental fishing in Breiðasund.

During autumn of 2015 and 2016 two further camera surveys were carried out mainly focusing on the northern part of Breiðafjörður (Figure 9). The areas covered in the northern part in 2015 were areas where experimental fishing was pre-planned, based on information from the 2014 survey. Further areas west of and around Flatey were also covered in 2015, with several stations of high scallop abundance.

In 2016, several stations were carried out in southern Breiðafjörður west and around Stykkishólmur where scallops were found to be present in rather low abundance. The stations in the experimental fishing sites in the northern part were revisited, and also a better coverage was made of areas west of Flatey where there had been planned fishing experiments. The inlet Bjarneyjaflói (SE of Flatey) was thoroughly surveyed, where scallops were found in high densities on several stations. Few stations were east of that area with few alive scallops found, but usually the substrate was also unfavourable or too muddy. Bottom images from the surveys can be found here: <http://www.hafro.is/~jonasp/>

## EXPERIMENTAL FISHERIES

In the autumn of 2014 an experimental fishery was conducted in Breiðasund in the southern part of Breiðafjörður, yielding a catch of 281 tonnes. The experimental fishery is a joint program by the MFRI and local fishermen which also supply boat for the camera survey that takes place prior to the fishing activities in the autumn. The dredge used is lighter than the one that was used when the fishery was still open, but further modification and development of harvest technique is warranted. The fishing experiments are re-evaluated every year, but their aim is to gather data over a few years and find optimal harvest ratio for the stock and management strategy. Each year there are certain limits set for each region and the aim is to fish with different harvest ratios; 4%, 8% or 12%. Within each region the catch and effort is recorded on ~1.08 km<sup>2</sup> rectangles. The actual fishable area within each region was rather poorly known, but VMS data are gathered during the fishing activities. The original abundance estimate in each region will therefore be adjusted a posteriori.

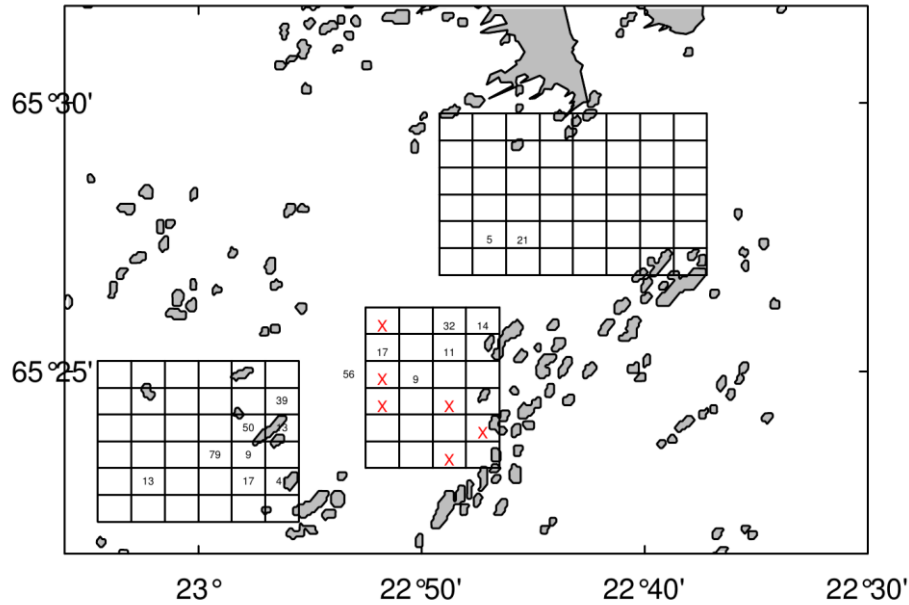


Figure 10. Catch (tonnes) in northern areas during winter of 2016/2017; west of Flatey region on the left, Látralönd region on the lower right and Skálmarnes region on the upper right. Red crosses mark rectangles that are not fished.

Mynd 10. Yfirlit yfir afla (tonn) á norðursvæði veturinn 2016/2017. Svæði vestur af Flatey til vinstri, Látralöndsvæði til hægri að neðanverðu og Skálmarnessvæði til hægri að ofanverðu. Rauðir krossar tákna reiti sem ekki var veitt úr.

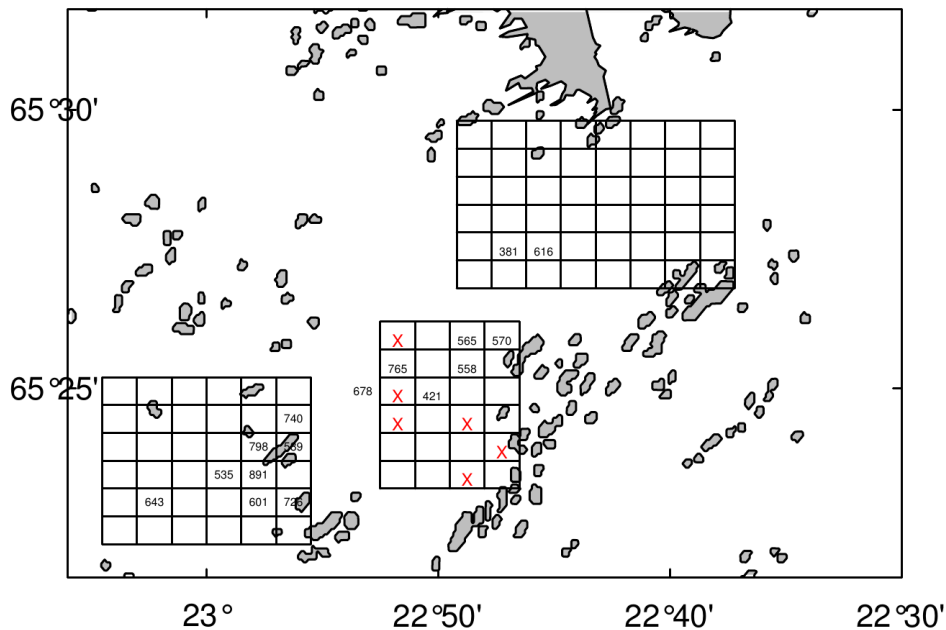


Figure 11. CPUE (kg per nautical mile) in northern areas during winter of 2016/2017, west of Flatey region on the left, Látralönd region on the lower right and Skálmarnes region on the upper right. Red crosses mark rectangles that are not fished.

Mynd 11. Yfirlit yfir afla á sóknareiningu (kg per sjómílu) á norðursvæði veturinn 2016/2017. Svæði vestur af Flatey til vinstri, Látralöndsvæði til hægri að neðanverðu og Skálmarnessvæði til hægri að ofanverðu. Rauðir krossar tákna reiti sem ekki var veitt úr.

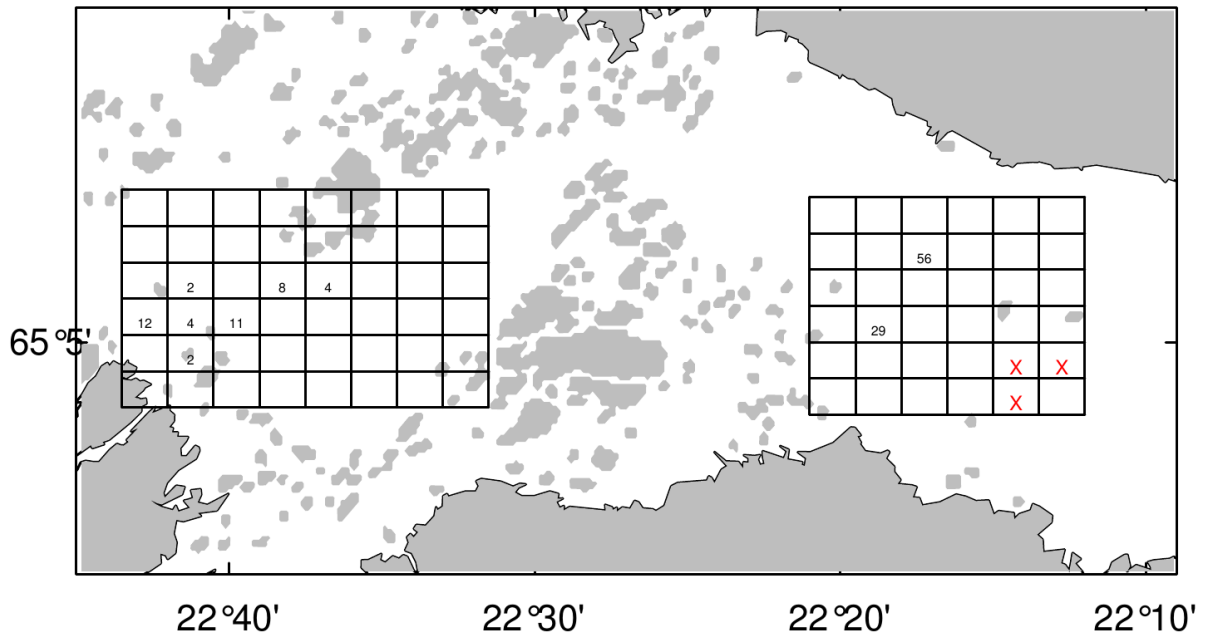


Figure 12. Catch (tonnes) in southern areas during winter of 2016/2017, Breiðasund region on the left and Hvammsfjörður region on the right. Red crosses mark rectangles that are not fished.

Mynd 12. Yfirlit yfir afla (tonn) á suðursvæði veturinn 2016/2017. Breiðasund til vinstri og Hvammsfjörður til hægri. Rauðir krossar tákna reiti sem ekki var veitt úr.

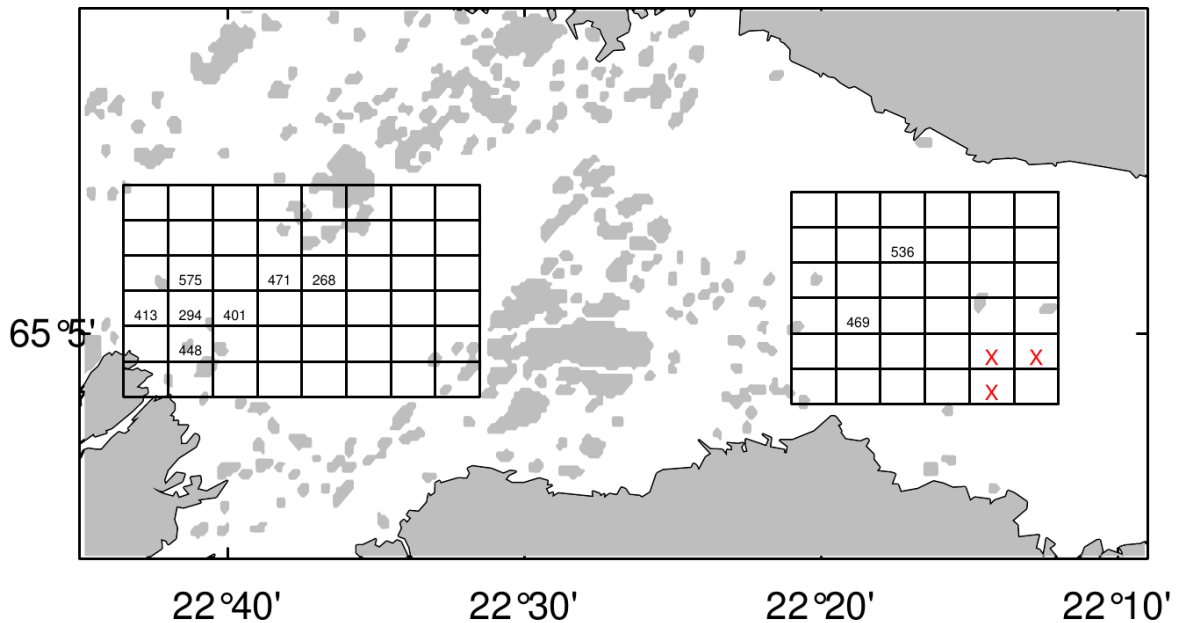


Figure 13. CPUE (kg per nautical mile) in southern areas during winter of 2016/2017, Breiðasund region on the left and Hvammsfjörður region on the right. Red crosses mark rectangles that are not fished.

Mynd 13. Yfirlit yfir afla á sóknareiningu (kg per sjómílu) á suðursvæði veturinn 2016/2017. Breiðasund til vinstri og Hvammsfjörður til hægri. Rauðir krossar tákna reiti sem ekki var veitt úr.

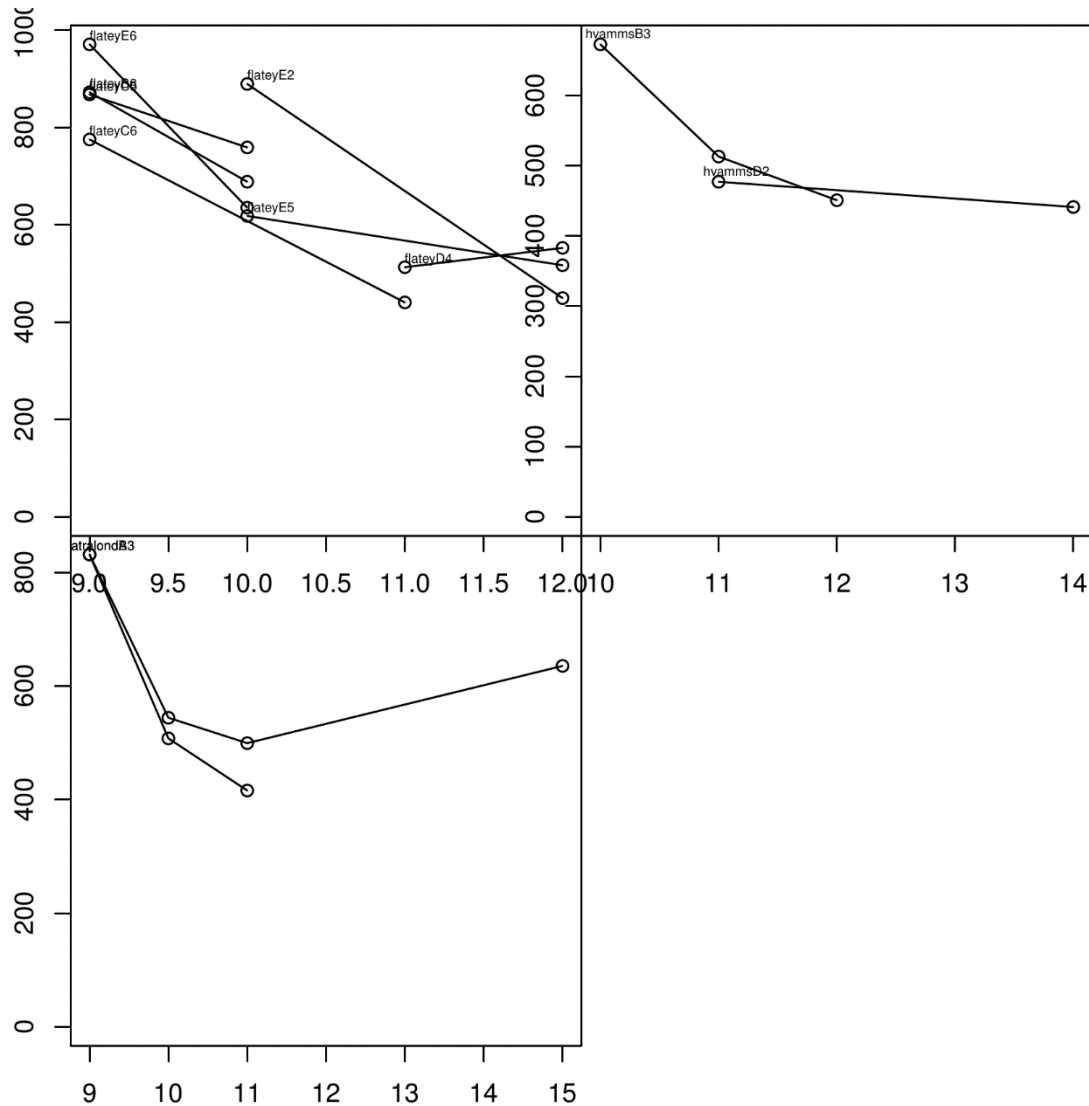


Figure 14. Development in CPUE (kg per towed mile) from September (9) to March (15) during the winter of 2016/2017. Rectangles within regions are plotted (a minimum of 2 tonnes caught each month). Upper left, west of Flatey, upper right, Hvammsfjörður, lower left, Látralönd.

Mynd 14. Þróun í afla á sóknareiningu (kg á togmílu) veturinn 2016 /2017 eftir mánuðum frá september (9) til mars (15). Sýnd eru undirsvæði þar sem að lágmarki 2 tonn voru veidd hvern mánuð. Svæði vestur af Flatey eru vinstra megin að ofanverðu, Látralönd vinstra megin að neðanverðu og Hvammsfjörður hægra megin.

The experimental fishery continued in the winter of 2015/2016, when 635 tonnes were caught on four defined fishing grounds outside of the traditional Iceland scallop grounds in Breiðafjörður. During the winter of 2016/2017, 575 tonnes were caught on five different regions in the fjord. The original plan for the winter of 2016/2017 was to harvest in total 950 tonnes on all regions with two boats (Table 2). In practice only one boat was active and the fishermen went on strike for 10 weeks (December - February).

In the three northern regions in 2016/2017, 260 tonnes were caught in areas west of Flatey, which was roughly according to plan, but the spread of activities over the region was less than anticipated (Figure

10). On eight rectangles between 13 and 79 tonnes were fished and CPUE (kg per towed mile) was between 535 -740 kg/nm (Figure 11). Around 155 tonnes were caught in Látralönd region, on six rectangles (9 – 56 tonnes), which was less than the original plan of 250 tonnes. CPUE was between 421 – 795 kg/nm. In the northernmost region of Skálmarnes, only 26 tonnes out of 200 planned were caught, on two rectangles (5 and 26 tonnes) with CPUE of 381 and 616 kg/nm.

In the two southern regions, 85 tonnes were caught in Hvammsfjörður, close to the planned 100 tonnes (Figure 12). Fishing activities were recorded on two rectangles, 56 and 29 tonnes, with CPUE of 536 and 469 kg/nm (Figure 13). In Breiðasund, only 31 tonnes out of 150 tonnes planned, were caught. The activity was recorded on 7 rectangles (2 – 12 tonnes) and CPUE was between 268 – 575 kg/nm.

Development in CPUE by months during the winter of 2016/2017 was monitored (on rectangles with a minimum of 2 tonnes caught each month). As expected the CPUE decreased but the rate differed between regions with less drop in Hvammsfjörður compared to the regions west of Flatey and Látralönd (Figure 14). The proposed harvest ratio in Hvammsfjörður was 4% compared to 8 - 12 % in Látralönd and Flatey, but those values will be reevaluated with more data.

Further analyses of the data gathered from the first years of experimental fisheries will be published in a special report.

## ADVICE

Throughout the period 1993–2000, the total allowable catch (TAC) in Breiðafjörður was relatively stable at about 8 000–8 500 tonnes (Table 1). At that time, the recommended annual TAC was 10% of the total estimated biomass from dredge surveys; since 1994, the national TAC and the landings have been in accord with the recommendations. Between 2003 and 2013 the MRI advised that no fishery should be conducted on scallop grounds in Breiðafjörður. In 2014 the advice was no fishery on conventional grounds, but small scale fishing experiment were allowed in areas outside the limits of the dredge survey. The same advice was given in 2015 and 2016 and fishing trials continued.

MFRI advises that when the precautionary approach is applied, no fishery, apart from the experimental fishing, for Iceland scallop should be conducted on fishing grounds in Breiðafjörður for the fishing year 2017/2018.

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Stokesbury, K. D., 2002. Estimation of Sea Scallop Abundance in Closed Areas of Georges Bank, USA. *Transactions of the American Fisheries Society* 131:1081–1092.

**Table 1.** Recommended TAC of Iceland scallop within Breiðafjörður, recommended TAC in Iceland, TAC in Breiðafjörður, catch in Breiðafjörður, total catch in Iceland. Since 1992 the TAC was for following quota year. \*Experimental fisheries.

*Tafla 1. Ráðgjöf fyrir hörpudisk í Breiðafirði, heildarráðgjöf fyrir hörpudisk, aflamark í Breiðafirði, heildaraflamark, afli í Breiðafirði og heildarafli hörpudisks. Síðan 1992 er ráðgjöfin fyrir fiskveiðiárið. \*Tilraunaveiðar.*

Year	Rec. Breiðafj. TAC	Rec. N. TAC	TAC Breiðafj.	C. Breiðafj.	Catch Total
1980	-			7 100	9 100
1981	-			8 300	10 200
1982	-			10 000	12 100
1983	-			11 200	15 200
1984	11 000	14 100	11 000	11 900	15 600
1985	11 000	15 400	12 000	12 100	17 100
1986	10 000	14 200	12 000	12 700	16 400
1987	11 000	14 500	11 000	11 000	13 300
1988	10 000	13 500	10 000	9 800	10 100
1989	9 000	12 500	10 000	10 100	10 800
1990	10 000	13 500	10 000	10 100	12 400
1991	9 000	12 500	9 000	8 900	10 300
1992	8 500	11 200	8 500	10 600	12 400
1992/93	8 500	11 500	8 500	10 300	11 600
1993/94	8 000	10 100	9 800	8 000	9 400
1994/95	8 500	10 200	8 200	8 800	9 400
1995/96	8 000	9 500	8 000	7 400	8 000
1996/97	8 000	9 300	8 000	8 400	9 200
1997/98	8 000	9 300	8 000	8 900	10 600
1998/99	8 500	9 800	8 500	8 100	9 100
1999/00	8 500	9 800	8 500	8 700	9 200
2000/01	8 000	9 300	8 000	7 900	8 200
2001/02	6 500	6 750	6 500	6 400	6 600
2002/03	4 000	4 150	4 000	4 435	4 505
2003/04	0	0	0	0	0
2004/05	0	0	0	0	0
2005/06	0	0	0	0	0
2006/07	0	0	0	0	0
2007/08	0	0	0	0	0
2008/09	0	0	0	0	0
2009/10	0	0	0	0	0
2010/11	0	0	0	0	0
2011/12	0	0	0	0	0
2012/13	0	0	0	0	0
2013/14	0	0	0	15	0
2014/15	*	-	-	266	0
2015/16	*	-	-	634	0
2016/17	*	-	-		
2017/18	*				

**Table 2.** The scheme for the experimental fishery in Breiðafjörður by areas. Estimated initial harvest ratio. The starting proposal and the catch of each area during the following winter.

*Tafla 2. Tillögur fyrir tilraunaveiðar í Breiðafirði eftir svæðum. Metið veiðihlutfall og tillaga hvers veturs og veiði.*

Area	H. ratio	Proposed 2017	Prop. 2016	Catch 2016	Prop. 2015	Catch 2015
Hvammsfj.	4-6 %	100	100	85	80	106
Breiðasund	8 %	140	150	31		116
Skálmarnes	8 %	150	200	26	410	59
Látralönd	8 %	190	250	155	250	354
Flatey	12 %	250	250	260	-	-
Bjarneyjar	4 %	200	-	18	-	-
<b>Total</b>		1030	950	575	740	635